TCHESINKUT LAKE MANAGEMENT PLAN

PREPARED FOR
THE TCHESINKUT
WATERSHED PROTECTION SOCIETY

PREPARED BY
LISA WESTENHOFER AND ANNE-MARIE ROBERTS
AND IAN SHARPE

PROVINCE OF BRITISH COLUMBIA
B.C. ENVIRONMENT
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Thanks to the BC Lakes Stewardship Society this plan is available at:
www.nalms.org/bclss/lakestewardshiptools.htm

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1.1 Goal Statement:

The lake management plan will benefit users by providing a mechanism for the evaluation and protection of lake water quality. Protecting water quality will enhance the quality of life and preserve living aquatic resources. The lake ecosystem includes both the lake and its entire drainage basin. To meet this goal, the plan includes tools to manage land and water uses as well as aquatic life and wildlife.

1.2 Objectives:

- To identify current and potential sources of water quality degradation in the watershed and the lake. To provide workable management options to eliminate or reduce the effect of these sources.
- To provide a set of recommended actions that will implement each option.
- To develop communication links between the Tchesinkut Watershed Protection Society, government, industry, First Nations groups, and other 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 the benefit of concensus on relevant technical, social and political issues.
- To assist in identifying and applying appropriate regulatory requirements and volunteer driven actions that are consistent with the goal of the plan.
- To improve public education on issues affecting water quality in the lake and the watershed.
- To implement a volunteer monitoring program as an efficient and cost effective method of monitoring the lake condition.

2. SUMMARY

2.1 Identifying the Issues - What do we spend our time doing?

Protecting water quality and the lake environment is a concern for residents and lake users. Issues that may affect water quality and the lake environment were identified and ranked for importance by the members of the Tchesinkut Watershed Protection Society (TWPS). The results of this process were then used to construct a matrix to analyse how parts of the lake ecosystem are related to one another. The issues were ranked again based on this analysis and the issues identified by the TWPS.

2.2 Understanding the Issues - What is Involved?

Potential sources of water quality degradation in the Tchesinkut Watershed include

- leaking or failing septic systems
- sewage from small vessels
- fertilizers, herbicides, and road salts entering the lake
- animal waste causing hazards to human and animal health through drinking water contamination.

Other issues presented by the society included

- beaver dams blocking the lake outlet resulting in lake level fluctuations and blocking the upstream migration of spawning fish
- impacts of boating traffic on nesting birds
- the negative impacts of a) forestry practices within the watershed and b) development along the lakeshore and foreshore area, including visual quality degradation.

2.3 Actions Needed

In the process of gathering information on the issues, many communication links have been made within the community, various government agencies, and industry. These contacts have helped identify possible management and land use planning options and actions. We have also identified regulations pertaining to many of the issues and options.

Concerns with potential fish population declines or habitat losses must be addressed by initially determining the status of these populations. A creel survey must be done to identify fisheries conditions and trends. Creel surveys can be structured in many ways and can be accomplished using a range of degrees of effort. The survey format chosen will be determined by the amount of money and time available to do it. There are several available options which will lessen fishing pressure. These include changing the way that fishing derbies are run, changing to a catch and release fishery, putting harvest restrictions on long-lived species, and educating the public about the sensitivity of lake trout to overharvesting. Ice fishing is a large pressure on fish populations and its effects should be considered in a population survey. Habitat concerns can initially be addressed by stream surveys that include mapping of obstructions to fish passage and spawning

habitat. Once the present status of fish populations are determined, then the TWPS will have answers regarding management options and monitoring they may wish to promote.

2.3.1 Solutions through Direct Action

Lake level management on Tchesinkut Lake is influenced by the presence of beavers and beaver dams on Tchesinkut Creek (lake outlet). Managing the level of a lake involves several Branches of the Ministry of Environment. Water Management is involved because of possible "work in and about a stream", the presence of water lines and changes to lake water levels. Fish and Wildlife is involved because of management options involving beaver and because "work in and about a stream" creates fish population concerns. Lakeshore residents must have consensus about an acceptable lake level if they are to manage it. The lake level issue may be solved with an agreement in the form of a Memorandum of Understanding between the Ministry of Environment, Lands and Parks (MELP) and the TWPS. Through this agreement, the society would be able to regulate lake levels by managing beaver populations. This option is a direct solution, but it requires ongoing attention in the form of maintenance.

Direct actions can be taken to solve concerns over the use of fertilizers and herbicides by residents and resort and campground owners. When using fertilizers and herbicides, there are recommended application methods that minimize the impacts to the lake and streams. However, there are alternatives to fertilizer and herbicide use that include cultural, mechanical and biological control methods.

When nutrient loading from external sources is a problem, septic system maintenance and remediation can have immediate positive effects on water quality. There are methods outlined in the plan about how to test a septic system and what to do, if it is discovered that a system is failing or leaking, and who to get help from.

Designating "no sewage dumping" through the Canada Shipping Act small vessel regulations is an option to limit the discharge of sewage into the lake.

Maintaining vegetation buffer zones around the lake on private property protects habitat for animals and acts as a buffer to contaminants that would enter the lake.

Many of the management actions presented are preventative. This means that actions taken should prevent certain problems from occurring or worsening. The plan provides information about these issues and how future problems may be avoided. Public education is key to the success of many of the options in a lake management plan.

2.3.2 Action through Influencing Land Use Decisions

Influencing land use decisions can be achieved through participating in planning and permitting processes that affect the watershed.

Influencing forestry decisions in the watershed will require the TWPS to be involved in all planning processes. A representative of the Society should also be involved in the

Ministry of Forest (MOF) planning processes such as the Land and Resource Management Plan (LRMP) for the area, Local Resource Use Plans (LRUP) and 5 Year Development Plans. The Regional District should be contacted to ensure that a representative of the TWPS is involved in the planning processes for zoning in the Tchesinkut Lake watershed. Guidelines for development along lakeshores may be an option that the society may wish to pursue through the Regional District. These types of guidelines would be specific to protecting aquatic habitat.

Industrial use of herbicides requires a permit through the Ministry of Environment and the permit application must be advertised. Liaison of the TWPS with the Ministry of Forests and forestry companies is advised so that the society can be informed of applications for herbicide use and proposed use of fertilizers as well.

Public education about the effects of different activities and development on the lake water quality and ecosystem health can influence the choices made by the residents living on the lake. Participation of the residents, recreational users and industries that use the lake, in the protection of water quality, habitat and wildlife is essential for long term safekeeping of these values. Commitment of the TWPS to implement the options in this plan will go a long way towards educating the public and involving all stakeholders in the goals and objectives of this plan.

2.4 Outstanding Issues

Options to address the effect of boating disturbances on nesting birds requires additional investigation. The options that have been listed on this issue should be researched further and provided they are deemed worthy of further consideration, may be included in future revisions of the plan.

Some of the recommended actions have immediate solutions whereas others require long term involvement in complex processes. It is important that the society keep committed to all of these processes.

3. METHODS

3.1 Strategic Planning/ Systems Design

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 as opposed to strategic thinking which is long-term and treats the causes of the problem. Lake management planning involves complex issues and a strategic approach is the most appropriate. In general, a tactical approach may be the simplest and appear to be the least expensive. However, a tactical approach to a problem is usually expensive because the problem is never solved and the symptoms will keep reappearing (Rast and Holland 1988). A strategic approach requires long term commitment and may be expensive but it is the most practical and efficient approach to solving a complex problem.

To address the problem of designing a strategic lake management plan for Tchesinkut Lake, a systems approach was taken. This approach is warranted due to the complexity of the problem(s) and the variety of the stakeholders. This is a problem solving model which is designed to initiate creative thinking about exceedingly complex physical and social phenomena which interact and evolve over time (Spitzer 1991).

The systems design approach is used to set up a framework for decision making which is flexible to allow integration and consideration of new information and data as it is made available. There are five phases to the systems design approach; analysis, design, development, implementation, and evaluation/revision. The design model is interactive and the process is non-sequential as illustrated in Figure 1.

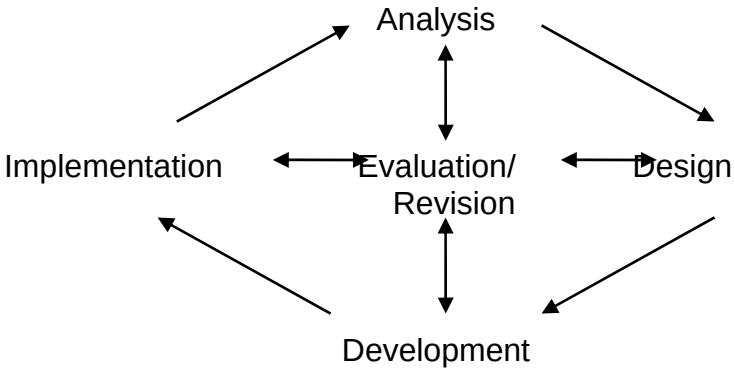


FIGURE 1. Interactive Model of the Systems Design Approach (Spitzer 1991)

- **Analysis** is the process of identifying and refining the goals and requirements of the lake management plan. The water quality characteristics of a specific water-body can affect the selection of specific management goals.
- Phase two is **design**. Specifications for meeting the lake management goal and requirements are identified by this process.
- **Development** is phase three. This is the process of improving and revising the plan according to feedback from the stakeholders based on the initial design.
- The **Implementation** process involves trying out the plan to see if it works.
- **Evaluation and Revision** are implemented throughout the process. Phase five is used to evaluate the system, identify improvements and make changes to the system accordingly. It is acknowledged that evaluation/revision drives the systems design process and therefore the plan is never completely finished, and will always be subject to improvements through testing and evaluation.

Systems design goes from the general, exhaustive inventory and analysis of the inter-related systems and system components, through a process of analysis and refinement, to a decision making process which utilises the refined set of systems and system components. The process is iterative in nature and uses an interactive approach which allows and encourages stakeholders to participate throughout. For more information on the analysis of interrelated systems see section 6.0 and Appendix A. A more thorough discussion on the systems design approach and a breakdown of the system components can be found in the Generic Lake Management Plan (Lightowlers 1995).

3.2 Consensus Building

A successful lake management program begins with a lake management plan which has widespread support from stakeholders. It is essential to involve all interested groups and regulatory agencies in the planning process to discuss the issues and work toward achieving a consensus (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. This is essential for implementation and perpetuation of the plan (Rast and Holland 1988). Stakeholders include but are not limited to government agencies, lake residents, lake user groups and environmental groups. For a full list of the stakeholders involved in the Tchesinkut Lake Management Plan see Appendix B.

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 recognised (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). This knowledge can be documented for use in developing the management program.

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. Key times for conducting stakeholder meetings have been identified and include: during identification of the plan goals and requirements, when possible alternatives have been identified, after a plan has been selected but before it is carried out, during implementation of the selected lake management program, and once a year after a plan has been implemented to conduct post-treatment evaluation and revision of the long term plan (Gibbons *et al.* 1994).

Due to the technical nature of various issues, in some cases it is necessary to use the knowledge of experts to clarify misconceptions (Gibbons *et al.* 1994). The goal of consensus building is to inform and assist decision making by identifying advantages and disadvantages of different lake management options. The relative merits of different lake management options should be compared and assessed by individual stakeholders who then must collaborate and come to an agreement on the most effective and feasible plan (Shaffer 1993).

The key role of the lake management planner is to ensure at an early stage that the goals and objectives of the lake management plan are acceptable to all stakeholders.

4. NUTRIENTS IN LAKE SYSTEMS

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. The 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).

4.1 Trophic Status

Trophic status refers to the amount of biological productivity in a system and is directly related to nutrient inputs. The amount of algae, aquatic plant growth, transparency, chlorophyll a levels, phosphorus concentration, quantity of 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 are called eutrophic and are characteristically relatively shallow and warm in the summer. Lakes which produce little aquatic life (mainly algae and macrophytes) are called oligotrophic. These lakes are characteristically deep and cold, usually with clear water and rocky shores. There is a continuum of trophic states that range from ultra-oligotrophic 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 morphological differences related to depth, water residence time, degree of stratification, watershed characteristics such as geology, soil type, vegetation, topography, and climate (Daniel *et al.* 1994).

Eutrophication is part of the natural ageing process of small lakes. This is a slow process associated with the gradual build up of organic matter, nutrients and sediments in lake basins through which an open lake can become a marsh and eventually fill in completely. During 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. If cultural eutrophication is left unmanaged, the result will be significant ecological changes (water quality degradation) and significant reductions in the appeal of the lakes for residents and recreational user groups who use it.

Tchesinkut Lake is an ultra-oligotrophic lake characterised by a relatively low level of biological productivity and low concentrations of soluble nutrients. It is a deep lake with a large volume of clear water. Lab analysis of Tchesinkut Lake water samples taken in

February 1997 revealed the winter concentrations of phosphorus and nitrogen in deep stations of the lake (section 5).

4.2 Nutrients - Phosphorus and Nitrogen

Aquatic life has several requirements for survival and growth. For algae and aquatic plants, 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 become limiting. 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 therefore, the next limiting nutrient (Wetzel 1983). Most lakes are phosphorus limited but some are nitrogen limited or co-limited by phosphorus and nitrogen. 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. Of the major nutrients, phosphorus is the most effectively controlled using existing engineering and land use management (USEPA 1990).

4.3 Phosphorus Limited Lakes

Growth of algae and aquatic plants can cause low oxygen levels, decreased recreational value due to odours and aesthetics, 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), a reduction of phosphorus inputs is generally the most effective method to reduce excessive growth of algae and aquatic plants.

Phosphorus is chemically reactive, technologically easier to remove from water than nitrogen, and does not have major reserves in the atmosphere (Wetzel 1983). These characteristics make phosphorus better suited for removal from lakes and control of input sources. Once external loading to a lake is decreased, the lake will require at least 2 to 10 years for recovery 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).

4.4 Nutrient Sources- Internal and External Loading

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

4.4.1 Internal Sources

Internal sources include nutrient cycling through plant growth and decay, groundwater 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 resuspended into the water under reducing conditions (chemical reactions

favouring reduction reactions as opposed to oxidation) when there is a low oxygen concentration at the sediment-water boundary.

4.4.2 External Sources

External sources are grouped into "point" and "non-point" sources.

Non-point nutrient source- A dispersed source that cannot be traced to any single source, such as a pipe. These sources usually originate from land use activities (Gibbons *et al.* 1994). Examples include runoff from forestry and agricultural practices, urban stormwater runoff, and construction sites. These sources can reduce the quality of the surface water through runoff and/or ground waters though leaching.

Point Source- A source that discharges through a pipe, creek, ditch or culvert. Examples of point source discharges include industrial and waste water treatment plants that discharge directly into a stream, and live stock facilities.

4.5 Nutrient Models

A mathematical model serves as a descriptive and quantitative tool for the construction of a nutrient budget. These models can be useful both in diagnosing problems and in evaluating alternative solutions. Since phosphorus is central to the productivity of many 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, these 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 modelling. Refer to the 1995 Tyhee Lake Management Plan for more information.

The prediction from a model is inherently uncertain because it is a simplification of the "real" world. However, the model can be used along with a prediction of the uncertainty of the model which indicates the relative value of the information contained in the prediction. This allows those making management decisions to understand where and to what degree there are uncertainties. These uncertainties can then be factored into the decisions. There are several different models, some better suited to certain types of lakes. 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.

Once the phosphorus concentration is predicted through the application of the empirical model, it is useful to interpret this prediction in the context of expected water quality characteristics for the lake of interest. A nutrient budget like that shown in Figure 2, and at least one years worth of lake data is necessary before lake management actions can be identified.

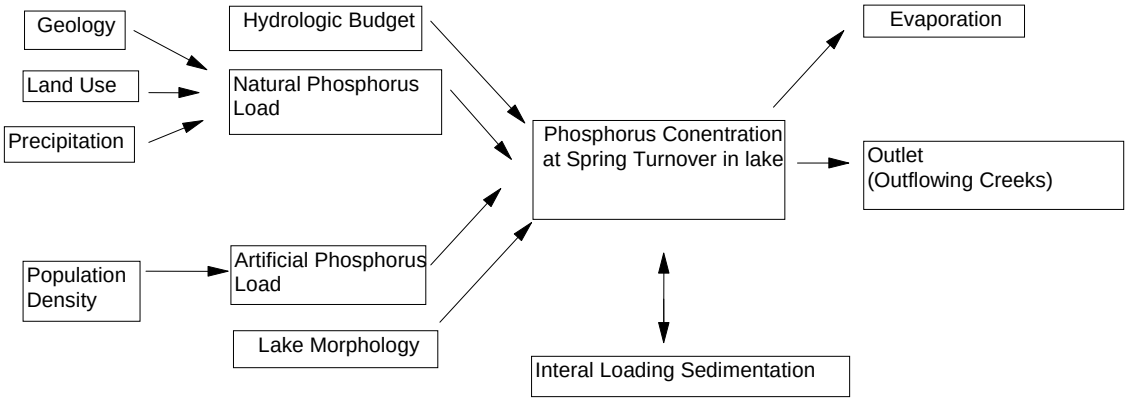


Figure 2: Diagram of a Typical Nutrient Budget (adapted from Dillon and Rigler,1975).

Total nutrients into the lake minus the total nutrients out of the lake should equal the total phosphorus the concentration in the lake at Spring turnover plus or minus the internal nutrient loading (if sediments are a source of the nutrient) or sedimentation rate (if sediments are a sink for nutirents).

5. WATERSHED & LIMNOLOGICAL INFORMATION

This section of the lake management plan includes a description of the area, including maps, morphometric and hydrologic data, and an accurate summary of all measurement methods and sampling locations.

5.1 Watershed

Tchesinkut Lake is located on the Central Interior Plateau of British Columbia near the geographic center of the province (Figure 3). The lake lies at 54N latitude, 125W longitude. It is 13 km south, south west of Burns Lake and 5 km to the north of Francois Lake, within the Bulkley-Nechako Regional District in Skeena Region. The drainage basin is outlined in Figure 4 (Skeena GIS 1997). The approximate size of the drainage basin is 344.3 km^2. The drainage basin is determined by the physical height of the land and the boundary outlines the area within which all water flows towards the lake.

