

WATERSHED STUDY

UNDERSTANDING THE IMPACTS OF FOREST PRACTICES ON WATER

FINAL DRAFT TECHNICAL BULLETIN

MARCH 4, 2005

POCKWOCK LAKE WATER QUALITY ASSESSMENT

Effects of Forest Harvesting Activity On Surface Water Quality

Background

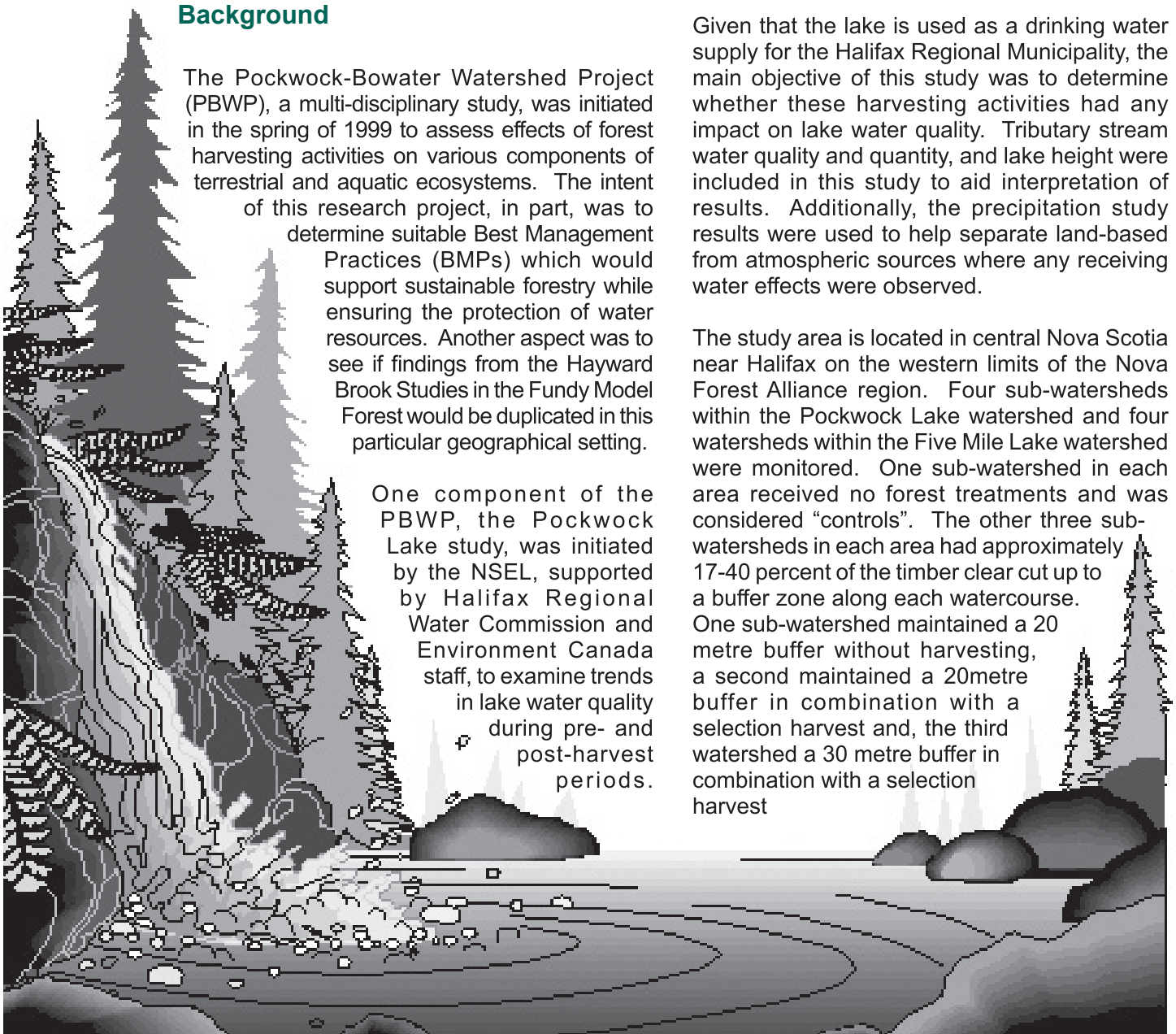
The Pockwock-Bowwater Watershed Project (PBWP), a multi-disciplinary study, was initiated in the spring of 1999 to assess effects of forest harvesting activities on various components of terrestrial and aquatic ecosystems. The intent

of this research project, in part, was to determine suitable Best Management Practices (BMPs) which would support sustainable forestry while ensuring the protection of water resources. Another aspect was to see if findings from the Hayward Brook Studies in the Fundy Model Forest would be duplicated in this particular geographical setting.

