Water Quality

Ambient Water Quality Assessment And Objectives For Elk And Beaver Lakes Saanich Peninsula

Overview Report

Water Management Branch
Environment And Resource Division
Ministry Of Environment, Lands And Parks

Prepared pursuant to Section 2(e) of the
Environment Management Act, 1981

Original signed by J. O'Riordan
Assistant Deputy Minister
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March 24, 1992.

Canadian Cataloguing in Publication Data
McKean, Colin J. P. (Colin John Pearce), 1955-
Saanich Peninsula area, Elk and Beaver Lakes water quality assessment and objectives

[Vol. 2] constitutes technical appendix.
Includes bibliographic references.
ISBN 0-7726-1663-9

1. Water quality - British Columbia - Elk Lake (Saanich Peninsula).
2. Water quality - British Columbia - Beaver Lake (Saanich Peninsula).
I. BC Environment. Water Management Division. II. Title.

TD227.B7M335 1992 363.73'942'0971128 C92-092383-6

SUMMARY

The protection and management of water quality is of significant concern in Elk and Beaver lakes because of their important recreation and fisheries resources. Recent observations by the public suggest that water quality in Elk and Beaver lakes has deteriorated. Ambient water quality objectives for Elk and Beaver lakes were developed in this report to ensure that the future water quality is acceptable for the existing and future water uses.

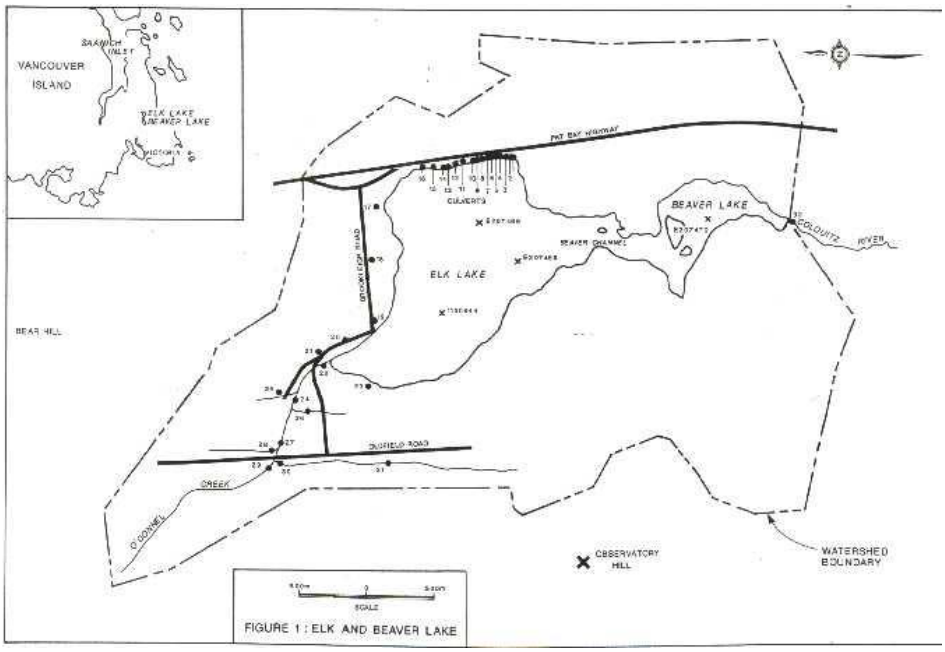
The Elk Lake watershed has a significant amount of residential and agricultural development. The developed areas include agricultural range and hay production to the northwest (Oldfield Road) and residential housing adjacent to the north and east sides of Elk Lake. The Capital Regional District park occupies 411 hectares around the perimeter of both Elk and Beaver lakes. Septic tanks are the sewage disposal method used throughout the Elk Lake watershed.

The combination of watershed development and the internal release of phosphorus from the bottom sediments has resulted in excessive growth of cyanophytes (blue-green algae) in Elk and Beaver lakes and low dissolved oxygen concentrations below the thermocline in Elk Lake. Cyanophytes can form unpleasant surface scums, cause taste and odours in the water and the fish, or reduce water clarity, creating a safety hazard for swimmers and boaters.

Provisional water quality objectives were set for those water quality characteristics that exceeded or were near criteria levels for designated water uses (primary-contact recreation, aquatic life) and that may be affected by watershed development. They include temperature, dissolved oxygen, water clarity, (Secchi disc depth) and phytoplankton biomass (chlorophyll-a) and community structure.