Figure 3: Location of Tchesinkut Lake (Ellickson and Larkin 1969)

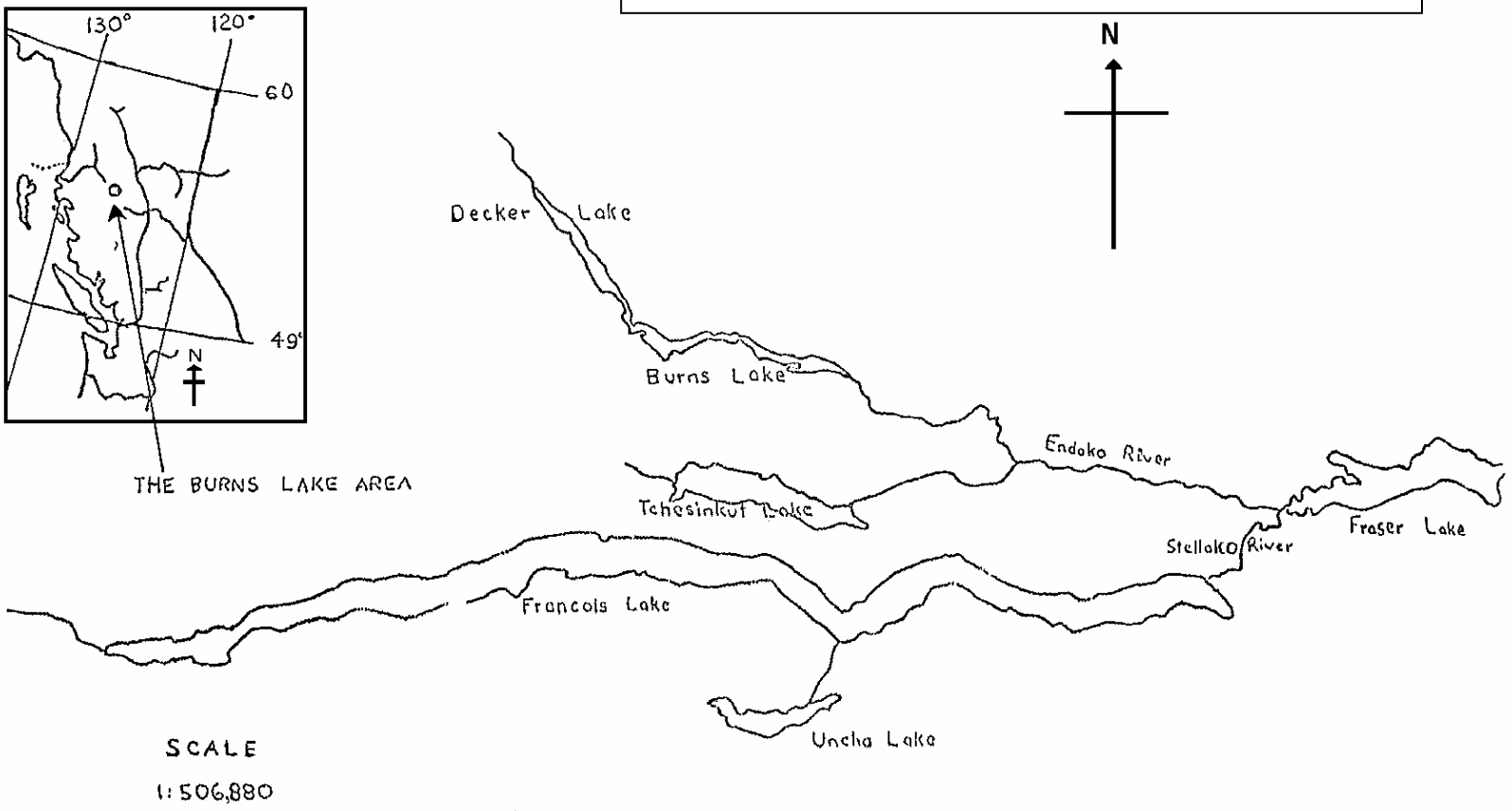
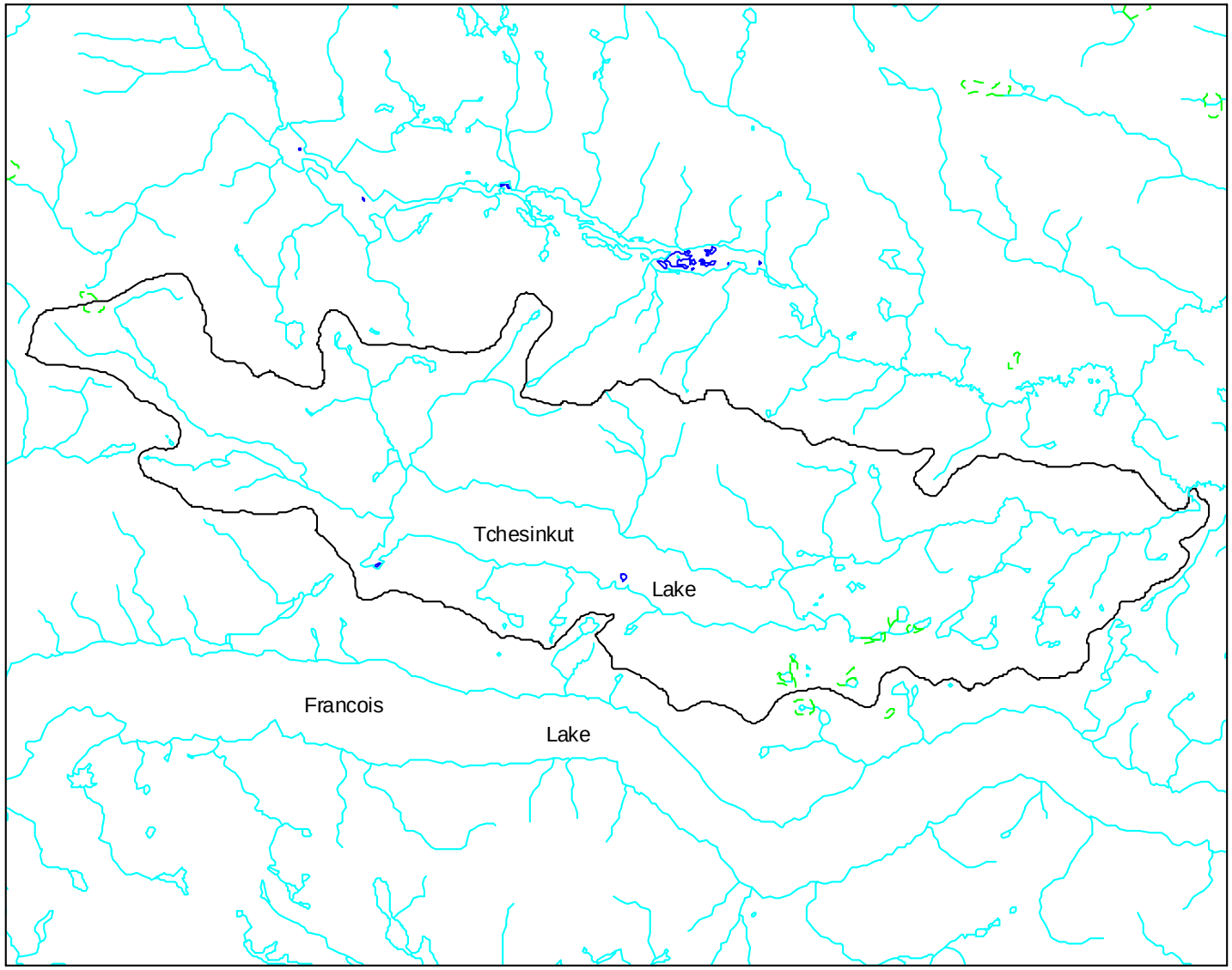


Figure 4: Drainage Basin of Tchesinkut Lake (Skeena GIS 2000)



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(at map centre)

NTS, Water - Points, 1:250K-M

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BC Min. Env. Lands, Parks
Skeena Region
March 24, 2000

5.1.1 Land Use Activities

Land use activities in the Tchesinkut Lake Catchment Basin include:

- residential
- fishing lodges / resort
- campgrounds
- forestry
- agriculture -livestock / cultivation

5.1.2 Zoning

Reduction in the productive capacity and the loss of integrity of aquatic habitats is occurring at an accelerated rate within the developed and developing portions of regional districts. Considerable effort has been spent by a variety of concerned groups over the last several years to provide land owners, developers and the public with specific information and development guidelines designed to assist them in proceeding with their developments while minimizing the impacts on aquatic ecosystems (White *et al.* 1996). Even with these initiatives in place, however, complete loss or reduction in productive capacity of aquatic habitats is still occurring through deliberate or misguided development activities. The Tchesinkut Lake watershed is located in Electoral District E. Currently the zoning of land with in the Tchesinkut Lake watershed is determined and restricted by the Bulkley Nechako Regional District Zoning Bylaw No. 700, 1993. Almost all cottages, summer homes and permanent residence are located along the extreme west shoreline. There are a few other dwellings on the north accessed by way of Tchesinkut Road East. Zoning bylaws could be re-written as part of a larger Official Community Plan, and should include lakeshore development guidelines. This would direct development in the public interest and provide aquatic habitats with enhanced protection heading off many future problems of deteriorating lake quality.

Eilene Benedict is the Electoral District E Director in the Bulkley Nechako Regional District. Mark Andison is the Director of Planning in the Regional District. Both will be among the reviewers of the plan, since they may play significant parts in achieving consensus on needed management options.

5.1.3 Water Sources - Tributaries and Groundwater

Sources of water inflow into the lake include groundwater, creeks, precipitation, and overland runoff (water flowing over the ground following a precipitation event or spring melt). Tchesinkut Lake drains an area of approximately 64.36 km^2 by a series of twelve creeks which are seasonal. The lake is drained at the eastern extremity by a creek named Tchesinkut Creek. (Ellickson and Larkin 1969).

5.1.4 Water Body Usage and Bathymetric Maps

The water body usage map provides a visual representation of the specific uses of the lake. This representation allows the many different uses to be identified in the lake management plan. Specific uses of Tchesinkut Lake include but are not limited to, boat

launch and beach areas, seaplane bases, waterfowl nesting areas, fish spawning areas, and water supply intakes. Figure 5 is a first draft water body usage map for Tchesinkut Lake. A bathymetric map, like the one of Tchesinkut Lake in Figure 6, provides depth data for the lake. The standard method for collecting bathymetric data is by continuous paper traces from a recording electronic sounder. This type of map was very useful when performing the interrelatedness analysis (considering how parts of this lake's ecosystem are related to one another) and identifying the location of the deep basins in the lake for sediment core sampling.

5.2 Limnological Characteristics

5.2.1 Morphometric Data

Tchesinkut Lake has a surface area of 33.83 km^2, a volume of 2,079,292.3 dam^3 and lies at a mean elevation of 760 metres. Table 1 summarises the morphometric data for Tchesinkut Lake as described by Webber and Tupniak (1981).

TABLE 1. Summary of Morphometric Data (Webber and Tupniak 1981).

Attribute	**Value**	**Units**
Elevation	760	metres (m)
Surface area	33.83	square kilometres (km^2)
Volume	2,079,292.3	cubic decametres (dam^3)
Mean Depth	61.5	metres (m)
Maximum Depth	149	metres (m)
Perimeter	47,100	metres (m)

Water Retention Time: The water retention time is the average time that the water remains in the lake. It equals the volume of the lake divided by the annual outflow volume. Water retention time is dependent on the bathymetric characteristics, such as lake size and depth. The water retention time and flushing rate for Tchesinkut Lake have been approximated based on the annual discharge of nearby systems. The estimated water retention rate for Tchesinkut Lake is 19 years.

Flushing Rate: Flushing rate is how fast the water in the lake is replaced. It is determined by calculating the inverse of the water retention time (1/retention time). The flushing rate of the water in Tchesinkut Lake has not been calculated directly, however the estimated flushing rate is 0.05%.

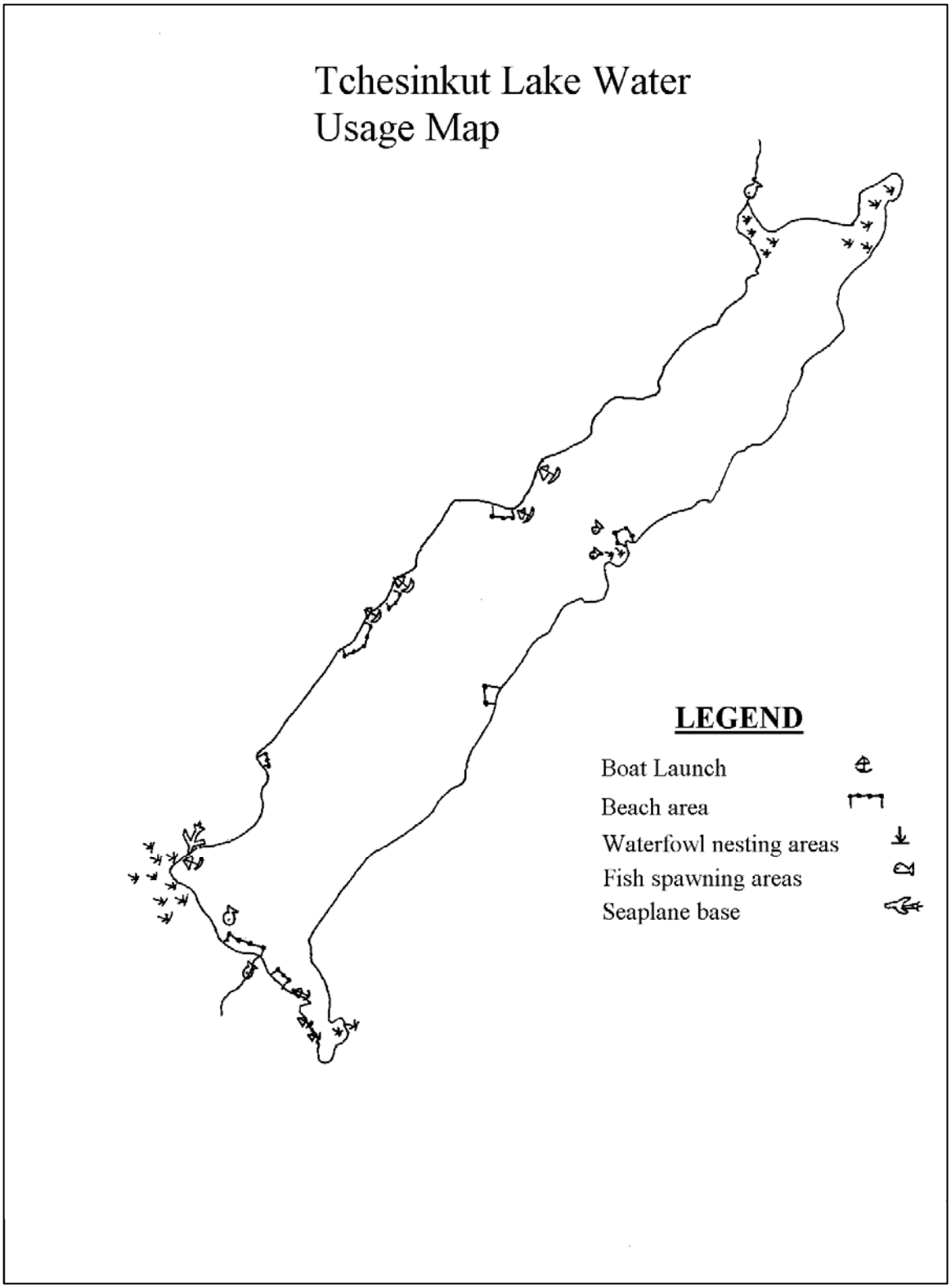

FIGURE 5. Water Body Usage Map

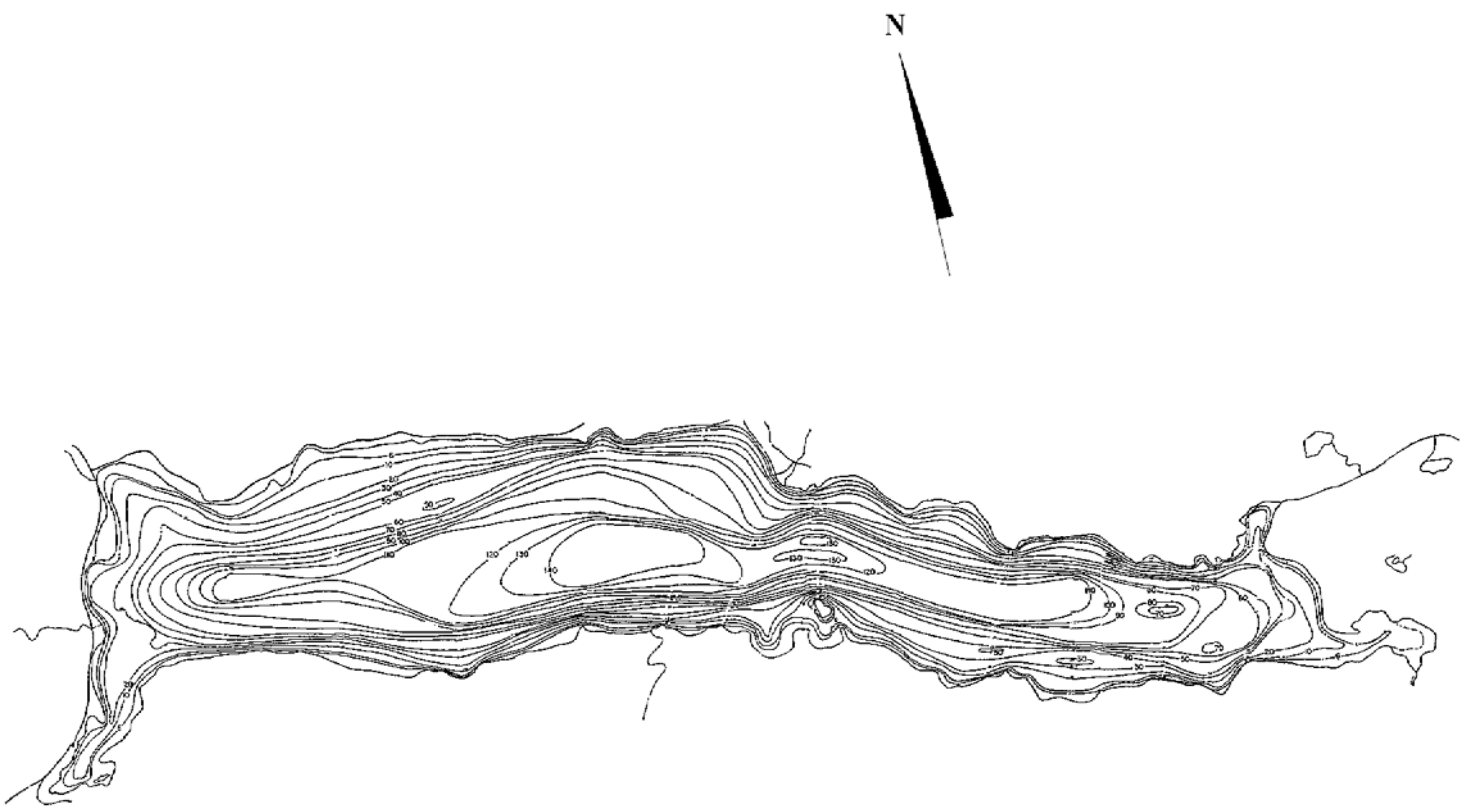

Figure 6. Bathymetry of Tchesinkut Lake

Depth lines are in 10 meter intervals

Resource Analysis Branch, Ministry of the Environment, 1982

5.2.2 Physical / Chemical Water Quality Characteristics

In February of 1997 two sampling sites were established on Tchesinkut Lake. Table 2 lists all known sampling sites, their description and their site number. Appendix J contains 1997 sampling results for the two deep stations established on Tchesinkut Lake.

