Burns and Decker Lakes
Draft Management Plan

PREPARED FOR:
THE LAKES DISTRICT WATERSHED ENHANCEMENT SOCIETY

PREPARED BY:
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PROVINCE OF BRITISH COLUMBIA
MINISTRY OF WATER, LAND AND AIR PROTECTION
SKEENA REGION
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2.0 Acknowledgements

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3.0 Executive Summary

The Burns and Decker Lakes watershed is located on the Nechako plateau in North-Central British Columbia. The lakes are relatively shallow, very productive, and have naturally high concentrations of phosphorus. In recent years, many watershed residents have observed increased algal and macrophyte production and a shift in fish species distribution. These are typical characteristics of lakes undergoing eutrophication. Studies suggest that land use activities in many parts of the watershed may be contributing to the water quality and eutrophication concerns in Burns and Decker lakes.

The overall goal of the lake management planning process is to create a recipe "to enhance and preserve the quality and health of the Burns and Decker Lakes watershed". This management plan marks the end of the first iteration of the process, and is intended to provide long-term direction to the Lakes District Watershed Enhancement Society as it undertakes projects to improve the quality of the watershed. To date, the planning process has opened communication links between numerous stakeholders, and has created a local awareness of lake management and watershed health.

3.1 Problems and Concerns in the Watershed

At the beginning of the management planning process, stakeholders identified six major problems in the watershed:

Cultural Eutrophication - Residents claim that water quality in the lakes is degrading as a result of land use in the watershed. Both "point" and "non-point" sources of nutrients have been implicated. They include: the Village sewage system, individual septic systems, and agricultural, forestry, commercial and residential activities in the watershed.

Aquatic Weeds - The amount of aquatic weeds (macrophytes and algae) in Burns and Decker Lakes has been steadily increasing. *Elodea canadensis* has been identified as the most widespread and problematic weed in both lakes and its distribution has now spread to include a large portion of the littoral zone (0-4m depth).

Fish Species - The lakes provide important habitat for many salmonids, but the distribution of fish species in Burns and Decker Lakes may be changing. Anecdotal evidence suggests that in the past there were many more sport fish in the lakes, and fewer coarse fish.

Social Values - The social value of Burns and Decker Lakes has declined substantially in recent years. The lakes are no longer as visually appealing, and aquatic plant growth is interfering with many recreational pursuits. Furthermore, beavers have been changing shoreline aesthetics.

Lake Levels - The future level of Burns Lake is uncertain as the Carrier-Sekani Tribal Council is investigating lake level control options for enhancing fish habitat in the Endako River. Residents are worried that if a weir is installed at the lake outlet, their properties may be subject to higher water levels, and excess nutrients may enter the lake from septic systems.

Beaver Populations - Beaver populations in the watershed are high. Dams are affecting the regularity of water flows in many of the creeks and tributaries of the watershed, and there are associated safety and aesthetic concerns.

3.2 Management Plan Goals and Objectives

To address the concerns, a series of management goals and objectives were identified:

Goal 1: Improve water quality in Burns and Decker Lakes by managing the causes of cultural eutrophication

- Objective 1.1: Reduce point source nutrient (phosphorus) inputs to Burns Lake from sewage treatment facilities
- Objective 1.2: Reduce non-point source nutrient (phosphorus) inputs to the lakes from domestic sewage systems on individual properties along the lakeshore
- Objective 1.3: Reduce non-point source nutrient (phosphorus) inputs from land use activities in the watershed

Goal 2: Restore ecosystem balance in Burns and Decker Lakes by controlling the symptoms (excessive weed growth and changing distribution of fish species) of eutrophication

- Objective 2.1: Improve sport fish habitat in the Burns/Decker Lakes watershed
- Objective 2.2: Reduce coarse fish species in the Burns/Decker Lakes watershed
- Objective 2.3: Remove excessive macrophytes (aquatic weeds) that are currently growing in Burns and Decker Lakes
- Objective 2.4: Create and implement a long-term plan to control macrophyte and algae growth in the Burns/Decker Lakes watershed
- Objective 2.5: Reduce the concentration of nutrients (phosphorus) in the lake system by reducing the amount of phosphorus dissolved or suspended in the lake water, and stored in bottom sediments

Goal 3: Maintain a quality and quantity of water in Burns and Decker Lakes that maximizes benefits for both watershed residents and aquatic life

- Objective 3.1: Establish a long-term policy or plan for the outflow of Burns Lake by deciding whether or not to artificially regulate flows
- Objective 3.2: Create and implement a beaver management program to preserve uninterrupted flows in tributary streams
- Objective 3.3: Manage water-based activities to minimize water quality degradation in the lakes
- Objective 3.4: Manage potentially harmful land-based activities to minimize pollutants entering the lake system

Goal 4: Improve the shoreline aesthetics of Burns and Decker Lakes

- Objective 4.1: Create and implement a beaver management program to protect trees adjacent to the lake

3.3 Plan Highlights

For each objective, an exhaustive list of management options was compiled. The advantages and disadvantages of many of the options were summarized, and a panel of key stakeholders participated in a consensus-building exercise to judge the overall merit of each option. The panel considered a set of five criteria, which are of equal importance when evaluating management options: social acceptability, financial cost, environmental concerns, long-term sustainability, and effectives. At the end of the session, the panel decided that some of the management options were realistic and likely to be effective in the Burns/Decker Lakes watershed. Results from the panel make up the core recommendations in this management plan; some highlights are summarized below.

In the short-term:

- The Village of Burns Lake's sewage system could be upgraded to include a phosphorus-removal stage, which will substantially reduce phosphorus loadings to the lake; a 10-year plan for this already exists, with completion expected sometime in 2003.
- Potable water supplies are needed in outlying subdivisions, and the LDWES could advocate for these to be installed.
- Best Management Practices should be encouraged for all land use activities in the watershed. It is necessary to achieve an awareness of aquatic ecosystem issues as they pertain to these activities; this can be achieved through LDWES participation in numerous meetings and planning initiatives.
- A volunteer monitoring program is needed to collect tributary and lake data.
    - The program should focus initially on collecting nutrient and general water quality data, with an emphasis on phosphorus budgeting.
    - An aquatic plant inventory also needs to be conducted to map aquatic weed occurrences in the watershed and determine the extent of the problem. *Elodea canadensis* biomass should be estimated and monitored.
- The LDWES should undertake activities to improve general public awareness of the following:
    - Onsite septic systems and their impacts on the aquatic environment
    - Fisheries issues in the watershed
    - Lake values and human (land use) influences on lake quality
    - Beaver management, and current policies and mechanisms to deal with beaver concerns
- Coarse fish derbies can be held to remove some of the coarse fish from the lakes.
- The Village of Burns Lake could be encouraged to install a benthic barrier on Radley Beach to control aquatic weeds, and its effectiveness should be monitored. Other low-tech means of weed control such as hand cutting or pulling could also be encouraged.
- The Carrier-Sekani Tribal Council's final weir proposal needs a thorough technical review once it is complete. The LDWES should promote, and where possible, coordinate such a review so that decisions regarding its technical validity can be made quickly.
- (In the short or long term) A Memorandum of Understanding could be developed with the Ministry of WLAP, and a beaver control program could be implemented. The program may include the following components:
    - Increased trapping by registered trappers through an incentive program
    - Beaver dam destruction (by hand or with small machinery)

In the long-term

- Improved sewage services are needed for outlying subdivisions, and the LDWES could advocate for these to be installed.
- A comprehensive fisheries assessment needs to be conducted so that a management strategy can be developed. Once this is complete, numerous projects

can be initiated to improve the quality and quantity of sport fish habitat in the watershed.

- The volunteer monitoring program (described above) could be expanded to include collecting sediment delivery data, and other water quality measurements in tributary streams. The sediment core samples in the Ministry of WLAP freezer should also be sent to a lab for analysis. This will provide valuable information, and contribute to an understanding of the relative influences of natural and land-use related nutrient inputs to the lakes.
- An Integrated Aquatic Plant Management Plan could be created for the watershed to provide guidance for future activities relating to aquatic weeds.

4.0 Lake Management Planning Process – Goal Statement and Purpose

4.1 Overall Goal

The overall goal of the lake management planning process is to create a recipe:

"To enhance and preserve the quality and health of the Burns & Decker Lakes Watershed"

4.2 Purpose of the Planning Process

The lake management planning process for the Burns/Decker Lakes watershed is ongoing, and this document will provide the long-term direction necessary to achieve the overall goal. This version of the plan is intended to act as a handbook and reference guide for both resource managers and the Lakes District Watershed Enhancement Society (LDWES). It identifies current and potential sources of water quality degradation, and describes concerns of natural resource managers and local stakeholders regarding water quality protection. It then outlines in detail, the logistics and resources required to implement desirable management options for the watershed. It is intended that the society will refer to the document on an ongoing basis: to identify projects to undertake which will prevent further degradation to the lake and its watershed, and improve lake quality.

It is important to remember that this document does not indicate completion of the lake management planning process; it merely represents the conclusion of the first iteration. As recommendations in the plan are implemented, the planning process will continue in a cyclical nature with assessments and revisions occurring on an ongoing basis (Section 5.2 provides more details on the entire process).

To date, the lake management planning process has served many other important purposes that go far beyond this document. They include:

- Developing communication links between the LDWES, levels of government, industry, First Nations groups, and other local residents and stakeholders. This will: a) keep the society advised of activities in the watershed which may affect water quality and b) ensure land use decisions are made with sufficient input and agreement of stakeholders on relevant technical, social and political issues pertaining to the quality of the lake and its tributaries.
- Improving public education about issues affecting water quality in the lake and the watershed.
- Creating awareness in the community about lake management, and motivating people to get involved.
- Identifying volunteer-driven actions, and setting the stage for a volunteer monitoring program to monitor the lakes' condition.

If the management planning process is successful and the plan contributes to a healthy watershed with functioning ecosystems, everyone will benefit:

- Government officials will be able to comfortably make decisions which represent the best interests of all stakeholders
- Business and industry will thrive by operating in a vibrant, healthy community centered around the lakes
- First Nations will be assured the lake and their resources are being protected
- And most importantly, area residents will see an enhanced quality of life, with safe water to drink, an aesthetically pleasing lake, and many recreational opportunities.

5.0 Lake Management Planning Process - Methodology

5.1 Strategic Planning

There are two standard ways of approaching a problem. One way is to use tactical thinking and the other involves strategic thinking (Spitzer, 1991). Tactical thinking is short-term and treats only the symptoms of a problem, while strategic thinking is long-term and treats the causes of the problem. In general, tactical approaches are *relatively* simple and appear to be the least expensive. Strategic approaches tend to require long-term commitment and may be expensive. For solving complex problems, however, they are often the most practical and efficient approach that can be used.

Developing management strategies for environmental protection is not an easy task. Ecological systems are complex, and there are many relationships and interactions that we still do not completely understand. The current state of the environment is (arguably) deteriorating, and the general public is becoming increasingly concerned about environmental issues. We cannot wait for clear unequivocal signals of environment degradation (fish kills for example) since it is likely that in doing so, we will forgo relatively low-cost means of problem solving. Now is the time to determine a long-term plan of action to protect environmental and social values associated with these two lakes and their watersheds.

Lake management planning is complex because solutions cannot simply be generated by applying technical or scientific reasoning. There are many economic and social considerations and consequences associated with any proposed technical solution. For example, eutrophication (nutrient enrichment) concerns will not likely go away by employing tactical solutions that treat the symptoms of the problem. While in-lake treatment methods may form an important part of the overall solution, a long-term sustainable solution needs to look beyond the symptoms and treat the underlying causes: nutrient inputs from the surrounding watershed.

5.2 Project Methodology

To implement a strategic approach for the Burns/Decker Lakes management plan, we have used a framework similar to the one outlined by Rast and Holland (1988). Figure 1 is a schematic representation that illustrates the steps outlined in Rast and Holland’s framework. It has been modified from its original form, to reflect the actual process of creating this management plan. This document follows a similar organizational structure as the planning process itself.

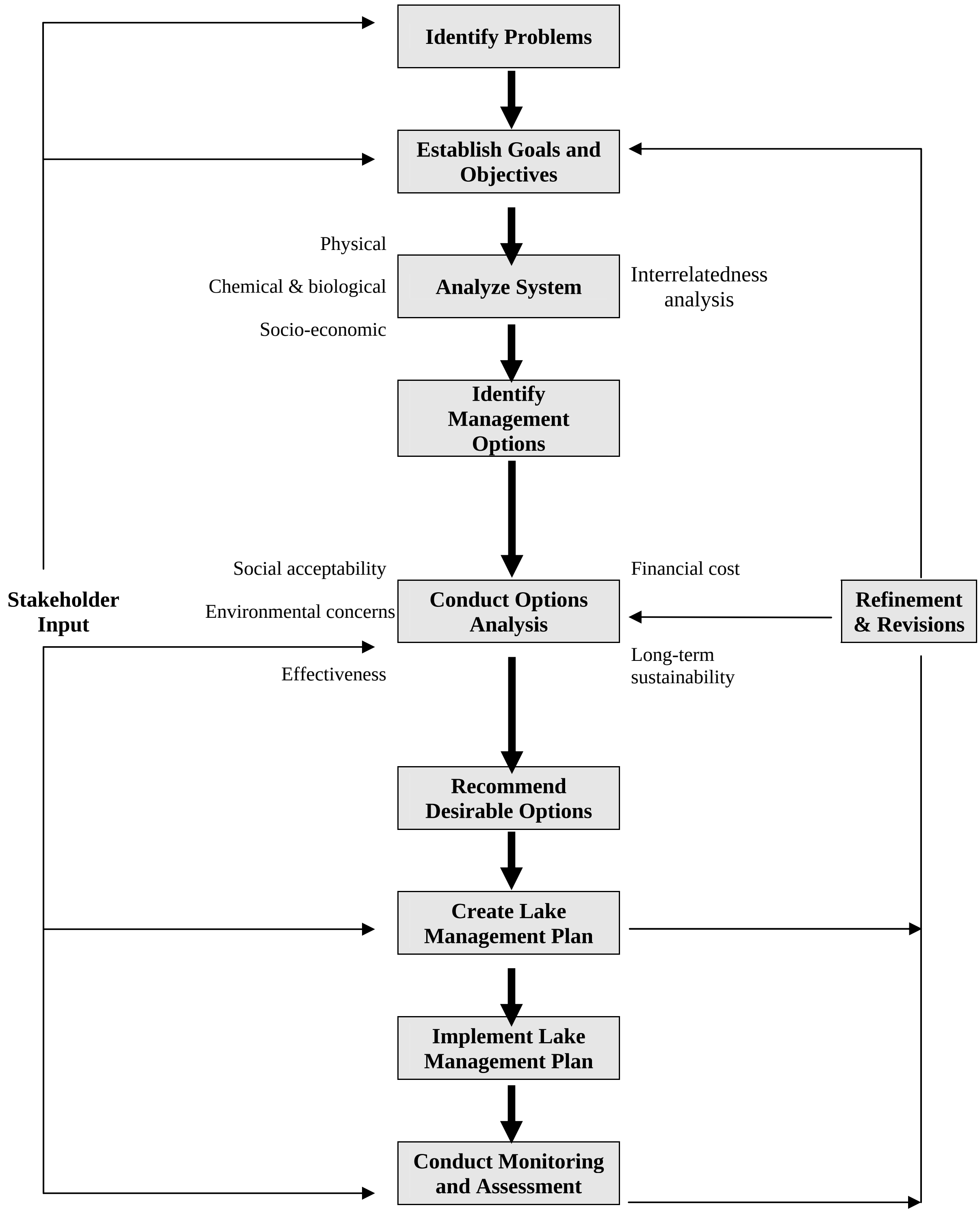

Figure 1. The Lake Management Planning Process (Modified from Rast and Holland, 1988).

The management planning framework consists of the following steps:

Step 1: Identify local problems and issues of concern – concerns were identified by talking with natural resource managers/scientists and concerned stakeholders who are members of the LDWES, and by conducting a general telephone survey of residents who live in the watershed and along the lakeshores. Everyone's concerns relate to 6 main problems that will be addressed in this management plan. The problems are described in Section 8.0.

Step 2: Define lake management goals and objectives – the problems outlined in step 1 were categorized and grouped into 4 general goals. Management objectives were then defined for each of the goals. Section 9.0 provides details.

Step 3: Analyze the Burns and Decker Lakes systems - background information on the physical, chemical/biological and socio-economic systems was gathered for Burns and Decker Lakes. Existing data has been used to characterize the physical and chemical/biological systems. The data in this report represents the most recent or most complete data sets that were available. To gain a better understanding of how each of the individual systems and components interact, an *inter-relatedness analysis* was conducted. The data is presented in Section 7.0 and details of the analysis are included in Section 10.0 and Appendix D.

Step 4: Identify possible management options to achieve the objectives – to identify possible options, a comprehensive literature search was conducted and experts from around the province and across North America were consulted. Descriptions of each option, along with considerations for implementation of the option, are included in Appendix E.

Step 5: Conduct an analysis of options – the costs and benefits of each option were researched, and a set of criteria was developed to help determine which options are the most desirable. The analysis takes into account the values of various stakeholders, and is based on judgements made by a panel of experts and key stakeholders. The entire process is described in Section 11.0.

Step 6: Provide recommendations – the most desirable options are the ones that fared the best against the analysis criteria. These options are summarized in the *Recommendations* section (Section 13.0). In addition, information on possible resources, and other implementation considerations are included in this section of the plan.

This management plan represents completion of Step 6 in the management planning process. The framework shown in Figure 1 (pg. 13) includes 2 additional steps, which form an important part of the ongoing process. It is our hope that management planning for the Burns/Decker Lakes watershed will continue through Steps 7 and 8 and become an ongoing and cyclical process.

Step 7: Plan implementation – we hope that the LDWES will continue to generate support in the community and gather resources to undertake activities recommended in the plan.

Step 8: Assessment (and revisions) – as the plan is implemented, arrangements should be made to monitor the success of the plan, and to make changes as necessary. It is a good idea to schedule regular meetings (eg. once a year) to review and update the management plan.

5.3 Consensus Building

A successful lake management program begins with a lake management plan that has widespread support from stakeholders. It is essential to involve all interested groups and regulatory agencies throughout the planning process (Gibbons et. al., 1994). Persons that are invited to participate at an early stage of the planning process are more likely to become advocates of the program, and this is essential for implementation and perpetuation of the plan (Rast and Holland, 1988).

Due to the complexity of the concerns and the variety of the stakeholders, consensus building is a very important part of the lake management planning process. The plan design must acknowledge that lake management planning is a group endeavour and that each person's opinion is important and should be recognized (Gibbons et. al., 1994). There is no substitute for local knowledge of the lake's problems and/or a lifetime of observations of a lake (Rast and Holland, 1988).

Stakeholders who have been identified in lake management planning projects include government agencies, first nations, lakeshore and watershed residents, lake user-groups, environmental groups and others. A list of contacts and stakeholders involved in the Burns/Decker Lakes Management Plan is included in Appendix A.

All interested parties should be involved from the formative stages and throughout the planning process to constructively discuss the issues and work towards achieving widespread support. During the planning process it is critical to conduct public meetings and keep the community informed. It is most important to obtain stakeholder input: during identification of the problems, during creation of plan goals and objectives, when possible management options have been identified and are being evaluated, after desirable options have been selected but before they are implemented, and during implementation of the selected lake management program to evaluate and review the success of the program. The framework we have adopted includes stakeholder input, and the schematic diagram in Figure 1 (pg. 13) illustrates input at critical stages in the management planning process.

For many parts of the plan, public input was sought through the Lakes District Watershed Enhancement Society (LDWES). Government representatives (from all levels of government) were consulted as necessary. On certain occasions, individual stakeholders were approached for their input on particular issues (interviews, telephone surveys, etc.).

6.0 General Information about Lakes

Over tens of thousands of years, lake basins change in size and depth as a result of climate, movements of the earth's crust, shoreline erosion, and the accumulation of sediment. Lakes receive inflows of water from the surrounding basin and from the atmosphere, so the observed water quality in a lake reflects, in part, the cumulative effects of the materials carried in all waters flowing into the waterbody (Rast and Holland, 1988).

6.1 Eutrophication

Eutrophication is the natural "aging" of small lakes. This is a slow process associated with the gradual build up of organic matter, nutrients and sediments in lake basins. Over long periods of time, an open lake will first become a marsh, and then eventually fill in completely and become a terrestrial ecosystem (Rast and Holland, 1988). Throughout this process, rooted plant biomass will increase, water clarity will become reduced, the lake volume will decrease and algal blooms can become more frequent.

Cultural Eutrophication is a term used to describe the accelerated rate of the eutrophication process due to human settlement, clearing of forests, and development of farms within a lake's watershed (Rast and Holland, 1988). These activities increase the rate of nutrient enrichment and biomass production by increasing nutrient inputs to the lake. A lake that is undergoing cultural eutrophication can be restored so that it will again have water quality that is more characteristic of the natural situation. However, if cultural eutrophication is left unmanaged, the result will be significant ecological changes (water quality degradation) and a significant reduction in appeal of the lake for residents and recreational user-groups that use it.