Lake and watershed management strategies designed to reduce the phosphorus loading to Elk Lake include lake aeration, decreased agricultural loadings and maintenance of existing septic tanks.

Figure 1. Elk and Beaver Lake (Saanich) Location Map



PREFACE

Purpose of Water Quality Objectives

Water quality objectives are prepared for specific bodies of fresh, estuarine and coastal marine surface waters of British Columbia as part of the Ministry of Environment, Lands and Parks' mandate to manage water quality. Objectives are prepared only for those waterbodies and water quality characteristics that may be affected by human activity now or in the near future.

How Objectives Are Determined

Water quality objectives are based the BC approved and working criteria as well as national water quality guidelines. Water quality criteria and guidelines are safe limits of the physical, chemical, or biological characteristics of water, biota (plant and animal life) or sediment which protect water use. Objectives are established in British Columbia for waterbodies on a site-specific basis. They are derived from the criteria by considering local water quality, water uses, water movement, waste discharges, and socio-economic factors.

Water quality objectives are set to protect the most sensitive designated water use at a specific location. A designated water use is one that is protected in a given location and is one of the following:

- raw drinking water, public water supply, and food processing
- aquatic life and wildlife
- agriculture (livestock watering and irrigation)
- recreation and aesthetics
- industrial water supplies.

Each objective for a location may be based on the protection of a different water use, depending on the uses that are most sensitive to the physical, chemical or biological characteristics affecting that waterbody.

How Objectives Are Used

Water quality objectives routinely provide policy direction for resource managers for the protection of water uses in specific waterbodies. Objectives guide the evaluation of water quality, the issuing of permits, licences and orders, and the management of fisheries and the province's land base. They also provide a reference against which the state of water quality in a particular waterbody can be checked, and help to determine whether basin-wide water quality studies should be initiated.

Water quality objectives are also a standard for assessing the Ministry's performance in protecting water uses. While water quality objectives have no legal standing and are not directly enforced, these objectives become legally enforceable when included as a requirement of a permit, licence, order, or regulation, such as the Forest Practices Code Act, Water Act regulations or Waste Management Act regulations.

Objectives and Monitoring

Water quality objectives are established to protect all uses which may take place in a waterbody. Monitoring (sometimes called sampling) is undertaken to determine if all the designated water uses are being protected. The monitoring usually takes place at a critical time when a water quality specialist has determined that the water quality objectives may not be met. It is assumed that if all designated water uses are protected at the critical time, then they also will be protected at other times when the threat is less.

The monitoring usually takes place during a five week period, which allows the specialists to measure the worst, as well as the average condition in the water.

For some waterbodies, the monitoring period and frequency may vary, depending upon the nature of the problem, severity of threats to designated water uses, and the way the objectives are expressed (*i.e.*, mean value, maximum value).

INTRODUCTION

The protection and management of water quality is of significant concern in Elk and Beaver lakes because of their important recreation and fisheries resources. Approximately 250,000 recreational visits per year are made to Elk and Beaver lakes, making them one of the most popular primary-contact recreational areas on Vancouver Island. Angling for smallmouth bass and rainbow and cutthroat trout in the lakes is currently the highest in the Vancouver Island Region. Promotion of Elk Lake as an international rowing site and its use for the British Columbia Summer Games, the 1994 Commonwealth Games and the Annual Victoria Boat Race are expected to result in a continued increase in recreational demand.

Recent observations by the public suggest that water quality in Elk and Beaver lakes has deteriorated. Aquatic weeds, such as coontail, native water lilies and pondweeds are a problem in many near-shore areas and are mechanically removed annually. Cyanophytes (blue-green algae) dominate the phytoplanlton community during the summer months, forming aesthetically displeasing surface scums. It is anticipated that increasing residential, agricultural and commercial development in the watershed will affect water quality. In response to these observations, the Capital Regional District and the Ministry of Environment undertook extensive water quality monitoring in 1988 to assess the water qaulity of Elk and Beaver lakes.

Ambient water quality objectives based on all data available for Elk and Beaver lakes were developed in this report to ensure that the future water quality is acceptable for the existing water uses. A detailed Technical Appendix was prepared summarizing the water quality data.It forms the basis for the recommendations ond objectives presented here.

HYDROLOGY

The watershed runoff from the Elk/Beaver watershed is typical of lowland lakes on Vancouver Island. The majority of runoff occurs during the winter months and precipitation typically occurs as rain. Stream flows are negligible during the summer as rainfall is low and evapotranspiration is high. Evaporation from the lakes during the summer results in a net water loss.

Based on the outflow estimates, the average water retention timws for Elk and Beaver lakes are 4.4 and 0.25 years.