Spring sampling has been conducted on the lake in 1998 and 1999. This information will be summarized and provided to the Protection Society under separate cover so that it can be easily updated after subsequent sampling events.

Transparency (Secchi Disk)

The transparency of the lake is related to the density of algal and total suspended solids. Transparency can be an indicator of the trophic status of a lake (Michaud 1991) but it is a difficult parameter to set objectives for. The more transparent the lake, the more light will penetrate to deeper depths and as a result there will be potentially higher growth rates of rooted aquatic plants if nutrients are available(Cooke *et al.* 1993). The black and white Secchi disc is lowered into the water with a rope until it is no longer visible, at which point the depth is recorded. The assumption is that the greater the Secchi depth, the better the water quality of the lake for most uses except fish productivity. In June of 1981 the Secchi disc reading for Tchesinkut Lake was 8.6 meters (Webber and Tupniak 1981). In July of 1999 Mike Comeau took a reading of 12.19 meters and in 2000 he took a reading of 17.6 meters.

Temperature Profile

A temperature profile gives an indication of the effects of temperature on the biology, chemistry and water density of the lake. A temperature profile will reveal if a lake thermally stratifies, whether stratification is complete, and can also indicate how often turnover occurs. Lake turnover is complete when the water column is isothermal (uniform temperature and density at all depths). At a deep station in the lake temperature measurements are taken at different depths. If the temperatures differ then the lake is thermally stratified.

Thermal stratification in the summer months consists of three layers; the epilimnion (the upper warm, well mixed and oxygenated layer), the metalimnion (the middle layer characterised by rapidly decreasing temperature with increasing depth), and the hypolimnion (the dark, cold bottom layer). Thermal stratification also occurs in the winter months. The temperature in the hypolimnion during the winter is generally 4° C, while the temperatures in the epilimnion are colder.

Dimicitic lakes have a turnover event twice a year, once in the spring and once in the fall. With the onset of spring, the sun will warm the upper layer of water in the lake and when acted upon by wind action this layer will mix with the other layers. This is a time known as turnover and results in isothermal conditions. With continued warming through the summer, the lake will again slowly become thermally stratified. In the fall, with the cooler temperatures, the lake may once more become isothermal, and have complete

mixing, before it stratifies a second time. There is not yet a complete annual temperature profile for Tchesinkut Lake.

Dissolved Oxygen Profile

Oxygen is essential for life in the lake. Cold water holds more oxygen than warm water, so as the temperature of water increases, oxygen is released to the air (Cooke *et al.* 1993). Renewal of dissolved oxygen levels occurs:

- through exchange at the air/water boundary
- wind mixing water from the epilimnion to deeper water depths
- the process of photosynthesis by aquatic plants and algae
- the inflow of oxygen rich water into the lake from creeks, streams and rivers.

Dissolved oxygen levels in the lake are strongly correlated to the thermal profile. During spring and fall turnover of the lake, the water becomes isothermal and the lake destratifies. Loss of the thermal layering in the lake allows oxygenated surface waters to mix with oxygen depleted deeper layers. In this way, the water in the lake becomes replenished with dissolved oxygen. Figure 7 illustrates the relationship between temperature and dissolved oxygen.

The movement of phosphorus between the water column and the bottom sediments is regulated by the presence and absence of oxygen at the sediment /water boundary. If the water at the sediment-water boundary contains no oxygen, phosphorus may be released from the sediments into the water column. If the water at the boundary is oxygenated, phosphorus is trapped in the sediments. Algal growth, dissolved oxygen levels and phosphorus concentrations in the water are also related. After turnover, the dissolved oxygen levels in the lake are high and algal growth occurs. This growth leads to two oxygen related effects. One is that the photosynthesis of algae gives off oxygen, and the second is that the decomposition of algae after they die utilises oxygen. This chemical oxygen demand from the decomposition of algae can be quite high if there has been a lot of algae growth. In addition, plants and algae respire at night, which further depletes dissolved oxygen levels (Cooke *et al.* 1993). The overall biochemical and chemical oxygen demand can be greater than oxygen replenishment. With no more dissolved oxygen in the lower layer of the lake, phosphorus is released from the sediments into the water column. An increase in phosphorus concentration leads to increased algal growth and the cycle continues until the anoxic water is replenished with oxygen during the next turnover.

Alkalinity/ Ph

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. Alkalinity is influenced by the geology of the surrounding watershed. pH on the other hand 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. The water in Tchesinkut lake is basic. Although pH is easily measured in the field, it is accurate for the current conditions only. This is

because, as a result of gas diffusion, biological activity and chemical reactions, lake water pH values may change rapidly. For this reason alkalinity is considered a more useful parameter as a long term monitoring tool. The water quality standard for alkalinity should be "no measurable change from its natural conditions" (Michaud 1991).

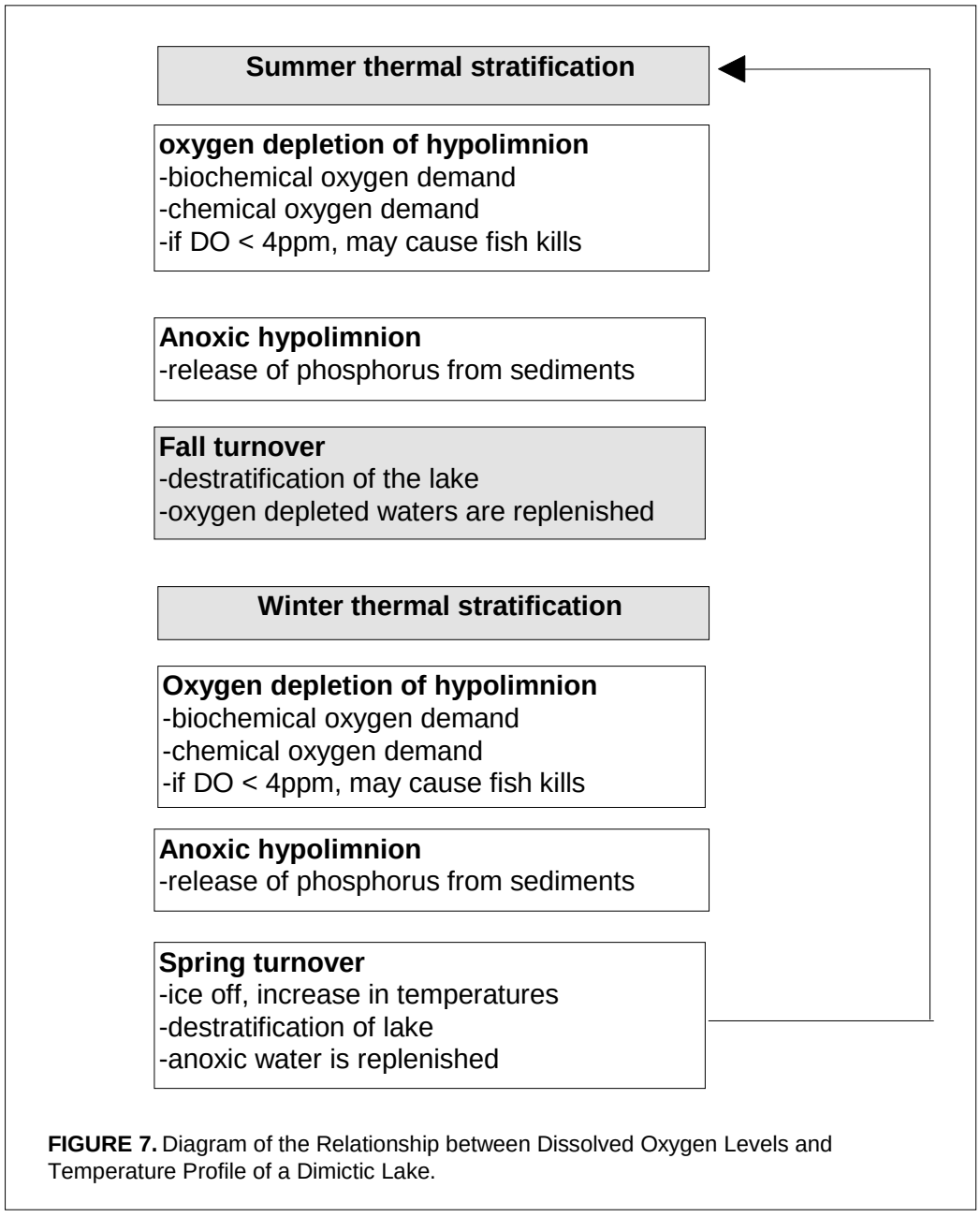

FIGURE 7. Diagram of the Relationship between Dissolved Oxygen Levels and Temperature Profile of a Dimictic Lake.

TABLE 2. Sampling sites within the Tchesinkut Lake watershed.

Station type	Description	Site Number
Deep Station (102m)	West Sub-Basin	E224893
Deep Station (149m)	Central Basin	E224944
Deep Station	unknown	E207616
Inlet	Tchesinkut Creek	E208138
Outlet	Tchesinkut Creek	E208894

Nutrients - Phosphorus and Nitrogen

Nitrogen and phosphorus are usually the two limiting nutrients in freshwater systems. Before a lake management action plan can be identified, it is important to determine which is the limiting nutrient in the lake or if the nutrients are co-limiting. Lakes are most commonly phosphorus limited (Rast and Holland 1988). In Tchesinkut Lake, the spring weight ratios of nitrogen to phosphorus were calculated from the May 1998 and 1999 sampling results. If the weight ratio of total nitrogen to total phosphorus in the lake is greater than or equal to 15:1, the plankton growth is limited by the availability of phosphorus and if the weight ratio is less than or equal to 5:1, the plankton growth is limited by nitrogen (Boyd *et al*. 1985). The total nitrogen to total phosphorus weight ratio for Tchesinkut Lake was 38:1, and 35:1 in May 1998 and 1999 respectively. This indicates that plankton growth in this lake is limited by phosphorus. It would be useful to obtain additional data on the ratio of N:P in the lake by sampling about 4-6 times over the course of an entire year. This is because it is better to base conclusions on several sampling results rather than a single sampling event. Following identification of the limiting nutrient or nutrients in the lake, it must be determined whether the majority of the nutrient loading to the lake is coming from internal or external sources (Cooke *et al.* 1993). Internal sources include nutrient recycling, groundwater and sediments whereas external sources can be grouped into point sources such as septic systems and creeks and non-point (diffuse) sources such as overland runoff from agricultural land, forestry practices and new developments.

5.2.3 Biological Characteristics

To document current biological conditions there needs to be the following surveys conducted:

Algae and Aquatic Plants

Algal biomass and species diversity are an indicator of trophic status in a lake. Excessive growth of one or more species of algae is termed a bloom. The regular occurrence of visible algal blooms often indicates that nutrient levels in the lake are too high and are often a symptom of cultural eutrophication. Too many algae and the wrong kinds can interfere with some lake uses by, among other things, clogging the filters in drinking water intakes and causing taste and odour problems in water and fish. The most common use of lakes is aesthetic enjoyment, and excess algae growth can interfere with this simple pleasure.

There are several types of aquatic plants, submerged plants, emergent plants, rooted plants and floating (non-rooted) plants. Rooted plants are dependent on available nutrients in the sediments, whereas floating plants are dependent on levels of available nutrients in the water column. Like algae, aquatic plants are a vital part of the lake because they provide cover for fish and food for wildlife. However, too many aquatic plants can limit swimming, fishing, boating and aesthetic appreciation.

Based on information provided by Tchesinkut Lake residents, excessive algal growth is a concern in the north-west corner of the lake. Aquatic plants are sparse and almost non-existent throughout the lake. The bottom of almost all shallow areas is mostly gravel and sands, very little detritus (Webber and Tupniak 1981).

Zooplankton

Zooplankton are an important part of the food web in a lake system because they feed on algae. In natural food chain interactions zooplankton populations play a balancing role as nature's direct algae control mechanism (Wallis 1995). From an environmental managers point of view zooplankton populations can act as lake "guardians" against algae over abundance. Therefore it is important to maintain healthy zooplankton populations in the lake. Zooplankton also serve as a food source for fish (Gibbons *et al.* 1994).

Fish

Species of fish which have been identified in Tchesinkut Lake include rainbow trout (Bustard 1989), lake trout, lake whitefish, kokanee and burbot.

Terrestrial Wildlife and Waterfowl

Song birds nest in the riparian vegetation near the lake shore. There are large numbers of breeding and migratory waterfowl that utilise the lake. At least three areas around the lake have been identified by residents as important nesting sites for loons and other nesting waterfowl. The intensity of water-based recreation on the lake in the form of motorized watercrafts, has the residences concerned about the potential negative impacts on the success of the nesting waterfowl populations. Eagles, hawks, owls, moose, coyote, fox, beavers, and deer also depend on the lake and nearby wetlands as a part of their life cycle habitat requirements and are therefore a part of the lake biota.

6. DIAGNOSIS OF TCHESINKUT LAKE

6.1 Interrelatedness Analysis

In the analysis stage of the plan, three systems (socio-economic, biological, and physical) were identified. The systems are artificial and most likely incomplete but were a systematic attempt at identifying and classifying all the important and controllable aspects of the lake system and it's watershed.

A complete inventory of all components of the lake and watershed was developed in conjunction with the issues identified through the consensus exercise. The interrelatedness analysis created an overview of the entire lake ecosystem and it's components and how these relate to social, economic and political factors.

For further information on the method of the interrelatedness analysis, see Appendix A. This exercise facilitated the commencement of the plan by allowing the determination of key components relevant to Tchesinkut Lake. The key components are lake specific. In the event that a professional limnologist or expert in the field of lake management is developing the plan, some of this exercise may be unnecessary, as an expert may be able to identify key components based on prior experience.

6.1.1 Key Components of the Physical System

Bathymetry and Flushing Rate

The bathymetry (size and shape) of a lake basin has profound effects on nearly all physical, chemical and biological properties of a lake (Wetzel 1983). It determines the mix of aquatic animals and plants as well as their distribution within the lake.

Deep, steep-sided lakes usually statify thermally during the summer, which prevents complete mixing of the lake water. These lakes may have fewer areas that are shallow enough for rooted aquatic plants to receive light to grow. Flourishing aquatic plants are indicative of a productive lake. Thus, a deep lake, like Tchesinkut generally has a high proportion of open water habitat and the food web would tend to be based on the organic matter produced by free floating alage. In Tchesinkut Lake, except for a few shoals, much of the shoreline drops steeply into the water (Webber and Tupniak 1981).

Shallow lakes, tend to be more biologically productive than deep lakes because of the larger area of bottom sediments relative to the volume of water which results in more complete mixing of the lake water by the wind. This mixing action circulates nutrients and oxygen throughtout the water column, making them available to organisms all through the lake. The gentle sloping basin of a shallow lake results in extensive littoral (shallow) areas along the lake perimeter. In these areas rooted and floating aquatic plants are able to colonize successfully.

The balance between the amount of water coming into a lake (ie. rainfall, groundwater and stream inflow) and outputs (ie. evaporation, outflow and withdrawal) influences the nutrient supply to the lake, flushing rate (the rate at which water enters and leaves a lake, relative to the lake volume), lake water residence time (the amount of time required to completely replace the lake's current volume of water with an equal volume of "new" water) and consequently, the lake productivity and water quality.

Generally, a slower flushing rate may coincide with a higher possibility of poor water quality and susceptibility to eutrophication through nutrient enrichment whereas, a higher flushing rate can be associated with better odds of maintaining good water quality when nutrients are added (Rysavy and Sharpe 1995).

A long residence time and complete mixing of the water can lead to increased macrophyte growth and an increase in the frequency and duration of algal blooms, as a result of more bioavailable nutrients in the lake (USEPA 1990). This decreases the recreational quality and use of the lake. Potability of lake water may also deteriorate as a result of chemical and physical changes associated with nutrient enrichment under these hydrologic conditions.

Water level

Through manipulation of the outlet (raising or lowering it), the water level in the lake can be altered. Beavers can manipulate the level of the outlet by building dams. Once beavers set up house in the outlet of a lake, the water level can increase significantly which can alter shoreline vegetation and wetland areas. A water level which changes frequently will cause increased shoreline erosion.