6.2 Trophic Status

Trophic status refers to the amount of biological productivity in a lake system and is directly related to nutrient inputs. The amount of algae and aquatic plant growth, water transparency, chlorophyll *a* levels, phosphorus concentration, dissolved oxygen in the hypolimnion (bottom layer of a thermally stratified lake), and growth of other organisms such as fish, are all indicators of trophic state. Highly productive lakes with abundant aquatic life (mainly algae and macrophytes) are called *eutrophic* and are usually relatively shallow and warm in the summer. Lakes which produce little aquatic life are called *oligotrophic*. These lakes are characteristically deep and cold, usually with clear water and rocky shores. *Mesotrophic* lakes are waterbodies in transition between oligotrophic and eutrophic. There is a continuum of trophic states that ranges from ultra-oligotrophic through mesotrophic to hyper-eutrophic.

The productivity of a lake is dependent on many factors. One of the most important is the amount of nutrients, particularly phosphorus, in the water. Individual lakes or reservoirs will respond differently to phosphorus loading because of differences in basin depth, water residence time, degree of stratification, and watershed characteristics such as geology, soil type, vegetation, topography, and climate (Daniel et. al., 1994).

Burns and Decker lakes are highly productive lakes that have naturally high concentrations of phosphorus (water quality data is included in the *Background Information* section of this document). The lakes are relatively shallow and have a fairly large surface area. In recent years, many residents of the watershed have observed increases in algae and macrophyte production, and a shift in fish species distribution toward coarse fish. Maclean (1985) has classified both lakes as eutrophic, and speculated that developments in many parts of the watershed are further contributing to the unusually high nutrient concentrations and water quality concerns in the lakes. His 1985 report states that marked increases in nutrients down-lake of the village of Burns Lake provides evidence that cultural eutrophication is occurring.

6.3 Nutrients – Nitrogen and Phosphorus

Aquatic life has several requirements for survival and growth. For algae and aquatic plants (which form the base of the aquatic food web), these requirements include sunlight, oxygen, hydrogen, carbon, nitrogen, phosphorus and other micronutrients. The ratio of carbon(C):nitrogen(N):phosphorus(P) by weight in plants is 40C:7N:1P and this is the ratio that is needed in their environment for growth (Wetzel, 1983). If sunlight and other micronutrients are available for growth, then phosphorus will be the first major nutrient to limit growth. Additional phosphorus that enters the lake environment will result in increased levels of photosynthesis, and therefore growth of algae and aquatic plants. If phosphorus is in excess within the lake, then there will be a high level of photosynthesis until nitrogen becomes scarce and thus the next limiting nutrient (Wetzel, 1983).

Phosphorus-Limited Lakes:

Most lakes in North-Central B.C. are phosphorus-limited, and a few are co-limited by phosphorus and nitrogen. Studies conducted by Maclean (1985) indicate that Decker Lake is most certainly limited by phosphorus, while Burns Lake may in fact be limited by both nitrogen and phosphorus. We anticipate that Burns Lake is more likely to be phosphorus-limited like Decker Lake, but more data is needed to confirm this. It should be noted that only the dissolved reactive fraction and some portion of the particulate fraction of phosphorus are available to organisms for growth (Cooke et. al., 1993). Therefore, while phosphorus in biota is recycled very quickly, phosphorus that is bound in the sediments is not available for growth.

Growth of algae and aquatic plants can cause low oxygen levels from decay processes, decreased recreational value due to odours and other aesthetics concerns, and poor habitat for other aquatic organisms such as fish (Wetzel, 1983). Since the rates of biological productivity of many lakes are governed by the rate of phosphorus cycling (Wetzel, 1983), decreasing phosphorus inputs is generally the most effective method to reduce the productive capacity of a lake and therefore mitigate these concerns. Phosphorus is chemically reactive, easier to remove from water than nitrogen, and does not have major reserves in the atmosphere (Wetzel, 1983). These characteristics make it possible for phosphorus inputs to be controlled, or for the nutrient to be removed from lake systems. Phosphorus inputs can often be effectively controlled using engineering and land use management. Once external loading to a lake is decreased, the lake will require at least 2 to 10 years to recover from eutrophication symptoms such as increased algae growth (Wetzel, 1983). The exact number of years will depend on the water exchange time of the lake (flushing rate).

6.4 Nutrient Sources: Internal and External Loading

Nutrients entering a waterbody can come from internal and external sources.

Internal Sources

Internal sources include nutrient cycling through plant growth and decay, and sediments. The chemical equilibrium in the lake, and especially at the sediment-water boundary, dictates how much phosphorus is released from the sediments. Phosphorus is re-suspended into the water under *reducing* (low oxygen) conditions at the sediment-water boundary. See the nutrients section (Section 7.3) in the *Background Information* for details about internal phosphorus sources entering Burns and Decker Lakes.

External Sources

External sources of nutrients can be classified as either “point” or “non-point” sources. Both can contribute significant amounts of nutrients to aquatic systems.

<u>Non-point nutrient source</u> – Non-point sources cannot be traced to a specific origin or starting point but seem to enter the lake system from many places. There are three major sources of non-point source nutrients: those that are carried by overland flow during ice melt, flood or storm events (often originating from agriculture, forestry, urban development, and mining); those that are deposited from dust in the atmosphere (during rainfall events); and those sources seeping into the lake from deep and shallow groundwater flow (onsite septic system leachate). The nutrient section (Section 7.3) in the *Background Information* describes the locations and amounts of external phosphorus entering Burns and Decker Lakes.

<u>Point source nutrients</u> – External point sources include direct discharge into the lake from specific, identifiable pipes, points or outfalls (such as the Burns Lake sewage treatment plant). These sources are generally more readily measurable than non-point nutrient sources.

6.5 Nutrient Model or Budget

A nutrient model or budget is a quantitative assessment of nutrients moving into, being retained in, and moving out of an aquatic system. It is a mathematical tool that describes both the sources (and sinks) and quantities of nutrients in aquatic ecosystems. Models are useful to help diagnose problems within a lake, and evaluate possible solutions for these problems. Several different nutrient models have been developed, some better suited to certain types of lakes. Predictions from all models are inherently uncertain because they are based on a simplification of "real world" features. Each model has a certain level of associated uncertainty that is dependent on the complexity of the model and on the factors that are addressed. However, models can still be a valuable tool when making management decisions pertaining to nutrients in lakes, and uncertainties from the model can be factored into the decisions that are made.

Since phosphorus is central to the productivity of lakes, many models focus on phosphorus loading. These models can account for the phosphorus loading due to climate, watershed characteristics and human activities (including land use). Depending on the model chosen, values are modified by environmental factors to give the lake's average phosphorus concentration. The relationship between the land use and the lake trophic quality can be explored and quantified through mathematical modeling (see Rysavy and Sharpe, 1995 sections 2.4 & 4.2.2.5). Once the phosphorus concentrations are predicted from a model, it is useful to interpret this prediction in the context of expected water quality characteristics for the lake of interest.

A typical nutrient model is shown in Figure 2. Phosphorus budgets for Burns Lake are included in the nutrients section (Section 7.3) of the *Background Information*.

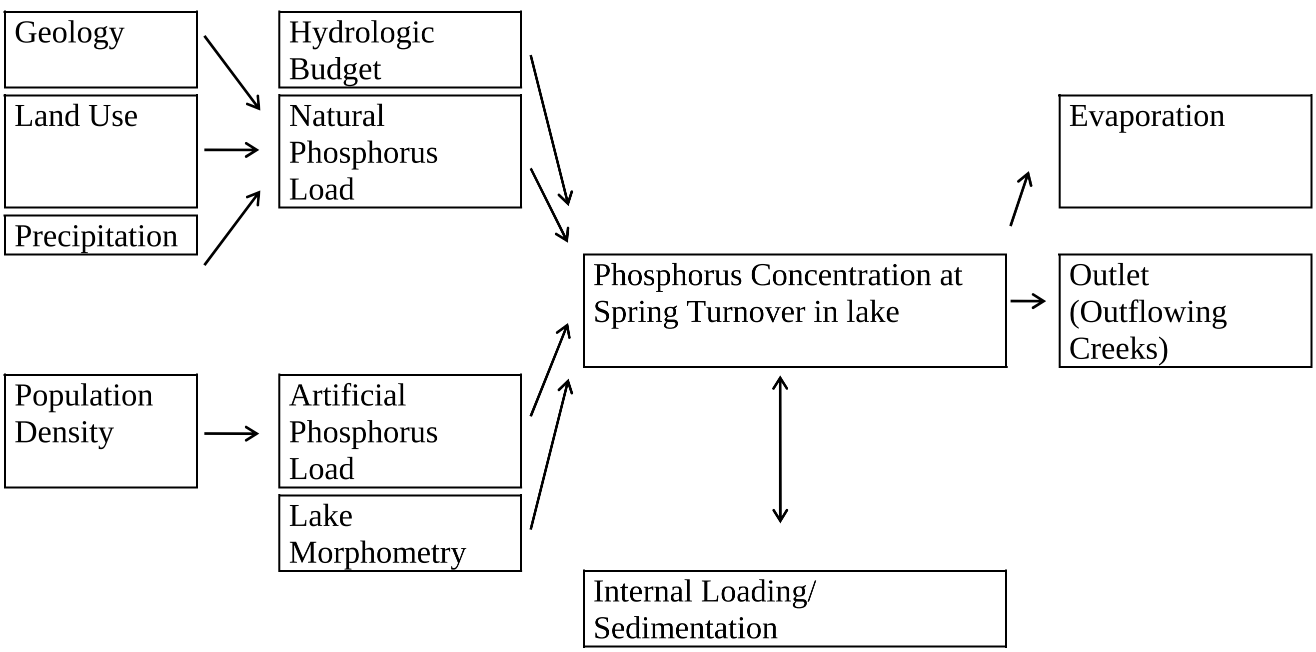

Figure 2. Diagram of a Typical Nutrient Budget (adapted by Rysavy and Sharpe, 1995, from Dillon and Rigler, 1975). Total Nutrients into the lake minus the total nutrients out of the lake plus or minus the internal nutrient loading (if sediments are a source of the nutrient) or sedimentation rate (if sediments are a sink for nutrients). should equal the total phosphorus concentration in the lake at spring turnover

7.0 Burns and Decker Lakes: Background Information

This section includes a description of the region around Burns and Decker Lakes, including maps, morphometric and hydrometric data, and a summary of all measurement methods and sample locations.

7.1 Watershed Characteristics

The Burns/Decker Lakes watershed is located on the Central Interior Nechako plateau along the Hwy 16 corridor, 226km west of Prince George, B.C. (Figure 3). The watershed lies at 54^{o}N latitude, 125^{o}W longitude and is located within the Regional District of Bulkley Nechako in the Skeena Region. The drainage basin has an area of 1146km^{2} and a perimeter of 385km (Figure 4).

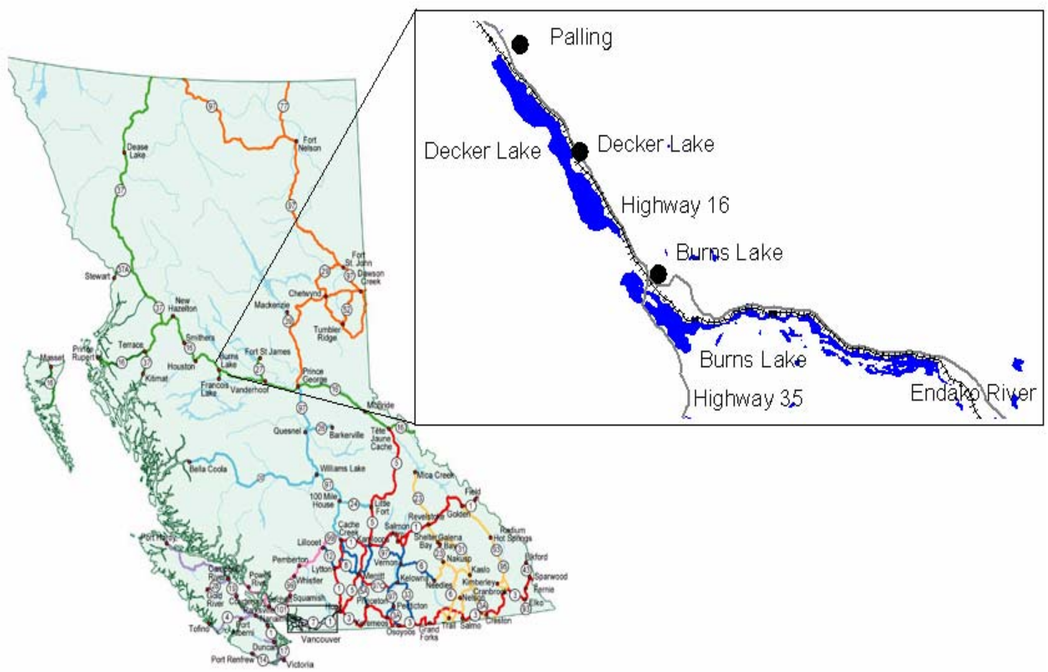

Figure 3. Location of the Burns/Decker Lakes Watershed.

Land Use Activities

Land use activities in the Burns/Decker Lakes watershed include (Figure 5, pg. 22):

- Agriculture (hobby farming, haying/swathing, open range grazing)
- Forestry (Two lumber mills are located within the watershed; one is located at the east end of Burns Lake and one is located at the west end of Decker Lake. The forested area of the watershed is a part of the Burns Lake Provincial Forest)

- Urban and Built-Up Areas (There are a number of small communities within the watershed including: Decker Lake, Burns Lake, and Palling Indian Reserve)
- Recreation Sites (Dead Man's Island Provincial Park is located on the south side of Burns Lake; other, non-designated areas are scattered throughout the watershed)

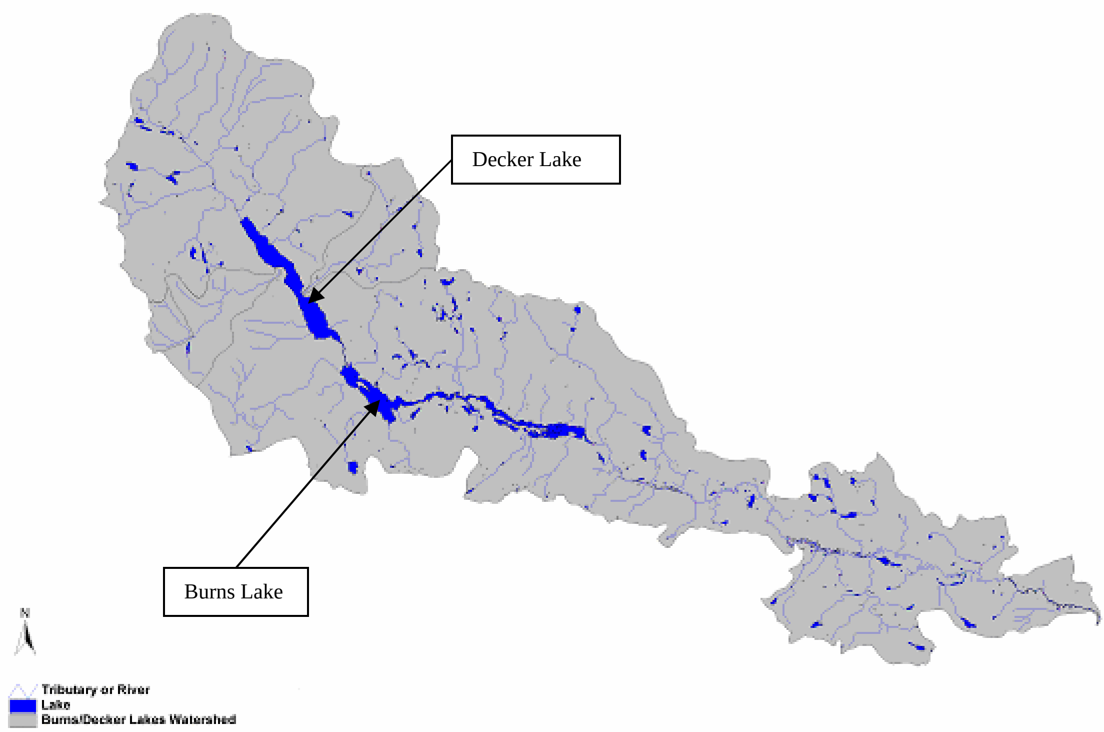

Figure 4. Burns/Decker Lakes Watershed.

Zoning

With any development in a watershed, there is often a subsequent reduction in the amount and quality of aquatic and terrestrial habitat. It is beneficial to both the land owner/developer (increased property values) and to the environment to strategically develop in a way that maintains the long-term integrity of the watershed ecosystem. Planning initiatives in other areas are starting to use an overall "watershed approach" when allocating land for development. Pressure and lobbying by an informed populace can most certainly promote strategies that minimize negative impacts to the natural environment.

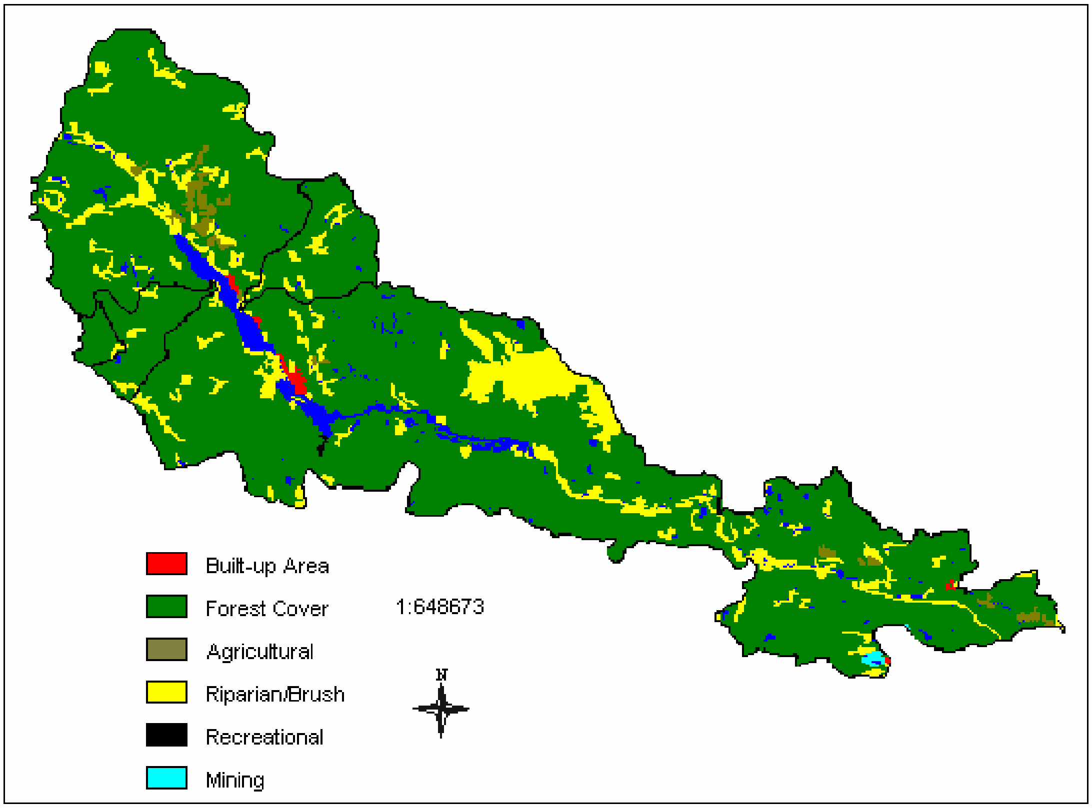

Figure 5. Land use in the Burns/Decker Lakes Watershed.

Water Sources: Tributaries and Groundwater

There are five sources of water inputs to Burns and Decker Lakes:

- ***Precipitation***: water falling directly onto the surface of the lakes
- ***Overland flow***: water that enters after flowing over the land surface
- ***Subsurface flow***: water that enters after flowing through pores and spaces in the soil
- ***Groundwater flow***: water that enters from deep, subsurface substrate
- ***Tributary streamflow***: water entering from tributary streams

After a rain shower, each input source enters the lake system at a different rate. Direct precipitation is the fastest, followed by tributary and overland flow, subsurface flow and finally groundwater flow. The last two sources of transport can sometimes have a significant lag time between entry into the watershed and input into the lakes.

Tributary sources into Decker Lake include but are not limited to (Webber and Tupniak, 1981):

1. ***Endako River*** (105.98km long): Drains into the northwest side of the lake and consists of a 6m average channel with placid flow.

2. ***Powder House Creek*** (7.8km long): Drains from the north bank of the lake, west of the Village of Decker Lake. Channel width is approximately 2m with moderate flow stage[1] and 2% slope.
3. ***Decker Creek*** (17.82km long): Drains from the north bank of the lake, east of the Village of Decker Lake. Channel width is approximately 3m with moderate flow stage and 2% slope.
4. ***Gerow Creek*** (12.44km long): Drains from the south bank of the lake, perpendicular to the Village of Decker Lake. Channel width is approximately 1m with moderate to high stage flow and high debris accumulation.

