ENVIRONMENTAL PROTECTION DIVISION
ENVIRONMENTAL SUSTAINABILITY DIVISION
MINISTRY OF ENVIRONMENT

Water Quality Assessment and Objectives for Comox Lake

OVERVIEW REPORT

May 2011

Library and Archives Canada Cataloguing in Publication

Epps, Deborah
Water quality assessment and objectives for Comox Lake [electronic resource]: overview report.

Author: Deborah Epps.
Electronic monograph in PDF format.
A technical report is available separately.
Published in cooperation with: Environmental Sustainability Division.
ISBN 978-0-7726-6472-3

1. Water quality--British Columbia--Comox Lake.
I. British Columbia. Environmental Protection Division II. British Columbia. Environmental Sustainability Division III. Title.

TD227 B7 E65 2011 363.739'42097112 C2011-909023-6

SUMMARY

This document is one in a series that presents water quality objectives for British Columbia. This overview report summarizes the findings of the technical report, which is available as a separate document. The overview report provides general information about the water quality of Comox Lake, a community watershed supplying drinking water to the Comox Valley Regional District on the east coast of Vancouver Island in British Columbia. It is intended for both technical readers and for readers who may not be familiar with the process for setting water quality objectives. Separate tables listing water quality objectives and monitoring recommendations are included. The technical report presents the details of the water quality assessment for Comox Lake, and forms the basis of the recommendations and objectives presented here.

The primary activities occurring within the watershed that could potentially impact water quality are timber harvesting, power generation, recreation, residential and historical mining activities.

Water quality objectives are recommended to protect source water (raw drinking water supply), recreation, irrigation, wildlife and aquatic life.

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's (MoE) 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 future.

Authority to set Water Quality Objectives

The MoE has the authority to set water quality objectives under Section 5(e) of the *Environmental Management Act*. In addition, Section 150 of the *Forest and Range Practices Act* (FRPA) contains provisions for the MoE to establish objectives to protect water quality in designated community watersheds. This legislation is intended to protect consumptive uses of water in designated community watersheds within working Crown forests. For this reason water quality objectives developed for community watersheds generally focus on potential impacts from timber harvesting, range activities and forestry-related road construction.

The Puntledge River, including Comox Lake, was designated as a community watershed in 1995, as defined under the *Forest Practices Code of British Columbia Act* ("the drainage area above the downstream point of diversion and which are licensed under the *Water Act* for waterworks purposes"). This designation was grandparented and continued under the *Forest and Range Practices Act* (FRPA) in 2004 and infers a level of protection. The purpose of this designation is to conserve the quality, quantity

and timing of water flow or prevent cumulative hydrological effects.

As the majority of the Puntledge River community watershed is on private land, the FRPA does not apply to most of the watershed. However, the MOE uses other tools, such as water quality objectives, and legislation, such as the *Private Managed Forest Land Act* and the *Drinking Water Protection Act*, to ensure that water quality within these watersheds is protected and managed in a consistent manner.

How Objectives Are Determined

Water quality objectives are the safe limits for the physical, chemical or biological characteristics of water, biota (plant and animal life) or sediment that protect all designated water uses in a given waterbody or a watershed. The water uses considered in this exercise are the following:

- source water for public water supply and food processing
- aquatic life and wildlife
- agriculture (livestock watering and irrigation)
- recreation and aesthetics
- industrial (e.g., food processing) water supplies.

Objectives are established in British Columbia for waterbodies on a site-specific basis taking into consideration provincial water quality guidelines, local water quality, water uses, water movement, waste discharges and socio-economic factors. 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 are not legally enforceable unless established under the Government Actions Regulation (B.C. Reg. 582/2004). Objectives are most commonly used to guide the evaluation of the state of water quality in a watershed, the issuance of permits, licenses and legal orders, and the management of fisheries and the province's land base. Water quality objectives are also a standard for assessing the ministry's performance in protecting water uses.

Monitoring Requirement

Monitoring of water quality objectives is undertaken to determine if the designated water uses are being protected. Monitoring usually takes place at a critical time when a water quality specialist has determined that the water quality objectives may not be met. In the case of forestry-related impacts, these critical times may be associated with periods of peak flows when the majority of suspended and dissolved particulates and other contaminants, such as bacteria, are introduced into a waterbody. Late summer periods of low flow could also be sensitive to impacts due to human disturbances. It is assumed that if all designated water uses are protected at the critical times, then they also will be protected at other times when the threat to water quality is less.

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

For some water bodies, the monitoring period and frequency may vary, depending upon the nature of the problem, severity of threats to designated water uses and the way objectives are expressed (e.g. mean value, maximum value, 95th percentile, etc.). Generally lakes are sampled on a quarterly basis.