Many aquatic organisms require an area of overhanging shoreline vegetation to provide temperature moderating influences. The prevalence of overhanging shoreline vegetation can be altered by a rise in water level. The presence/absence of beavers may determine the mix of waterfowl species that will inhabit the lake by altering the species composition of aquatic and terrestrial plants. An increase in the water level will lead to drowning of riparian vegetation which means loss of habitat for a variety of species from loons to benthic invertebrates.

Many residential users are opposed to beaver inhabiting the lake outlet since water level increases cause inundation of shoreline property. The consequences of this are loss of property and destruction of established beaches.

The lake outlet may be lowered through manipulation which if not planned for correctly can have significant effects. If the water level in the lake is decreased, spawning areas associated with inflowing creeks may dry up more quickly, which would affect fish populations, species, stocking plans and fish harvest management. This would also cause habitat disruption for invertebrates which are an important part of the food web.

Variations in annual precipitation can have dramatic effects on water level, flushing rate and stream inflow rates (Rysavy and Sharpe 1995), and land use may alter runoff

patterns, causing excessive sediment transport into the lake and alteration of stream channels

6.1.2 Key Components of the Biological - Chemical System

Fish Populations

Sportsfishing on Tchesinkut Lake provides valuable recreational opportunities for a large number of anglers. The lake contributes substantially to the quality of life in the surrounding communities as well as to the economy of Burns Lake. Tchesinkut Lake has provided a popular year round sportsfishery for rainbow trout and lake trout for many years. Rainbow trout, lake trout and kokanee are the predominant species angled. Residents, recreationalists and resort owners are all concerned about maintaining healthy fish populations in Tchesinkut Lake and have suggested that fishing success on the lake has been deteriorating over the past number of years due to increased fishing pressure. It is essential that the lake fisheries are managed to ensure that stocks are not over-exploited and that enhancement opportunities are identified and pursued (Bustard 1989).

Fish populations in a lake have the following basic needs; oxygenated water that is free from excessive nutrient and toxic input, food supply and habitat - places to hide from predators and carry out their basic activities of feeding and reproduction. Most fish are both predators and prey so they depend heavily on cover - both for feeding and for safety. Some of their best hiding places are found, within 30 metres of shore. Some specific habitat types that are essential to the fulfilment of certain life cycle requirements include spawning and rearing habitat, both in the lake as well as the tributaries and outflow streams.

Large organic debris, rocks, sediment, cut banks and food resources are all important habitat components. However, just as the lake ecosystem is dependent on influences outside the water so to are fish. Riparian vegetation, like trees, shrubs, grass and other plants around the edge of the lake are also important components of fish habitat. Riparian vegetation acts as a nursery for many insect species, and insects drop into the water from overhanging vegetation and are eaten by fish. Overhanging banks and downed wood in the water are used as hiding places because of the accumulation of food around these structures. Riparian vegetation helps ensure access to spawning areas by maintaining a high water table in dry seasons and reducing erosion and sedimentation inputs to the lake. Access to important spawning and rearing habitats that is limited by man made or beaver obstructions can be detrimental to fish populations.

Fish also require a certain level of dissolved oxygen in their environment (> 5 mg/L for most lake species). The concentration of dissolved oxygen in the water column can be especially critical for overwintering conditions. Tchesinkut Lake is not susceptible to oxygen deficits attributable to this mechanism. This has been demonstrated by the February 1997 oxygen concentrations which were relatively high well into the lower layers of the water column, even under winter conditions.

6.1.3 Key Components of the Socio-economic System

Development / Changes to landuse

New development displaces wildlife and often alters the habitat of many aquatic organisms. New developments lead to increased overland runoff and the input of nutrients in a lake which over time can alter the trophic status of a lake.

External sources which contribute to nutrient loading in a lake include fertilizer (through overland runoff), soil disturbance, septic system and animal waste inputs, and boat sewage discharges. This can lead to a decrease in the lake's potable water quality as well as it's aesthetic value. This may lead to water that is unsafe for human contact. Flood periods (change in the peak flows) often result from changes in the land use such as timber harvesting near streams, land cleared for agriculture and residential development.

Flood periods can change the water level for short periods and may be very destructive over a short time causing external nutrient loading into the lake, shoreline erosion, and damage to riparian vegetation and property around the lake. New development and forestry practices can affect fish passage and populations by destroying riparian vegetation and wetland areas that are important for absorbing overland runoff and preventing erosion. Fish habitat can be lost by backfilling to further develop shoreline property. Agriculture, forest practices and new development must be kept a certain distance from inflowing streams and the shoreline to avoid destruction of riparian vegetation and input of sediments, nutrients and chemicals to the lake.

6.2 Resources at Risk

Sport fishing and recreational uses of the lake are extremely important to user groups. As well the lake supports a wide variety of wildlife. Any substantial disruption of the natural balancing forces which maintain the aquatic ecosystem in its present form will result in the inability of some species to meet their life cycle requirements. In addition to the aquatic and terrestrial wildlife resources present, Tchesinkut Lake is a source of drinking water for residents and park users. It is also a popular recreation area with high levels of boating activity. These uses are also dependant on water quality being maintained within limits which may be defined by setting water quality objectives for a range of physical and chemical attributes.

6.3 Range of Desired Outcomes of Varied User Groups

Each group of lake users has their own interests to protect. It is likely that residential users have the most at stake in terms of the lake. The value of their land, their quality of life and the water which they drink are all dependant on the state of the water in the lake. Some factors that will affect these desired conditions involve surrounding land use, including agricultural and forestry practices as well as development and construction practices.

Recreational users include boaters, swimmers, tourists, campers, beach users, anglers, and wildlife observers. Various users are interested in the maintenance of the fish habitat and sport fish populations including Rainbow trout. There are many factors

involved in maintaining fish habitat including dissolved oxygen levels, macrophyte and algae growth, water temperature, and maintenance of thermal stratification of the lake. For all users, high water quality and lake aesthetic quality are a top priority.

6.4 Regulatory Requirements

Management of lakes and shorelines and their components are protected by federal, provincial, regional district or municipal legislation. Table 4 contains some of the regulatory requirments for specific lake components. See Appendix C for further explanations on the role of the various regulatory agencies.

TABLE 3. Regulatory Requirements for Specific Lake Components

Component	Legislation	Regulatory Agency
agriculture	Agricultural Waste Control Regulation and Code of Agricultural Practice for Waste Management	Agriculture Canada B.C Ministry of Agriculture, Fisheries and Foods
beavers	Water Act Wildlife Act	BC Environment, Fish and Wildlife, Water Management
boat launch		BC Parks
fish	Fish and Wildlife Act Federal Fisheries Act	BC Environment, Fish and Wildlife Department of Fisheries and Oceans
park use		BC Parks
motorized watercrafts	Navigable Waters Act	Canada Coast Guard
residential subdivision development and land use (forestry, agriculture)	Regional District Zoning Bylaws Municipal Act Forest Practices Code	BC Transportation and Highways Regional District of Bulkley Nechako Ministry of Forests
riparian vegetation	Fisheries Act Forest Practices Code	Department of Fisheries and Oceans Ministry of Forests
septic systems sewage disposal from small vessels	Health Act Canada Shipping Act- Small Vessel Regulations	Ministry of Health BC Environment, Pollution Prevention Program Canada Coastguard
waterfowl	Migratory Game Bird Act	Canadian Wildlife Services
wildlife	Fish and Wildlife Act	BC Environment, Fish and Wildlife

7. ASSESSING LAKE MANAGEMENT ALTERNATIVES

Specific lake issues and watershed physical characteristics have been identified. Next a set of actions must be identified so that the goals and objectives of the plan may be achieved given local constraints (Rast and Holland 1988). The process of identifying lake management options which are feasible can be complex. Decisions must be made with serious regard to cultural, social and political dimensions (Brewer 1986) as well as ecological and financial dimensions. This is a complex, uncertain process as there is difficulty in assessing cultural, social, political, ecological, and financial dimensions and expressing each in terms of relative value on a common scale.

Each of the lake management options will have consequences which must be analyzed in terms of the basic objectives of the lake management plan (McDaniels 1992). It is expected that one or more of the lake management alternatives will be determined to be the most effective in terms of achieving the goals of the plan.

7.1 Types of Analysis

7.1.1 Cost Benefit

One approach used to assess the worth of lake management alternatives is the cost-benefit analysis. The cost-benefit analysis is based on a branch of Economic Theory called "welfare economics" (Rast and Holland 1988). Cost-benefit analysis compares all of the positive and negative elements of each lake management alternative in a general, broad context.

Traditionally, cost-benefit analysis looks only at monetary costs and benefits which can be estimated in dollar figures. However, the problem with this approach is that some dimensions are difficult to quantify, such as cultural values, long-term sustainability of natural resources, political realities, societal and governmental structure and stability, and the national or regional distribution of wealth (Rast and Holland 1988). Some of these elements cannot be quantified at all or else can only be quantified in an artificial and perhaps inaccurate manner. An approach which encompasses ecological, social, political and cultural dimensions as well as the financial dimension is needed to determine whether or not the expected benefits are a good investment of funds (Rast and Holland 1988).

7.2 Selecting Options

To assess options it is important that social, biological, economic, cultural, and political costs and benefits are included in the ranking criteria.

Initially an exhaustive list of options should be developed. Each option should be thoroughly researched and the negative and positive aspects of the alternatives recorded in a chart. An example of this type of chart is in Appendix D.

If resistance to implementation of an option is experienced, it may be necessary to complete further iterations of the matrix. This will allow the determination of the most important plan objectives based on social impact values. It is possible that different

ranking criteria are needed and this should not be overlooked in subsequent iterations of the social-impact matrix.

7.3 Lake Management Alternatives

Before discussion of the specific lake management alternatives, two points about costs and benefits need to be made. The first is that it is important that all available resources be considered for each option including technical expertise, financial resources, volunteer labour and equipment among others. It should also be noted that costs can vary substantially in different areas due to the local cost of labour, equipment, supplies and availability of specialized equipment (Rast and Holland 1988).

7.3.1 The option of doing nothing

It is important to consider the consequences of doing nothing because it offers one basis of comparison with the potential effects of implementing a lake management program (Rast and Holland 1988). Evaluation of the option of doing nothing can help decide if implementation of a lake management program is even required. However, some concerns can be difficult to estimate when or how quickly they will impact the lake and therefore it may be difficult to estimate the state of the lake in any given time in the future.

7.3.2 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 it's causes, this treatment will only be temporary. Until the problem is identified and the causes of the problem are addressed, it will continue to occur and the symptoms will continually reappear.

Most options that treat the causes involve reducing point and non-point sources of external nutrient and sediment inputs by implementing specific land use management practices. For example, in a lake which obtains the majority of it's phosphorus loading from external sources, appropriate watershed management can provide long-term control.

External sources of nutrient loading must be addressed before internal management options are considered (Rysavy and Sharpe 1995). Since the watershed and lake are interconnected, any reduction in contaminant loading to a water body as a result of land use management practices can maintain or extend effectiveness of in-lake controls (Gibbons 1994). In general, the 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). Often a combination of lake management options is required to maximize the effectiveness of restoration and control of the lake conditions.

8. POTENTIAL LAKE MANAGEMENT OPTIONS

8.1 Water Level Options

Lake level management on Tchesinkut Lake is influenced by the presence of beavers and beaver dams on Tchesinkut Creek (lake outlet). Beavers have dammed this creek in the past, resulting in a high water level that threatened to flood low lying riparian property and caused erosion of the shoreline.

Managing the water level of a lake involves several Branches of the Ministry of Environment. Water Management is involved because of their mandate governing work in and about a stream, water licenses and lake level. Fish and Wildlife is involved because of management options involving beaver and their habitat and concerns for fish populations when working in and around a stream.

8.1.1 To Do Nothing

Not addressing water level concerns on Tchesinkut Lake could result in a situation where low lying riparian property is flooded as a result of high water levels caused by beaver dams obstructing the outlet.

8.1.2 Beaver Management

Beaver management on Tchesinkut Lake would enable the Society to influence Tchesinkut Lake water levels. Through the continued removal of beavers and clearing of beaver dams from Tchesinkut Creek, the lake water level would fluctuate in accordance with seasonal inlet and outlet flow and would be controlled by the natural elevation of the outlet creek bed.

Beaver management should reduce flooding of low lying properties and should slow shoreline erosion processes by eliminating beaver influenced high water level fluctuations. Tchesinkut Lake area residents must come to a consensus on the need to control lake water levels and there must be agreement that historic and normal water level fluctuations are acceptable and preferred to beaver influenced water levels.

A Memorandum of Understanding, dated June 14 1997 was signed between the Tchesinkut Watershed Protection Society (TWPS) and B.C. Environment, allowing the society to remove beaver dams interfering with the Tchesinkut Lake surface water. This permit is valid until revoked. Volunteers from the Tchesinkut Watershed Protection Society will carry out annual cleaning of debris and beaver dams. The society must notify the conservation officer in Burns Lake prior to the removal of a beaver dam or in a emergency as soon as possible after removal, advising location and time of removal. The society must also submit a report by February 1 of each year which includes the number of dams removed, location and times of removal. They will also monitor the outflow through out the ice free months. In addition the T.W.P.S is working with a local trapper to “thin out” the beaver population in the area. A bounty will be paid to the trapper by

the T.W.P.S for each beaver taken within a one kilometre radius of the outflow. A copy of the permit is included in Appendix E.

8.1.3 Culvert with Siphon

Beaver dams that are obstructing water flow from the lake can be bypassed by placing a culvert through the beaver dam and a siphon to the lake. The siphon would go from the lake to the culvert and the culvert would run though the beaver dam to a point downstream past the dam. The siphon would have to extend far enough into the lake so that the beaver do not detect it and block the flowing water.
This would be a fairly expensive option that would require continual maintenance to keep the culvert and siphon clean of debris. There is also the possibility that the beaver dam could blow out and the culvert would be washed downstream.

8.1.4 Engineering Means

A weir or a dam would be expensive engineering options to control lake water levels.
Water Management and Fish and Wildlife are not in favour of engineering means for managing lake water level.

8.2 Septic System Failure, Remediation and Maintenance

The amount of nutrient loading to the lake through septic systems can be variable and difficult to estimate. Using a water budget formulation where input is equal to output (black box model) other sources of nutrient loading can be measured and the nutrient contribution from septic systems can be estimated indirectly (Cooke *et al.* 1993). This modelling exercise is likely to show that septic system discharges comprise only a small percentage of total external and internal loading, however, it may be a large percentage relative to external loading only.

It is a fact that problems associated with septic system failure are difficult to diagnose, therefore it is up to the individual house owner to maintain the system. Often, people do not realize that there is a problem with their system until it has reached a serious failure stage.

Each septic system on lakefront property should be assessed and any maintenance needed should be undertaken at the owners expense. Information on proper system maintenance can be obtained from the system manufacturer, Ministry of Health, Ministry of Environment and resources in the public library.

The efficiency of phosphorus removal is directly related to groundwater flow characteristics and soil type (Kerfoot and Skinner1981). Kerfoot and Skinner (1981) observed a high correlation between location of nutrient rich plumes and attached plant growth. Well-drained, porous soils were observed to be the most efficient for attenuation of nutrients from wastewater. Percolation tests are used to determine the ability of the soil to absorb effluent.

One way of diagnosing failing systems is through the use of a septic leachate detector. The Health Inspector adds a dye to the septic system and then assesses whether any of the

dye seeps into the lake (detection of plumes). This process is made more effective if a flourometer is available to improve the detection of low concentrations of dye. The regional health officer may be able to inspect each septic system on a request basis. Residents should be encouraged by the TWPS to participate on a voluntary basis for a maintenance inspection.

Depending of the soil's ability to remove nutrients recommended septic system set backs on some lakes have ranged from 30 to 300 metres from the shoreline to prevent nutrient loading to the lake. Identification of soil types around the lake and setting respective septic system setbacks could be addressed through Zoning Bylaws for presently undeveloped land in the area. Soil surveys in aid of these zoning efforts are required.

Another option to reduce nutrient contributions from septic system leachate, is to install a community sewage treatment plant. The cost of this would be millions of dollars, part of which would be borne by the lake residents. Before this is ever considered, there has to be an evaluation of whether septic tanks are a significant portion of the phosphorous budget of the lake or if they are having an effect. If so an immediate result would be a reduction in nutrient input to the lake. Due to the high cost of this option, it is feasible only for high density residential or commercial developments.
There are many new and innovative ways to deal with the treatment of waste water.

8.3 Chemical Applications within the Watershed

To address the concern over various chemical applications (fertilizer, herbicide, dust control) within the Tchesinkut Lake watershed, committed volunteers must establish a liaison with those parties using and approving these chemicals. This would include residents, resort owners, Ministry of Forests, Ministry of Transportation and Highways and the Ministry of Environment, Lands and Parks.

8.3.1 Chemical Use by Lakeshore Residents and Resort Owners

The biggest problem is convincing shore land owners that they can't have fertilized and beautifully manicured city lawns at the lake, that run right down to the water, and then expect high water quality. The two are mutually exclusive.
Environmentally safe lawn care practices for lake shore residents are simple and should include the following:

- Instead of chemical herbicides, handpulling and grubbing are generally effective methods used to eliminate weed species that do not reproduce vegetatively from rootstocks and where the infestation is light.
- Phosphorus is the most common limiting nutrient to aquatic plant and algal production and is a common ingredient of garden fertilizers. When improperly applied the phosphorus gets into the lake water through storm runoff. Consider not fertilizing, or instead of using commercial fertilizers, pump water out of the lake to water the lawn to obtain nutrients contained in the lake. Alternatively, use a low phosphorus fertilizer where the middle number on the bag is less than 3 or if it is a liquid fertilizer, the phosphorus content should be less than 1/2 %.

- When watering lawns provide just enough water without creating runoff. Maintain a 10 to 15 metre buffer zone of native vegetation along the lakeshore, with as narrow as possible pathway through the buffer zone to the lake/dock.
- Do not throw grass clippings or lawn rakings in the lake.
- In a log book keep track of the amount and frequency of chemical applications each year. Take note of local conditions before and after applications so that as a responsible shore land owner you can be sure you are only using what is necessary and not more.

8.3.2 Pesticides

To keep pesticide use to a minimum in the Tchesinkut Lake watershed, the membership may wish to participate in the pesticide use permitting process.