Refer to Figure 6 (pg. 24) for a map of all tributaries entering into Decker Lake.

Tributary sources into Burns Lake include but are not limited to (Webber and Tupniak, 1981):

1. ***Endako River***: This is the main inlet into Burns Lake. It flows from Decker Lake and enters on the northwest side of Burns Lake's west basin. Channel width varies from 10 to 15 m with a very placid stage flow (Figure 7, pg. 25).
2. ***Guyishton Creek*** (6.6km long): Drains into the west basin of Burns Lake from the south west side bank. Channel width is approximately 2m with moderate stage flow and 1.5% slope (Figure 7, pg. 25).
3. ***Stearns Creek*** (8.3km long): Drains from the north near the middle of the lake. Channel width varies due to the formation of side and flood channels created by beaver activities. Stage flow is moderate (Figure 8, pg. 26).
4. ***Tintagel Creek*** (9.48km long): Drains into the north side near the middle of the lake, east of Stearns Creek. Channel width is 5m with wetted are of approximately 2 to 3m. Stage flow is moderate with a 3% slope (Figure 8, pg. 26).

7.2 Lake Characteristics

Morphometric Data

<u>Decker Lake</u>

General Characteristics:

Decker Lake is an oblong-shaped lake that is roughly 12.5km long with a simple shoreline, no islands and one main basin. The maximum depth of Decker Lake is 16m. The surface area is 1122 hectares, with a shoreline perimeter of 28.8km. Its lake characteristics are summarized in Table 1.

---

[1] An arbitrary height of water measured from a benchmark on land.

Table 1: Lake Characteristics for Decker Lake

Decker Lake Characteristics		
Elevation	716	metres (m)
Surface Area	11.3	square kilometres (km^2)
Volume	105,950	cubic decametres (dam^3)
Mean Depth	9.4	metres (m)
Max. Depth	16	metres (m)

Water Retention Time and Flushing Rate

Water retention time (RT) is the average time that a given molecule of water remains within the lake basin. It is calculated by dividing the entire volume of water in the lake by the annual outflow volume (RT = lake volume ÷ annual outflow). Retention times are dependent on the bathymetric characteristic of the lake basin (lake size, shape and depth).

Another method of describing how fast the water passes through a lake basin is flushing rate. This value is determined by taking the inverse of the water retention time multiplied by 100 to get a percentage (Flushing rate = $^{1}/_{RT} \times 100^{\%}$).

Unlike Burns Lake, which has a continuous flow monitoring system at its outlet, there has been no such monitoring for Decker Lake. Thus, it is not possible to calculate either the water retention time or flushing rate of Decker Lake.

Bathymetry

A bathymetric map is a contour map of the depths in a lake basin. Figure 6 shows the bathymetric map for Decker Lake (the labels on the map indicate sampling locations; see Table 3, pg. 27)

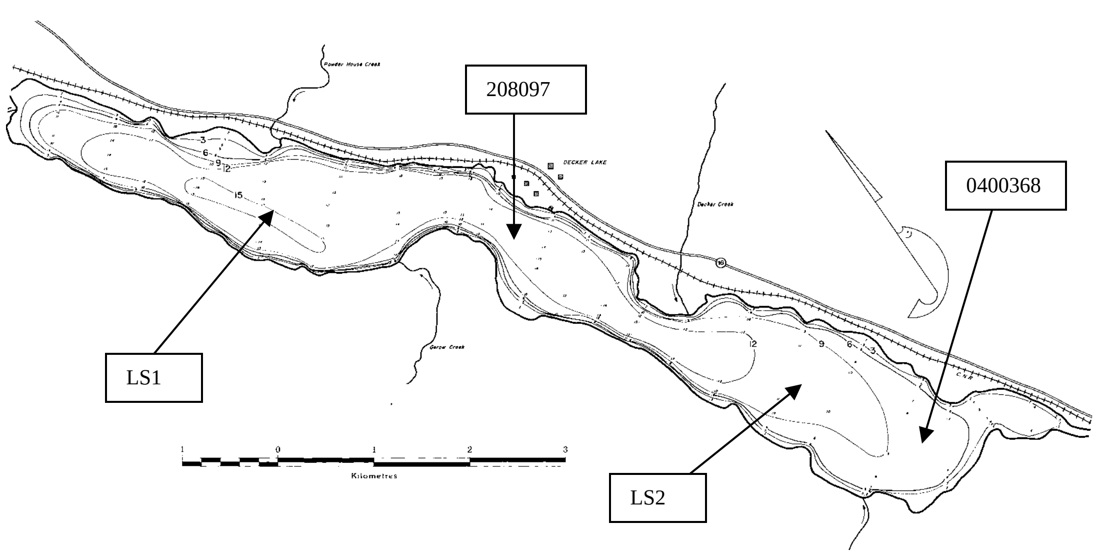

Figure 6. Bathymetric map of Decker Lake

Burns Lake

General Characteristics

Burns Lake is a long and narrow lake that is roughly 19.5km long with a complex shoreline, several islands and two basins. The maximum depth of Burns Lake is 40m, in an area off the east side of Deadman's Island. The surface area is 1180 hectares and it has a shoreline perimeter (including islands) of 65km (see Table 2).

Table 2: Lake Characteristics for Burns Lake

Burns Lake Characteristics

Elevation	701	metres (m)
Surface Area	11.8	square kilometres (km^2)
Volume	106551	cubic decametres (dam^3)
Mean Depth	9	metres (m)
Max. Depth	40	metres (m)

Water Retention Time

Based on an annual mean water discharge of 4.45 m^3/sec measured at the Endako River at the outlet of Burns Lake (Environment Canada Station 08JB012, 1996 to 1999), the water retention time of Burns Lake is estimated to be 0.76 years. This means that the water in Burns Lake is replaced every 0.76 years.

Flushing Rate

Based on a retention time of 0.76, the flushing rate of Burns Lake is approximately 132 % per year.

Bathymetry

Figures 7 through 9 show the bathymetric contour map of Burns Lake. The lake is presented as three separate maps due to the long length of the lake.

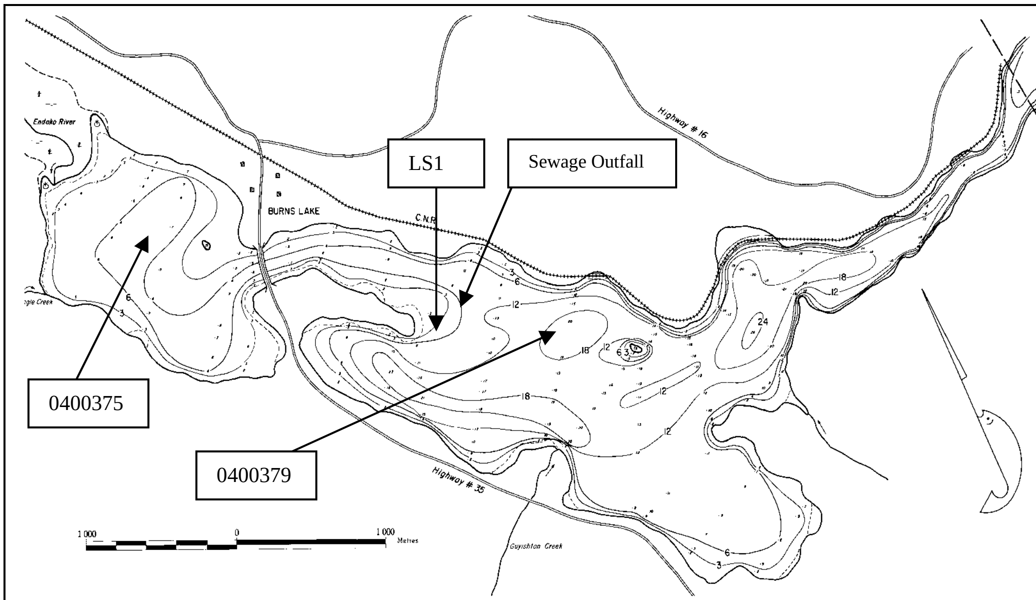

Figure 7. Bathymetric map of Burns Lake West section.

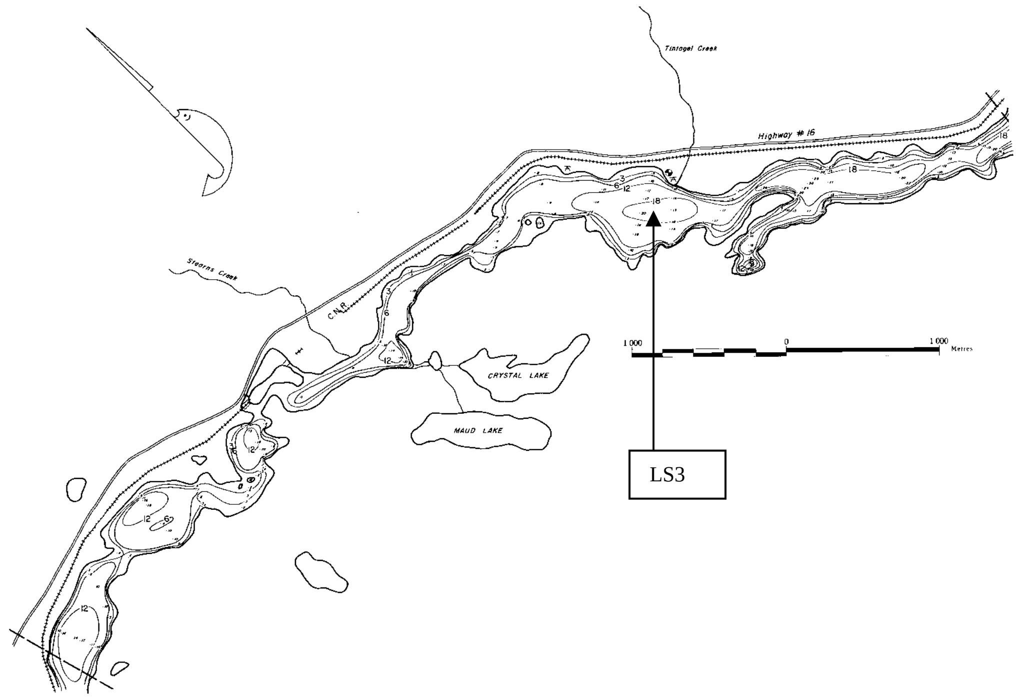

Figure 8. Bathymetric map of Burns Lake Narrows section.

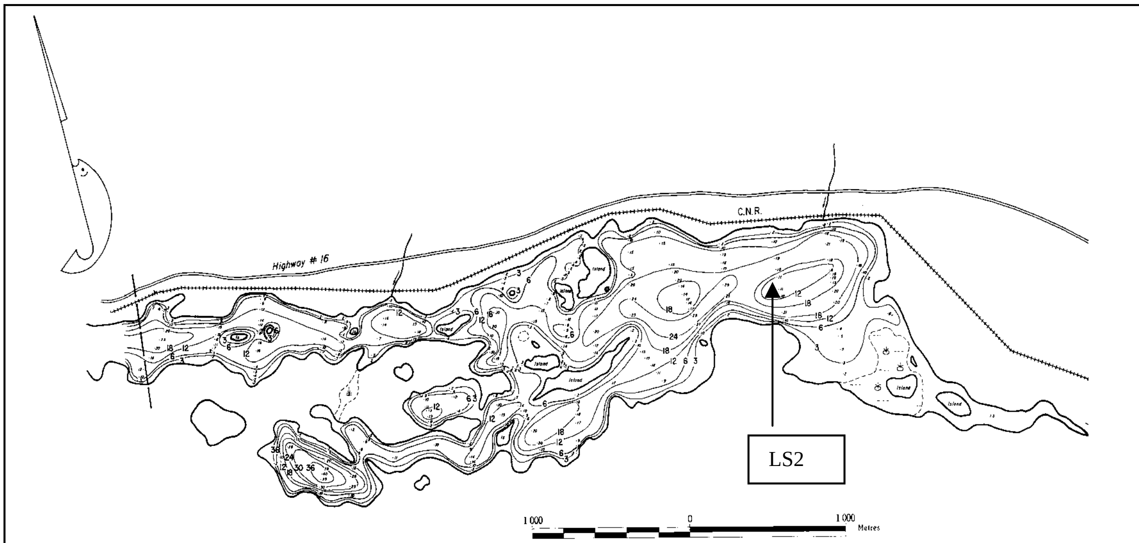

Figure 9. Bathymetric map of Burns Lake East section.

7.3 Physical & Chemical Water Quality Characteristics

Over the years, there have been multiple sampling events on Burns and Decker Lakes, (and their tributaries) where physical and chemical water quality measurements have been taken. Table 3 summarizes the site numbers, data collector, and description for each sampling location. The labels in Figures 6 through 9 indicate the map locations of the sites.

Table 3. Water Quality Sampling Sites on Burns and Decker Lakes

Burns Lake

Station/ Site Number	Source	Description
LS1	Webber and Tupniak, 1981	East Basin
LS2	Webber and Tupniak, 1981	Narrows
LS3	Webber and Tupniak, 1981	Near outlet
0400375	Maclean, 1985	Close to the village water inlet near the middle of the West Basin
0400379	Maclean, 1985 and Beatty-Spence, 1990	Middle of lake between Deadman's Island and point of land
0400376	Maclean, 1985 and Beatty-Spence, 1990	East of bridge, north arm, west of sewage discharge
0400377/Sewage Outfall	Maclean, 1985 and Beatty-Spence, 1990	East of bridge, north arm, at point of sewage discharge

Burns Lake Tributaries

Station/ Site Number	Source	Description
E208129	Beatty-Spence, 1990	Stearns Creek near mouth
E208130	Beatty-Spence, 1990	Tintagel Creek near mouth
E208131	Beatty-Spence, 1990	Guyishton Creek near mouth
E208132	Beatty-Spence, 1990	Wardrop Creek near mouth

Endako River

Station/ Site Number	Source	Description
E208132	Beatty-Spence ,1990	Endako River between lakes
E208892	Beatty-Spence, 1990	Endako River at Burns Lake outlet

Decker Lake

Station/ Site Number	Source	Description
LS1	Webber and Tupniak, 1981	Deep station east of Powder House Creek
LS2	Webber and Tupniak, 1981	West of outlet of Decker Lake
0400368	Webber and Tupniak, 1981 and Beatty-Spence, 1990	Near outlet of Decker Lake
E208097	Beatty-Spence, 1990	Across from Village of Decker Lake

Transparency/Secchi Depth

The transparency (or clarity) of a lake is affected by the density of algae and total suspended solids within the water column. Water transparency is usually measured using a black and white Secchi disk. The disk is lowered into the water column to the point where it is no longer visible (recorded) then raised to the point that it becomes visible again (recorded and averaged). Secchi depth measurements are a rough indicator of the trophic status of lakes (Michaud, 1991). Lakes with a low Secchi values tend to be very productive (eutrophic) while lakes with high values tend to be less productive (oligotrophic). Figure 10 shows Secchi depths from Decker Lake, and the east and west basins of Burns Lake in 1990.

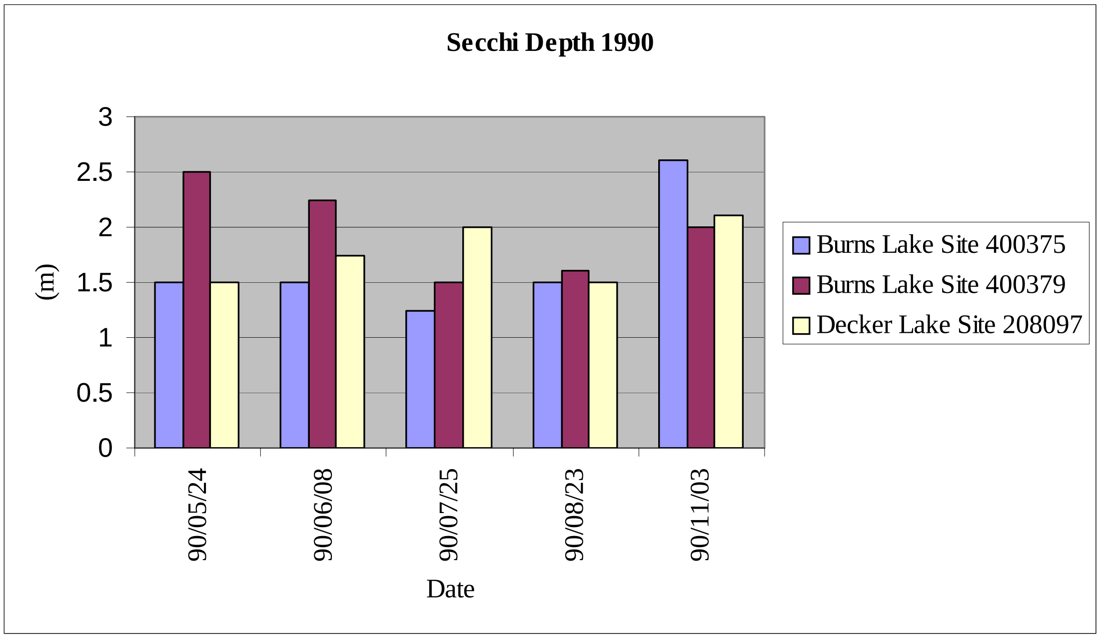

Figure 10. Secchi depths for Burns and Decker Lakes taken in the summer of 1990.

Temperature

Of all the properties of a lake, temperature has the greatest influence on the biology and chemistry of the lake system (Holdren et. al., 2001). The density of water is directly related to temperature. Generally, as temperature decreases, the density of the water increases (the water becomes heavier and sinks to the bottom). However, once the water temperature has cooled to 3.94^{o}C it has reached its maximum density. As the water gets even colder, its density actually decreases again as ice starts to form. This characteristic, coupled with a very high specific heat, helps to explain why some lakes stratify and mix at certain times of the year.

Thermal stratification in a lake occurs in the summer when the surface water warms and becomes more buoyant than underlying cold, dense water. Three distinct layers are formed during summer stratification: the *epilimnion* (upper, warm and well mixed layer), the *metalimnion* (middle layer where there is a rapid decrease in water temperature) and the *hypolimnion* (cold, dense bottom layer). During the spring and fall the temperature of the lake becomes constant throughout the water column and the layers mix with one another. During the winter (when an ice layer forms on top) the water re-stratifies in reverse order (the *hypolimnion* is warmer than the *epilimnion*). Lakes that stratify in the winter and summer, and mix in the spring and fall are called dimictic lakes. For a more detailed explanation about thermal stratification, see Holdren et. al. (2001). Figures 11 and 12 show the temperature profiles of Decker Lake and the east and west Basins of Burns Lake. See Appendix B for a temperature profile of Burns Lake eighteen years apart.

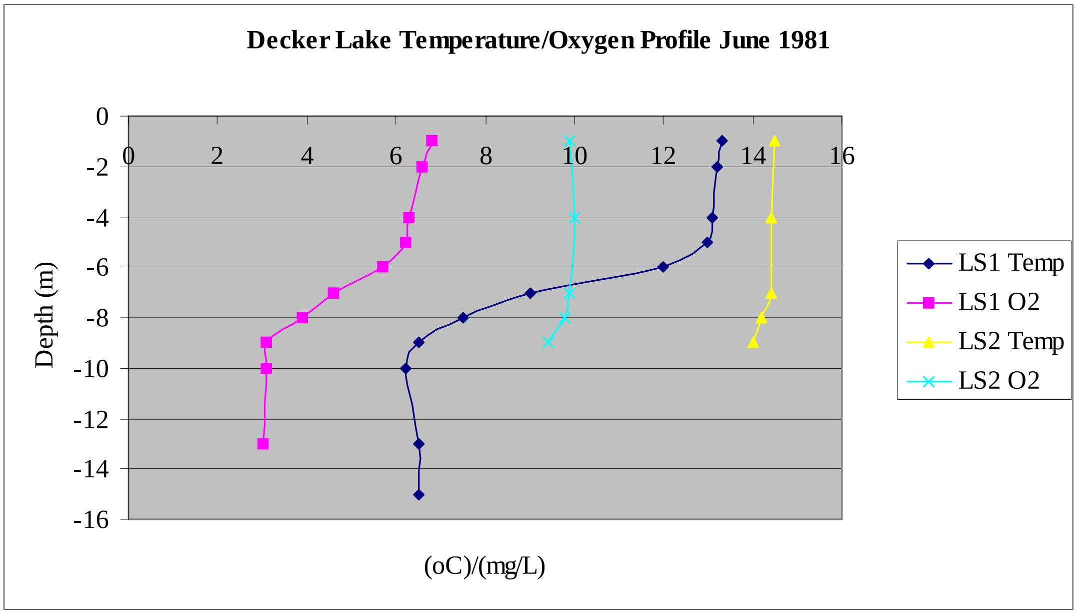

Figure 11. Temperature and dissolved oxygen versus depth for Decker Lake taken in June 1981.