One component of the PBWP, the Pockwock Lake study, was initiated by the NSEL, supported by Halifax Regional Water Commission and Environment Canada staff, to examine trends in lake water quality during pre- and post-harvest periods.

Given that the lake is used as a drinking water supply for the Halifax Regional Municipality, the main objective of this study was to determine whether these harvesting activities had any impact on lake water quality. Tributary stream water quality and quantity, and lake height were included in this study to aid interpretation of results. Additionally, the precipitation study results were used to help separate land-based from atmospheric sources where any receiving water effects were observed.

The study area is located in central Nova Scotia near Halifax on the western limits of the Nova Forest Alliance region. Four sub-watersheds within the Pockwock Lake watershed and four watersheds within the Five Mile Lake watershed were monitored. One sub-watershed in each area received no forest treatments and was considered "controls". The other three sub-watersheds in each area had approximately 17-40 percent of the timber clear cut up to a buffer zone along each watercourse. One sub-watershed maintained a 20 metre buffer without harvesting, a second maintained a 20metre buffer in combination with a selection harvest and, the third watershed a 30 metre buffer in combination with a selection harvest



ACKNOWLEDGEMENTS

NSEL was assisted in their efforts by staff at the Halifax Regional Water Commission. Examination of the chemical data was supported by hydrometric data generated by Environment Canada. The Centre for Water Resources Studies at Dalhousie University was contracted to perform analysis of the water quality data, and draft associated reports.

To examine the potential effects on surface water quality, this study focused its efforts on Pockwock Lake and two tributaries, Peggy Brook (the control watershed) and Moose Cove Brook (the treated watershed). In brief, 18.8 hectares, or approximately 16.7 percent of the total Moose Cove Brook sub-watershed area were harvested between June 28 and October 17, 2001.

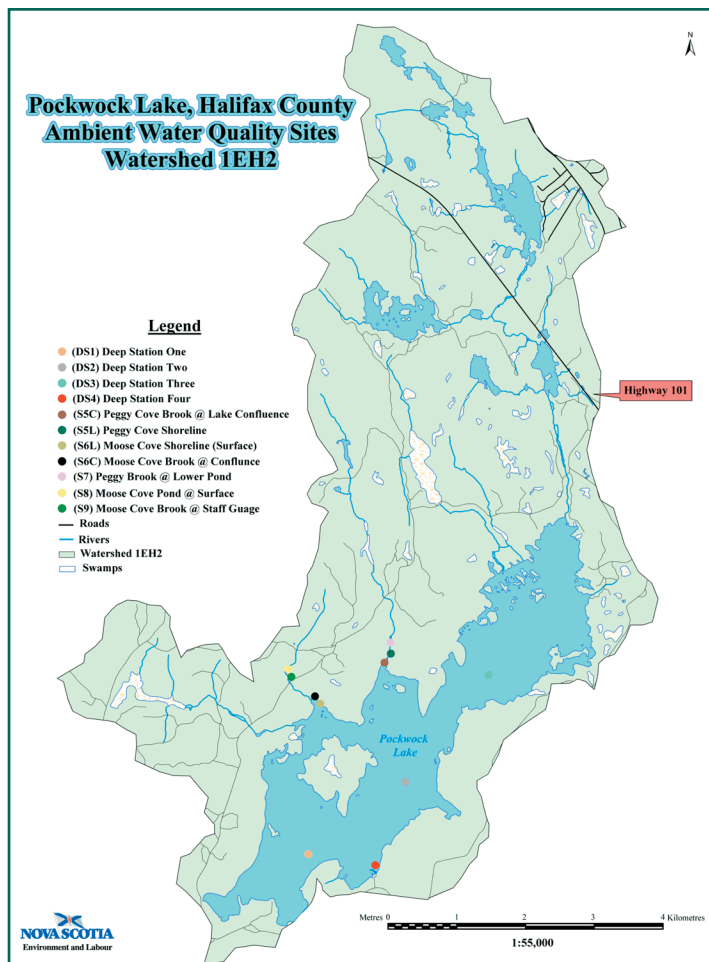
The main objectives of the lake study were to assess changes in lake-water quality resulting from forest harvesting activities in the watershed, with the primary areas of interest relating to acidification, eutrophication, siltation, and the drinking water supply.