WATER USE

Elk and Beaver lakes were used as a source of domestic water for the City of Victoria from the late 1880's to 1920, for the airport in the 1940's and for the Municipality of Central Saanich from the 1950's to the late 1970's. At the present time there are no domestic water withdrawals from Elk or Beaver lakes.

Elk and Beaver lakes are one of the most important recreational areas on southern Vancouver Island. The lakes are the most important recreational fisheries lakes, providing 11,000 angler-days per year. The lakes have a small resident cutthroat trout and smallmouth bass population and are stocked annuallly with yearling and catchable rainbow and cutthroat trout.

Water-contact recreation is also very important in the lakes. The Capital Regional District Parks Department operates several beacj\hes around the lakes with one quarter million visits per summer. In addition, Elk Lake is very important for recreational boaters (sailing, wind surfing and water skiing) and competitive rowing (Victoria Rowing Club).

The designated water uses for Elk and Beaver lakes are primary-contact recreation and aquatic life.

WATERSHED DEVELOPMENT

The Elk Lake watershed has a significant amount of residential and agricultural development Figure 1. The developed areas include agricultural range and hay production to the northwest (Oldfield Road) and residential housing adjacent to the north and east sides of Elk Lake. The Capital Regional District park occupies 411 hectares around the perimeter of both Elk and Beaver lakes.

Septic tanks are the primary sewage disposal method used throughout the Elk Lake watershed. The extent and location of residential development around Elk and Beaver lakes was determined from April 1988 air photographs obtained from the Municipality of Saanich. The impact of the septic tanks on the nutrient budget is discussed below.

WATER QUALITY AND PROVISIONAL WATER QUALITY OBJECTIVES

The combination of watershed development and the internal release of phosphorus from the sediments has resulted in high excessive growth of cyanophytes (blue-green algae) in Elk and Beaver lakes and low dissolved oxygen concentrations below the thermocline in Elk Lake. Cyanophytes can form unpleasant surface scums, cause taste and odours in the water and the fish or reduce water clarity creating a safety hazard for swimmers and boaters.

Provisional ambient water quality objectives were set for those water quality characteristics that exceeded or were near criteria levels for designated water uses (primary-contact recreation, aquatic life) and that may be affected by watershed development. A summary of the provisional water quality objectives is presented in Table 1.

The provisional ambient water quality objectives for temperature, dissolved oxygen and chlorophyll-a were set to ensure that the physical conditions of Elk and Beaver lakes were optimal for a cold water fishery (aquatic life). The secchi disc objective was set for safety reasons for primary-contact recreation activities. Good water clarity is essential to ensure sufficient visibility for swimmers to avoid underwater hazards or for rescuers to find swimmers or divers in difficulty. The objective for the phytoplankton community is primarily for aesthetics ans secondarily for the fishery. High concentration of cyanophytes can cause unsightly surface scums, as well as impart a muddy flavour in fish tissue.

Ambient water quality objectives are policy guidelines for resource managers to protect water uses in the specified water bodies. They will guide the evaluation of water quality, the issuing of permits, licences and orders and the management of the fisheries and of the Province's land base (Municipal zoning). They will also provide a reference against which the state of water quality in a particular water body can be checked and serve to make decisions on whether to initiate basin-wide water quality studies.

Depending on the circumstances, ambient water quality objectives may already be met in a water body, or may describe water quality conditions which can be met in the future. To limit the scope of the work, objectives are only being prepared for water bodies and for water quality characteristics which may be affected by man's activity now and in the foreseeable future.

Not all provisional ambient water quality objectives will be met immediately in Elk and Beaver lakes. Potential lake management strategies are outlined below that will improve the water quality of the lakes to levels where the objectives are met

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LAKE MANAGEMENT STRATEGIES

A destratification aeration system has been operating in Langford Lake since 1985. The system has been credited with eliminating internal phosphorus loading and shifting the phytoplankton community from cyanophytes to green and diatom spesies. The results have been a decreased spring overturn phosphorus concentration, elimination of surface cyanophyte blooms and improved aesthetics and water clarity.