Vancouver Island Eco-Region Approach

There are over 60 community watersheds within the Vancouver Island Region of the Ministry of Environment. Rather than develop water quality objectives for each of these watersheds on an individual basis, an ecoregion approach has been implemented, whereby Vancouver Island has been split into six ecoregions based on similar climate, geology, soils and hydrology. Representative lake and stream watersheds within each ecoregion are selected and a three year monitoring program is implemented to collect water quality and quantity data, as well as biological data. Watershed objectives will be developed for each of the representative lake and stream watersheds based on this data, and these objectives will also be applied on an interim basis to the remaining lake and stream watersheds within that ecoregion. Over time, other priority watersheds within each ecoregion will be monitored for one year to verify the validity of the objectives developed for each ecoregion and to determine whether the objectives are being met for individual watersheds.

INTRODUCTION

This report examines the existing water quality of Comox Lake and recommends water quality objectives for this watershed based on potential impacts of certain key water quality parameters of concern.

The Puntledge River, or more specifically Comox Lake, provides a significant source of drinking water to the local community and has important fisheries values, with chinook, chum, coho, sockeye and pink salmon, cutthroat and rainbow trout, and steelhead all present at some point during the year. Anthropogenic land uses within the watershed include timber harvesting, power generation, residential and recreation. These activities, as well as natural erosion and the presence of wildlife, can all potentially affect water quality in the Comox Lake watershed.

The purpose of this report is to develop water quality objectives specific for Comox Lake to help ensure long-term sustainability of the water resource.

BASIN PROFILE

Watershed Description

The Puntledge River, which contains Comox Lake, is a fifth-order stream 29 km in length, entering Georgia Strait near the community of Courtenay, BC. Comox Lake has a surface area of 2,100 ha, a maximum depth of 109 m and a mean depth of 61 m. The community watershed portion of the Puntledge River watershed (which includes all of the area upstream of Comox lake,

and extends downstream to the Comox Valley Regional District (CVRD) water intake near Courtenay) is approximately 58,591 ha in area and ranges from approximately 2,000 m elevation at the Comox, Moving and Cliffe glaciers in the upper watershed to near sea level at the CVRD water intake (located at the BC Hydro Penstocks intake, approximately 3.7 km downstream from Comox Lake) (Figure 1).

The Puntledge River watershed falls within the Coastal Western Hemlock biogeoclimatic zone (western very dry maritime, CWHxm2), with higher elevations passing through Mountain Hemlock (windward moist maritime MHmm1) and Coastal Mountain-heather alpine (CMAunp). Comox Lake falls within the Nanaimo Lowland (NAL) ecoregion established for Vancouver Island by MOE staff.

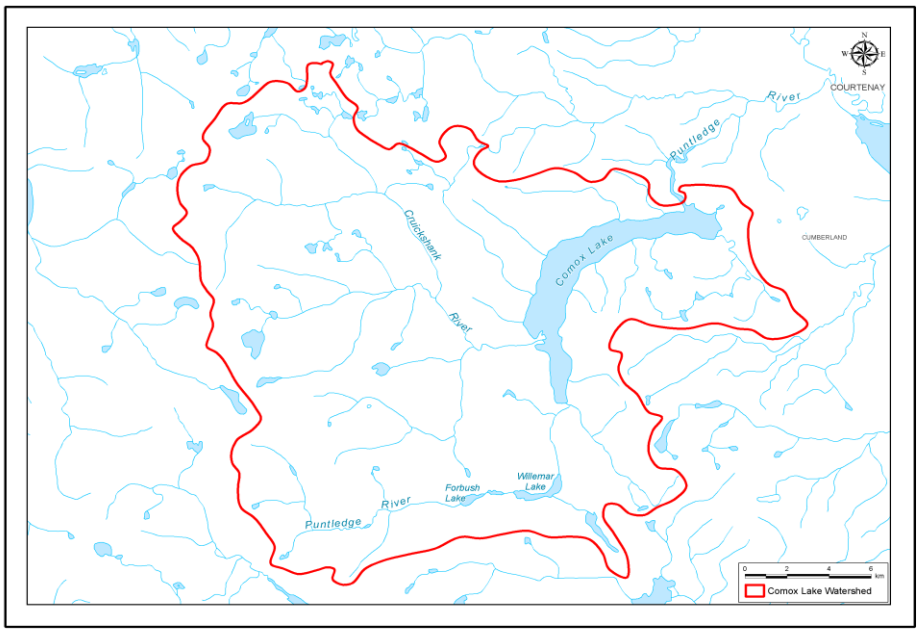

Figure 1. Map of the Comox Lake watershed.