Permitting Process - Pesticide Use Permits and Pest Management Plans

The British Columbia *Pesticide Control Act* has been amended to allow pesticide uses under a Pesticide Use Permit to be authorized under an approved Pest Management Plan (PMP). The ministry intends to replace the existing Pesticide Use Permit system with PMPs.

A Pest Management Plan has two major parts which describe, a program for controlling pests or reducing pest damage using integrated pest management, and methods of handling, preparing, mixing and applying pesticides within that program. There are four major goals to this type of plan:

- To promote IPM to ensure that pesticides are used in the context of an IPM program.
- To reduce, and eliminate where possible, pesticide impacts on the environment and to protect human health.
- To broaden public awareness of, and involvement in, IPM programs.
- To make more efficient and effective use of administrative and technical efforts currently devoted to the Pesticide Use Permit system.

Integrated Pest Management (IPM) is a decision making process that uses a combination of techniques to suppress pests and includes the following six elements:

- planning and managing ecosystems to prevent organisms from becoming pests;
- identifying potential pest problems;
- monitoring populations of pests and beneficial organisms, pest damage and environmental conditions;
- using injury thresholds in making treatment decisions;
- reducing pest populations to acceptable levels using strategies that may include a combination of biological, physical, cultural, mechanical, behavioral and chemical controls;
- evaluating the effectiveness of treatments.

Approved PMPs will authorize pesticide use within the context of a plan by stating *why* and *how* pesticides will be used, and may identify specifically *where* pesticides will be used. If necessary, the ministry will require the proponent to provide detailed site-specific information of proposed pesticide use. A Pest Management Plan term may vary from one to five years depending on the period of pest management required, with five years being the maximum term duration. The system for Pest Management Plan approvals will operate in a similar way to the current Pesticide Use Permit system. As with the Pesticide Use Permit process, applicants/proponents will be required to give the public notification of their proposed pesticide use. It is expected that this will continue to be done through advertisements published in local newspapers or in local regional offices, and will contain information on a location where copies of the plan, permit application and maps of the treatment area may be examined in detail.

The PMP process will require that proponents get public input during the preparation stage of their plan , before they submit it to the Ministry for approval, thereby enhancing the public awareness and involvement. PMPs will be reviewed by government Regional Pesticide Review Committees which will recommend approval, denial or modification. The Deputy Administrators of the *Pesticide Control Act*, acting at the regional level, will use guidance from the review agencies, program policies and procedures in making a decision. The final approval of a plan will normally be given by the Deputy Administrator at the regional level, although the review of province wide PMPs will be coordinated by the Administrator in Victoria. In addition to adhering to the terms of the PMP, conditions and standards may be added by the ministry in the approval. Holders of approved PMPs will be legally required to apply pesticides in accordance with the approved PMP and will still be required to record and report their pesticide use. PMPs may be suspended or revoked for reasons of noncompliance. Decisions of the Administrator or Deputy Administrators of the *Pesticide Control Act* on PMPs are appealable before the Environmental Appeal Board.

For more information, visit the following web sites
Pesticide Control Act Regulation www.env.gov.bc.ca/epd/cpr/regs/pcareg.html
Pest Management Plans www.elp.gov.bc.ca/epd/epdpa/eripm/uoipmipm.html
or contact Pesticide Management Officer, Jennifer McGuire in Prince George at
(250) 565-6945 or Pollution Prevention and Remediation Branch, (250) 387-4441.

If it is the wish of the TWPS to be provided with notice of applications within their watershed, the following are potential options.

Liaison between pesticide permit applicants and the public:
The most effective strategy for obtaining notice of application is for a subcommittee of the TWPS to establish a liaison with the permit holders and applicants, which may include individuals, companies, public or private corporations, associations and Provincial Government employees. Through such contacts the TWPS could be provided with direct notice of both present and future applications for pesticide use permits within their watershed.

As a first step to identifying the past, present and future applications/permits for pesticide use within the Tchesinkut Lake would be to contact the Pesticide Management Section of the Pollution Prevention and Pesticides Branch of the Ministry of Environment in Victoria. Most permit applications are received between November and May. A request to the above office at the end of May would provide the TWPS with information necessary to further the objective of establishing a liaison between the public and the applicants

Northwest B.C Coalition to Alternative Pesticides

This group of individuals work mainly on increasing public awareness of pesticide use in the Smithers area. However, they are a good source of general information on how to keep advised of pesticide use within your watershed, the pesticide use permit process and pesticide alternatives.

Northwest Weed Committee

This committee is made up of representatives from the Ministry of Agriculture, the Ministry of Environment, Skeena Cattlemen's Association, Northwest B.C Coalition for Alternatives to Pesticides, Regional District of Bulkley-Nechako, Ministry of Forests and other liaisons with public agencies including CN Rail, BC Hydro.
This committee deals with applications of pesticides throughout the Northwest and therefore the TWPS may find their scope too broad to get actively involved at meetings. If the TWPS wishes to pursue representation on this committee at their next general meeting, they should contact the committee chairman, Dave Riendeau. However, it would be useful for the society to first canvas TWPS members which may also be current members of associations represented on the Northwest Weed Committee. Through their associations the TWPS may be able to obtain any information they are seeking.

Permit Conditions

Due to government reorganisation, the Skeena Regional office does not have a Pesticide program at present, and it has not yet been determined how the permitting process will be managed in the long term in this region. Once this has been decided, the TWPS may wish to approach the appropriate Pesticide Manager to discuss the possibility of including specific public notification requirements for those permit applications within the Tchesinkut Lake watersheds. The requirement would be that the applicant notify the TWPS directly of their application and provide the society with a copy of the permit and permit details.

Alternatives to Using Herbicides

Efforts to manage the problem of noxious weed invasion involves many activities other than spraying with herbicides and includes:

- Prevention of inadvertent introductions of noxious species into uninfested areas
- Cultural control
- Mechanical Control, Handpulling and Grubbing
- Biological Control

These methods will only be adopted after efforts to educate and inform herbicide users have met with success. The TWPS may undertake and/or promote these efforts.
For further information on these herbicide alternatives refer to the letter from the Central/North East Region Ministry of Transport and Highways in Appendix G.

8.3.3 Fertilizer Use

Fertilization is a silvicultural treatment that can be effectively used to increase the merchantable yield and value of established forests. By adding nutrients that are limited on a site, fertilizers can improve the growth of individual stands (FPC 1995). Although fertilizers are normally applied to accelerate stand development, an alternative objective is the rehabilitation of disturbed sites.
There are two general classes of fertilizer: organic and inorganic. Most operational fertilization has focused on the application of inorganic fertilizers because of their known chemical and physical properties and their cost-effective means of application.

Operational Costs

The operational costs of fertilization can be high. Those factors which affect the operating costs include, location, access, slope, project and block size. Large-scale programs (e.g. >300 ha) every 2-5 years are generally more cost effective than small-scale programs every year.
The limited use of fertilizers in the Lakes Forest District in the past has been due to the lack of money available to support these practices. Recently, however, FRBC is funding forestry work which includes fertilization of some of the older forest stands in the Lakes District that have been fertilized once already.

Season and Method of Application

A single application of fertilizer will generally increase the growth of a treated area for more than six years. In the Interior of B.C the season of application is usually May 15 - September 15, while more specifically; application in the Lakes Forest District is generally in September and October.
The method of fertilizer application in B.C which is the most efficient and cost effective for large-scale projects is the aerial approach.

No Fertilizer Application Zone

Nutrients from forest fertilization applications can enter water bodies through leaching, runoff, or directly when fertilizers are applied aerially. Sensitive areas are protected using buffers and limiting the area receiving the fertilizer treatment.
A 10-meter "no fertilizer application zone" or buffer zone should be left around the following water bodies:

- a fisheries lake
- any designated fishery stream
- a stream that can be identified, on a pre-flight inspection, as one observable as open water that flows into any designated fishery stream.

Water quality sampling is required in community watersheds and should be done when fertilising near fisheries-sensitive zones. Refer to section 8.7.4 for information on community watershed status.

Five Year Silviculture Plan \ Forest Development Plan

The Five Year Silviculture Plan was an operational plan as required by the Forest Practices Code outlining proposed silviculture activities for a five year period. It allowed other resource agencies and the public the opportunity to assess and make comment on the potential impact of proposed silviculture treatments on a landscape basis. To date, the public have generally been in support of silviculture treatment and have not shown interest in review of the five year silviculture plans. On June 9, 1997 an Order in Council was passed which eliminated the requirement to produce five year silviculture plans. This decision has been made in response to the Operational Planning Review Report which recommended a number of changes to improve the efficiency of planning requirements under the Forest Practices Code. Any plans already in existence and retroactive to June 1995 are now void. The Five Year Silviculture Plan will be replaced by a policy that sets up a much less onerous Strategic Referral Process for silviculture treatments. However, this process will likely not be in place provincially for at least a year. For more information contact the Lakes Forest District Office, Silviculture Officers or Al Waters, Site Preparation Program Specialist in Victoria (Appendix B).

The public can still make comments on proposed silviculture treatments by asking appropriate questions during viewing of forest development plans. A forest development plan is a document that describes and illustrates how harvesting and road development for a specific area will be managed for a period of at least five years. These issues are of greater concern to the public and therefore receive more public involvement than the five year silviculture plans for silviculture treatments did. The forest development plan must demonstrate conformity with objectives and strategies established in higher-level plans for an area or region, including such plans as resource management zones, interpretative forest sites, recreation sites/trails, landscape units, and sensitive areas. Forest development plans must be updated and submitted for approval annually with the exception of woodlot licences which are approved every five years. The objective is to provide a minimum of two years of approved operations (years 1 & 2) and notice of intended operations for years 3, 4, and 5. This allows for any necessary future amendments. It is required that advertisements of these plans are placed in local newspapers for 60 days, for the purpose of public notification. The advertisement indicates where the details of the plan can be publicly viewed and to whom any information, comments and/or concerns should be directed. This is usually the Forest District Manager.

The Lakes Forest District Office welcomes and invites communication with the public to address any concerns they have regarding forest practices within their district. It would be beneficial for representatives of the TWPS to approach the Lakes Forest District with their questions and concerns.

The TWPS could invite the managers of the relevant Forest District(s) to a special TWPS meeting to introduce the various parties to one another and address the society's wish to establish and maintain communication links with the Forest District(s).

8.4 Management of Human Disturbances on Waterfowl

Waterfowl are wary, seeking refuge from all forms of disturbance, particularly those associated with loud noise and rapid movement (Korschgen and Dahlgren 1992). Human activities can cause different degrees of disturbance to waterfowl and can be intentional or unintentional.

8.4.1 Impacts

Disturbances of nesting birds may cause abandonment of nests, disruption of the pair bond, reduction in clutch size, increased egg mortality, abandonment of nesting area, and increased predation of the nest. Other impacts on waterfowl that have been shown to be associated with human disturbances include, displacement of waterfowl from feeding grounds and increased energetic costs associated with flight (Korschgen and Dahlgren 1992). Disturbances during critical times of the nesting cycle eventually cause some waterfowl to nest elsewhere or not nest at all (Korschgen and Dahlgren 1992).

8.4.2 Watercraft Management Options / Implications

Appropriate management alternatives that reduce human disturbances of waterfowl include; inviolate refuges; voluntary compliance refuges; no-wake or nonmotorized boating zones; fishing or hunting restrictions; or both; and public awareness campaigns (Khal 1991).

Public Awareness

Providing public awareness campaigns would help to educate the public as to the effects of disturbances on the predominant waterfowl species as well the migration and wintering requirements of these species.

Reducing the Sources of Disturbances

Reducing the sources of loud noises and rapid movements of vehicles and machines is key and can be achieved in a variety of different ways:

- create voluntary avoidance areas on federal and provincial waterways
- close or restrict the fishing season during peak nesting periods
- limit access until most young waterfowl are three weeks old.
- limit size and horsepower of boats on the lake

Motorized Watercraft Restrictions

- **Prohibition** of all or certain types of motorized watercraft is the most severe restriction but is often warranted. The use of prohibition is justified when human safety considerations are paramount (Wagner 1990).
- A more subtle and less discriminatory form of prohibition involves **restricting access**. The density of motorized watercraft on a lake will greatly influence impacts. A single boat is likely to do much less damage than 100 boats in the same area,

although even a single boat can do great harm in a sensitive environment. Such restrictions may limit density but will not necessarily eliminate impacts by motorized watercraft and may be perceived as unfair by lake users (Wagner 1990).

- **Horsepower limits** represent a modified form of prohibition, which addresses engine size but not watercraft design or operational features (Wagner 1990).
- **Speed limits** address the operational features in a general way but do not consider engine size or watercraft design. Horsepower limits are easier to implement and enforce than speed limits, while the latter are more likely to minimise disruptive ecological effects than horsepower limits. Either may be construed as unfair or arbitrary by some user groups for logical reasons (Wagner 1990).
- The most flexible approach to motorized watercraft restrictions involves time and/or space zoning of the lake. **Time zoning** of a lake involves setting hours for motorized transport and other uses or establishing a schedule of rotating days for specific uses. Other uses of time zoning include quiet hours during which more passive recreational pursuits can be enjoyed. The key is in reaching a consensus among user groups that satisfies the greatest number of users for the greatest amount of time while preserving desirable lake qualities (Wagner 1990).
- **Space zoning** involves setting aside portions of the lake for specific uses. This allows key habitat areas to be set aside, can restrict motorized watercraft to areas of least potential impact, protects the best fishing spots from disturbance, and promotes safe swimming (Wagner 1990). Examples of space zoning would include **No-wake zones or nonmotorized boating zones** which would reduce disturbances by discouraging unnecessary boater travel through these zones and by reducing the speed of boats (Korschgen and Dahlgren 1992).

The speed of watercraft operation is an important impact-determining feature of watercrafts and is related to the wake created. To understand the relationship between watercraft speed and wake, one must consider the displacement volume of the watercraft and how it changes with speed. For a detailed explanation of this relationship refer to Wagner (1990) within the Tchesinkut Lake Management Plan reference material. In short the speed-wake relationship is boat specific and likely to have a peak at some intermediate speed such that lowering of open water speed limits may increase wakes. For this reason, a "no wake" ordinance is likely to be more effective than establishing some moderate headway speed limit to control wakes (Wagner 1990).

- **Inviolate refuges** are the most effective and most enforceable because they eliminate subjectivity of interpretation, but they also are the most controversial option (Korschgen and Dahlgren 1992).

With careful planning, deleterious effects of human disturbance on waterfowl can be mitigated or eliminated by creating sanctuaries in time and space.

8.4.3 Other Management Options

- Screened buffer zones could be established around important waterfowl roosting and feeding areas.

- Disturbances of feeding waterfowl can sometimes be mitigated by acquiring feeding areas on privately owned land. This would increase the quantity, quality, and distribution of foods to compensate for energetic costs from disturbances,
- Construction activities near nesting sites should be scheduled for non-critical times in the annual activity cycle of waterfowl.

Careful evaluation of lake features and user expectations is recommended before formulating lake-specific boating regulations. These must also be considered in any evaluation of probable impacts which will vary among systems. If one wishes to successfully manage motorized watercraft on a lake, it is critical that the goals of such management be derived in a logical fashion and be clearly stated. Determining the management objectives will involve evaluating and balancing ecological, social, and economic considerations (Wagner 1990).

8.4.4 Programs Dealing with Waterfowl Management

Canadian Wildlife Service

Conservation and protection of migratory birds

The Canadian Wildlife Service conducts research on a wide variety of migratory birds, including seabirds, shorebirds, forest birds and waterfowl, as well as other species of mammals, birds and amphibians. This research, combined with population surveys, provides the scientific knowledge necessary to establish and direct programs that protect and conserve wild species.

For more information, contact the Canadian Wildlife Service. In British Columbia contact the Delta Office at (604) 666-0143.

The North American Waterfowl Management Plan

The North American Waterfowl Management Plan (NAWMP), signed by Canada and the United States in 1986 and more recently by Mexico, aims to restore waterfowl populations to mid- 1970s levels by improving habitat in 34 designated areas across Canada.

Since 1986, public and private sources in Canada and the United States have raised $512 million for waterfowl and wetland conservation by all partners under the Plan. Over two million acres of habitat has been purchased, leased, restored, secured or enhanced for wildlife.

Among other things, the plan involves private landowners in the protection and improvement of habitat. Included are about 1.5 million hectares of breeding habitat in mid-continent; over 240,000 hectares of breeding and migration habitat in the Great Lakes-St. Lawrence lowlands; and more than 4,000 hectares on the east coast.

For more information, contact NAWMP, the Canadian Wildlife Service.

Ducks Unlimited Canada

Ducks Unlimited Canada is a private, non- profit, internationally supported conservation organization. Its goals are to preserve, restore, enhance and manage waterfowl habitat in Canada. The Canadian organization is part of an international network.
There are over 140,000 individual contributors in Canada and over 500,000 in the United States. Ducks Unlimited Canada, incorporated 55 years ago, traditionally concentrated on wetland development projects in prairie Canada. Now it operates in all provinces and territories. In recent years, Ducks Unlimited's habitat conservation programs have focused on landowner stewardship.

Ninety-nine percent of new habitat programs are conducted under the auspices of the North American Waterfowl Management Plan. The Prairie CARE program (Conservation of Agriculture Resources and Environment) provides incentives to farmers to encourage conservation farming and habitat protection. Sustainable agriculture on good quality land and revegetation of cropped marginal lands enhance soil and water quality, waterfowl habitat and biodiversity values.

Ducks Unlimited has pioneered the use of native grass and shrub species in the revegetation of marginal lands. Sculptured seeding of different native species seed mixes to soil types and moisture regimes to which the plants are best adapted provide self-sustaining plant cover for a wide variety of species.

While waterfowl will always be a key ingredient of Ducks Unlimited's conservation programs, it can also be considered as sustainable development and biodiversity conservation in action.

For more information, contact Ducks Unlimited Canada. In British Columbia the contact office is 954 A Laval Crescent Kamloops, B.C. V2C 5P5 (604) 374-8307.