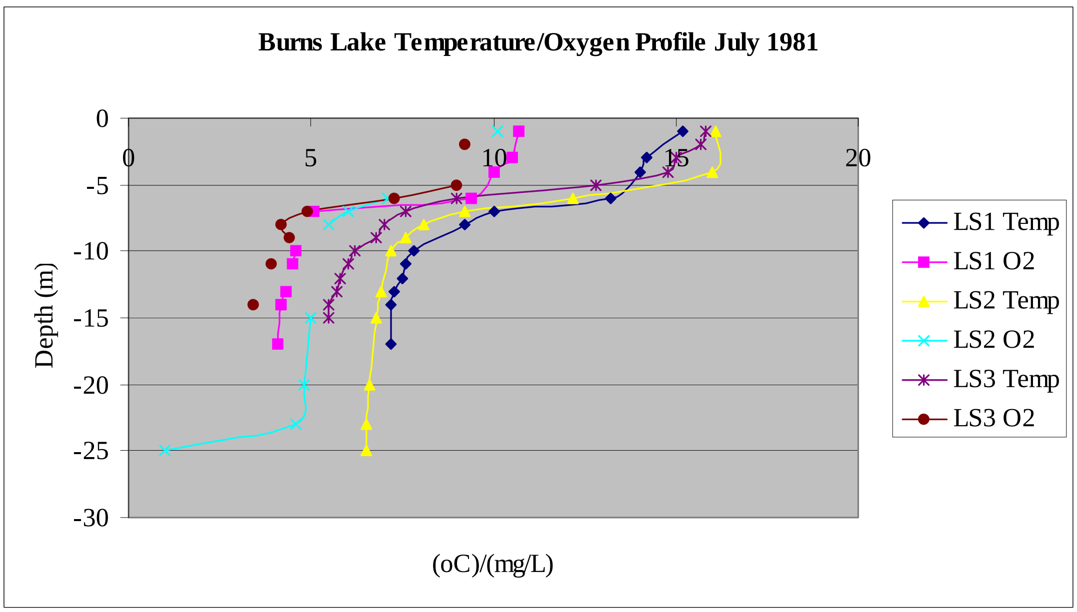

Figure 12. Temperature and dissolved oxygen versus depth for Burns Lake taken in June 1981.

Dissolved Oxygen Profile

Dissolved oxygen (DO) is the weight (or volume) of oxygen that is contained in a given volume of water. This oxygen enters the water through photosynthetic processes (aquatic biota) and by direct transfer across the air-water interface. Cold water is able to hold more oxygen than warmer water. When lakes become stratified in the summer and winter, low dissolved oxygen levels can cause stress on aquatic organisms and have been attributed to fish kills in severe circumstances (Holdren et. al., 2001). Low dissolved oxygen can also release phosphorus trapped in bottom sediment making it available for algae and macrophytes. As plants and algae blooms die, they sink to the bottom of the lake and decompose, further reducing the oxygen content of the water. The result is a positive feedback loop that increases through each cycle. Figures 11 and 12 show the dissolved oxygen profiles of Decker Lake, and both the East and West Basins of Burns Lake. Figure 13 shows the relationship between dissolved oxygen and temperature in a typical dimictic system like Burns Lake.

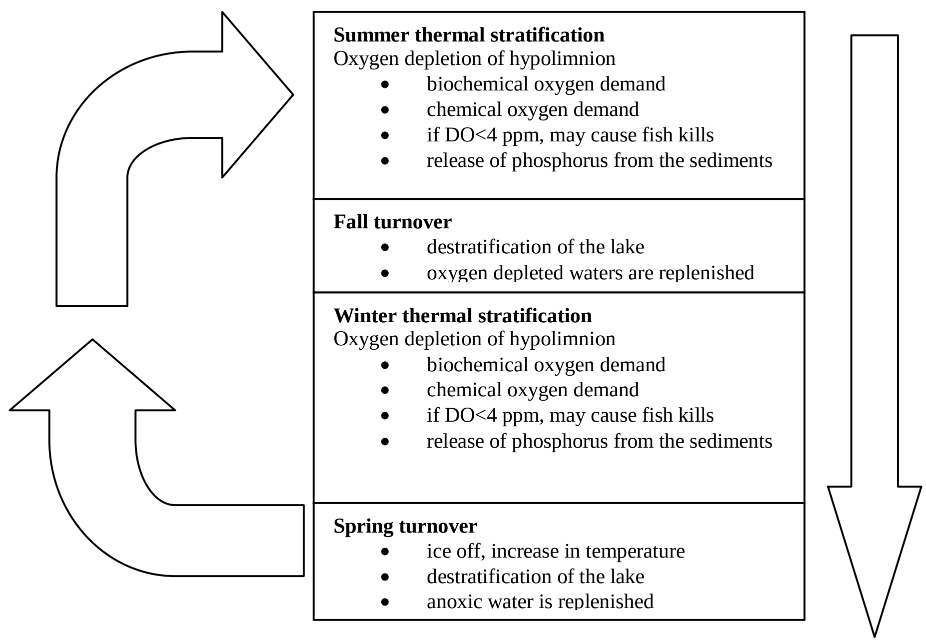

Figure 13. Oxygen in the Stratification Cycle

Nutrients: Phosphorus

As mentioned in the *General Information* section, phosphorus seems to be the limiting nutrient in Decker Lake and may be limiting in Burns Lake. Because phosphorus is the nutrient that regulates the general trophic status of the lakes, it is important to determine the internal (within the lake) and external (outside the lake) sources of this nutrient.

<u>External Phosphorus Sources</u>

1. Tributaries (no P values) (Figures 14 and 15)
2. Groundwater infiltration (Combined with atmospheric~500Kg/year P for Burns Lake)
3. Village of Burns Lake Sewage treatment outfalls (~2500 Kg/year) (Figure 16)
4. Atmospheric deposition (no P values)
5. Overland flow (no P values)
6. Onsite septic system infiltration (~300 Kg/year for Burns Lake)

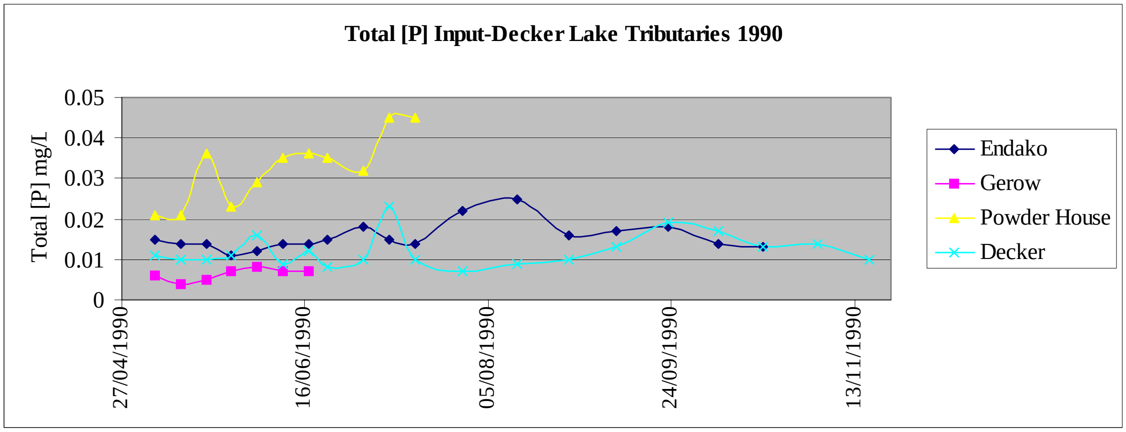

Figure 14. Total phosphorus concentrations for Decker Lake tributaries from April to November 1990.

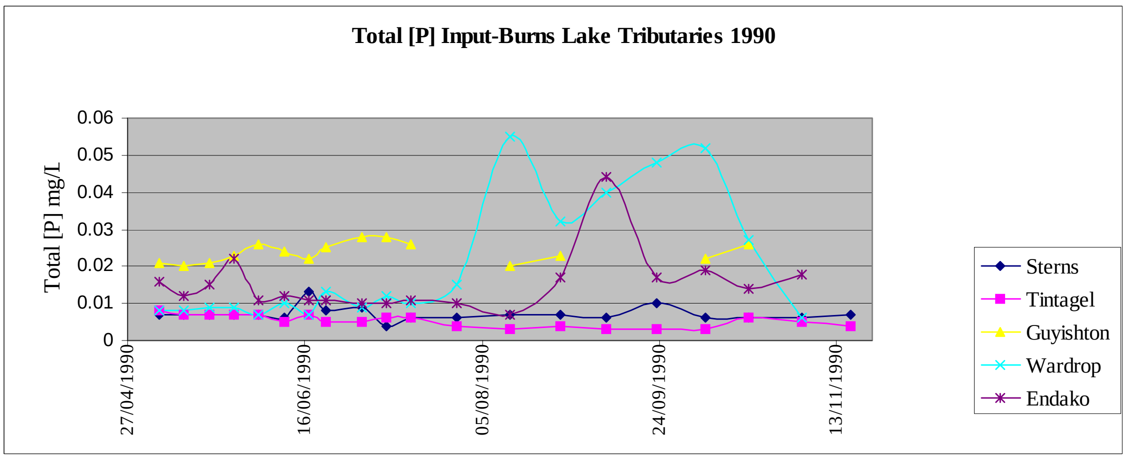

Figure 15. Total phosphorus concentrations for Burns Lake tributaries from April to November 1990.

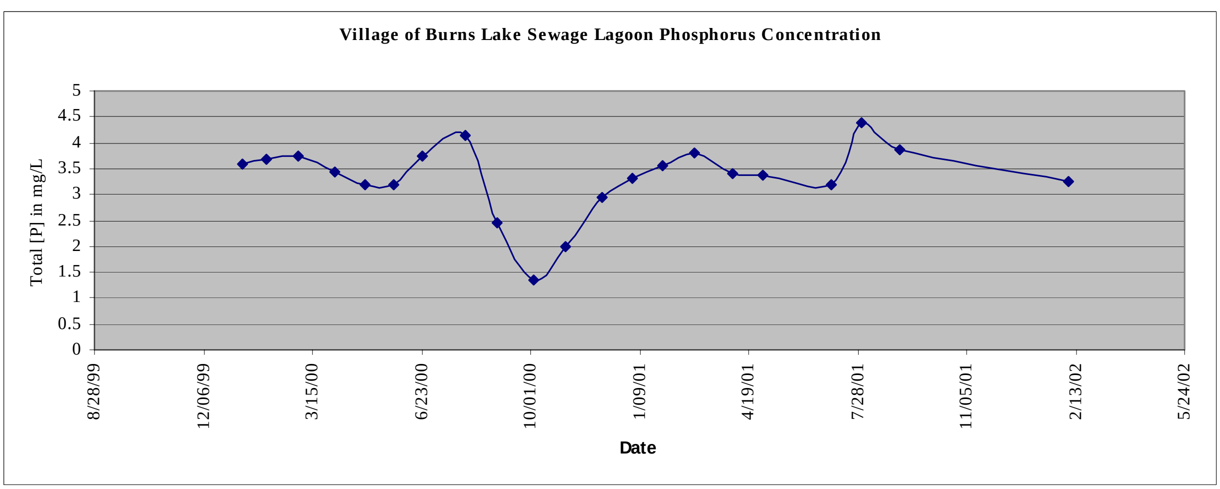

Figure 16. Total phosphorus concentrations for the Village of Burns Lake sewage lagoon over time.

<u>Internal Phosphorus Sources</u>

1. Sediment (~700 Kg/year for Burns Lake East Basin/~200 Kg/year for West Basin)
2. Biological Decay (no P values)
3. Water Column (no P values) (Figures 17 through 19)

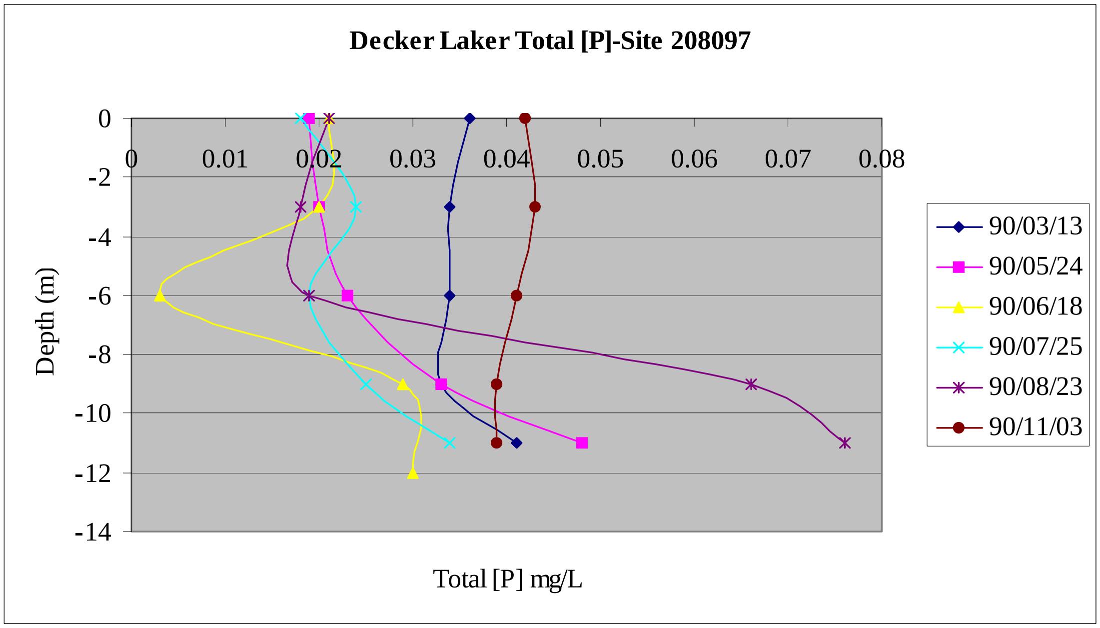

Figure 17. Total phosphorus concentrations versus depth in Decker Lake from March to November 1990.

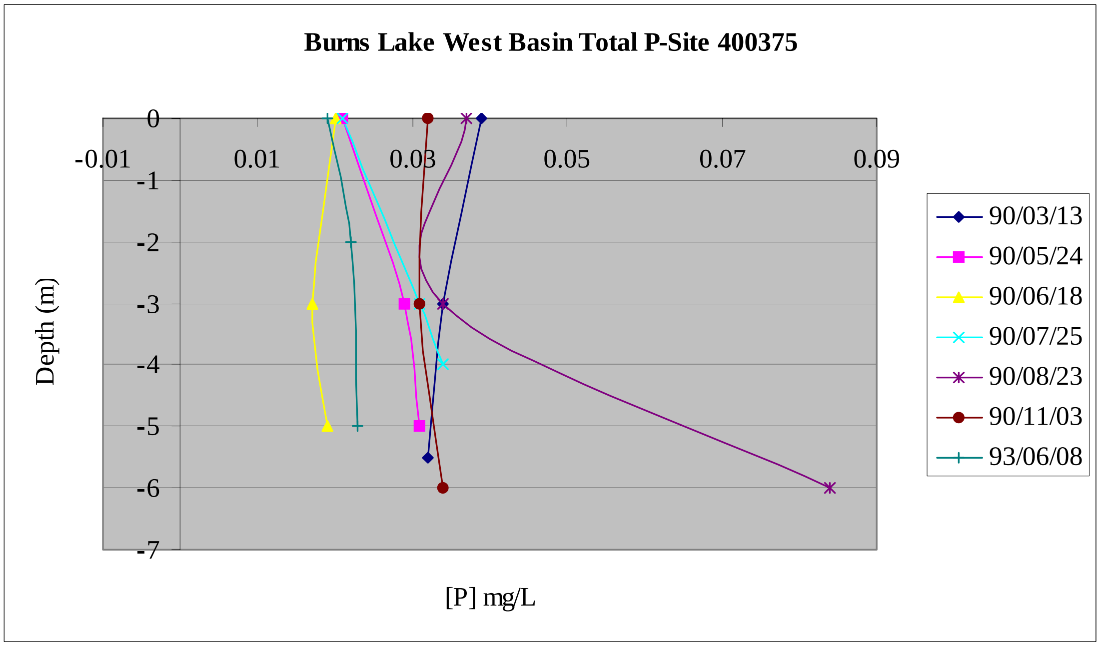

Figure 18. Total phosphorus concentrations versus depth in Burns Lake west basin from March to November 1990 and June 1993

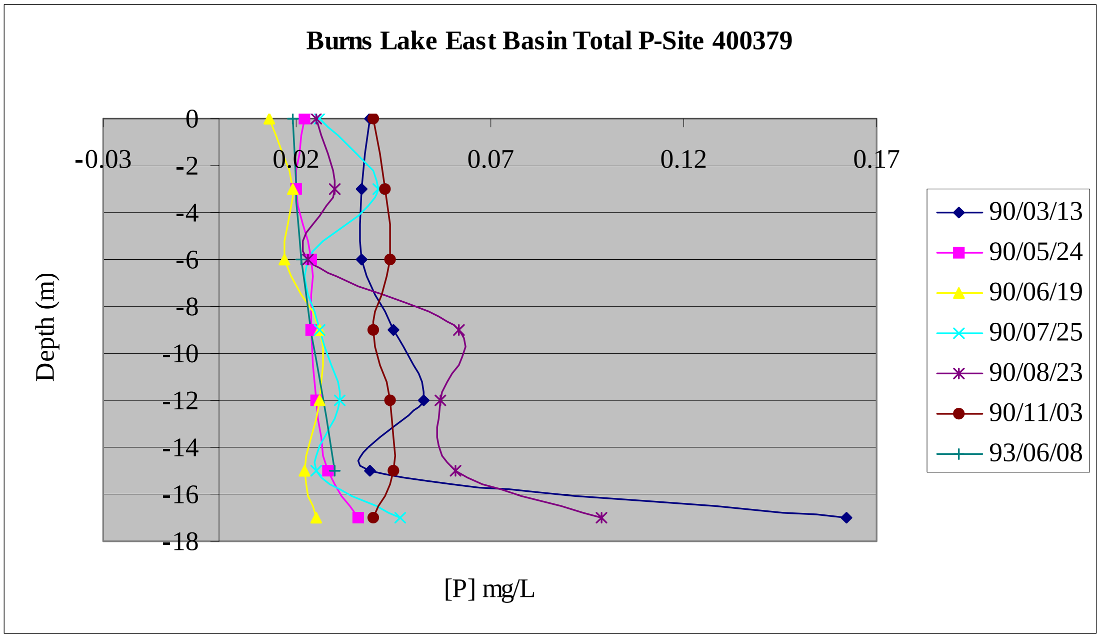

Figure 19. Total phosphorus concentrations versus depth in Burns Lake east basin from March to November 1990 and June 1993

Phosphorus Budget

As discussed in the *General Information* section (Section 6.0), a phosphorus budget combines both internal and external sources to estimate all phosphorus sources and sinks in a lake. Recall that budgets can only be considered "best guess" estimations because they simplify the contributions of all phosphorus sources entering into the system.

Phosphorus budgets for Burns Lake have been created using a technique developed by Sharpe in 1999 (Sharpe pers. comm., 2002). Figures 20 through 22 show phosphorus budgets for 1985, 1993 and 1998 by percent source. Some sources do not appear in the 1985 model due to lack of information. There is no budget for Decker Lake because of data limitations.

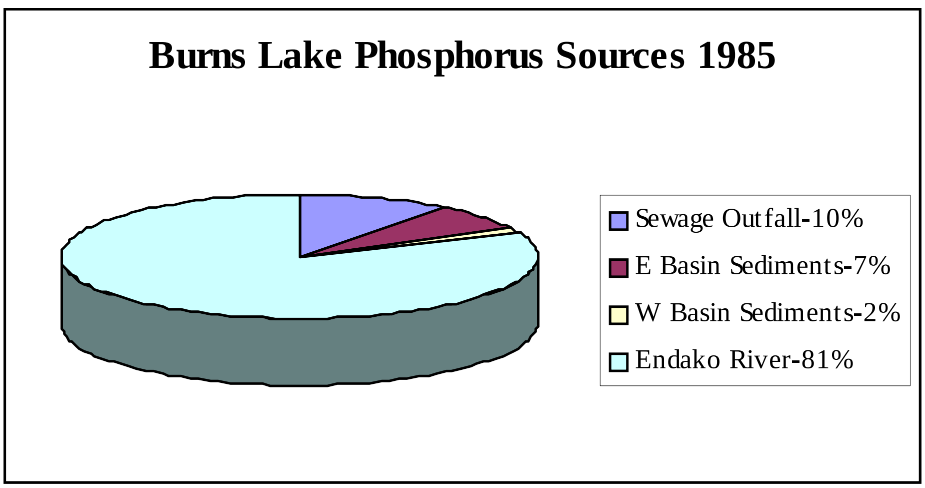

Figure 20. Burns Lake phosphorus budget showing sources by percentage in 1985.