Hydrology

Water levels in Comox Lake are controlled by the Comox Dam. These levels are guided by the 2004 BC Hydro Water Use Plan for the Puntledge River System. Water Survey Canada (WSC) operated a hydrometric station on Comox Lake between 1993 and 2007. The maximum daily water level recorded was 136.146 m above sea level (asl), while the minimum level was 130.493 m asl. Water Survey Canada also operates a hydrometric station on the Puntledge River downstream from the BC Hydro Diversion, located approximately 3.7 km downstream from Comox Lake.

Climate

The nearest climate station to the watershed for which climate normal data (1971-2000) are available is the Comox A station (elevation 25.6 m) (Environment Canada Climate Station 1021830). Average daily temperatures range from 3°C in January to 17.6°C in July and August. Average total annual precipitation is 1,100 mm, with only 74 mm (water equivalent) (6%) of this falling as snow. Most precipitation (917 mm, or 78%) falls between October and March. Snowpack reaches a maximum in May, and snowmelt coupled with glacial melt contributes to spring freshet and summer flows.

Water Uses

Water Licenses

BC Hydro has a license to withdraw 28.3 m^3/s (893,000 dam^3/a) from the Puntledge River downstream from Comox Lake. In addition, BC Hydro and the Department of Fisheries and Oceans each have licenses for water storage in the Puntledge River, for

conservation purposes. There is only one water license issued for water withdrawals from Comox Lake itself, allowing for the withdrawal of 119.7 dam^3/year for fire protection. There are also a number of domestic and irrigation licenses, as well as a license for fire protection on the Puntledge River downstream of the lake.

Recreation

Comox Lake is a very popular recreational area. There are 77 cabins on the lake (70 of which are used seasonally, while the remaining seven are used year round). As well, there are two designated campgrounds: the Cumberland campground on the south shore of the outlet basin and the Courtenay and District Fish and Game Protective Association campground on the north shore of the outlet basin. There are a number of popular day-use beaches for swimming; walking, fishing and boating (powerboats, canoes, and kayaks) are also very popular activities on the lake.

Fisheries

Fish species in Comox Lake include rainbow trout (*Oncorhynchus mykiss*), brook trout (*Salvelinus fontinalis*), cutthroat trout (*O. clarkii*), steelhead (*O. mykiss*), Dolly Varden (*S. malma malma*), kokanee (*O. nerka*), chinook (*O. tshawytscha*), chum (*O. keta*), coho (*O. kisutch*) and Atlantic salmon (*Salmo salar*), coast range sculpin (*Cottus aleuticus*) (also known as the Aleutian sculpin), and threespine stickleback (*Gasterosteus aculeatus*). The outlet of Comox Lake is equipped by a fishway, and passage is controlled for fisheries management.

From 2004 to 2006, more than 200,000 steelhead and 2,000 anadromous cutthroat trout have been stocked in the Puntledge River (the vast majority as smolts, with a few adults). The Department of Fisheries and Oceans (DFO) has also released hatchery fish in Comox Lake and its upper watershed tributaries in the past and may propose to continue this in the future.

Flora and Fauna

The Puntledge River watershed provides habitat to a variety of wildlife species typical of west coast Vancouver Island, including blacktail deer, black bear, cougar, and numerous other small mammals and birds. A number of rare plant species, including red and blue-listed species, are also found within the watershed.

Designated Uses

Based on the information presented here, the water uses to be protected should include drinking water, recreation, irrigation, wildlife and aquatic life.

Influences on Water Quality

Land Ownership

The upper portion of the Puntledge River watershed is part of Strathcona Provincial Park. Much of the remaining watershed is comprised of privately owned lands primarily managed for forestry activities, as well as a small portion of privately-owned land, Crown land, municipal land, and land owned by BC Hydro.

Of the 77 cabins located around Comox Lake, 51 are on leased TimberWest properties along the southerly half of the lake. The remaining 26 cabins are located on Comox Lake Land Corporation property at the east end of the lake. Potential impact from the cabins to surface waters include contamination from grey water or black water systems, garbage disposal, spilling of household chemicals or hydrocarbons, and inundation of cabins and waste disposal facilities during extreme flooding events and subsequent runoff of contaminants. Fire suppression activity, if any of these cabins catch fire could also be a significant source of water quality contamination.