Canadian Lakes Loon Survey (CLLS)

There has been speculation that loon populations in North America have been negatively impacted by motorized watercraft (Wagner 1990). This is a long-term project designed to monitor the numbers and breeding success of loons on lakes across Canada.

Upon request, a kit with detailed instructions are provided to volunteers wishing to take part in the survey. The minimum that is required of any volunteer is that they survey the lake at least three times over the summer, filling out information on what they observed. Detailed information on the CLLS as well as a kit order form and/or donations form may be acquired through their web page at: http://www.bsc-eoc.org/cllsmain.html

8.5 Fisheries Options

The first step in addressing the concerns expressed about potential fish population declines or habitat losses is to obtain verification that these concerns are justifiable or

valid. Anecdotal information needs corroboration through a more accurate means of tracking fisheries trends and conditions.

8.5.1 Volunteer Monitoring

A relatively cost effective method to obtain an assessment of fish population dynamics in Tchesinkut Lake may be to examine the fishing derby records kept by campground and resort owners on Tchesinkut Lake. These records may indicate trends of declining catches or sizes of fish. Any records obtained would effectively lessen the time required to gain information and aid management decisions. The society would have to access the records and summarize them. The Fisheries section could then evaluate population trends and possibly make decisions based on this information.

This management option requires that volunteers make a commitment of their time to research records and summarize them. There are many associated benefits. These include acquiring information that would aid identification of fish population trends and would help management decisions for fisheries in the lake. This is a first step that the Fisheries section of Ministry of Environment, Smithers endorses because of the low cost and relative availability of information.

If historic records have not been kept, refer to Appendix K for sample data sheets that could be used by lodge and resort owners to collect information on the fish populations. Before using these forms the Fish and Wildlife Branch of MELP should be consulted to ensure that all relevant information is collected.

Angler Survey

Angler surveys can be conducted by the TWPS that would be tailored after a creel survey. Even though this would not be as complete a survey as was done in 1987-1988 by Dave Bustard and Associates, it would be able to provide data about angler effort and catch per unit effort.

This type of survey can be tailored to fit the amount of time that volunteers can contribute. For example, this information could be collected on a weekly basis, on a monthly basis or over a long weekend during the fishing season. Careful records providing information about where and when the survey was done, who did the survey and the results of the survey must be kept.

This survey should be repeated every year so that any trends can be followed. The information that is gathered could be used together with information collected from resorts on the lake to help determine fishing pressure and fish population trends.

Streamkeepers Program

Streamkeepers Program is sponsored and supported by the Department of Fisheries and Oceans (DFO), Canada. The program educates volunteers in habitat assessment and re-habilitation and touches on activities which involve monitoring of fish populations. Volunteer driven fish monitoring programs could be set up under the framework and guidance of the Streamkeepers modules.

A lake survey has been done on Tchesinkut Lake (Webber and Tupniak 1981) that included surveys of four inlets and the outlet stream. This document would be useful for identifying potential indicator streams.

Before indicator streams are selected, the type of monitoring information that can be collected should be determined based on volunteer training and knowledge. The type of information that is collected must be quantitative and collected in a scientific manner.
The streamkeepers program can also be applied in the context of increasing habitat quality for fish.

The streamkeepers contacts in this area are Allan McCracken, Directory of Nadina Community Futures and Brenda Donas, Community Advisor with the Department of Fisheries and Oceans. It is Ms. Donas' recommendation that individuals and community groups like the Tchesinkut Lake Watershed Protection Society become involved in Streamkeepers**.**

8.5.2 Harvest Restrictions

Changes to the catch limit are based on angler effort and population size. Closure periods are based on sensitive times when fish are spawning. In 1988, although rainbow trout were the predominant species angled in Tchesinkut Lake both lake trout and kokanee were prevalent (Bustard 1988). The harvest of lake trout in 1988 was exceeding the maximum sustainable harvest (Bustard 1988). As well, the presence of winter lake trout fishery on Tchesinkut adds an unknown amount of pressure to this fishery. However, changes to catch limits or changes to the type of fishery, such as a change to a catch and release, should be based on data collected about the present conditions.

The Fisheries Branch can address overharvesting issues for long-lived species, such as lake trout, by implementing conservative angling regulations.

8.5.3 Fishing Derbies

Fishing derbies can be a large strain on fish populations in the lake. The effect on fish populations is compounded by several derbies in a season and by categories such as hidden weight and largest fish. The hidden weight category encourages anglers to kill all fish caught, regardless of size, in pursuit of a prize. The largest fish category places an unbalanced strain on the oldest, largest fish in the system.

It is recommended that fishing derbies be organized so as to keep the harvest of fish as minimal as possible. This can be accomplished in part by limiting the number of entrants in a derby, by minimum size requirements for derby entry or a move to catch, measure and release derbies and no hidden weight prizes.

A representative of the TWPS could address this option by approaching the Derby sponsors. Catch, measure and release derbies have been successfully held in other places and it would be a straightforward option to stop the hidden weight category.

Catch and release derbies allow anglers to continue fishing practices while at the same time responding to the growing concern about our fisheries. Though catch and release fishing practices are viable for most species of fish found in Tchesinkut Lake, lake trout tend to suffer high mortality rates even with such practices. During the summer months lake trout tend to delve deep into the cooler depths of the water. If they are hooked, and pulled up rapidly, their swim bladders, which keep them buoyant in the water, may burst due to the rapid change in pressure. If they are caught, measured and released, they tend to float on top of the water rather than swimming back into the depths because of their swim bladders. This leads them to be easy targets to predators. Hence it is essential that the species of fish is viable to such practices for it to be successful (per comm. Sig Hatlevic 2000).

8.5.4 Indexed Gillnetting Sites

Indexed gillnetting sites could be established on Tchesinkut Lake that would act as a long term monitoring tool. Index netting sites involve setting a gill net at a specific, catalogued site each year with the same net at the same time of year. Several of these sites may be chosen for Tchesinkut Lake. This would track long term fish population trends.

Gillnets capture fish that swim into a net that is suspended in the water column. The capture process is called gilling and occurs when the maxillary or opercular area is caught in a single mesh when the fish encounters the net. Fish may also be entangled by their teeth, spines, girth or scales as they try to pass through or free themselves. This method is only used when the intent is to kill the sample, as the fish do not live through the gilling process. The nets are very selective for both fish size and type because of where it hangs in the water column and the size of the net mesh.

Care must be taken to avoid over sampling a lake especially when the lake may support population or species sensitive to harvest. As a rule the length, weight and age data from thirty fish of each species is required to develop statistically useful relationships. In areas where it is necessary to minimize the number of fish killed in the gillnet, short sets of one hour or less can be used. The crew can also monitor the net for any movement of the corl line that indicates fish have been caught.

This information is useful on a long term basis and would be moderately expensive. Presently, the Fisheries section does not have sufficient staff to undertake this type of project but alternative methods for achieving this should be explored.

8.5.5 Creel Survey

A creel survey would entail an intensive evaluation of the current population of lake trout, rainbow trout, and kokanee in Tchesinkut Lake. This survey could replicate the study that was done in 1987-1988 by Dave Bustard and Associates. The data obtained from conducting a present day study could be compared to this past information. If fish population declines have occurred, this should be evident by a reduction in catch per unit effort, or by a significant shift in the population size and/or age structure. A survey of this nature would accomplish the first step of supporting the concerns expressed. This

type of survey would be the most effective method of assessing the status of fish populations.

A creel survey was performed from August to October in 2000. Funding has also been secured for a winter ice-fishing creel survey. To accurately assess the annual harvest and population of lake trout in Tchesinkut Lake, the survey should be continued in the summer of 2001 to cover an entire one year period. Results will be available in the MELP report: Tchesinkut Lake creel survey 2000/01.

Funding for the survey came from a variety of sources including the Environmental Youth Team program, the Ministry of Environment, Lands & Parks, the TWPS and Burns Lake Nordic Ford, with additional support from numerous other agencies and individuals. Currently the MELP Fisheries Section does not have the staff or financial resources to completely fund a continuation of the survey.

8.5.6 Habitat Restoration/Protection

Mapping Culverts

Poorly placed culverts may inhibit movements of rainbow trout or kokanee in their ascent and descent of streams to reach their preferred spawning beds. To reseat poorly placed culverts, the Ministry of Highways may be amenable to re-seating them or replacing them, but an outside source of funding would be required and is very expensive. Some of the forestry related culverts may be eligible for funding under the Forest Renewal BC Watershed Restoration Program.

Mapping of culverts is an option that the Tchesinkut Watershed Protection Society could undertake to facilitate the identification of poorly placed culverts. This option would entail taking a systematic approach to mapping and assessing fish passage. This approach could be based on looking in your own backyard so to speak, or it may be based on stream tributary characteristics. Included in a mapping survey would be photographs of the downstream and the upstream end of the culvert, measurement of the length and diameter of the culvert and a subjective guess of whether it would be a barrier to fish passage. Based on this information plus the streams importance to fish production, then the agency responsible for the culvert (i.e. Ministry of Highways, or Forestry) should be approached about re-seating the culvert.

Mapping of culverts should be done at a time of year when the culverts are easily measurable (i.e. not at spring freshet). A recommended time to undertake this project would be in late June to early July**.**

8.5.7 Public Education

Public education the most important option for each of the addressed issues. It is important to educate the public about how they affect the lake through their choices and activities. The long term life of the plan depends on public awareness and volunteer involvement.

A public education program should be designed and implemented that encourages the community, schools and area visitors to be aware of the lake ecosystem that they are enjoying. Education programs could include a stream stewardship or lake stewardship program in the schools where school children are educated about the life cycle requirements of the fish in the lake.

The public should be made aware of the sensitivity of lake trout to overharvest (eg. the long time that it takes lake trout to reach sexual maturity). The public should be encouraged to switch to a catch and release approach to fishing for this species, with the long term goal of more larger-sized fish available to anglers.

Other public education ideas include the watershed stewardship program that has families in the watershed adopt a stream. A family will choose a stream near their home that they monitor over the year.

8.6 Control of Forest Management

Land use management practices within the watershed catchment basin of Tchesinkut Lake all have some effect on external nutrient and sediment loading. Forest management programs such as logging, and forest renewal may involve uprooting vegetation, decreasing stability of soils, and application of nutrient rich fertilizers. Erosion reduction and runoff control measures can minimize sediment and nutrient inputs to the lake. The cost of these programs would be borne by forest managers and the practices would have to be evaluated as to their effect on forest productivity (I. Sharpe, pers. comm. 1997).
The FPC establishes mandatory requirements for planning and forest practises, sets enforcement and penalty provisions, and specifies administrative arrangements. Many of the concerns related to forest practices, including timber harvesting and road construction activities on scenic areas are addressed in the regulations and standards set out in the FPC.

British Columbia's world renowned landscapes are a source of everyday enjoyment for residents, as well as a foundation for our tourism industry. The new Forest Practices Code of British Columbia (FPC) recognizes scenic landscapes as an integral component of the forest resource base. The Code requires that when timber harvesting and/or road construction are proposed in scenic areas, visual impact assessments are included as part of the forest development plans and access management plans (FPC 1995). An important or key part of the visual landscape management process is visual landscape design. This is a creative process which involves working with the visual patterns and forces of nature to guide changes to the landscape in ways that meet the needs of society, both aesthetically and economically. It is the responsibility of all licensees, including the Small Business Forest Enterprise Program, to carry out visual landscape design when operating in scenic areas with visual quality objectives.

8.6.1 Visual Landscape Management Process

Visual quality is the extent to which the aesthetic or scenic value of a landscape is altered compared to the pre-existing or natural condition. The visual quality of landscape features is significant to the residents of Tchesinkut Lake. The primary objective in the

management of visual resources is to ensure a level of visual quality which meets the expectations of the community, yet is consistent with the principles of integrated resource management.

The Visual Landscape Management Process (VLM), formerly known as the Forest Landscape Management process, is concerned with the visual features of a landscape and the consideration of these values in the integrated management of provincial forest and range land. Visual Quality Objectives (VQOs) are the cornerstone of the Visual Landscape Management process and are the means by which District Managers or planning processes identify the level of alteration that would be acceptable on a viewscape. Five classes of VQOs are prescribed (Table 5). Once established, VQOs give direction to landscape design and the implementation of forest practices. VQOs establish the landscape management objectives to be met. The standards, design guidelines and management strategies that should be achieved to make VQOs measurable, auditable and implementable will be contained in the Visual Landscape Management Guidebook which is expected to be out in print within the next year. Contained within this guidebook will be design guidelines and impact mitigation strategies that will assist planners develop timber harvesting proposals which will achieve VQOs. Some of the parameters that will be addressed to ensure meeting of the VQO definition include, design, shape, size, distribution of cut blocks, percent alteration in persective of landscape permitted to be in non-vegetative state, harvesting method (clearcut, partial cut, selection cut), roads and other site disturbances (per comm, Lloyd Davies 1998).

TABLE 4. Visual Quality Objectives are an assessment of the amount and kind of visual alteration that could be made to a visually sensitive area, beyond which it is forecast there would be public concern. (MOF Forest Landscape Handbook 1981)

VQO	**Description**
Preservation	Allows activities, such as maintenance of minimal facilities that enhance or protect natural wildlife values. Alterations beyond these, such as logging are not acceptable
Retention	Requires that forest development activities or alternation will not be visually apparent
Partial Retention	Requires that alterations remain visually subordinate to the natural-appearing landscape
Modification	Allows alterations to dominate the landscape. However, these alterations must borrow from natural disturbance in the background. Alterations may dominate the original characteristic landscape
Maximum Modification	Permits a dominant change to the landscape. Alterations may be out of scale or show detail quite different from natural occurrences when viewed from close range. From the background, changes should appear to be natural occurrences.

The existing VQOs for Tchesinkut Lake would have been arrived at using the Landscape Inventory and Detailed Landscape Analysis procedures set out in the Forest Landscape Handbook and Forest Landscape Management: section 11.3 of the Ministry of Forests Recreation Manual (per comm, Lloyd Davies 1998). Over time these procedures and standards have been tested, refined, and new inventory factors included and/or replaced. As recently as June 1997, the previous ministry procedures and standards for Visual Landscape Inventory (Phase 1 of 6, in the Visual Landscape Management process, Figure 8) has been replaced with a new procedures and standards document for Visual Landscape Inventory. Since VQOs are established in phase 3 of the VLM process, they will continue to be used to express visual quality objectives for an area.

Visual Landscape Management Process	Outputs
PHASE 1: Visual Landscape Inventory	• Delineation and classification of the provincial landbase into visually sensitive/not visually sensitive areas • Delineation of visually sensitive areas into visual sensitivity units (VSC) and their classification into visual sensitivity classes (VSCs)
PHASE 2: Visual Landscape Analysis	• Assessment of implications and options • Recommendations, including recommended Visual Quality Objectives (RVQOs) • Modeling of current management practices for timber supply reviews
PHASE 3: Setting of objectives, priorities and guidelines	• Identification of scenic areas • Establishment of VQOs • Approval of operational plans
PHASE 4: Visual Landscape Design	• Visual simulation • Visual impact assessment • Visual landscape design solutions
PHASE 5: Implementation	• Achieved visual conditions
PHASE 6: Monitoring	• Monitoring/inspections of field activities

FIGURE 8. Visual Landscape Management Process adapted from the Visual Landscape Inventory: Procedures and Standards Manual 1997.

However, the newly developed Visual Sensitivity Class (VSC) inventory parameter, and the four factors that are used to calculate it will likely be used by staff specialist during the analysis phase as a consideration when setting recommended VQOs (RVQOs) and in turn by the district manager when establishing VQOs. There is no direct link between VSC (Table 6) and VQOs. The only correlation between them maybe, that in general the higher the visual sensitivity class the more restrictive the VQO that may be prescribed.

TABLE 5. VSC are an assessment of the likelihood that carrying out forest practices or other resource development activities in the area would result in some degree or kind of criticism or concern. VSC is expressed in terms of 5 classes as follows: (adapted from the Visual Landscape Inventory: Procedures and Standards Manual 1997)

VSC Class	Description
1	Very high sensitivity to human-made visual alteration. The area is extremely important to viewers. There is a very high probability that the public would be concerned if the Visual Sensitivity Unit was visually altered in any way of to any scale.
2	High sensitivity to human-made visual alteration. The area is very important to viewers. There is a high probability that the public would be concerned if the Visual Sensitivity Unit was visually altered.
3	Moderate sensitivity to human-made visual alteration. The area is important to viewers. There is a probability that the public would be concerned if the Visual Sensitivity Unit was visually altered.
4	Low sensitivity to human-made visual alteration. The area is moderately important to viewers. There is a risk that the public would be concerned if the Visual Sensitivity Unit was visually altered.
5	Very low sensitivity to human-made visual alteration. The area may be somewhat important to viewers. There is a small risk that the public would be concerned if the Visual Sensitivity Unit was visually altered.

On the other hand, since there is no direct link between VSC and VQOs the district manager has some added latitude when establishing VQO. In addition to the factors considered by the inventory the district manager can also weigh other prevailing factors such as economics, the level of public concern, biodiversity, and valued riparian habitat against one another to establish a more or less restrictive VQO for the area.

A map identifying existing visually sensitive polygon areas and their respective VQOs for Tchesinkut Lake can be requested from the Ministry of Forest, Lakes Forest District Office in Burns Lake. It is expected that the visual landscape inventory polygon label for these areas will follow format A in Figure 9, while format B shows the new polygon label.

A)

VSR	VAC
EVC	VQO

B)

	EVC		
VAC	BR	VC	VR
	VSC		

KEY:

BR = Biophysical Rating
EVC = Existing Visual Condition
VAC = Visual Absorption Capability
VC = Viewing Condition
VQO = Visual Quality Objective
VR = Visual Rating
VSC = Visual Sensitivity Class
VSR = Visual Sensitivity Rating

FIGURE 9. Visual Landscape Inventory polygon label : (adapted from the Visual Landscape Inventory: Procedures and Standards Manual 1997)

According to the new Visual Landscape Inventory standards and procedures recommending and establishing VQOs is clearly not part of the inventory phase of the process but rather is dealt with in the analysis and objective, priorities and guideline setting phase once the inventory is completed.