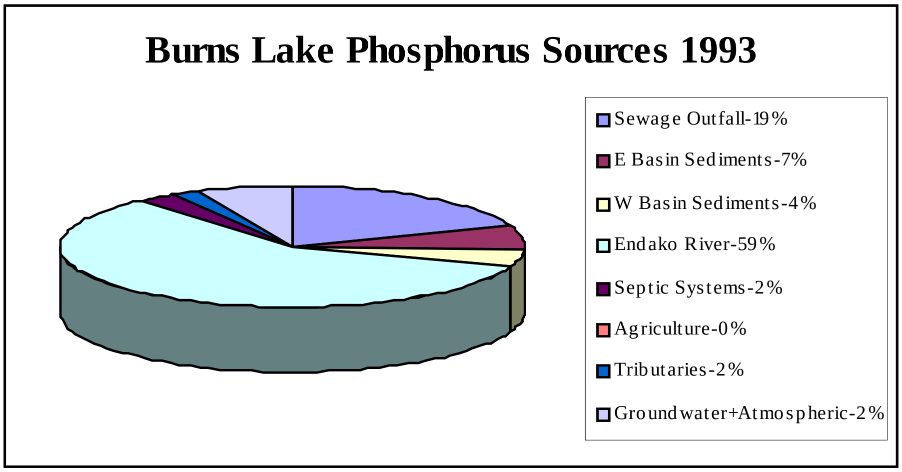

Figure 21. Burns Lake phosphorus budget showing sources by percentage in 1993.

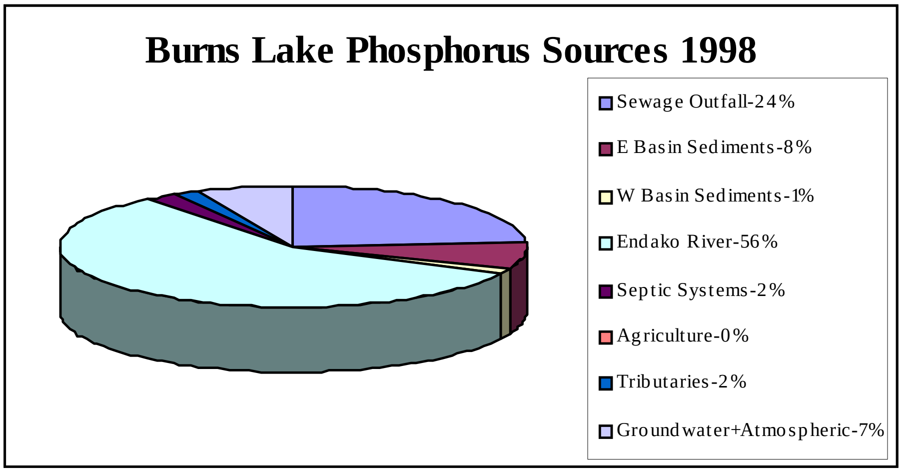

Figure 22. Burns Lake phosphorus budget showing sources by percentage in 1998.

7.4 Biological Characteristics

Algae

Aquatic algae are single celled, photosynthetic organisms that form the base of aquatic food chains. These organisms are separated into three groups based on where they grow: algae that float on or just below the surface of the water are called *phytoplankton*, mobile algae (flagella or cilia) are called *planktonic*, and those algae that attach themselves to the bottom substrate are called *periphyton* (Holden et. al., 2001). Abundance of all forms is primarily a function of light, temperature, and concentration of nutrients.

Algae are classified into five divisions according to colour: Diatoms (*Bacillariophyta*), Green (*Chlorophyta*), Golden (*Chrysophyta*), Blue-green (*Cyanobacteria*) and Dinoflagellates (*Dinophyta*). Algal biomass and species diversity is a good indicator of the trophic status of the lake. See Appendix C for a list of species present in Burns and Decker Lakes. Algal biomass can be indirectly estimated by measuring the concentration of chlorophyll *a* within the water column (see Figure 23).

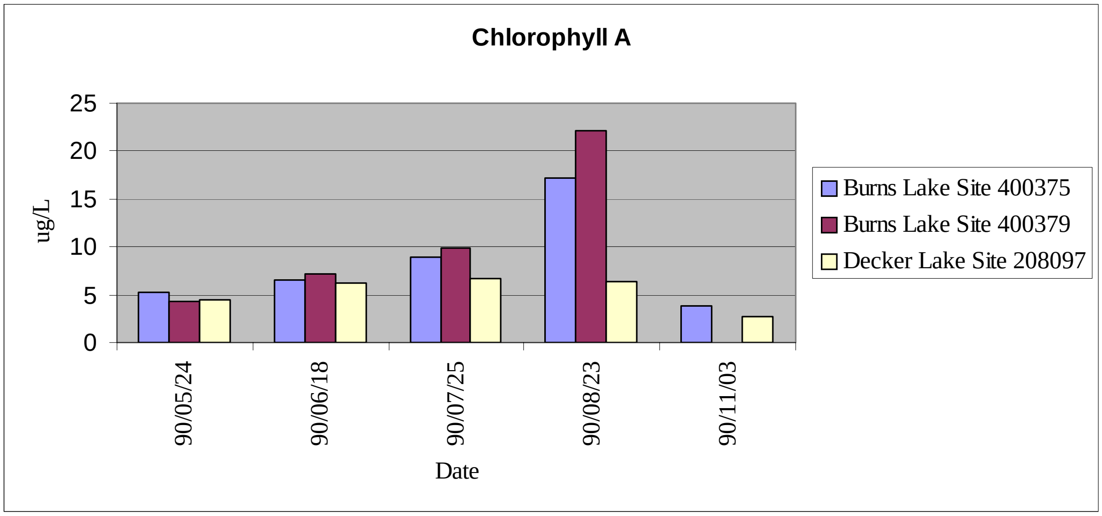

Figure 23. Concentration of chlorophyll *a* for Burns and Decker Lakes taken from May to November 1990.

Aquatic Macrophytes

Aquatic macrophytes are vascular plants (plants with conducting tissue) that provide the most productive and important habitat in a lake (Holdren et.al., 2001). There are different types of growth forms for macrophytes, including submergent, emergent, floating-leaved, and free floating. Macrophyte growth is effected by temperature, light penetration, nutrients, and slope and sediment type (for rooted types). Rooted macrophytes tend to rely primarily on nutrients found in the sediment while free floating forms draw upon nutrients found in the water.

Studies suggest that there is an inverse relationship between algae and macrophytes. When there are large algae blooms, there are often fewer macrophytes. Where there is large macrophyte growth, there is usually reduced algae growth (Wetzel, 1983). Although a complete species inventory of aquatic macrophytes has never been conducted in Burns and Decker Lake, area residents and users have noticed an increase in Canada waterweed (*Elodea canadensis*) in both lakes. See Dr. Pat Warrington's website (http://www3.bc.sympatico.ca/warrington/consult.html) for a complete list of macrophytes found in British Columbia.

Zooplankton

Zooplankton are microscopic single- or multi-celled animals that form an integral part of the aquatic ecosystem. Not only do zooplankton form a major food source for fish and invertebrates, they also act like gazers on the algae community. Zooplankton can significantly increase the clarity of the water by feeding on algae (Holdren et.al., 2001).

No information on zooplankton species present in Burns and Decker Lakes could be found.

Fish

Burns and Decker Lakes:

There have been fish surveys conducted on both Burns and Decker Lakes using sinking monofilament gill nets and seine netting from shore. Figures 24 and 25 show a representation of the species assemblage in the lakes. [Note: Anecdotal evidence (communication with local residents) suggests that other species such as lake trout and Chinook salmon may also be present in either lake, but they are not represented in the survey results. This confirms some of the sampling limitations of a survey conducted in this manner.]

This survey data should be considered a rough estimation, and may or may not represent actual fish populations in the lakes. The data does, however, reveal that there is a large coarse fish population in both Burns and Decker Lakes.

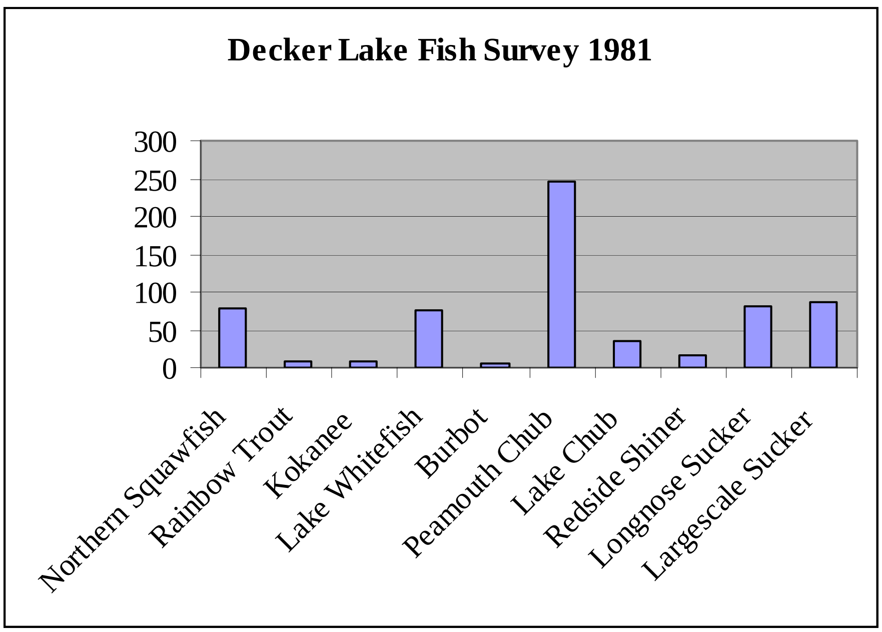

Figure 24. Decker Lake fish survey conducted by Webber and Tupniak, 1981.

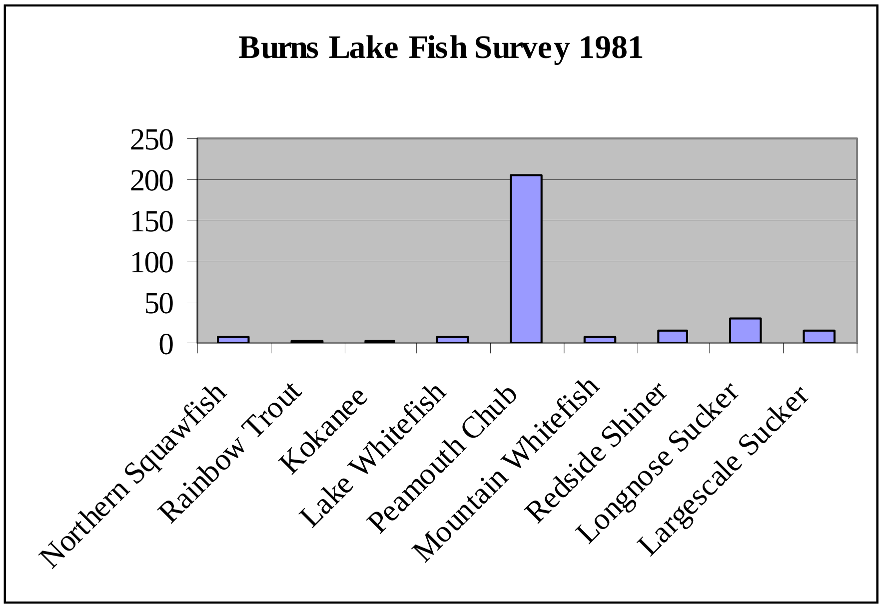

Figure 25. Burns Lake fish survey conducted by Webber and Tupniak, 1981.

<u>Endako River Watershed:</u>

Burns and Decker Lakes form part of the Endako River watershed, and the quality of the lakes affects the quality of fish habitat in the river downstream of the lake. In addition, it is possible that some of the fish in the Endako River spend at least part of their life in Burns Lake. The following information is summarized from a number of fisheries enhancement studies conducted by the Carrier-Sekani Tribal Council in the Endako River.

Chinook salmon:
The Endako River has a small anadromous population of Chinook salmon (*Oncorhynchus tshawytscha*) that utilize the river and its tributaries to spawn and rear. This population is functionally extinct, because fewer than five hundred adults are counted here each year (Ableson, pers. comm., 2002). The salmon return from the sea and spawn in late summer and early fall, with peak spawning occurring during the first week of September. The majority of spawning habitat is directly downstream of Shovel Creek, with other minor locations near the Burns Lake outlet and other Endako River reaches (ARL, 2001c). When the juveniles hatch, they migrate from higher velocity spawning areas to lower velocity rearing locations to rear over the winter, before returning to the ocean via the Fraser River.

Kokanee salmon:
Kokanee salmon (*Oncorhynchus nerka*) is the common name for the landlocked Sockeye salmon. These salmon reside in Burns Lake for most of their four year life cycle, but spawn and over-winter below the lake outlet in the Endako River. In two independent enumerations, (ARL, 2001a, 2001b) the number of adult Kokanee counted at the outlet of Burns Lake during spawning were 7000 and 3000 respectively. Like the Chinook, peak

numbers of spawning salmon generally occur during early to middle September. Once the eggs hatch, the young over-winter in low velocity locations at the outlet before migrating back into Burns Lake in the spring. The Kokanee spend three years in Burns Lake before returning on the fourth year to the Endako River to spawn.

Terrestrial Wildlife and Waterfowl

Although we could find no population data for terrestrial species in the Burns/Decker Lakes watershed, the Resource Inventory Committee's website (www.for.gov.bc.ca/ric) lists all terrestrial vertebrates present in Northern BC. Many of these are likely present in the Burns/Decker Lakes watershed.

Personal communication with local residents indicates that the number of beaver (and the damage that they cause) has been increasing. Figure 26 gives a picture of the number of fur-bearing mammals being trapped in the watershed.

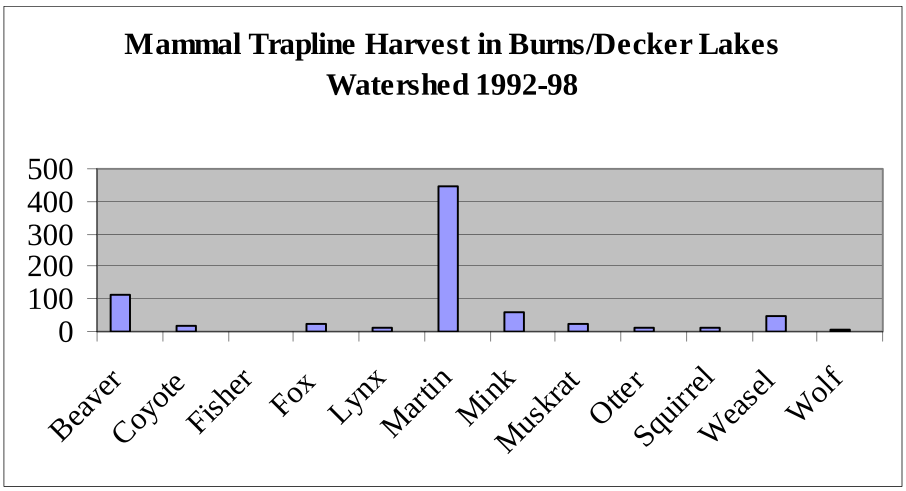

Figure 26. Total mammal trapline harvest in the Burns/Decker Lakes Watershed from 1993 to 1998 (Taken from MELP).

8.0 Issues of Concern in the Burns/Decker Lakes Watershed

For many years, residents in the Burns/Decker Lakes watershed have noticed degradation in the quality and health of their lakes. In 1999 a group of concerned individuals got together and formed the Lakes District Watershed Enhancement Society (LDWES), and throughout this planning process the group has served as a primary voice for the community.

Members of the LDWES identified a number of specific concerns regarding the quality and health of the Burns/Decker Lakes watershed, that they would like to see addressed in this management plan. In addition to these issues, staff at the Ministry of Water, Land and Air Protection were asked what they thought were the important issues surrounding the lakes, and the regional lake planners also conducted a general telephone survey of Burns Lake (and area) residents to identify additional concerns among the community. This consultation exercise yielded a comprehensive list of stakeholder concerns. The stakeholder concerns were classified into six main issues for consideration in this management plan.

8.1 Cultural Eutrophication

Burns and Decker Lakes are naturally eutrophic, but residents claim that water quality in the lakes is degrading as a result of nutrients/pollutants from development. Both point and non-point sources of nutrients are entering from the Village sewage system, individual septic systems, and agricultural, forestry, commercial and residential activities. In a scientific study in 1985, Maclean speculated that developments in many parts of the watershed are contributing to the unusually high nutrient concentrations and water quality concerns in the lakes.

8.2 Aquatic Weeds

The number of aquatic weeds (macrophytes and algae) in Burns and Decker Lakes has been steadily increasing. Although the extent of the problem has not been quantified with formal surveys, the problem is clearly evident. In the telephone survey, 79% of the surveyed residents thought the number of aquatic weeds in the lakes has increased in recent years. *Elodea canadensis* has been identified as the most widespread and problematic weed in both lakes (Warrington, pers. comm., 2001). Its distribution has now spread to include much of the littoral zone. Both scientists and area residents are worried that the weeds may be degrading fish habitat, and they are most certainly interfering with recreational activities on the lake. In addition, *Elodea canadensis* is the likely cause of fish kills in other lakes in this region (Petticrew pers. comm., 2002 and Sharpe pers. comm., 2001).

8.3 Fish Species

Residents claim that the distribution of fish species in Burns and Decker Lakes is changing. Anecdotal evidence from the LDWES members and the telephone survey suggest that there used to be many more sport fish in the lakes, and fewer coarse fish. Burns and Decker Lakes are known to support a large number of coarse fish species, and with the increase in aquatic weeds, it is likely that habitat conditions are no longer ideal sport fish species. The lakes also provide important rearing habitat for sport fish species including rainbow and lake trout, lake and mountain whitefish, kokanee, and chinook and sockeye salmon, and restoring the salmonid fish stocks is very important to many stakeholders.

8.4 Social Values

The social value of Burns and Decker Lakes has declined substantially in recent years. As eutrophication occurs, the quality of the lake water is getting worse and it is no longer visually appealing. Excessive amounts of aquatic weeds have made the lake unattractive to many recreational pursuits such as boating, waterskiing and swimming. The relatively high abundance of coarse fish in the lake has reduced the quality of the recreational fishery, and many of the residents surveyed claimed that they are not interested in eating any fish from Burns Lake. Riparian aesthetics has also been identified as a social concern, and is discussed further in the "Beaver Populations" issue below.

8.5 Lake Levels

The future level of Burns Lake is uncertain as the Carrier-Sekani Tribal Council is investigating lake level control options for enhancing fish habitat in the Endako River. In particular, the tribal council is considering installing a weir at the outflow of Burns Lake to increase summer storage in the lake in order to augment downstream flows in the fall. Residents have not been informed of specific impacts to the lake level, and they are worried that any increase at all will have negative impacts. The existing high-water level hampers agricultural activities in the watershed, is already dangerously close to residential developments, and is likely causing excess nutrients to enter the lake from septic systems.

8.6 Beaver Populations

Beaver populations around Burns and Decker Lakes are high. Dams are affecting the regularity of water flows in many of the creeks and tributaries of the watershed, and in the Endako River. The beavers' activities are resulting in safety and aesthetic concerns because they are destroying riparian habitat and cutting trees.

9.0 Lake Management Goals and Objectives

The issues identified above were examined to determine the watershed system components which relate to the concern. In addition, cause-effect relationships were speculated on. It was determined that the fish and aquatic weed problems have likely emerged as a result of cultural eutrophication processes. To enhance and preserve the quality of Burns and Decker Lakes, a successful management solution will need to treat the symptoms of the eutrophication (weeds, fish, etc.) as well as the causes (nutrient inputs). Beaver activities and lake level concerns are largely unrelated to the eutrophication issue, and can be classified as shoreline issues. The reduced social value of the lakes seems to be largely related to water quality concerns arising from cultural eutrophication, and to beaver activities in the watershed. Lake level concerns are not related to eutrophication, and are a result of proposed changes to the outflow of the lake and to beaver activities.

Based on this analysis, the concerns have been grouped into four general goals. Overall, the four goals address all six issues of concern, and they describe specific areas where actions are necessary in order to achieve the overall plan goal of enhancing and preserving the health of the Burns/Decker Lakes watershed.

Eutrophication Issues:
- Manage the causes of cultural eutrophication
- Control the symptoms of eutrophication

Shoreline Issues:
- Maintain a desirable quality and quantity of water in the lakes
- Improve the shoreline aesthetics of the lakes

Thirteen management objectives were defined underneath the four goals. The objectives represent a break-down of the goals, and they describe in general terms what needs to be done in order to achieve the goals. The objectives are more specific than the goals, but do not include measurable quantities in their description. As the LDWES gains access to more resources, establishes itself in the community, and becomes aware of its capabilities, the group should revisit its goals and objectives by adding measurable quantities to some of its objectives. For example, it should specify the *amount* of phosphorus to be removed from the lake, or the *percentage* of the lake's littoral zone to be subjected to weed control.