Surface Water Quality Monitoring Program

During the open-water season between 1999 and 2003, a monthly sampling program was undertaken in the Pockwock Lake watershed whereby physical and chemical characteristics of lake and stream water were documented. Water quality parameters measured included pH, conductivity, colour, nutrients, chlorophyll_a, major ions, and heavy metals.

Eight sampling locations were identified - three deep-lake stations positioned along the mid-line of the lake, three near-shore, and three in-stream.

In-situ measurements taken at each of the deep-station locations included water temperature and dissolved oxygen profiles and water transparency.



Stream Water Quality

Comparison of pre-, harvest, and post-harvest annual mean values for Peggy Brook and Moose Cove Brook, indicates that similar shifts in water quality occurred in both watercourses. The short monitoring record (4-5 years) and sampling frequency make it extremely difficult to attribute these changes in water chemistry to specific causes. This is especially so in a stream environment where water quality is highly variable over time. Because of generally low flow conditions during the harvest period and the similarity between water chemistries in both the control and treated watershed streams, suspicions are that observed changes in water quality are more likely a reflection of normal seasonal and annual variation and not an effect of the forest harvesting.

Lake Water Quality

Eutrophication and Trophic Status

Eutrophication and trophic status of Pockwock Lake were considered in terms of nutrient enrichment (phosphorus), a biological indicator (chlorophyll_a), and water transparency (Secchi Disk depth) using measurements from deep-lake stations. Data gathered for all three indicators during the five-year study showed that the trophic level remained in the oligotrophic category for the entire period.

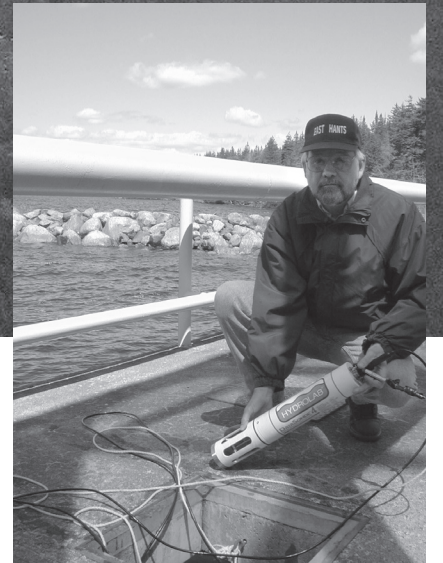
Trophic classification based on annual mean values for total phosphorus, chlorophylla, and Secchi depth (after Vollenweider and Kerekes 1982).

Trophic Level	Total Phosphorus ug L ⁻¹	Chlorophylla ug L ⁻¹	Secchi Depth m
Oligotrophic	≤10	<2.5	>6
Mesotrophic	10-35	2.5 – 8	6 – 3
Eutrophic	≥35	≥8	≤3
Pockwock Lake: 5-year mean Range of annual means	6.6 5-10	0.6 0.4-0.9	6.6 6.0-7.2

When looking at the potential impact of the harvesting on the trophic status of Pockwock Lake, phosphorus data from Moose Cove Brook (harvested watershed) indicates that the annual mean stream concentration was actually lower during the harvesting year (0.017 mg L⁻¹) when compared with both pre- (0.021 mg L⁻¹) and post-harvest (0.018 and 0.022 mg L⁻¹) years. This suggests that no additional export of phosphorus occurred as the result of forest harvesting in the Moose Cove Brook sub-watershed.

Siltation

Siltation in receiving waters due to forest harvesting was examined using total suspended solids (TSS) and turbidity information. The TSS test was performed only on an occasional basis, and the majority of measurements taken were reported as less than values, ranging from <1 to <5 mg L⁻¹. At these levels, the potential short-term and long-term effects on instream fish and fish habitat is considered



negligible. TSS levels observed at shoreline stations, deep-lake station and the pumphouse station were also observed to be at or below detection, which suggests the following. The TSS loads in these two tributary streams draining to Pockwock Lake have no impact on the TSS levels observed at all in-lake stations, implying no negative impact on the drinking water supply.