Water Licenses

Water licenses can impact aquatic habitat downstream from the withdrawal, especially during low-flow periods. However, in the case of Comox Lake, BC Hydro is required to maintain a minimum three-day average flow of 5.7 m^3/s and a minimum instantaneous flow of 5.1 m^3/s between the diversion dam and the powerhouse. As well, a number of releases (allowing at least 12 m^3/s) are provided throughout the year to allow for fish migration, rearing and spawning.

Forest Harvesting and Forest Roads

Forestry activities can impact water quality both directly and indirectly in several ways. The removal of trees can decrease water retention times within the watershed and result in a more rapid response to precipitation events and earlier and higher spring freshets. The improper construction of roads can change drainage

patterns, destabilize slopes and introduce high concentrations of sediment to streams.

Approximately 61% of the Comox Lake watershed is currently under active forestry management, including lands owned by TimberWest and Hancock. As the majority of forest activity takes place on privately-owned lands, it is governed by the *Private Managed Forest Land Act*. As such, the forest management objective for water quality is to protect human drinking water, both during and after harvest.

Recreation

Recreational activities can affect water quality in a number of ways. Erosion associated with 4-wheel drive and ATV vehicles, direct contamination of water from vehicle fuel, and fecal contamination from human and domestic animal wastes (*e.g.*, dogs or horses) are typical examples of potential effects.

Comox Lake experiences high levels of recreational activity, primarily during the summer months. Activities such as camping, swimming, fishing and boating can potentially impact water quality in a number of ways. Bacteriological contamination can be associated with campgrounds, backcountry activity, swimmers, and pets. Debris left by picnickers, fuel spills, and combustion by-products from ski-boats, jet-skis, and other motorized craft, could all potentially impact water quality in Comox Lake.

Wildlife

Warm-blooded animals can carry microorganisms such as *Giardia lamblia* and *Cryptosporidium*, which are harmful to humans causing gastrointestinal disease. The Comox Lake watershed

contains valuable wildlife habitat and provides a home for a wide variety of species.

Mining

Mining activities can impact water quality by introducing high concentrations of metals to the watershed, depending on the location, and can also contribute to acidification of the water.

Historically, coal mining has occurred in the Browns River watershed, below the Comox Lake watershed. There are a few showings in the upper Cruikshank River watershed that contain a number of minerals, including gold, silver, copper, molybdenum, lead, and zinc. However, these showings have not been developed.

WATER QUALITY ASSESSMENT AND OBJECTIVES

Water Quality Assessment

Three deep station water quality monitoring locations were established within Comox Lake: one in the inlet basin (Site E259497); one in the main basin (Site E259498); and one in the outlet basin (Site E249499). Physical, chemical and biological parameters were collected for the deep station lake sites. In addition, seven near-shoreline locations in the inlet and outlet basins were sampled for bacteriological analyses (Figure 2). Water quality monitoring was conducted on a quarterly basis (March, June, August and November) for the three deep basin sites from March 2005 to March 2008. For the near-shoreline stations the sampling frequency was increased to weekly for five consecutive weeks during summer low-flows (August/September) and during fall peak-flows (October/November) from 2005 to 2007.