The management goals and objectives for the Burns/Decker Lakes management plan are as follows:

Goal 1: Improve water quality in Burns and Decker Lakes by managing the causes of cultural eutrophication
- Objective 1.1: Reduce point source nutrient (phosphorus) inputs to Burns Lake from sewage treatment facilities
- Objective 1.2: Reduce non-point source nutrient (phosphorus) inputs to the lakes from domestic sewage systems on individual properties along the lakeshore

- Objective 1.3: Reduce non-point source nutrient (phosphorus) inputs from land use activities in the watershed

Goal 2: Restore ecosystem balance in Burns and Decker Lakes by controlling the symptoms (excessive weed growth and changing distribution of fish species) of eutrophication

- Objective 2.1: Improve sport fish habitat in the Burns/Decker Lakes watershed
- Objective 2.2: Reduce coarse fish species in the Burns/Decker Lakes watershed
- Objective 2.3: Remove excessive macrophytes (aquatic weeds) that are currently growing in Burns and Decker Lakes
- Objective 2.4: Create and implement a long-term plan to control macrophyte and algae growth in the Burns/Decker Lakes watershed
- Objective 2.5: Reduce the concentration of nutrients (phosphorus) in the lake system by reducing the amount of phosphorus dissolved or suspended in the lake water, and stored in bottom sediments

Goal 3: Maintain a quality and quantity of water in Burns and Decker Lakes that maximizes benefits for both watershed residents and aquatic life

- Objective 3.1: Establish a long-term policy or plan for the outflow of Burns Lake by deciding whether or not to artificially regulate flows
- Objective 3.2: Create and implement a beaver management program to preserve uninterrupted flows in tributary streams
- Objective 3.3: Manage water-based activities to minimize water quality degradation in the lakes
- Objective 3.4: Manage potentially harmful land-based activities to minimize pollutants entering the lake system

Goal 4: Improve the shoreline aesthetics of Burns and Decker Lakes

- Objective 4.1: Create and implement a beaver management program to protect trees adjacent to the lake

10.0 Analysis of Burns/Decker Lakes System – An Inter-relatedness Analysis

Much of the background information on Burns and Decker Lakes (and their watershed) has been presented in Section 7.0 of this document. To better understand the relationships between individual components of the lake and watershed, an inter-relatedness analysis was conducted as part of the planning process. It is based on the fact that changes in one component or variable (of the physical, chemical/biological, or socio-economic system) will affect a number of other components both indirectly and directly. It helped to gain an understanding of some of the key cause/effect relationships and interactions in the system that need to be considered when defining management options that will "work".

To conduct the inter-relatedness analysis, the watershed system was broken down into its components in three system categories: physical, chemical/biological, and socio-economic. It is true that the list is incomplete, and the classification of components into the three systems is artificial. The exercise may also be biased because it represents an anthropocentric perspective; it involves the lake planners deconstructing a complex system into its base components based on their previous knowledge and experiences. However, without such a classification, there would be no way to make sense of the complexities associated with how land and water use influences lakes and their watersheds.

A copy of the inter-relatedness analysis matrix, and details on the methodology and results, are included in Appendix D.

11.0 Assessing Lake Management Alternatives

The first half of this management plan identified problems and issues of concern in the Burns/Decker Lakes watershed. Then a series of management goals and objectives were established in the context of the watershed. The remaining sections of this plan will identify possible management options or actions that can be implemented to protect and enhance the quality of the watershed.

Desirable management options are those that will help meet the goals and objectives of the plan, and can be implemented given local constraints. The process of identifying feasible options can be complex, and decisions must consider cultural, social and political dimensions, while recognizing ecological concerns and financial restrictions (Brewer, 1986). Each of the lake management options has pros and cons, and consequences that must be analyzed in terms of the goals and objectives of the lake management plan (McDaniels, 1992).

11.1 Analysis of Lake Management Options

In this management plan, we began the evaluation process by developing an exhaustive list of management options for each of the objectives. Each option was thoroughly researched, and the advantages and disadvantages of each were recorded in a chart. The chart is included in Appendix E.

There are many techniques that can be used to assess the desirability of lake management options. For more information about some of methods, the Tyhee Lake Management Plan (Rysavy and Sharpe, 1995) provides descriptions and references for the "cost-benefit analysis" and "social impact ranking matrix". The "weighted criteria matrix" is another useful tool because options can be evaluated using a set of criteria that represent a range of dimensions (social, economic, environmental, etc.).

A written survey administered to stakeholders in the Burns/Decker Lakes watershed showed that social, financial, and environmental criteria are equally important in evaluating management options. Also of equal importance was the notion of long-term sustainability and effectiveness of any activities begun as part of the plan. With this knowledge in hand, a panel of key stakeholders participated in a consensus-building exercise to judge the overall merit of each management option while *considering* the set of evaluation criteria (social acceptability, financial cost, environmental concerns, long-term sustainability, and effectives). For financial costs, the panel considered all available resources including technical expertise, financial resources, volunteer labour and equipment. The panel included representatives from the Village of Burns Lake, the Regional District of Bulkley Nechako, the Burns Lake Band (First Nations), the Ministry of Water, Land and Air Protection, and the LDWES.[2] In the end, the panel came up with a series of management options that should be recommended for the watershed.

[2] The Department of Fisheries and Oceans (federal government) and the Fisheries Branch (WLAP) invited to participate in the panel but were unable to attend. Their comments have still been incorporated into the recommendations of this plan.

12.0 Potential Lake Management Options

12.1 The Option of Doing Nothing

Before presenting the list of potential lake management options for the Burns/Decker Lakes watershed, it is important to note that "Do nothing" is a viable management solution in certain circumstances. Planners should always consider the consequences of doing nothing because it offers one basis of comparison for the potential effects of implementing a lake management program (Rast and Holland, 1988). The "Do nothing" option helps highlight cases where a management program is desirable, and other cases where a program may not be required or should be postponed until further information permits a better analysis of options.

12.2 Other Lake Management Options

There are three general categories of lake management options; those which treat the symptoms of a problem, those which treat the causes, and those methods which attempt to restore lake conditions. When the symptoms are treated without any effort to identify and correct the problem and its causes, this treatment will only be temporary. Until the problem is identified and the causes of the problem are addressed, the symptoms will continually reappear.

The management goals and objectives in this lake management plan are organized with this in mind. The first goal of the plan is to manage the causes of eutrophication, and the options for this goal involve improving specific land use and/or watershed management practices to minimize nutrient inputs (Objectives 1.1 to 1.3). External nutrient sources that can degrade lake water quality must be addressed before internal management options are considered (Rysavy and Sharpe, 1995).

The second goal of the plan is to restore ecosystem balance in the lakes. Objectives 2.1 to 2.4 relate to controlling the symptoms of eutrophication, and Objective 2.5 involves in-lake techniques to remove phosphorus from the system. In general, in-lake methods are usually more expensive and less effective over the long term than those options which treat the causes of a problem (Rysavy and Sharpe, 1995).

It is likely that a combination of lake management options is required to maximize the effectiveness of restoration and control of the lake conditions. The following is a list of potential lake management options that were **considered** (not necessarily recommended) for the Burns/Decker Lakes watershed:

Goal 1: Improve water quality in Burns and Decker Lakes by managing the causes of cultural eutrophication

- <u>Objective 1.1: Reduce point source nutrient (phosphorus) inputs to Burns Lake from sewage treatment facilities</u>
    - Install phosphorus removal stage in sewage treatment system
    - Extend Burns Lake sewage system outfall

- Objective 1.2: Reduce non-point source nutrient (phosphorus) inputs to the lakes from domestic sewage systems on individual properties along the lakeshore
    - Advocate improved services (water and waste disposal) for outlying subdivisions
    - Improve general awareness and public education relating to septic systems and their environmental impacts

- Objective 1.3: Reduce non-point source nutrient (phosphorus) inputs from land use activities in the watershed
    - Encourage high quality stormwater treatment
    - Encourage improved forestry practices in the watershed to minimize sediment delivery to the lake
    - Encourage improved agriculture practices in the watershed to minimize nutrient inputs
    - Include LDWES participation in regional planning processes (zoning bylaws, etc.)
    - Collect more data to improve knowledge of the watershed system and track changes in lake quality
    - Improve general public awareness of lake values and human influences on lake quality

Goal 2: Restore ecosystem balance in Burns and Decker Lakes by controlling the symptoms (excessive weed growth and changing distribution of fish species) of eutrophication

- Objective 2.1: Improve sport fish habitat in the Burns/Decker Lakes watershed
    - Improve access to spawning habitat blocked by beaver dams
    - Improve the quality and quantity of salmonid habitat in the Burns/Decker Lakes watershed
    - Improve general awareness and public education, and make fisheries data more accessible to the public
    - Conduct an assessment of existing fish populations and develop a fisheries management strategy

- Objective 2.2: Reduce coarse fish species in the Burns/Decker Lakes watershed
    - Hold coarse fish derbies
    - Implement a coarse fish control program

- Objective 2.3: Remove excessive macrophytes (aquatic weeds) that are currently growing in Burns and Decker Lakes
    - Chemical control with Diquat
    - Chemical control with Fluridone
    - Biological control with grass carp
    - Mechanical control by hand cutting or pulling
    - Mechanical control using mechanized harvester
    - Mechanical control using diver-operated suction harvesting (or dredging)
    - Mechanical control by mechanized de-rooting methods, such as rototilling
    - Physical control by dredging/sediment removal
    - Physical control by installing benthic barriers

- Objective 2.4: Create and implement a long-term plan to control macrophyte and algae growth in the Burns/Decker Lakes watershed
    - Create and implement an Integrated Aquatic Plant Management Plan (begin by conducting an inventory of aquatic macrophytes and algae in the lake)

- Objective 2.5: Reduce the concentration of nutrients (phosphorus) in the lake system by reducing the amount of phosphorus dissolved or suspended in the lake water, and stored in bottom sediments
    - Implement a volunteer monitoring program to collect data
    - Reduce P release from sediments by installing a hypolimnetic aeration system
    - Remove P-rich water from the hypolimnion with a hypolimnetic withdrawal system
    - Remove P-rich sediments from the lake bottom by dredging
    - Remove P from the water through P-inactivation techniques (apply alum to the lake bottom)

Goal 3: Maintain a quality and quantity of water in Burns and Decker Lakes that maximizes benefits for both watershed residents and aquatic life

- Objective 3.1: Establish a long-term policy or plan for the outflow of Burns Lake by deciding whether or not to artificially regulate flows
    - Wait until the Carrier-Sekani Tribal Council's final weir proposal is complete and all stakeholders have an opportunity to review the document and provide input

- Objective 3.2: Create and implement a beaver management program to preserve uninterrupted flows in tributary streams
    - Manage the population by implementing a "live-trapping and relocation" program
    - Control beaver problems by increasing trapping by registered trappers through incentive plans
    - Control beaver problems by destroying dams using manual, mechanical, or explosive techniques

- Objective 3.3: Manage water-based activities to minimize water quality degradation in the lakes
    - *For future investigation; not considered in the lake management plan due to time constraints*

- Objective 3.4: Manage potentially harmful land-based activities to minimize pollutants entering the lake system
    - *For future investigation; not considered in the lake management plan due to time constraints*

Goal 4: Improve the shoreline aesthetics of Burns and Decker Lakes

- Objective 4.1: Create and implement a beaver management program to protect trees adjacent to the lake
    - Increase awareness of status quo policies and options to prevent and control beaver problems
    - Provide assistance for beaver control activities carried out by property owners
    - Allow beaver control by property owners by adding a beaver hunting season
    - Manage the population by implementing a "live-trapping and relocation" program
    - Control beaver problems by increasing trapping by registered trappers through incentive plans

Details including the advantages and disadvantages of each option are included in the tables in Appendix E.

13.0 Recommendations

The options analysis panel members received a copy of the table describing the advantages and disadvantages of each option. They were asked to consider the five criteria (social acceptability, financial cost, environmental concerns, long-term sustainability, and effectives), and discuss as a group the applicability and feasibility of each option for the Burns/Decker Lakes watershed.

At the end of the session, the panel decided that some of the management options are realistic and likely to be effective in the Burns/Decker Lakes watershed. This section highlights the best options for each of the objectives. These options should be included in the overall management approach for Burns and Decker Lakes.

Goal 1: Improve water quality in Burns and Decker Lakes by managing the causes of cultural eutrophication

<u>Objective 1.1: Reduce point source nutrient (phosphorus) inputs to Burns Lake from sewage treatment facilities.</u>

Recommendation: Install a phosphorus removal system in the Burns Lake municipal sewage treatment facility

Upgrading the Village of Burns Lake sewage treatment facility to further remove phosphorus from treated effluent will reduce the amount of phosphorus in the lake (stored in the sediments of the East basin), and will lessen the effects of population increases in the future. There is already a ten-year plan (written in the early 1990's) in place to upgrade the sewage treatment facility for phosphorus removal. To date, a berm has been constructed to bisect one of the polishing ponds for future phosphorus treatment. The upgrade is expected be finished by the end of 2003, and once the system is complete, total phosphorus at the outfall into Burns Lake will be reduced from approximately 3 mg/L to below 1 mg/L.

The biggest disadvantage of upgrading the treatment system to include phosphorus removal is financial cost. However, the upgrade is quite feasible given infrastructure cost sharing programs that are available to supplement money that has already been budgeted for this upgrade. The better a treatment system is in removing nutrients, the less algal and aquatic plant growth will occur (Holdren et. al., 2001).

<u>Objective 1.2: Reduce non-point source nutrient (phosphorus) inputs into the lakes from domestic sewage systems on individual properties along the lakeshore</u>

Recommendation: LDWES should advocate improved services (potable water sources and sewer installation) for areas outside the Burns Lake municipal service area

Service improvements to these areas will benefit both the aquatic environment and (more importantly) human health. Connecting peripheral subdivisions (Gerow Island and First Nations properties on the south side of the lake) to the Burns Lake municipal sewage system would reduce leachate (non-point sources of phosphorus) from inadequate onsite septic systems. Municipal sewage connection would also reduce the risk of pollutants contaminating the drinking water supply (from surface or shallow wells). In Byetown, further protection from pollutants entering into drinking water can be achieved by accessing water from deep groundwater supplies.

Implementing this solution should occur in two phases. In the short-term, a drinking water assessment should be conducted for residences on or near that lakeshore that are not currently serviced by the Village of Burns Lake. Areas where drinking water supplies are at risk of contamination would then be dealt with through the province's new drinking water protection system. With the province's increased emphasis on providing clean drinking water supplies, this phase can and should be implemented soon.

In the long-term (10+ year planning horizon), a plan could be initiated to extend municipal sewer services. A "service area" program may be set up early in the plan to raise funds in anticipation of sewage extensions. This "service area" funding source (administered by the Regional District of Bulkley Nechako) could be supplemented with cost sharing infrastructure grants.

LDWES advocacy regarding these issues could help to initiate actions to protect human health and improve the quality of the aquatic environment. Unknown factors related to lakeside septic systems (inputs to the lakes) could be eliminated; and the risk of drinking water contamination could be reduced.

Recommendation: It is important to improve general awareness and public education relating to onsite septic systems and their impacts to the aquatic ecosystem.

The LDWES should disseminate educational information about septic systems and their effects on lakes. Septic system awareness and educational materials are available from a number of sources including industry, educational institutes and government agencies. A package can then be developed and tailored to the local community.

Septic system information packages should include information about:

- System operation, construction and maintenance
- Alternative septic system designs that may be used in areas where normal systems cannot be placed
- Everyday habitats that have a direct positive or negative impact on the local aquatic environment (for example: use of phosphate-free soaps)

A package with this material could be put together for very little cost using cheap or free publications. The packages should be distributed at community meetings, and to municipal and regional offices. At the panel discussion, it was suggested that a Regional

District seasonal employee (eg. weed inspector) may be enlisted to disseminate this information and conduct septic system assessments for those residents who wish to use this service. The biggest advantage offered from this solution is that it is a cost-effective way of reducing septic leachate immediately (septic maintenance and upgrade) while providing a long-term, sustainable way of addressing septic leakage.

<u>Objective 1.3: Reduce non-point source nutrient (phosphorus) inputs from land use activities in the watershed</u>

Recommendation: LDWES should actively encourage Best Management Practices (BMPs) within the watershed

Stormwater treatment, agricultural and forestry best management practices should be implemented in Burns/Decker Lakes watershed. These practices will help conserve soil, reduce non-point source nutrient and pollutant flows, and protect water resources. Overall, BMP plans will lessen the detrimental effects of land use activities on the aquatic system, and help preserve the health of the aquatic watershed ecosystem while maintaining a sustainable resource extraction.

Before any BMP plans are implemented within the watershed, different sites should be rated for ecological sensitivity. A plan tailored to each activity and site can then be created.

- **Stormwater:** LDWES should encourage the Village of Burns Lake to undertake a high level of vigilance when treating stormwater runoff. BMP plans for other areas of the watershed should concentrate on preventing/minimizing runoff or improving stormwater treatment measures (or a combination of both).
- **Forestry:** LDWES members could become involved in forest development planning as it relates to the watershed. Through participation in these forums, LDWES may accomplish sediment minimization and control by promoting BMPs.
- **Agriculture:** Sound agricultural practices should encourage farming/grazing techniques that protect aquatic resources without diminishing agricultural productivity. A forthcoming (September 2002) document developed by the Ministry of Agriculture, Food and Fisheries entitled "Developing an Environmental Plan" will be a useful tool to promote BMPs. LDWES members could become involved in reviewing plans like these, and promoting their "uptake" amoung the agricultural community in the watershed.

Members of the LDWES should attend other organizations' meetings (eg. ComFor and the Cattleman's Association) and become involved in their activities. Joining other organizations may offer an excellent opportunity to recruit members from these groups into the LDWES. Advocacy is likely an effective and realistic option to promote change, given the small population of the community and the functional role of the LDWES in the community.

The advantage of joining organizations and encouraging BMPs is that it incurs no direct costs. BMP plans have already been produced, and are usually general enough to be customized to activities in this watershed. Implementing best management practices will encourage resource-use sustainability while protecting social, environmental, spiritual and environmental concerns.

Recommendation: LDWES should promote local aquatic ecosystem issues in Official Community Planning and land-use zoning initiatives in the watershed

LDWES representatives should provide input to municipal and regional planners on Official Community Planning and land-use zoning initiatives. Participation in these initiatives will ensure that aquatic ecosystem issues are considered in local decision-making. The Regional District of Bulkley Nechako has requested that LDWES participate in creating their Lakeshore Development Guidelines in 2002; LDWES should follow up on this request, and support similar initiatives in the future.

Recommendation: Collect more data to quantify the impacts of land-use activities and increase knowledge of the watershed system

The need for a volunteer data collection and monitoring program is discussed under Objective 2.5. In the future, the monitoring program can be expanded to include data to quantify the impacts of various land use activities on the aquatic environment.

Recommendation: Improve general public awareness of lake values and human influences on lake quality

Watershed education is the most cost effective method of instigating change in the way community residents use, perceive, and value the natural environment. Education and awareness is a useful tool for highlighting the interaction between human land use and its effects on lakes and watersheds. Without an awareness of the ecological footprint each individual has on his or her own local ecosystem, there will be no personal responsibility for watershed health.

An education and awareness program should be developed for both general community residents and local school curricula. A public education program could be organized by the LDWES. Educational materials could describe ecosystem components, interactions, functions, and include ideas for individuals, families or the community to help restore or maintain the quality of the watershed. The program could be disseminated to residents through multiple media sources: television, radio, websites, pamphlets, brochures and meetings.

Incorporating a watershed education program into a school curriculum can be done in a cheap and timely manner if other successful programs are used as a template. Sample programs are found on the web include:

- USGS School Water Resource Program (http://water.usgs.gov/outreach/wrei.html)
- Telkwa Elementary School Lake Science Activity Program (http://tel.sd54.bc.ca/lake/lakek.pdf)

The watershed education program will be a relevant, “hands on” approach for science education. For the students, it will instil a life long appreciation of the ecosystem they are learning about.

Goal 2: Restore ecosystem balance in Burns and Decker Lakes by controlling the symptoms of eutrophication.

<u>Objective 2.1: Improve sport fish habitat in the Burns/Decker Lake watershed</u>

Recommendation: Conduct an assessment of the existing fisheries population and develop a management strategy

Prior to initiating any restoration activities that will impact fish habitat and fish populations/communities, an assessment of the existing population(s) must be conducted to determine sustainability (Giroux pers. comm., 2002). Analysis of fish population data will reveal the community dynamics contributing to an existing sustainable population. Using this information, a fisheries/fish community management strategy should be created before any further activities occur.

A qualified professional biologist should be hired to design and conduct the fisheries assessment of Burns and Decker Lakes. The fisheries management strategy should be based on the fisheries assessment data, and include input from local community members, government, and technical experts. The strategy should consider all existing federal or provincial legislation (Federal Fisheries Act and Fish and Wildlife Act).

The LDWES and other local organizations interested in fish population health should investigate and apply for any funding sources applicable. Hiring university or college students, under professional supervision, may be a viable option to reduce costs. Although a complete fisheries assessment may be expensive, it is needed to determine a complete picture of fish population dynamics/interactions, and to predict the effects of any restoration projects.

Recommendation: Undertake projects to improve the quality and quantity of sport fish spawning and rearing habitat in the Burns/Decker Lakes watershed

Rehabilitating spawning areas with marginal or reduced value will most certainly help local salmonid populations by increasing recruitment rates (Watershed Restoration Technical Circular No. 9, 1997). Activities that augment existing holding and rearing habitat will likely increase the survivability of juvenile fish (age <3 years). Streambank restoration initiatives in tributary streams are also useful in conjunction with spawning and holding/rearing habitat rehabilitation to reduce sedimentation rates (Giroux, pers. comm., 2002).