The more frequent turbidity measurements offered a better means of examining the issue. It is clear from these data, that the clarity of surface water in the Pockwock Lake watershed is excellent. All nine stream and lake stations posted mean turbidity levels below 1 NTU. Only rarely did discrete measurements exceed this limit and seldom for two consecutive sampling dates. Although turbidity levels in Moose Cove Brook produced an increase in turbidity levels during the harvesting period, this increase was likely attributable to patterns in hydrology rather than to the harvesting itself, since a similarly timed response in turbidity levels was observed to occur in Peggy Brook (the control watershed).

Acidification

pH data were used to evaluate the potential acidifying impacts of forest harvesting on surface waters. Other research has reported seeing an increase in pH as a result of this type of activity. Results from this study, represented by pH measurements gathered from sampling locations on

Moose Cove Brook and Peggy Brook, expressed as annual means, indicate no effect. In fact, pH levels at each location remained stable during the entire study period.

CCME Water Quality Guidelines

Surface water quality at two in-lake stations were used for comparison with guidelines established by the CCME for drinking water use and freshwater aquatic life (Health Canada, 2003).

With the exceptions of aluminum, pH, manganese, and turbidity, all measured values at the two lake stations met the CCME limits in both categories. The majority of aluminum, pH and manganese measurements taken during the study exceeded the limits and these were evenly distributed throughout the study period. This suggests that the elevated values are a normal occurrence and not a reflection of the harvesting activity. While none of the readings taken at mid-lake exceeded the drinking water limit for turbidity, only 4 of 46 turbidity readings at the pumping station were seen to exceed that limit.

Conclusions/HIGHLIGHTS

1. Water quality changes were observed for Moose Cove Brook and Peggy Brook during and immediately following forest harvesting.
2. These water quality changes appear to be related to changes in surface water hydrology and not the forest clearing activity.
3. Weak seasonal and annual trends were observed for conductivity at mid-lake station of Pockwock Lake. These trends are considered typical of water bodies exposed to a maritime climate.
4. Water quality data collected does not indicate that the forest harvesting taking place between June 28 to October 17, 2001 impacted on the water quality of Pockwock Lake.
5. The BMPs applied to the study area were thought to be generally effective at reducing effects on receiving waters.
6. With the exception of aluminum, pH, manganese, and turbidity, water quality at the two deep-lake stations in Pockwock Lake is within limits set by CCME for both drinking water use and freshwater aquatic life.
7. Observed CCME exceedences for the two deep-lake stations are considered to be a reflection of typical lake water quality and not an impact of forest harvesting activity.
8. Water quality sampling at the mid-lake station of Pockwock Lake was performed in the ice-free season only, representing the months of May to November.
9. Water quality observed at the two Pockwock Lake stations (ie mid-lake, and near shore at the pumping station) was similar.

Although subtle changes in surface water quality were recorded in both test watersheds during the harvesting period, the impact of the forest harvest was considered to

be negligible. The fluctuation in water quality between pre- and post-harvest periods was deemed to be a reflection of normal seasonal and annual variation.

Based on the application of total phosphorus, chlorophyll_a, and Secchi disk measurements to a fixed-boundary classification system, the trophic status of Pockwock Lake is considered to be oligotrophic.

There was no indication that the forest harvesting had an impact on suspended solids and turbidity levels in receiving waters. Whether this was an effect of the frequency of sample collection or the BMPs applied to the site (e.g. riparian buffer zones) is uncertain. Nevertheless, the BMPs were thought to be effective at reducing effects on receiving waters.

The harvesting also appeared not to have an impact on the acidity in stream runoff. Annual mean pH measurements for the both the control and treated watersheds remained constant throughout the entire study period.

CCME water quality guidelines for drinking water use and freshwater aquatic life were compared with data from two in-lake stations. With the exceptions of aluminum, pH, manganese, and turbidity, all measured values at the two lake stations were below CCME limits in both categories. The majority of aluminum, pH and manganese measurements taken during the study period were above the limits and exceedences evenly distributed throughout the study period. This suggests that this is a normal occurrence and not a reflection of the harvesting activity. While none of the readings taken at the deep-lake station exceeded the drinking water limit for turbidity, only 4 of 46 turbidity readings at pumping station location were seen to exceed that limit.

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The Nova Forest Alliance, Nova Scotia's Model Forest is a partnership of more than forty organizations working together towards sustainable forest management (SFM). The Nova Forest Alliance is part of the Canadian Model Forest Network, developed and supported by Natural Resources Canada.



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