A lake destratification aeration system uses a submerged air diffuser located a few metres above the deepest point in the lake. The aerator is designed to prevent the formation of the summer thermocline

and to mix oxygen down to the sediment/water interface. The destratification system will oxygenate the bottom waters and increase fisheries habitat, reduce internal phosphorus loading from the hypolimnetic sediments and change the algal community from cyanophytes to green and diatom species. Because the green and diatom species do not form surface scums, the shift in algal species will result in an increase in water clarity and aesthetics. The disadvantage of a destratification aeration system is that it would prevent the formation of a thermocline and eliminate the cold water refugia (hypolimnion) used by fish during the summer months

Another method of introducing oxygen to the lake bottom is through hypolimnetic aeration. The advantage of this process is that it maintains the lake's thermal stratification. The disadvantage is that it does not shift the phytoplankton community from cyanophytes to green and diatom species.

Any improvement in the water quality of Beaver Lake is dependent upon the water quality of Elk Lake. It is therefore recommended that any management strategy for Beaver Lake be evaluated after an Elk Lake strategy has been implemented and the lake has had time to respond.

Reduced phosphorus loading from O'Donnel Creek, the main inlet to Elk Lake, could be achieved through the reduction of livestock access to the creek and the stabilization of any eroding banks. A detailed study of O'Donnel Creek should be conducted to determine soil characteristics, agricultural activities and the potential management strategies to reduce agricultural loadings.

With reference to septic tanks, the Municipality of Saanich and the Capital Regional District should develop a plan to maintain existing septic tank systems to ensure that they are working efficiently. In addition, large lot sizes should be maintained to keep the density of septic tanks low. It must be emphasized that sewers in conjunction with small lot sizes may not be an adequate solution to reduce phosphorus loading to Elk and Beaver lakes. High phosphorus concentrations in runoff from high density sewered residential housing could easily exceed the phosphorus loading from a rural area with efficient septic tanks.

MONITORING RECOMMENDATIONS

The sampling program designed to monitor the provisional ambient water quality objectives is summarized in Table 2.

The summer temperature and dissolved oxygen objectives can be checked by sampling in late August. Temperature and dissolved oxygen concentrations should be sampled at the deepest part of Elk and Beaver lakes at 1 m intervals from the surface to the bottom Figure 1.

Spring overturn phosphorus samples for Elk and Beaver lakes are recommended even though there are no ambient water quality objectives. Spring overturn phosphorus measurements are the best method of monitoring long-term trends in phosphorus loading from the watershed to the lakes. Samples should be taken in mid-April prior to any thermal stratification. Samples for total phosphorus should be collected at 2 m intervals from the surface to the bottom at sites 1100844 and E207470 Figure 1.

Chlorophyll-a and phytoplankton samples should be collected at the deepest part of Elk and Beaver lakes (sites 1100844 and E207470) every four weeks, from May to August Figure 1. DDuplicate chlorophyll-a and phytoplankton samples should be collected from 0, 2, 4 and 6 m water depths in Elk Lake and 0, 2 and 4 m in Beaver Lake. Phytoplankton samples should be collected at the same time as the chlorophyll-a but at the 0 m water depth only.

Secchi disc measurements apply to any point in the lake at any time of year. A minimum sampling regime should include summer measurements at the same frequency as the chlorophyll-a and phytoplankton samples. Sample sites should include the center of the lakes as well as recreational areas (Figure 1).

TABLES

Table 1. Ambient Water Quality Objectives for Elk and Beaver Lakes, primary contact recreation and aquatic life

characteristics	objective values
maximum hypolimnion temperatures	15 degrees Celcius
minimum summer dissolved oxygen	5 mg/L at 1 m above the sediment
mean summer chlorophyll-a range	1.5 to 2.5 micrograms/L
secchi disc depth	greater than 1.9 m
phytoplankton community	not dominated by Cyanophytes less than 50% of the cells /mL

Table 2a. Recommended Monitoring for Elk (site 1100844) and Beaver (site E207470) Lakes

Frequency and Timing	Characteristics to be Measured
spring overturn (mid April)	total phosphorus every 2 m from

	the surface to the bottom
May to August (every 4 weeks)	**chlorophyll-a (duplicate samples from 0, 2, 4 and 6 m depth) secchi disc, surface phytoplankton community**
August	**temperature and dissolved oxygen readings at every meter from the surface to the bottom**
spring overturn (mid April)	**total phosphorus every 2 m from the surface to the bottom**

-The 6 m sample is in Elk Lake only as Beaver Lake is too shallow.
-The phytoplankton community is a discrete sample at 0 m every 4 weeks from May to August.
-Chlorophyll-a is duplicate samples from 0, 2, 4, and 6 m every 4 weeks from May to August and the objective is the grand mean of these samples.

Table 2b. Recommended Monitoring for Elk and Beaver Lakes beach areas

Frequency and Timing	Characteristics to be Measured
May to August (every 4 weeks)	**secchi disc**

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