Before any habitat rehabilitation improvements are considered, review by a qualified rehabilitation biologist should be conducted. Any mechanical restoration work should only be considered feasible if it does not require ongoing maintenance.

The greatest return for fisheries enhancement funding is achieved by performing restoration activities (Ableson pers. comm., 2002). Funding for rehabilitation initiatives may come from local non-government agencies and clubs (such as Rod and Gun Clubs) or through federal/provincial funding sources (such as D.F.O.). Materials, labour, and equipment for habitat construction projects should be donated from within the local community to keep costs to a minimum.

Recommendation: Improve the general awareness of sport fish issues within the Burns/Decker Lakes watershed

A fisheries education program will help all community residents and resource users acquire an awareness of fish and their habitat requirements. It will help cultivate social and technical skills necessary for solving local fisheries management problems.

The education program should be tailored to provide information to specific user groups, general community residents, and the young. To reduce costs, previously written material and programs should be used as templates, with changes reflecting local watershed conditions. Existing community groups (LDWES, Boy Scouts, Rod and Gun Club, and schools) should act as the means of program administration. Resources that will be useful for developing educational materials include:

- Canadian Wildlife Federation "Fish Ways" (http://www.wildeducation.org/programs/fish_ways/fishways.asp)
- "The Four Seasons: Habitat Requirement for B.C Salmonids" and "Riparian Areas" Videos
- Fisheries Information Summary System (http://www.bcfisheries.gov.bc.ca/fishinv/fiss.html)

A fisheries education program is a low cost means of promoting positive attitudes towards fish, habitat protection and rehabilitation, an ecosystem approach to responsible fisheries management, and respect for the environment.

Objective 2.2 Reduce coarse fish species in the Burns/Decker Lakes watershed

Recommendation: Hold coarse fish derbies to catch and remove coarse fish from Burns and Decker Lakes

The LDWES should organize regular coarse fish derbies, using the expertise of the Burns Lake Band (organizers of past derbies in Burns Lake). A good advertising campaign and careful date selection are critical to ensure success of the event. The derby may be a good fundraising opportunity, and could be a good venue for distributing both sport and coarse fish educational material. Residents should be encouraged to set up booths to highlight local businesses and organizations, and tourism opportunities. The waste fish can be used as fertilizer for the local community (nurseries, small scale agriculture and community gardens).

Past derbies held on Burns have removed more than 20,000 coarse fish over three years. Although this number of fish is not likely going to affect the long-term population dynamics, it will be a short-term reduction in the coarse fish population.

A major strength of a successful derby is the opportunity to distribute information and increase awareness about both coarse and sport fish species in Burns and Decker Lakes. It will encourage an appreciation of the aquatic resources in the watershed, especially for young participants. The derby may be able to attract out-of-town participants, which could benefit the local economy and tourism industry. Burns Lake is an ideal location because it is on a major travel corridor with easy access to the lakes.

Objective 2.3: Reduce excessive macrophytes (aquatic weeds) that are currently growing in Burns and Decker Lakes.

An Aquatic Weed Conference was held in Burns Lake on March 8-9, 2002. At the conference, participants discussed various options to control aquatic weeds in North-Central B.C. lakes and rivers. In some cases, the options presented at the conference (and summarized in Appendix E) have already been implemented in other nearby lakes. In other cases, the technique is not authorized for local use, and further investigation by various permitting agencies is required (eg. triploid grass carp are currently illegal in British Columbia, and *Sonar* aquatic herbicide is not yet registered for use in Canada). A copy of the conference proceedings is included in Appendix F.

All of the keynote speakers at the conference agreed that weed control activities need to be carefully thought out in the context of the lake and its watershed, and that an Integrated Aquatic Plant Management Plan is needed. Objective 2.5 (see below) describes some considerations for developing an aquatic plant management plan. The extent of the aquatic weeds concerns in Burns and Decker Lakes have not yet been formally defined, and the impacts of the infestation are not yet known. Until each of the control options described in Appendix E can be adequately considered in an aquatic plant management plan, only two of the options should be implemented in the Burns/Decker Lakes watershed.

Recommendation: Encourage the installation of benthic barriers to control nuisance aquatic plants in high-use areas

Benthic barriers have been installed by BC Parks at Tyhee Lake (near Smithers, B.C.) and by other organizations at numerous locations around the province. They eliminate the growth of aquatic weeds in localized areas, without having adverse effects in other parts of the lake. Installing barriers in high use areas will make the water more desirable for recreational uses (swimming, etc.). The Village of Burns Lake has already indicated an interest in installing a geotextile fabric at Radley Beach. The LDWES should encourage the Village to proceed with this option, and monitor its effectiveness. If it does prove to work, the LDWES could encourage other concerned individuals and organizations to install similar barriers in small areas on their own waterfront. The Department of Fisheries and Oceans (DFO) should be notified before any barriers are installed.

Recommendation: Control nuisance aquatic plants by hand cutting or pulling

Using low-tech mechanical techniques to remove aquatic plants can also provide relief from localized aquatic plants problems in high use areas. The technique is appropriate for use in Burns and Decker Lakes because it has few adverse environmental impacts, and it is a cheap way to achieve interim control until an aquatic plant management plan can be developed. Individual homeowners and others who are concerned about aquatic plant infestations on their waterfront areas can selectively remove undesirable plants by hand.

Objective 2.4: Create and implement an Integrated Aquatic Plant Management Plan

Recommendation: Conduct an inventory of aquatic plants in Burns and Decker Lakes, and create and implement an Integrated Aquatic Plant Management Plan

It is important to remember that plants are an integral part of a balanced aquatic ecosystem, and they perform a wide variety of ecological functions (see Appendix F). However, under certain conditions, aquatic plants can be problematic. Excessive growth can negatively affect recreation and aesthetic enjoyment of a waterbody, and aquatic plants can form dense stands that create poor habitat for fish and wildlife. The solution to problem plant growth lies in careful management.

Before any of the other aquatic plant control options (suggested for Objective 2.3) are implemented, an Integrated Aquatic Plant Management Plan should be developed to provide long-term direction for controlling macrophyte and algae growth in the Burns/Decker Lakes watershed. A plan provides a means to make informed decisions for managing aquatic plants to protect human health and the environment. Through integrated aquatic plant management, solutions can be found that are effective, ecologically sensitive, and economically feasible (Gibbons et. al., 1994).

Preparing the Plan

A successful plan is created by identifying and understanding the features and users of a waterbody, establishing management goals, considering a range of management techniques, and implementing an action and monitoring plan.

LDWES should establish a sub-committee to deal with aquatic plant concerns. This group should concentrate on preparing an aquatic plant management plan. The following two sources will offer guidance and provide excellent reference material for the sub-committee:

Gibbons, M. V., H. L. Gibbons and M. D. Sytsma. 1994. A Citizen's Manual for Developing Integrated Aquatic Vegetation Management Plans. Washington State Department of Ecology. http://www.ecy.wa.gov/programs/wq/plants/management/manual/index.html

Hoyer, M. V. and D. E. Canfield, Jr., eds. 1997. Aquatic Plant Management in Lakes and Reservoirs. Prepared by the North American Lake Management Society and the Aquatic Plant Management Society for U.S. Environmental Protection Agency, Washington, DC. http://aquat1.ifas.ufl.edu/hoyercon.html (see Chapter 6)

The extent of aquatic weed concerns in Burns and Decker Lakes is not well known at this time, so in the interim, the sub-committee should concentrate its initial efforts on conducting an inventory of algae and aquatic macrophytes in the lakes. All aquatic plants need to be identified, and their locations and abundance needs to be determined and mapped. *Elodea canadensis* biomass should be estimated. Chapter 8 of Gibbons et. al. (1994) provides details for mapping aquatic plants.

<u>Objective 2.5: Reduce the concentration of nutrients (P) in the lake system by reducing the amount of P dissolved or suspended in the water, and stored in the bottom sediments.</u>

Given the lack of baseline data and the current financial restrictions of the LDWES and relevant government agencies, eutrophication concerns in Burns and Decker Lakes do not currently warrant phosphorus removal action. Most of the options for this objective (described in Appendix E) are very expensive and should only be considered once other external phosphorus control methods have been implemented (see Objectives 1.1 to 1.3) and a good set of environmental data (phosphorus budget, macrophyte and algal biomass data, etc.) has been collected and analyzed.

Recommendation: Implement an ongoing volunteer monitoring program to collect data

Before any internal phosphorus management techniques can be recommended for Burns and Decker Lakes, it is necessary to have a much clearer understanding of the lake systems. The *Background Information* section (Section 7.0) of this management plan presented some preliminary phosphorus budgets for Burns Lake. However, these budgets can only be considered best-guess "snap-shots" of the lake because they simplify the system and use only estimations of some phosphorus sources. General nutrient budget data is badly needed for both lakes. A realistic phosphorus budget will require accurate data on the sources and mass loadings of phosphorus entering the lakes, and the distribution and changes of phosphorus in the system over time.

Volunteer Monitoring Program

The involvement of stakeholders as volunteers has been found to be of enormous value in the lake monitoring process. Volunteers are an efficient and cost effective method of monitoring lakes, and a well-organized and maintained volunteer lake monitoring program can achieve the following goals:

- Provide credible information on water quality conditions to local agencies
- Educate the public about water quality issues (volunteers will learn about water sampling, lake biology, and the impacts of land use activities)
- Build a constituency of involved citizens

The cost of implementing a volunteer monitoring program is relatively inexpensive: some simple equipment needs to be purchased (or borrowed), a sampling protocol needs to be developed, and the volunteers need to be trained. To implement a program, the LDWES should work with the Ministry (WLAP) to develop a list of data requirements and sampling protocols. Many other lake societies in British Columbia are involved in successful volunteer monitoring programs, and attempts should be made to piggyback on their efforts. Bruce Carmichael (WLAP, Prince George) has developed a program for the Omineca-Peace region. Samples of his procedures and data sheets are included in Appendix G. To ensure a specific degree of confidence in the data collected, sampling must be conducted under a sound quality assurance program. More detailed information on quality assurance and quality control is also contained in Appendix G.

A successful water quality monitoring program should target variables which represent general water quality, as well as any other variables based on specific situations in the lake.

<u>Nutrient Variables</u>

Because most of the concerns in Burns and Decker Lakes are eutrophication-related, Temperature, Dissolved oxygen, and other "Nutrient variable" data is needed to define and monitor the nutrient status of the lake. Dr. Rick Nordin (pers. comm.., 2002) has recommended that a monitoring program for Burns and Decker Lakes include measurements of:

Temperature: Of all the properties of a lake, temperature has the greatest influence on the biology and chemistry of the lake system. A temperature profile is useful to observe the stratification pattern in a lake, and a uniform profile also proves that you have sampled during spring turnover. Water temperatures should be measured at 1m intervals throughout the water column.

Dissolved Oxygen: Dissolved oxygen (DO) is the weight of oxygen that is contained in a given volume of water. It also affects the suitability of the lake as habitat for various aquatic organisms and influences the solubility of many metals and other compounds (including phosphorus compounds). If a dissolved oxygen meter is available, oxygen levels should be measured throughout the water column.

Transparency: Transparency (or clarity) measures the transmission of light through water. This depends on the natural color of the water and the amount of suspended solids in the water (Holdren et. al., 2001). Secchi depth is the most frequently used variable in limnology, and is easily measured in the field by lowering a black and white Secchi disk into the water until it can no longer be seen. Secchi depth can be correlated with phosphorus and chlorophyll *a* to estimate the trophic status of a lake.

Total Phosphorus: Phosphorus is critical for plant growth, and is a key nutrient in determining the quantity of algae (and macrophytes) in a lake (Holdren et. al., 2001). Phosphorus generally occurs in water as phosphates in solutions, in particulate detritus, and in the bodies of aquatic organisms. Total phosphorus is a measure of the total concentration of phosphorus species present in the sample. In the lake basin, it is important to determine the total phosphorus concentration at the deepest part of the lake during spring turnover (Rysavy and Sharpe, 1995).

Chlorophyll *a*: Chlorophyll *a* is a pigment found in all types of algae, and is sometimes in direct proportion to the biomass of algae (Holdren et. al., 2001). It is used to help determine the degree of eutrophication of a lake, and is often correlated with spring overturn phosphorus concentrations (Maclean, 1985).

Nitrogen: Nitrogen is the other major nutrient that has a large influence on aquatic plant growth. Nitrogen occurs in various forms in lakes. If sampling funding is available, it is useful to analyze three different nitrogen forms in the lake: Kjeldahl nitrogen (total nitrogen), Nitrate (NO_3), and Ammonia (NH_4). Note: if necessary, the remaining forms of nitrogen can be calculated from these three (Nordin pers. comm., 2002).

Sampling locations (and depths) can influence any conclusions drawn from the data collected, so it is important that the sampling stations accurately represent the lake conditions (Holdren et. al., 2001). In Burns and Decker Lakes samples should be taken from the deep sections of the East and West basins (See Figures 6 to 9). Temperature and dissolved oxygen should be measured at regular depth intervals (eg. every 1m) throughout the water column to create a depth profile. Other variables only need to be measured at the surface, and at the top and bottom of the hypolimnion (middle and bottom of the water column).

Sampling frequency will need to be determined based on the availability of volunteer samplers and lab analysis funding. Spring turnover is the most critical time to sample for nutrient variables, and at a minimum, samples should be collected at this time. The second most important time to sample is in the late summer/early fall (August-September), but an ideal year-round sampling program will involve four sampling times per year: spring turnover, mid-summer, fall, and through the ice in the winter. If volunteers and funding is available, additional sampling should be conducted at regular intervals over the summer months.

Sampling for these variables will require a Secchi disk, dissolved oxygen meter and temperature probe (with a 30 meter cable between meter and probe), and a Van Dorn sampler to collected water samples from various depths in the water column. It is possible that some or all of this equipment may be borrowed from the Ministry of WLAP. For those variables that cannot be measured in the field, analysis should be conducted by Phillip Analytical Services (the WLAP contract lab in the lower mainland). Pre-washed sample bottles and coolers for shipping the samples to the lab are also necessary, and are likely available from the Ministry or contract lab.

Other Variables

In addition to sampling for the "nutrient variables", it is desirable to also measure the following general water quality parameters on an annual basis (at spring turnover):

Alkalinity: The buffering capacity (alkalinity) is a measure of a lake's ability to neutralize acid inputs and thereby resist changes in pH. The higher the alkalinity, the greater the ability of water to neutralize acids.

pH: is an indication of water acidity and is measured on a scale of 0 - 14. The lower the pH, the higher the concentration of hydrogen ions and the more acidic the water. Values less than 7 indicate acidic water conditions while values greater than 7 indicate basic conditions.

True Colour: colour in water may result from the presence of coloured organic substances (i.e. humus, peat material, plankton and weeds), natural metallic ions (iron and manganese and copper) or highly coloured industrial waste. The colour value of water is extremely pH-dependent, increasing as the pH of the water is raised.

Conductivity: is a numerical expression of the ability of an aqueous solution to carry an electric current. This ability depends on the presence of ions and their various properties, and is a surrogate for the potential contaminant load of the water.

Total Dissolved Solids (TDS): represents chemical constituents in the water that will pass through a filter 0.45 microns in size. The results provide a measure of the dissolved mineralization in the water.

Total Suspended Solids (TSS): Non-filterable residue, also referred to as total suspended solids is the term applied to the material retained by a filter of a standard size.

These parameters make up the general lake characterization variables which are useful for monitoring trends in water quality over time. Combining these variables with the nutrient variables listed above will provide a more holistic and accurate picture of the state of the lake.

The Ministry of Water, Land, and Air Protection (WLAP) Environmental Protection Division should be consulted if any special situations arise that might warrant testing for other variables (specific metals from mine effluent, etc.) It is likely that WLAP permits will address these issues when necessary.

Results from the volunteer monitoring program will provide a basis for future management decisions in the Burns/Decker Lakes watershed. Data collected in the program should be made available to all relevant agencies, including WLAP biologists (Environmental Protection and Environmental Stewardship divisions), agricultural agencies, public health agencies (MoH), and local and regional governments. The monitoring program should continually be reassessed as more monitoring information is gathered and interpreted and as new techniques are developed.

Sediment Coring

In recent years, limited chemical and biological sampling data has established that Burns and Decker Lakes are eutrophic in nature. Maclean (1985) suggested that:

- Developments in many parts of the watershed are contributing to unusually high nutrient concentrations and water quality concerns in the lakes
- High nutrient levels down-lake of the sewage treatment facility provide evidence that cultural eutrophication is occurring.

Additional sampling and analysis should be conducted to verify the validity of these statements, and perhaps prove that human settlement is speeding up the rate of eutrophication.

Sediment core sampling may provide the answer. Results from core studies will provide additional data about internal nutrient loading that can be used to refine the phosphorus budgets presented in this management plan. Cores also enable the reconstruction of productivity levels of the lakes over time (see Appendix H for details). A comparison of inferred “pre-settlement” phosphorus concentrations with current concentrations will conclusively determine the impact of human settlement on the nutrient status of the lake. This information will be extremely valuable when defining the best lake and watershed management strategies for the future.

On February 7th and 14th 2002, four sets of sediment core samples were taken from Burns and Decker Lakes (two from each lake). The sediment cores have been separated into 1cm thin slices, and are currently frozen in the Ministry (WLAP) freezer. Once funding has been secured (it is estimated that each sample will cost between $5,000 and $6,000 to analyze), the samples can be shipped to Dr. John Smol at Queens University in Kingston, Ontario for analyses. For detailed information about this type of analysis in other North-Central BC lakes, please see the report titled "Paleolimnological Analyses of Cultural Eutrophication Patterns in British Columbia Lakes" (Reavie et. al., 2000).

Additional sediment and water quality samples were also collected on the core sampling dates. Samples from the water-sediment interface and a second set of core samples (also in the freezer) are available to use for a very rough analysis by a lab here in British Columbia. The water samples will be analysed for heavy metals, nitrogen and organic carbon (volatile residue). The core analysis will estimate the differences in phosphorus loading between the two lakes. The rough analysis is much cheaper than the Queens analysis, but it will not provide information about the specific changes in phosphorus loading over time. It will merely offer a comparison of the two lakes to see (in general terms) if Burns Lake has received more phosphorus loading than Decker Lake.

Review and Update Phosphorus Budget:

Before an updated phosphorus budget can be prepared for Burns and Decker Lakes, it is necessary to define all the internal and external sources. The sediment core analysis will help determine the internal phosphorus loading rates to the lakes, but external phosphorus loads from the tributary creeks also needs to be measured. To accurately estimate this loading, stream flow and phosphorus concentrations need to be monitored periodically over the year (weekly, monthly) and supplemented with samples taken during storm events (Holdren et. al., 2001; Rysavy and Sharpe, 1995).

Until a solid base of volunteer lake samplers has been formed, it is not reasonable to expect this volume of data to be collected. In the future, the LDWES may want to consider embarking on a project to collect the data needed for a new phosphorus budget. Chapters 4 and 5 of Holdren et. al. (2001) provides a complete discussion of the data requirements for phosphorus modeling. Cooke et. al. (1993) and Ryding and Rast (1989) also have chapters relating to phosphorus modelling.

Goal 3: Maintain the quality and quantity of water in Burns and Decker Lakes that maximizes benefits for both watershed residents and aquatic life.

Objective 3.1: Establish a long-term policy or plan for the outflow of Burns Lake by deciding whether or not to artificially regulate flows

Recommendation: Wait until the Carrier-Sekani Tribal Council's final weir proposal is complete and then help coordinate a technical review of the document and provide input

The Carrier-Sekani Tribal Council (CSTC) has contracted Aquatic Resources Limited (ARL) to conduct a number of studies on salmonid habitat in the Endako River (Fielden, 1995; ARL, 1999, 2001a, 2001b, 2001c). They have found that preferred spawning and over-wintering rearing habitat in the Endako River (below Burns Lake) for both Chinook salmon and Kokanee is being limited during years of low flow velocities on the Endako River. A number of techniques are available to enhance salmonid habitat degraded by low flows, and ARL has proposed a flow control device at the outlet of Burns Lake to augment water flows in the Endako River during the fall spawning season.

The Proposed Weir

Past studies by ARL (2001c) suggest that a flow increase of $1.0m^3/s$ is needed to inundate most of the accessible spawning habitat in the Endako River. The proposed weir would increase the water velocity in the river to ensure that adequate flows are available during the peak Chinook spawning season. The increased flow velocity would also benefit Kokanee spawners by increasing access to $2000m^2$ of high quality gravel bed near the Burns Lake outlet (this gravel bed is currently prone to dewatering during years of low lake water level) (ARL, 2001c).

In 2001, Burns Lake residents were informed that ARL was considering a 0.6m high weir to obtain the increased flows. The weir would consist of a concrete wall across the width of the channel, with a large notch or orifice placed in the centre. This gap in the weir would be designed to facilitate the migration of Kokanee fry back into Burns Lake during late winter and early spring. Cobble and riprap would be placed on either side of the weir to mimic a natural wave pattern. The notch would be designed to provide the targeted 1.0 m^3/s flow during low flow periods (ARL, 2001c).