These revised standards and procedures will be used to obtain VQOs for newly identified visually sensitive areas and over time to update old inventories to the new standards (per comm, Lloyd Davies 1998). It is common for the public to be involved, through participation in planning teams or through the review of draft plans, in the development of recommended VQOs and in the development of recommended visual landscape design solutions. Visual Impact Assessment will be used (FPC Guidebook, phase 4 of Visual Landscape Design) to assess whether proposed forest harvesting and road building will achieve the established VQO.

8.7 Zoning and Development

There are several planning processes that affect zoning and development of the lakeshore and foreshore area. Involvement of the TWPS in any and all of these planning processes is recommended for the inclusion of the Societies concerns and interests. A representative of the TWPS should contact the Regional District planning co-ordinators to request that the TWPS be included as a community group in any of the following planning processes.

8.7.1 Bylaw 700: Rural Plan

Land use and development in the Bulkley Nechako Regional District is governed by the Zoning Bylaw No. 700 document. Bylaw 700 was developed for the rural areas of the Regional District that are outside the boundaries of the municipalities. This document establishes zones and regulates within the zones the use of land, buildings and structures, the density of use of land, buildings and structures, and the sitting, size and dimensions of buildings, structures and uses permitted on the land. In addition, the bylaw regulates the shape, dimensions and area of parcels of land that might be created by subdivision.

Applications for rezoning are treated as applications to amend the bylaw 700. Rezoning applications are initially sent to the Regional District office using a standard form that addresses the current zoning bylaw and the amendment to the bylaw. Included in an application for rezoning must be a legal description of the area to be rezoned. The application for rezoning is reviewed three times. The Regional District first reviews the application before distributing the application to various agencies, such as the Ministry of Environment, for comment. The application is reviewed a third time during a Public Hearing. At this time, comments from the various agencies are made available to the public and community groups and individuals are given the opportunity to address changes to bylaws. The Regional District votes on the application to amend the bylaw and based on the results of this vote, the amendment is either allowed or disallowed. Public hearings are advertised on the radio, by written public notices.

Developing a zoning document and maintaining the provisions in that document is an ongoing process. Community involvement will ensure that public interests are considered during development and amendment of zoning plans.

The Tchesinkut Watershed Protection Society should contact Mark Andison or the appropriate area director at the Regional District to ask that referrals be sent to the executive as part of public comment efforts.

8.7.2 Official Community Plan

The purpose of an Official Community Plan (OCP) is to state the broad land use objectives and policies of the Regional District of Bulkley- Nechako for the area of focus. The intent of the OCP is to

- build a consensus among the residents, the general public and various government agencies as to the future of the plan area
- to establish direction and consistency to decisions pertaining to land use matters
- to ensure that development occurs in an orderly, economic and environmentally conscious manner
- form the basis for the preparation, adoption and revision of regulatory land use bylaws.

The Bylaw 700 document can be a part of the OCP or it can be separate. A community plan may designate areas for the protection of the natural environment (section 945(4)(a) of the Municipal Act) for the purposes of section 976(1) of the Municipal Act. Under section 976(1), land that is designated under section 945(4) in an official community plan has certain development restrictions for the protection of the natural environment.

8.7.3 Lakeshore Guidelines/Guidelines for Riparian Management Areas

Guidelines for lakeshore development are intended to provide specific direction for land adjacent to aquatic habitats as well as permit the staff of the Regional District and the environmental agencies to direct development in the public interest and minimize the potential for negative impacts to aquatic habitats. An additional benefit to these

guidelines is to educate land owners and developers with respect to the value and importance of the aquatic habitats within their proposed development areas.

These types of guidelines may only be designated in an Official Community Plan under the authority of the Municipal Act for special purposes, including the 'protection of the natural environment'. Portions of the lake shorelands which are considered environmentally sensitive may be identified in an Official Community Plan and subject to the guidelines of a development permit, pursuant to Section 976 (5)(c) and (d) of the Municipal Act.

For examples of these types of guidelines refer to the Land Development Guidelines for the Protection of Aquatic Habitat, September 1993, Lakeshore Guidelines of the Regional District of Fraser-Fort George, April 1994 and the Proposed Development Permit Guidelines for Riparian Management Areas, October 1996.

There are many benefits associated with the adoption of guidelines that protect and assist in managing the land adjacent to a lake and its tributaries. Guidelines can be developed for the protection of fish habitat, septic system setbacks and development restrictions to protect natural environment or wildlife values. Guidelines that promote leave or buffer strips of riparian vegetation along a lake shore and/or stream result in protecting many aspects of the ecosystem. Riparian buffer strips act as habitat for many creatures, intercept runoff into the lake thereby reducing contaminant inputs into the lake, act as a visual buffer along the shoreline, and moderates stream temperature, an important habitat criterion for migrating, spawning and rearing fish.

8.7.4 Community Watershed

Community watersheds have been given special consideration in the Forest Practices Code and applications for community watershed status must be directed to the Ministry of Forests Regional Manager and Water Management of BC Environment. The definition for a community watershed given in Bill 18-1995 Forest Practices Code of BC Amendment Act (June 1995) which amends section 41(8) of Bill 40, is:
the drainage area above the most down stream point of diversion on a stream for a water use that is for human consumption and that is licensed under the Water Act for (i) a waterworks purpose, or (ii) a domestic purpose if the licence is held by or is subject to the control of a water users' community incorporated under the Water Act if the drainage area is not more than 500 km^2 /and the water licence was issued before June 15, 1995.

There are various criteria that a watershed and the community within the watershed must possess to qualify for community watershed designation. These criteria are outlined in the Forest Practices Code 1996 Community Watershed Guidebook, which can be found at: www.for.gov.bc.ca/tasb/legsregs/fpc/fpcguide/watrshed/watertoc.htm.

8.7.5 Land Resource Management Plan (LRMP)

Planning exercises such as the Land Resources Management Plan (LRMP), have advisory committee(s) comprised of various stakeholders, including local residents. The LRMP for the Lakes District is in its final stages of completion. As a result of this higher

level planning process some of the shoreline around Tchesinkut lake have recently been identified as high value recreation areas. The Special Resource Management Zone (SRMZ), of which the recreation areas are sub-zones, emphasizes conservation-oriented land uses over development-oriented land uses. In this zone, the resource management priority is to conserve the integrity of the numerous special and sensitive values that are known to exist in those areas. Recreation areas are recognized for their significant public recreational values and ability to provide for a range of natural environment recreational experiences. Objectives and strategies for these areas include the development of local management plans with the benefit of public and inter-agency participation for each of the recreation areas identified. Also these areas are to be managed as visually sensitive areas. These types of plans are generally reviewed after several years. It is strongly advised that a representative of the TWPS participate in any future reviews and revisions of the LRMP. The MOF district manager should be contacted to ensure standing on these committees.

8.8 Lake Classification

Under the Forest Practices Code, the class of every lake lying within the area for which timber harvesting or silviculture activities are planned must be identified in the operational plans for the area so that the special values of lakeshores - including fisheries, water quality, wildlife habitat and biodiversity, and recreation and visual quality - can be protected. Lakes are classified into one of five categories, A (highest protection) to E.

Classification process

Lake classifications will be carried out by a District Lake Classification Team, (LCT) made up of a district manager or designates from the Ministry of Forests, designates from the BC Ministry of Environment and representation from the Department of Fisheries and Oceans. Using information available in the forest development plans, the team will be able to determine a priority list of lakes to be classified and for which ones data is still required. These lakes will be ones potentially impacted by future harvesting activities and have not been classified and/or lake management zones have not been determined. Lakes smaller than 5 ha in size will not be subject to classification unless they have values that warrant classification, as determined by the district manager and designated BC Environment official. Generally, lakes less than 5 ha, and all wetlands are guided by the *Riparian Management Area Guidebook*.

Using inventory data collected from the government agencies, the licensee and the public, the LCT will assess the four primary resource values: fisheries, water quality, wildlife habitat and biodiversity, recreation and visual quality according to the set criteria. In general, the final classification of a lake is determined by the primary resource value with the highest rating. The lake classification criteria for each of the four main resource values will be available in the "Lakes Classification and Lakeshore Management Guidebook" for the Lakes Forest District which is presently being reviewed. After classifying the lakes the lakeshore management area is determined.

A lakeshore management area is made up of two zones: a Riparian Reserve Zone (RRZ) and a Lake Management Zone (LMZ). The riparian reserve zone is measured from the

high water mark to the outer edge of wetland vegetation and is a minimum of 10 meters wide. The LMZ is an area of land surrounding a lake's RRZ which will receive special management considerations. Lakeshore management zones are an important element at the landscape level in supporting biological diversity. In general, the higher the value of the various resources with the zone, the higher will be the degree of protection.

The LCT presents the information to the District Manager who finalizes LMZs and lake classifications. The information is given to the appropriate agency staff and the licensees for incorporation into the forest development plans. Although some lakes may be given a single classification, on large lakes (> 1000 ha) different portions of lakeshore of a lake may be assigned different classifications to reflect differences in lakeshore values.

None of the lakes in the Region are classified as yet although there are numerous lakes throughout the Region which may have very high values in terms of fisheries and biodiversity. Since the classification process is anticipated to take a few years to be complete, it has been proposed that many of these lakes can be given some interim management protection designation until higher level plans such as LRMPs are completed.

The whole process of lake classification is regarded as a relatively technical one receiving minimal public input. However, the results of the process are reported to the public. A flow chart of the lake classification process for the Kamloops Forest Region is found in Figure 10.

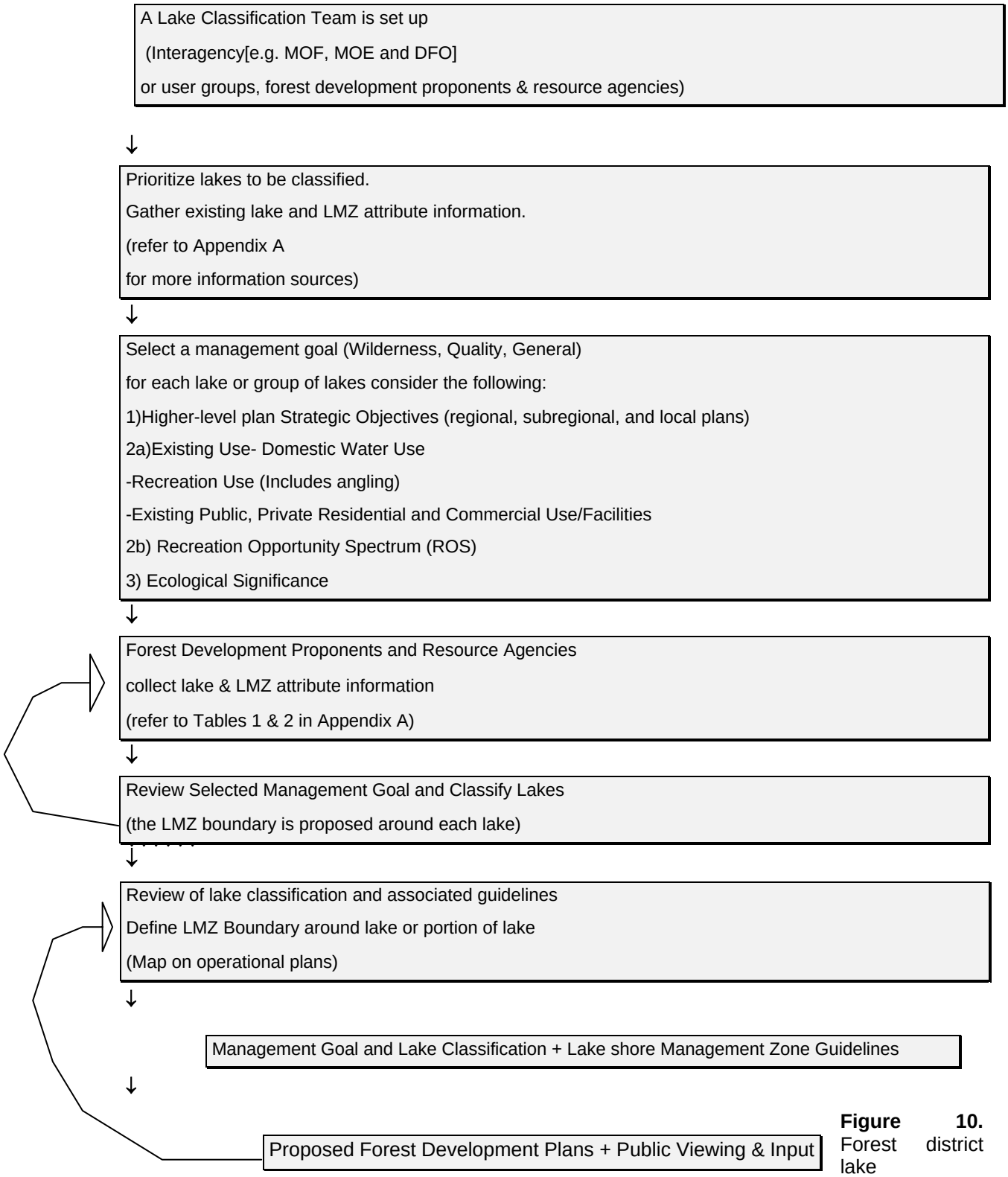

Figure 10. Forest district lake classification process taken from **Lake Classification and Lakeshore Management Guidebook: Nelson Forest Region.**

8.9 Agricultural Land: Maintenance and Remediation

Runoff from agricultural land that enters surface or groundwater may or may not be considered pollution, depending on the composition of that runoff and the nature of the receiving waters. The first step in addressing concerns over the impact of agricultural practises on water quality is to obtain verification that these concerns are justifiable.

8.9.1 Shoreline Survey

Sufficient information must be collected before time and money are invested in changing present practices. This would include an intensive and extensive survey of the shorelines for degradation and erosion as well as water quality monitoring at key times and locations along the shoreline. Such a survey can be both expensive and time consuming and would be conducted by the Ministry of Environment biologists, with help from Society members.

8.9.2 Volunteer Monitoring

An alternative to / or in addition to a shoreline survey, residents can seek advisement from the Ministry of Environment and the Ministry of Agriculture to perform visual observations of the shorelines with careful documentation at no monetary cost to the TWPS. If this was coupled with water sampling at key locations it could provide very useful information on the impact of agricultural practices on shoreline conditions and water quality.

8.9.3 Environmentally Sound Farming Practices - Controlling Runoff and Erosion

To reduce or eliminate contaminants in runoff, the Code of Agricultural Practice for Waste Management requires that contaminates not go beyond the farm boundary. There are farming practices which can be implemented that would have an immediate effect on reducing nutrients and pathogens to the lake. Farmers must be convinced of the benefits to the lake of new runoff control and treatment practices, especially if the suggested changes may be more expensive than the status quo (Rast and Holland 1988). The education program must include those farms located within the catchment basin.

Manure Storage - Bunkers

One very effective practice involves the use of manure storage bunkers which trap and hold runoff that is mixed with animal waste. This can be highly effective provided that animal waste is adequately collected and stored, and by-products (rotted manure and collected runoff) are properly used as soil amendment on lands at some distance from the lake or it's tributaries.

Ditches and Impoundments

These can be used to catch and hold nutrient rich runoff from pastures from entering the lake, and can provide additional benefits. The runoff is diverted into settling ponds where suspended solids including nutrients are allowed to settle out. The water which then seeps out of the treatment pond to the lake is much reduced in nutrient

concentration. An advantage of this practice is that the nutrient rich pond water can be used for irrigation of fields which may improve forage production. However, the treatment works are expensive to install, require regular maintenance, and may reduce the area of pasturage available (per comm. I. Sharpe 1997).

Soil Conservation Practices

A change in tillage practices from conventional types (soil annually cultivated in some fashion) to reduced tillage or to no-tillage, results in soils better retaining their structure and integrity, and therefore are less subject to surface erosion during heavy rains.

In the no-till cropping system, planting is the only operation which disturbs the soil. This practice aims is to minimize soil disturbance and maintain as much crop residue cover as possible because of the following benefits that are realized:

- reduced soil disturbance results in reduced soil moisture loss.
- more stubble on the surface protects the soil from wind and water erosion.
- soil organic matter increases which helps increase water infiltration into the soil.

also, from an environmental perspective:

- fewer tillage operations result in less fuel use and in turn reduced emissions of carbon dioxide into the atmosphere.

Since cultivation is not one of the available weed control options in zero till, more emphasis is placed on the effective use of herbicides. The correct identification of weeds and the growth stages of both crop and weed is critical. Herbicides should only be used to supplement prevention, sanitation, cultural, biological and physical control measures. According to material obtained through the Ministry of Agriculture, years of research in Alberta, Canada, have shown that over the long term there has been almost no indication of herbicide residue buildup in the soils.

A preseeding burnoff of emerging weeds is necessary when the no-tillage cropping system is used. Glyphosate (also known as RoundUp), is the most commonly used herbicide in northern BC of this purpose. It has no residual activity in the soil. When applied on a field, RoundUp binds tightly to the soil, inactivating it as a herbicide. It has a low potential to leach or contaminate groundwater because it is immobilized through strong absorption to soil particles. After immobilization, it biodegrades to natural end products of nitrogen, phosphorus, carbon dioxide and water. It does not bio-accumulate in the food chain. Since it is non-volatile, it stays were it is sprayed and won't move to non-target areas. RoundUp is considered by some to be a 'green' herbicide.

The ultimate goal of these alternative agricultural practices should be to minimize the use of herbicides, maximize profits, and maintain an acceptable level of weed control. Three factors are to be considered when switching from conventional to reduced tillage practices: residue management, weed control and crop rotation. Many farmers that have switched to reduced or no-till practices have reported noticeable economic benefits as well as environmental benefits. If the suggested practice can be demonstrated to cause a benefit to the farmer, it will be more easily implemented.

Further information on conservation tillage practices can be obtained through the Ministry of Agriculture, the B.C. Federation of Agriculture, the B.C. Cattlemen's Association, the B.C. Horticultural Coalition. Reference material includes the Conservation Tillage Handbook, the Journal of Soil and Water Conservation among others.