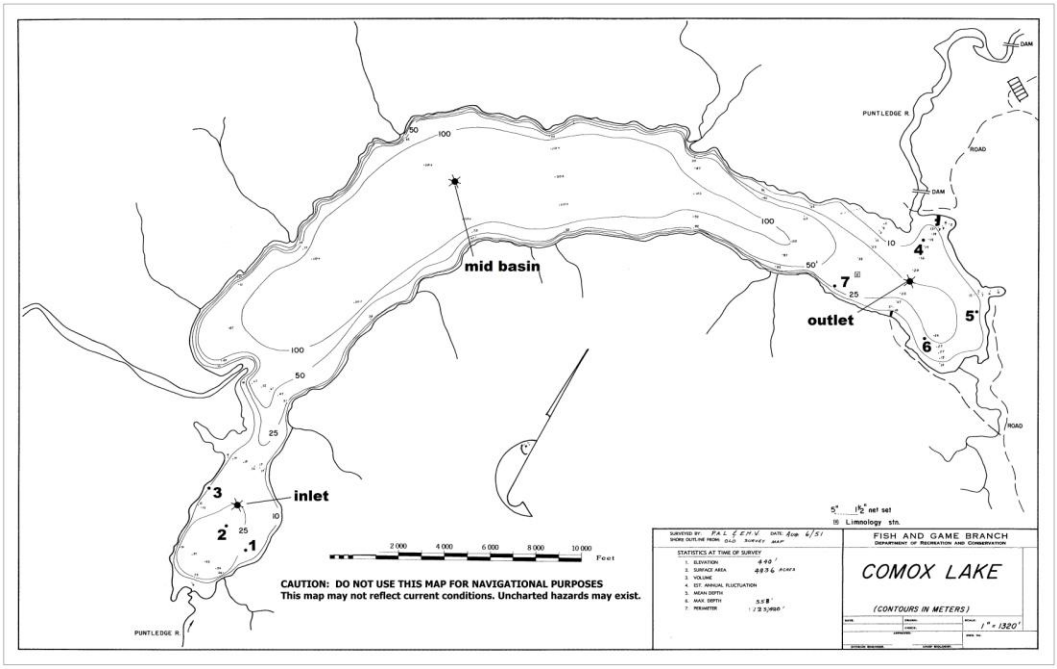

Figure 2. Water quality monitoring locations in the deep basins (stars) and nearshore areas (numbers 1 – 7).

The monitoring results for Comox Lake show that water quality is excellent. The water chemistry is typical of coastal lakes with low mineral content, ample dissolved oxygen, and very clear waters, which is indicative of high quality raw drinking water. Comox Lake is relatively unproductive, in a biological sense, and is classified as oligotrophic (low nutrient content). However, there is a diverse and normal plankton community. These types of lakes often support many fish species, like salmonids, which require cold, well-oxygenated waters.

Concentrations of microbiological indicators were slightly elevated in the outlet basin only. The drinking water guideline for *E. coli* in raw water receiving disinfection was exceeded in 12 of 24 sample sets (five samples in 30 days). The outlet basin has full time residents, seasonal campgrounds, and more boat and human traffic on the lake which could all be contributing to the bacterial levels reported here. A microbial source tracking study prepared for the Comox Strathcona Regional District in 2005 found that the predominant sources of fecal coliforms near the lake outlet were attributable to deer, dogs and seagulls. These exceedances demonstrate the need to treat water for human consumption to prevent potential health risks.

Water Quality Objectives

To protect the exceptional water quality in Comox Lake, water quality objectives have been established for Secchi depth, temperature, dissolved oxygen, total phosphorus and chlorophyll *a* for the protection of aquatic life (Table 1). Microbiological and turbidity objectives have also been established for the protection of drinking water. These objectives will also protect recreation, irrigation and wildlife uses in the watershed. As there has been little activity in the upper watershed

(which is part of Strathcona Provincial Park), these objectives were developed using the background concentration approach, whereby data collected from the inlet basin reflects the natural or background conditions in the watershed. These objectives are required to ensure that inputs from timber harvesting, recreation, and residential activities do not impair water uses in the future.

Table 1. Summary of proposed water quality objectives for the Comox Lake Community Watershed.

Variable	Objective Value
Secchi depth	Annual average ≥ 8 m
E. coli	≤10 CFU/100 mL (90th percentile) with a minimum 5 weekly samples collected over a 30-day period
Turbidity	≤ 2 NTU maximum
Total phosphorus	≤6 µg/L average during spring overturn
Chlorophyll *a*	≤ 1.5 µg/L
Water temperature	≤ 15°C summer maximum hypolimnetic temperature (>10m depth)
Dissolved oxygen	≥ 5 mg/L at any depth throughout the year

DESIGNATED WATER USES: DRINKING WATER, RECREATION, IRRIGATION, AQUATIC AND WILDLIFE

Monitoring Recommendations

The recommended minimum monitoring program for the Comox Lake watershed is summarized in Table 2. In order to capture the periods where water quality concerns are most likely to occur (i.e., freshet and summer low-flow, as well as spring overturn) we recommend quarterly sampling for a one year period. Microbiological samples should be collected at the seven perimeter sites once weekly for five consecutive weeks within a 30-day period both in late summer and mid-fall. Samples collected during the winter months should coincide with rain events whenever possible. In this way, the two critical periods (minimum dilution and maximum turbidity) will be monitored. Future

monitoring should also include sampling downstream of Comox Lake in the Puntledge River at the CVRD water intake location.

Table 2. Proposed schedule for future monitoring in the Comox Lake watershed.

Frequency and timing	Characteristic to be measured
Deep station sites (3 depths per site) - quarterly sampling (March, May, August, October)	pH, specific conductivity, TSS, turbidity, colour, TOC, DOC, nitrogen species, total phosphorus, total and dissolved metals (spring overturn only), chlorophyll *a*, DO and temperature profiles, and Secchi depth
Perimeter sites (surface grab sample) - summer and fall (weekly for five consecutive weeks in 30 day period)	*E. coli*
Deep station sites - twice per year (summer and spring overturn)	Phytoplankton and zooplankton taxonomy