Predicted Impacts

Endako River

The purpose of the proposed weir is to augment spawning habitat and increase the fisheries value of the Endako River. The weir is critical to protect the struggling population of Chinook salmon in the Endako River and sustain a viable Kokanee salmon population in Burns Lake (if spawning is interrupted for four consecutive years, the population will be extirpated). In addition, it would greatly benefit other sport fish populations in the watershed by increasing spawning habitat (for Rainbow trout) and enhancing food sources (for Lake trout) (Ableson, pers. com., 2002).

Aquatic Resources Ltd. Report 389-1 (2001c) mentions that it is hard to predict the direct effects of the weir on the Chinook population in the Endako River, but it states that inundation of all spawning and rearing habitat during low-flows would intuitively increase productivity and recruitment. During a high flow year in September 1999, approximately 7000 kokanee were counted spawning downstream of the Burns Lake outlet. This number translates to an estimated 600,000 fry assuming 400 eggs/female and a 47% hatch rate (ARL, 1999; 2001c). If flow enhancement from the weir were to emulate a naturally high September flow rate (as in 1999), it would be safe to assume that future fry production would be close to the numbers seen in 1999.

Burns Lake Level

Burns Lake residents are worried about possible impacts of the proposed weir, on water levels in Burns Lake. During years of naturally high flows, lakeshore property owners already face the risk of inundation of their property and damage to their landscaping and basements.

Through its investigation, ARL has concluded that the proposed weir at the outlet of Burns Lake would not significantly increase the water level of Burns Lake during spring freshet, but it would result in a substantially higher water level over the summer months. Reports in 1999 and 2001 claim that the "principal impact of the weir would be on the length of the interval during which the flood crest passes through the lake" (ARL, 1999, pg.9; 2001c, pg.18). Neither report contains specific data or modelling predictions for Burns Lake, and the 2001 report claims that "further analysis of the relationship between lake level and discharge is required to determine a robust prediction" (ARL, 2001c, pg.9). Thus, the effect of the weir on Burns Lake water levels, and the associated impact on lakeshore properties, is not well known at this time.

In February 2002, Denis Ableson (pers. comm.) confirmed that the Carrier-Sekani Tribal Council (CSTC) has engaged an engineering firm with hydrological expertise to review all water hydrology data collected to date. The firm has been asked to produce a Reservoir Rooting Analysis to model the behaviour of the system if a weir is constructed. It will consider variables such as the flushing rates and lake levels in Burns Lake. As well, the same firm is finalizing engineering designs for the weir. The expected completion date for this document is March 31, 2002. The LDWES has been asked by the CSTC (Ableson, pers. comm., 2002) to ignore the designs and impacts proposed in previous ARL reports, and wait for the current studies to be completed.

<u>Considerations for Future Action</u>

This version of the lake management plan cannot recommend that the LDWES support or reject the proposed weir project. LDWES must wait for the new report before deciding how to proceed. When the report is finished, the LDWES should help coordinate a technical review of the document so that decisions regarding its validity can be made quickly. The following is a list of considerations for future action by the LDWES (with respect to the weir project):

- Very thoroughly review the new document, paying careful attention to:
    - The predicted impacts to the Endako River, including water flow impacts (and their effect on existing water licences in the watershed), and impacts on salmonid species in the river; and
    - The predicted impacts to the lake level in Burns Lake.

  The LDWES will want to see that modelling has been done using specific data for Burns Lake (and not generic data *characteristic* of lakes like Burns Lake).

- Obtain professional and technical opinions from scientists who can judge whether or not the predicted impacts are realistic. Opinions should be sought from:
  - Department of Fisheries and Oceans
  - Ministry of Water, Land, and Air Protection (Fish and Wildlife, Water Management, and Pollution Prevention branches)

- Ensure that watershed residents are aware that the weir investigation and proposal is a project of the CSTC, and not the LDWES.

- Provide a venue for the CSTC and ARL to present the findings of the report to the general public, and receive and document input from individuals at the meeting, and stakeholders in the watershed.

- Write a letter to an appropriate governing body, to either support or reject the weir project, based on the outcome of the above actions.

<u>Objective 3.2: Create and implement a beaver management program to preserve uninterrupted flows in tributary streams.</u>

Before any beaver management occurs, it would be desirable to design a management program that is documented in a Memorandum of Understanding (MOU) with the Environmental Stewardship division of the Ministry of WLAP. The MOU will provide context for beaver control activities in the watershed, and will aid in future decision-making processes relating to beaver issues. It should address safety concerns and aesthetic impacts (Objective 4.1) as well as water levels and streamflow regimes (Objective 3.2). The Tchesinkut Lake MOU can serve as a template. An MOU for Burns/Decker should be drafted in a similar manner but expanded to address concerns throughout the watershed (tributaries and the Endako River outflow). A copy of the Tchesinkut Lake MOU is included in Appendix I.

The following two options for Objective 3.2 are feasible and likely to be effective in the Burns/Decker Lakes watershed. They should be included in the beaver management program. If possible, they should be implemented together to improve their effectiveness.

Recommendation: Control the beaver problem by increasing trapping by registered trappers through incentive programs

Incentive programs have proven to be one of few successful options for managing beaver problems. Policies and legislation in this province have divided much of landscape into registered traplines (it is not possible for anyone to simply go out and trap beaver). For legal and other reasons, it is therefore desirable for LDWES to work with the local trappers who have considerable knowledge and expertise in trapping beaver. An incentive program would help control the beaver population by encouraging a much larger harvest, while at the same time support the activities and livelihood of local trappers. If the registered trapline holder is unable to participate, it may be possible for that person to appoint someone else to work under the registration.

The Burns Lake First Nation has had a beaver management program on the Endako River (below the outlet of Burns Lake) for the past three years. It runs on a $6000 budget and provides a $40 subsidy for each beaver caught (Sam pers. comm., 2002). The program has been effective, and its success has been further enhanced by a beaver dam removal program. While dam removal is not important for the other beaver management objective (4.1), it is essential to meet this objective (3.2).

It is estimated that expanding the Endako River program to other areas of the watershed (with a $20,000 budget) will have a positive effect on reducing the beaver population (Sam and Sharpe, pers. comm. 2002). The Burns Lake First Nation has indicated an interest in this option, and the LDWES could pool its resources and coordinate its activities with them.

A monitoring program should be developed to assess the extent of the beaver problem before and after the program is implemented. Residents in beaver control areas should also be encouraged to participate in the monitoring program.

Recommendation: Control the beaver problem by destroying dams by hand or with small machinery

Dam destruction using manual or mechanical techniques rarely provides a long-term solution to beaver problems. However, when combined with beaver removal, it can effectively open up blocked stream channels to migrating fish. It is not desirable to use explosives in fish-bearing streams, so destruction should be by hand or with small machinery (when appropriate). It is possible that dam removal can result in severe environmental impacts downstream when the stored water is released and sediments are mobilized, so this activity should be carefully controlled. The MOU can address these issues.

Beaver dam removal was an important part of the Burns Lake First Nation's beaver management program on the Endako River, and it most certainly contributed to the success of the program (Sam pers. comm.. 2002). Funding for the program came out of the First Nations' fisheries budget [from Department of Fisheries and Oceans (DFO)].

If limited funds are available to expand this program, it can start with 3 or 4 important streams that contain valuable salmonid habitat and where beaver problems are clearly evident. If it is possible to prove (with data as evidence) that beaver dams are blocking salmonid habitat in the watershed, the cooperation and support of other stakeholders such as the DFO, First Nations, non-profit organizations, and forestry companies (including Decker Lake Forest Products and Babine Forest Products) will be easier to obtain. As mentioned above, LDWES should work with the Burns Lake First Nation in this initiative.

Goal 4: Improve the shoreline aesthetics of Burns and Decker Lakes

Objective 4.1: Create and implement a beaver management program to protect trees adjacent to the lake

As mentioned in Objective 3.2 (above), a Memorandum of Understanding (MOU) should be created. The following two options are feasible and likely to be effective for Objective 4.1:

Recommendation: Increase awareness of status quo policies and options to prevent and control beaver problems

Beaver problems are not new to the Burns/Decker Lakes watershed, and the Conservation Officer Service (COS) already has programs in place to address these concerns. For individual property owners, prevention is one method of eliminating safety concerns and visual impacts arising from beaver activity. The COS currently provides information on how to protect property and trees with electric fences, wire mesh, etc. In addition, the COS issues permits for property owners to remove beaver, and helps them retain the services of a registered trapper who can help them. This option is quite inexpensive, and the costs are borne primarily by property owners.

Because the policies and procedures for this option are already in place, it will be quite easy to implement (it is simply of matter of informing and educating the public that this option exists). The LDWES should consult with the COS to determine if educational brochures already exist, and if not, they could make arrangements to create and print some materials for distribution.

Recommendation: Control the beaver problem by increasing trapping by registered trappers through incentive programs

The details of this option have been presented under Objective 3.2 (above).

14.0 Plan Implementation

14.1 Summary of Recommendations

The recommendations listed in this management plan have been divided into two categories for their implementation:

- **Short term –** These recommendations should be considered priority actions because they are within the current capabilities of the LDWES, are relatively easy to implement, and provide results quickly. By implementing these recommendations, the LDWES will make visible progress towards their goals, and hopefully continue to gain support from the community.

- **Long term –** These recommendations are desirable actions, and should be initiated by LDWES when resources, labour, and funding become available, and the political will of the community favours such action.

Table 4 summarizes the recommendations for each objective, and classifies them for implementation. Although they will not yield immediate results, the data collection and volunteer monitoring recommendations should be initiated as soon as possible because they will provide the information needed to make effective decisions in the future. LDWES should make every effort to participate in activities and continue advocating for conditions that will facilitate the long term goals and recommendations in this plan. It is important for the society to set achievable short-term goals, and monitor its progress on an ongoing basis.

Table 4: Burns/Decker Lakes Watershed Management Plan Implementation Chart

GOALS	OBJECTIVES	OPTIONS	RECOMMENDATION	TIME FRAME	REFERENCE
Improve water quality in Burns and Decker Lakes by managing the causes of cultural eutrophication	Reduce point source nutrient (phosphorus) inputs to Burns Lake from sewage treatment facilities	Install phosphorus removal stage in sewage treatment facility	**Install a phosphorus removal system in the Burns Lake municipal sewage treatment facility.**	**Village of Burns Lake 10-year plan already exists** **2003 expected completion date**	**Page 50**
		Extend Burns Lake sewage system outfall			
	Reduce non-point source nutrient (phosphorus) inputs to the lakes from domestic sewage systems on individual properties along the lakeshore	Advocate improved services for outlying subdivisions not currently serviced by the Village of Burns Lake	**LDWES should advocate improved services (potable water sources and sewer installation) for areas outside the Burns Lake municipal service area**	**Short term (potable water)** **Long term (sewer installation)**	**Page 50**
		Improve general awareness and public education relating to septic systems and their environmental impacts	**Improve general awareness and public education relating to onsite septic systems and their impacts to the aquatic ecosystem**	**Short term**	**Page 51**
	Reduce non-point source nutrient (phosphorus) inputs from land use activities in the watershed	Encourage high quality stormwater treatment	**Best Management Practices (BMPs) should be encouraged through LDWES advocacy and participation in relevant planning processes**	**Short term**	**Page 52**
		Encourage improved forestry practices in the watershed to minimize sediment delivery			
		Encourage improved agricultural practices in the watershed to minimize nutrient inputs			

GOALS	OBJECTIVES	OPTIONS	RECOMMENDATION	TIME FRAME	REFERENCE
Improve water quality in Burns and Decker Lakes by managing the causes of cultural eutrophication	Reduce non-point source nutrient (phosphorus) inputs from land use activities in the watershed	Include LDWES participation in Regional District planning processes	**Through LDWES advocacy, local aquatic ecosystem issues should be considered in Official Community Planning and land use zoning**	**Short term**	**Page 53**
		Collect more data to improve knowledge of watershed system	**Collect more data to quantify the impacts of land use activities, and improve knowledge of the watershed system**	**Short term**	**Page 53**
		Improve general awareness and public education	**Improve the general public awareness of lake values and human influences on lake quality**	**Short term**	**Page 53**

GOALS	OBJECTIVES	OPTIONS	RECOMMENDATION	TIME FRAME	REFERENCE
Restore ecosystem balance in Burns and Decker Lakes by controlling the symptoms of eutrophication	Improve sport fish habitat in the Burns/Decker Lakes watershed	Improve access to salmonid habitat blocked by beaver dams	**See beaver control recommendations** ⇩		
		Improve the quality and quantity of salmonid habitat in the Burns/Decker Lakes watershed	**Undertake projects to improve the quality and quantity of sport fish spawning and rearing habitat in the Burns/Decker Lakes watershed**	**Long term**	**Page 54**
		Conduct an assessment of existing fish populations and develop a fisheries management strategy	**Conduct an assessment of the existing fisheries population to develop a management strategy**	**Long term**	**Page 54**
		Improve general public education and make fisheries data more accessible to the public	**Improve the general awareness of sport fish issues within the Burns/Decker Lakes watershed**	**Short term**	**Page 55**
	Reduce coarse fish species in the Burns/Decker Lakes watershed	Hold coarse fish derbies	**Hold coarse fish derbies specifically structured for catching and removing coarse fish from Burns and Decker Lakes**.	**Short term**	**Page 56**
		Implement a coarse fish control program			
	Reduce excessive macrophytes that are currently growing in Burns and Decker Lake	Chemical control with Diquat			
		Chemical control with Fluridone			
		Biological control with triploid grass carp			
		Mechanical control by hand cutting or pulling	**Control nuisance aquatic weeds by hand cutting or pulling**	**Short term**	**Page 57**
		Mechanical control using mechanized harvester			
		Mechanical control using diver-operated suction harvesting or dredging			

GOALS	OBJECTIVES	OPTIONS	RECOMMENDATION	TIME FRAME	REFERENCE
Restore ecosystem balance in Burns and Decker Lakes by controlling the symptoms of eutrophication	Reduce excessive macrophytes that are currently growing in Burns and Decker Lake	Mechanical control by de-rooting methods such as rotovating, rototilling or hydroraking			
		Physical control by dredging/sediment removal			
		Physical control by installing benthic barriers	**Encourage the Village to install a benthic barrier to control aquatic weeds at Radley Beach; if effective, encourage the use of benthic barriers in other locations**	**Short term**	**Page 57**
	Create and implement a long-term plan to control macrophyte and algae growth in the Burns/Decker Lakes watershed	Create and implement an Integrated Aquatic Plant Management Plan	**Create and implement an Integrated Aquatic Plant Management Plan; begin by conducting a plant inventory, mapping occurrences, and estimating Elodea biomass.**	**Short term (inventory, map, and biomass estimate)** **Long term (management plan)**	**Page 57**
	Reduce the concentration of nutrients (P) in the lake system by reducing the amount of P dissolved or suspended in the lake water and stored in the sediment	Implement an ongoing volunteer monitoring program to collect data	**Implement an ongoing volunteer monitoring program to collect tributary and lake condition data. Focus on nutrient, general water quality and sediment delivery data.**	**Short term (in the lakes)** **Long term (tributary streams and core sample analysis)**	**Page 58**
		Reduce P release from sediments by installing a hypolimnetic aeration system			
		Remove P rich water from the hypolimnion with a hypolimnetic withdrawal system			
		Remove P-rich sediments from the lake bottom by dredging			
		Remove P from the water through phosphorus inactivation techniques			

GOALS	OBJECTIVES	OPTIONS	RECOMMENDATION	TIME FRAME	REFERENCE
Maintain a quality and quantity of water in Burns and Decker Lakes that maximizes benefits for both watershed residents and aquatic life	Using a consensus building exercise, establish a long-term policy or plan for the outflow of Burns Lake by deciding whether or not to artificially regulate flows	Recommend a strategy for the LDWES with respect to the Carrier-Sekani Tribal Council's proposed weir project	**Wait until the Carrier-Sekani Tribal Council's final weir proposal is complete and then help coordinate a technical review of the document and provide input**	**Studies in progress** **2002 expected completion date**	**Page 64**
	Create and implement a beaver management program to preserve uninterrupted flows in tributary streams	Manage the beaver population by implementing a "live –trapping and relocation program"			
		Control the beaver problem by increasing trapping by registered trapping through incentive plans	**Control the beaver problem by increasing trapping by registered trappers through incentive programs**	**Short or long term**	**Page 66**
		Control the beaver problem by destroying habitat (beaver dams) using manual, mechanical, or explosive techniques	**Control the beaver problem by destroying dams by hand or with small machinery (when appropriate)**	**Short or long term**	**Page 67**
	Manage water-based activities to minimize water quality degradation in the lakes				
	Manage potentially harmful land-based activities to minimize pollutants entering the lake system				

GOALS	OBJECTIVES	OPTIONS	RECOMMENDATION	TIME FRAME	REFERENCE
Improve the shoreline aesthetics of Burns and Decker Lakes	Create and implement a beaver management program to protect trees adjacent to the lake	Increase awareness of status quo policies and options to prevent and control beaver population	**Increase awareness of status quo policies and options to prevent and control beaver problems**	**Short term**	**Page 68**
		Provide assistance for beaver control activities carried out by individual property owners			
		Allow beaver control by individual property owners by adding a beaver hunting season			
		Manage the beaver population by implementing a "live trapping and relocation" program			
		Control the beaver problem by increasing trapping by registered trappers through incentive programs	**Control the beaver problem by increasing trapping by registered trappers through incentive programs**	**Short or long term**	**Page 68**

14.2 Plan Review and Revisions

The management planning process includes ongoing evaluation and revision, and a portion of the resources allocated to plan implementation must be focused on refining it. In the first year of implementation, there should be a review of the plan by lake management experts. The reviewers should include regulators who may be called upon to write permits and licenses, or cooperate in some way to implement the various management recommendations. Ensuring that this occurs should be the first priority, and could be easily accomplished with assistance from the Ministry of WALP Environmental Protection division.

14.3 Financial Support

To begin implementing this lake management plan, an overall budget is required. Costs may include:

- Additional planning - sending the draft plan out for review to experts in the province and elsewhere
- Publishing the plan (government program funding may be available for this)
- Equipment
- Monitoring and evaluation programs (including volunteer training)
- Permits

Acquiring adequate funding to cover implementation costs will be challenging, therefore a funding strategy must be developed. Once a consensus on the management options and monitoring strategies has been reached, the level and duration of funding needed must be identified.

Some options for raising funds include:

- Using current government programs to fund aspects of the plan such as water quality monitoring (the provincial government's emphasis on providing clean drinking water may equate to increased funding)
- Voluntary donations, which should be sought in a systematic manner, such as an appeal campaign
- Modifying the lake society to allow the ability to collect revenue in the form of membership dues from anyone interested in helping
- Formation of a taxing district regulated by the Regional District of Bulkley Nechako. There are two possibilities: a "Local Service Area" or a "Local Improvement District". More information about establishing one of these areas can be obtained from the Community Services Coordinator at the Regional District of Bulkley Nechako.
- Application for grants or loans from public agencies
- Entering into partnerships with corporations and organizations
- Other private initiatives for raising funds include protection society membership dues, fund-raising events, and donor campaigns.

When the LDWES membership permits such action, a committee should be struck to formulate the financial strategy. Fundraising methods should be inventoried, evaluated and decisions made as to their applicability in this instance.

14.4 Volunteer Groups

Committed volunteers are essential to the success of the plan. Managing a lake is an ongoing process, and a mechanism is needed to keep the plan in motion after it is written. Therefore, an aggressive membership program is needed that is flexible enough to accommodate more than one level of participation (both volunteers and financial contributions).Volunteer groups who can assist with the implementation of the plan must be identified. In the Lakes District, this may include, but is not limited to:

- Other Lake Protection Societies in the region
- Youth and service clubs (4H, Rotary Club, Boy Scouts, Rod and Gun Club, etc.)
- Professional associations and groups (Cattleman's Association, Trappers Association, ComFor, etc.)
- BC Lake Stewardship Society (North American Lake Management Society)

One method of ensuring that tasks are completed successfully includes placing the volunteers in groups (committees), delegating tasks to each group and making sure adequate training is provided. Each group consists of one leader and their assistants. Each group is responsible for completing a set of well defined tasks. Examples of volunteer subcommittees are:

- Fundraising
- Sampling and monitoring
- General advocacy
- Education

To ensure that the tasks are carried out indefinitely, no leadership position should be vacant in any given year. Election of new subcommittee chair positions should occur every 2-3 years. An evaluation of the group's status should be held at regular intervals.

14.5 Regulatory Agencies

Most of the affected regulatory agencies have been consulted and involved during the lake management planning process. It is essential to identify all affected regulatory agencies and obtain the necessary approvals and permits. When applying for permits and approvals, it is helpful to include a deadline for which the approval is needed as it will allow the agency to prioritise incoming applications for approval. Allow sufficient time for the agencies to respond.

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