Another suggested practice, specific to the protection of lake water quality, is to leave a fringe of vegetation between pastures and the lake, allowing attenuation of nutrients from runoff before it reaches the lake.

8.9.4 Non-Regulatory Environmental Programs

The British Columbia Ministry of Agriculture, Fisheries and Food has 3 non-regulatory environmental programs available to beef producers.

Best Agricultural Waste Management Plans

This program provides waste management suggestions to beef cattle producers who have pollution concerns caused by: manure, dead animals, feed, yard runoff (not pesticide pollution). The plans are prepared by request of the producer to the local agricultural office and are designed to address the pollution concerns. The plan includes descriptions of current problems and suggestions for improvement.

Best Soil Management Plans

These plans are intended to provide soil management recommendations for farms that have problems with: soil erosion, compaction, structure deterioration, moisture deficit, acidity (not fertility). They are prepared by request of the producer to the local agricultural office and are designed to address the specific problem.

Nitrogen Behaviour Simulation Computer Model

This model simulates nitrogen behaviour from the time it leaves the animal as manure until it enters the soil and is eventually taken up by a crop, lost to the environment, or becomes part of the soil's organic mater. It is used to assess manure management practices and to determine effects on crop production. It will also predict the potential for environmental contamination. This model is prepared by request of the producer to the Soils and Engineering Branch of the Ministry of Agriculture, Fisheries and Food.

8.9.5 Livestock Watering

Intensive use of streams or lakes for watering livestock can degrade vegetation and contaminate the water source. This direct access may erode the soils, deteriorate water quality and reduce habitat for wildlife and waterfowl. But there are alternatives to direct access watering that preserve the environment around a water source while still providing clean drinking water for animals. Some of the alternatives can be categorized as follows:

- dugout - runoff collection
- gravity supply
- pump systems - onsite energy
- pump systems - offsite energy

- storage of precipitation
- water hauling
- water storage tanks

The costs of these various systems depends on how elaborate the system is (detailed information can be obtained from the Ministry of Agriculture). For the producer, the cost of a watering system is justified by the size of the herd or the number of animals to be serviced.

Detailed information on these and the many other management practices, available to producers, can be obtained through, but are not limited to the following agencies; Ministry of Agriculture, Fisheries and Food, Ministry of Environment, the B.C. Federation of Agriculture, the B.C. Cattlemen's Association and the B.C. Horticultural Coalition. The Tchesinkut Lake Watershed Protection Society has also been provided with a compilation of data, including information pertaining to this subject, namely, the "Livestock Watering Factsheets", and the "Engineering Factsheet: Why Keep Livestock Out of Watercourses?".

8.9.6 Public Education

Every lake management plan must include a public education program. Public education and involvement is an important option for most issues. It is important to educate the public about how they affect the lake through their choices and activities. The long term life of the plan depends on public awareness and volunteer involvement.

A public education program should be designed and implemented to encourage the community, schools and area visitors to be aware of the lake ecosystem that they are enjoying. Education programs could include a stream stewardship or lake stewardship program in the schools where children are educated about the life cycle requirements of the aquatic organisms in the lake. At Tchesinkut Lake the public should be made aware of the sensitivity of lake trout to overharvesting (eg. the long time that it takes lake trout to reach sexual maturity) and that human disturbances and lake level changes have negative impacts on breeding loons such that they are displaced from traditional nesting sites around the lake.

Other public education ideas include the watershed stewardship program that has families in the watershed adopt a stream. A family will choose a stream near their home that they monitor over the year.

Public education can also be effectively used to reduce external loading of nutrients and sediments. The public must be informed about land use/management practices to reduce nutrient loadings, especially if there is increased growth and development around the lake. This may include promoting the use of phosphate free detergents, the growth of riparian vegetation and reducing fertilizer use.

9. MONITORING AND EVALUATION OF LAKE QUALITY

Monitoring data is essential to compare the quality of the lake from year to year. When included in the lake management plan; 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;
- and build a constituency of involved citizens.

Collection of a comprehensive set of baseline data would allow for the development of a phosphorus budget for the lake and comparison of water quality before and after implementation of lake management techniques.

The collected data should be made available to the following; B.C Ministry of Environment biologists, (Pollution Prevention, Fisheries and Wildlife Programs), agricultural agencies, parks and recreation staff, as well as local government planning and zoning agencies.

A monitoring plan is key to aid in decision making. Once a decision to proceed with a management option is made, specific parameters which may assist in demonstrating a change (if one occurs) are identified and tracked over the implementation period. This allows continuing evaluation of the effectiveness of the actions taken.

The involvment of stakeholders as volunteers has been found to be of enormous value in the lake monitoring process. It is an efficient and cost effective method of monitioring lakes, which benefits both local agencies and stakeholders. The volunteers learn about water sampling, lake biology, and the impacts of land use activities.

9.1 Spring Turnover Sampling

Temperature and dissolved oxygen at spring turnover (approximately two weeks following ice off) should be monitored over several years. At turnover, water samples at various depths (ie 5-10 meter intervals) need to be collected and analysed for concentration of total phosphorus, total nitrogen, nitrates, nitrites, and total Kjeldahl nitrogen.

It is estimated that this program would require $300 - $500 in analysis costs, depending on how many rounds of depth profile sampling are needed to ensure that spring turnover (well mixed conditions) has been sampled.

It is anticipated that the equipment necessary for sampling at turnover can be made available to the Protection Society through the Ministry of Environment, Lands and Parks Pollution Prevention branch.

9.2 Monitoring Design

There are two approaches to designing a water quality monitoring program, both should be given consideration when developing long term monitoring strategies. The first approach is to target variables that will represent general water quality. It has been suggested that to fingerprint the productivity status of a water body, the following seven parameters are of great importance;

- **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 natural metallic ions, humus, peat material, plankton, weeds and 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 the chemical constituents in the water that will pass through a 0.45 micron filter. The results provide a measure of the dissolved mineralization in the water.
- **total suspended solids (TSS):** Nonfilterable residue, also referred to as total suspended solids is the term applied to the material retained by a filter of a standard size.
- **total phosphorus**: Phosphorus generally occurs in water as phosphates. The various types of phosphates may occur 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. Fertilizers and commercial cleaners are major sources of phosphorus.
-

The second approach is to target variables based on special situations in the lake. For example the presence of a mine would warrant testing for the specific metals and/or by-products that it produces, or the presence of a log dump might warrant on site measurements for turbidity, leachates such as resin acids and phenols and dissolved oxygen concentration.

To ensure a specific degree of confidence in the data collected, sampling must be conducted under a sound quality assurance program. For more detailed information on quality assurance and quality control refer to Appendix K. Also provided in this appendix is additional information and sample data sheets to facilitate the development of a volunteer monitoring program.

This section affects what action plan decisions are made. It should periodically be reassessed as more monitoring information is made available and interpreted. The

Resource Inventory Committee has produced a publication entitled Guidelines for Designing and Implementing a Water Quality Monitoring Program in British Columbia, which is available through their web site at:
http://www.for.gov.bc.ca/ric/Pubs/Aquatic/design/index.htm

This document discusses the purpose and requirements in undertaking such an initiative, and details the steps in designing a water quality monitoring program.

9.3 Sediment Cores

In February of 1997 sediment core samples were obtained from Tchesinkut Lake. A single sample was taken from two deep basins within the lake. The sediment cores were separated into 1 cm thin slices and shipped to Dr. John Smol at Queens University in Kingston, Ontario for analyses. The complete results from these analysis are in a report entitled, "Paleolimnological assessment of Tchesinkut, Takysie and Francois Lakes, British Columbia", which is available through the Pollution Prevention Branch of MELP in Smithers.

9.3.1 Types of Analysis

The analysis of relative diatom abundance identifies species assemblages in each slice of the sediment core analyzed. Through applying what we know about species affinities for a variety of nutrient regimes, trophic status of the lake over the long term can be inferred. This would help in setting best lake watershed management strategies for the future.

According to Reavie and Smol (1997), the diatom profiles from the two Tchesinkut Lake sediment cores are similar, having relatively stable diatom assemblages throughout history. Therefore, it is likely that Tchesinkut Lake is a naturally productive system and that the natural characteristics of the lake has allowed it to withstand long-term human impacts. Due to its size, Tchesinkut Lake has been relatively little affected by nutrient inputs thus far. Diatom records and diatom-inferred total phosphorus concentrations indicate that some increased nutrient loading has likely occured in response to human development. However, some reduction in total phosphorus may have occured in recent decades. (Reavie and Smol 1997).

The estimated costs for these analysis is between $5000 and $6000 per core. This type of analysis need not be repeated in the foreseeable future.

10. RECOMMENDATIONS

10.1 Public Education Program

The long term life of the plan depends on public awareness and volunteer involvement. The Tchesinkut Lake Watershed Protection Society should pursue their goals through publicising the plan and it's contents, seek support from the public for funding and obtain the necessary regulatory approvals. Means of heightening awareness through educational opportunities might include:

- Solicit help from resort owners, to promote environmentally friendly recreational use on and around the lake (ie. voluntary avoidance zones for power boat use in sensitive areas for waterfowl nesting and brood rearing) by putting up signs and distributing information brochures at resorts and other public access areas.
- Volunteer run booths at public functions such as fall fairs will promote public education and membership.
- Make presentations to service clubs, chambers of commerce, town councils and schools, showing off the management plan and any progress having been made to date.
- Solicit media coverage for the implementation of the plan and again at milestones within it, such as fund-raising targets to pay for various management option equipment or maintenance.

In addition, public education and awareness programs should encompass reduction and control of external nutrient loading through agricultural runoff treatment, septic system maintenance and control of inputs from new development as discussed in Section 8. Residential owners should be educated about the need to keep septic systems maintained and the potential impacts of gardening, shoreline development and other activities on water quality.

It is recommended that the TWPS invite guest speakers to be on the agenda of their monthly meetings to provide information and discussion on the various issues that have been brought out as a result of this plan. Refer to list of contacts in Appendix B.

10.2 Water Level

To deal with the the threat of flooding caused by high water levels in the lake it is recommended that the TWPS follow through with the criteria set out in the Memorandum of Understanding once it has been reviewed and approved by the Regional Director and the appropriate Section Managers.

10.3 Septic System Maintenance

Leaking and failing septic systems will contribute to the nutrient load of the lake. Each septic system which is on lake front property should be assessed and any maintenance needed should be undertaken by the owners. Residents should be encouraged by the

Tchesinkut Lake Watershed Protection Society to participate in a sanitary survey and to register on a voluntary basis with the Health Officer for a maintenance inspection.

Sanitary Survey

A sanitary survey needs to include the detection of all health hazards which includes a survey of all existing septic sytems, and the assessment of their present and future importance. The sanitary survey takes into consideratin geographic factors and probable sources of pollution from watershed tributaries to intakes. This includes sewage and industrial wastewater discharge, storm-water overflows, bird and animal populations, commercial and agricultural drainage, and their relationships to water use. The information provided by a sanitary survey is essential to complete interpretation of bacteriological and chemical data collected through sampling.

10.4 Monitoring Chemical Use in the Watershed

The TWPS should support and publicize the use of alternative methods to chemical applications of herbicides, fertilizers and pesticides, by residents and resort owners. It is recommended that a sub-committee of the TWPS be formed to watch for advertisements of any large scale chemical applications within the Tchesinkut Lake watershed and provide regular reports at the TWPS general meetings. Recommended activities of this sub-committee would include regularly looking for newspaper advertisements on Applications for Pesticide Use Permits or Forest Development Plans by various companies, the Ministry of Forests and the Ministry of Transportation and Highways. Contacting those who will be using the chemicals and requesting arrangements be made to keep the society advised of present and future work is also suggested.

10.5 Protecting Nesting Waterfowl

Due to the stresses placed on wildlife by intentional and unintentional human actions associated with recreation of all types, increased education of recreationists could go a long way towards minimizing impacts. Since the area of most concern is in the bay south-west of Beaver Point, public education signs could be errected by area residents at the enterance to the bay advising watercrafts of the presence of nesting waterfowl and requesting that they reduce their speeds in the bay. The Wildlife Branch of the Ministry of Environment can be consulted with regards to the information on these signs. It is also recommended that, to be most effective the signs should be removable so that they are only used during critical nesting periods.

Speed restrictions can be placed on a lake or sections of a lake under the Canada Shipping Act. The Ministry of Environment, Lands and Parks has been delegated the authority by the Federal Ministry of Transport to administer these regulations within the Province of British Columbia. However, applications for restricting waterways are only considered if there is a concern for human safety. Applications must be received by July 31st to be considered for implementation in the following year. A general information sheet and application for for boating restrictions is provided in Appendix H. The first step is for the TWPS to established, through formal concensus that lake residents want a reduced speed zone in the bay to protect the nesting waterfowl.

10.6 Fisheries Management

A volunteer sub-committee of the TWPS should implement both volunteer monitoring and angler survey options to determine the current status of the Tchesinkut Lake fishery. The Ministry of Environment, Fish and Wildlife Branch can assist in interpreting survey results and can suggest possible fishery management strategies for Tchesinkut Lake.

The TWPS can begin a volunteer group to survey indicator streams to further characterize the Tchesinkut Lake fishery. To decide on indicator streams to monitor it is recommended that the Brenda Donas, DFO Community Advisor, Alan McCraken, Local Co-ordinator with the Pacific Streamkeepers Federation and the Ministry of Environment, Fish and Wildlife Branch are consulted.

It is possible to approach fishing derby sponsors and the Ministry of Environment, Fish and Wildlife Branch about implementing changes to fishing derby rules and harvesting restrictions to sustain fish populations in the lake. However, this will require that some of the data describing the current status of the lake's fish populations has been compiled and interpreted, showing that such measures are warranted

10.6.1 Habitat Restoration and Protection

Mapping of culverts could be organized and accomplished by the TWPS. In conjunction with the volunteer monitoring and angler survey data, this data will help to answer some of the questions about the fish populations in the lake. The TWPS should liase with the Streamkeepers program to develop a fish and habitat monitoring strategy.

Habitat restoration and protection can be accomplished by seeking out the involvement of groups such as Ducks Unlimited, North American Lakes Management Society and the Canadian Wildlife Service.

10.7 Land Use Management

One of the long range goals of the management plan is to ensure development in the Tchesinkut Lake watershed is managed in such a way that water quality and the quality of life for all who use the lake is preserved and maintained. For example, agriculture, forest practices and new development must be kept a certain distance from inflowing streams and the shoreline to avoid destruction of riparian vegetation and input of sediments, nutrients and any chemicals. Such goals should be documented through the use of a periodically updated land use map and database. It should include the location and type of every potential loading in the watershed, including livestock pasturing and feedlot locations and number of animals present, onsite sewage disposal systems, and their state of functioning (to be documented on a voluntary basis), and any other discharges such as stormwater runoff from new housing subdivisions in the. This map will then serve as a focus for such things as educational initiatives and loading source monitoring.

Involvement of the TWPS in all of the planning processes is recommended so that their concerns and interests are addressed as part of these processes. In the short term, the

TWPS should contact the Regional District Planning Coordinators to ensure the society is represented during the various planning processes. Each process should be further researched by a sub-committee and all additional information should be presented at appropriate TWPS general meetings, as a method of updating all interested parties.

Additional information on the topics of lake classification, recreational areas and visual quality objectives can be obtained by contacting Alex Bergen, Lakes District Ministry of Forests Recreational Officer in Burns Lake.

10.8 Agricultural Land Use

Any fine tuning of livestock operations and pollution control that could reduce potential water quality degradation and nutrient inputs to the lake is suggested. This may be best accomplished through liason with the Cattlemen's Association voluntary audit program.

11. IMPLEMENTATION - ACTION PLAN

11.1 Plan Review and Revision - Testing

A systems design approach is subject to ongoing evaluation and revision, and it is accepted that a portion of the resources allocated to its 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 review should also include those regulators who may be called upon to write permits and licenses or cooperate in some way to implement the various management options. Ensuring that this occurs should be the first priority, and could be easily accomplished with assistance from the MELP Pollution Prevention Program.

11.2 Financial Support

To begin implementation of the lake management plan, an overall budget is required. Costs may include:

- use of government program funding to publish the plan
- planning - sending the draft plan out for review to experts in the province and elsewhere
- equipment
- monitoring and evaluation programs
- monitoring and evaluation programs - training volunteers and carrying out needed water, sediment and biota monitoring
- 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 have 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.
- voluntary donations, which should be sought in a systematic manner, such as an appeal campaign.
- modifying the lake association 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. There are two possibilities for forming one, the Local Service Area or the Local Improvement District. More information on the process of establishing one of these areas can be obtained from the Bulkley Nechako Regional District.
- application for grants or loans from public agencies. Grants or loans from public agencies include options such as the Habitat Conservation Fund, the Public Assistance Conservation Fund, and the Water Stewardship Grant. The Habitat

Conservation Fund deals with projects on habitat rehabilitation and maintenance (ie Rainbow trout spawning habitat). They also fund various research projects. Grants can be obtained through the Volunteer Lake Stewardship Program to establish lake management science and awareness programs in area schools. This is a new government initiative which provides funding, technical support through the Ministry, monitoring assistance and establishes a user group support network to produce educational materials and provide guidance. The goal of the program is to increase community awareness about lake management science. Such a program could potentially be initiated in the area schools with the school's co-operation and appropriate funding.

- Other private initiatives for raising funds include protection society membership dues, fundraising events, and donor campaigns.

Committees should be struck immediately to formulate the financial strategy. Fund raising methods should be inventoried, evaluated and decisions made as to their applicability in this instance.

11.2.1 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 financial and volunteer wise).

Volunteer groups who will assist with the implementation of the plan must be identified. In the Bulkley Valley and Lakes District, this may include, but is not limited to:

- Lake Protection Societies
- youth and service clubs (4H, Rotary Club, Scouts etc.)
- North American Lake Management Society, BC chapter
- Duck Unlimited
- Canada Wildlife Service

Volunteers can also assist with monitoring. 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:

- funding
- sampling and monitoring
- land use
- education

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

11.3 Regulatory Agencies

Most of the affected regulatory agencies have been consulted and involved in the development of the lake management plan. 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 prioritize incoming applications for approval. Allow sufficient time for the agencies to respond.

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