Materials and Methods

The major purpose of this project was to establish baseline data for lakes and streams on watersheds entering Algonquin Park. A secondary aim was to make the same baseline measurements on some of the lakes in the park itself that are, or in the future could be, subjected to anthropogenic influence.

One hundred and eighty-nine lakes and twelve streams were sampled over the three-year course of this study. The large scope and the finite resources available for the project necessitated the concentration of this study on lake parameters that are most likely to change due to human activity. The acidification of shield lakes in this area has been well documented (Jeffries, 1997; Neary and Dillon, 1988; Neary et al., 1990; Schindler, 1988), so pH and alkalinity values were measured to establish baseline data.

Although responsible management of potential sources of nutrient loading can limit human influence on the fertility of aquatic ecosystems, man's use of these ecosystems inevitably increases the amount of "fertilizer" introduced into the lakes and streams. Phosphorus is a limiting nutrient in most aquatic ecosystems (Schindler, D.W., 1974, 1977, 1978 and 1980), so samples were taken and phosphorus concentrations measured. The amount of nutrient loading can also be inferred from several other parameters. As the nutrient content of a lake increases, the productivity of the lake increases and the algal biomass in the lake increases. Higher algal biomass leads to lower secchi disc readings, increased chlorophyll concentrations and increased late-summer hypolimnetic oxygen deficits. Secchi disc readings were made at each sampling site, and oxygen, temperature and, on selected sites, chlorophyll profiles were established.

Although the measurement of a large number of the chemical components in these lakes is beyond the scope of this study, the sum of all of the ions in a lake or a stream can be estimated by measuring the conductivity of a water body. One would expect very low conductivity readings due to the insoluble nature of the shield bedrock. Unexpectedly high conductivity readings in lakes along the Highway 60 corridor of Algonquin Park indicated that further study should be conducted on these lakes. Chloride profiles for these lakes were established in the summer of 2002.

LAKES

Sampling Site Selection

Lakes were sampled at one point, a point selected to be at, or as near as possible, to the deepest point in the lake. In lakes where bathymetric maps were available, the deepest part of the lake could be found by using the bathymetric map to find the general area of the deepest part of the lake and then doing a brief search of the area with a depth sounder. When the depth sounder gave a reading at, or close to, the deepest area indicated on the bathymetric map, the anchor was sent down and the lake was sampled. In lakes where bathymetric maps were unavailable, the sampling site was the centre of the largest basin of the lake being sampled. Coordinates of all sampling sites were taken with a GPS so that the sites could be found again.

Sampling Frequency

Most lakes were sampled twice a year. Ideally they would be sampled at spring overturn and once again late in August after stratification to check for any hypolimnion oxygen deficit. This proved impossible with only one crew, but each lake was sampled in "spring/early summer" and then again in "late summer". Most lakes were sampled in only one of the three years of the study.

To get some idea of the year to year variation, a few selected lakes were sampled four times over the course of the sampling season and for the entire three years (Smoke Lake, Cache Lake, Found Lake and Jake Lake). Some lakes were sampled four times over the course of the one year (Canoe Lake, Corkery Lake, Cornick Lake, Kawawaymog Lake, Little Hemlock Lake, Little Joe Lake, Little Tyne Lake, Source Lake, Tanamakoon Lake, Tyne Lake and Wet Lake in 2001; Lake of Two Rivers in 2002; Brewer Lake, Cauchon Lake, Cedar Lake, Lake of Two Rivers and Little Cauchon Lake, Sec Lake and Wendigo Lake in 2003). Remote lakes that could only be sampled by helicopter were sampled only once a year in August.

Lake Chemistry

Oxygen, temperature, conductivity and pH profiles were established using a "minisonde multiprobe" in 2001 and a YSI multiprobe in 2002 and 2003. Some turbidity and chlorophyll and chloride profiles were measured using the YSI multiprobe on selected lakes in 2002 and 2003. Probes were calibrated for oxygen and specific conductivity at the required frequency and protocol described in the operation manuals.

Samples for total P and alkalinity were sampled according to the Ministry of the Environment Lake Partnership protocol (Ontario Ministry of the Environment, 2001). A KISS sampler (see Fig. 1) was used to hold the sampling bottles (rather than taping the bottle to a hammer as suggested by the MOE) for this sampling protocol.

In 2001 the MOE (Dorset) did the chemical analysis for total P and Kjeldahl Nitrogen. (for the methodology, see Wilson, P., 2000) In 2002 and 2003 only total P was measured. Alkalinity was estimated using the total inflection point (TIP) titration protocol for low alkalinity waters from "Standard Methods for the Examination of Water and Wastewater" (1992).

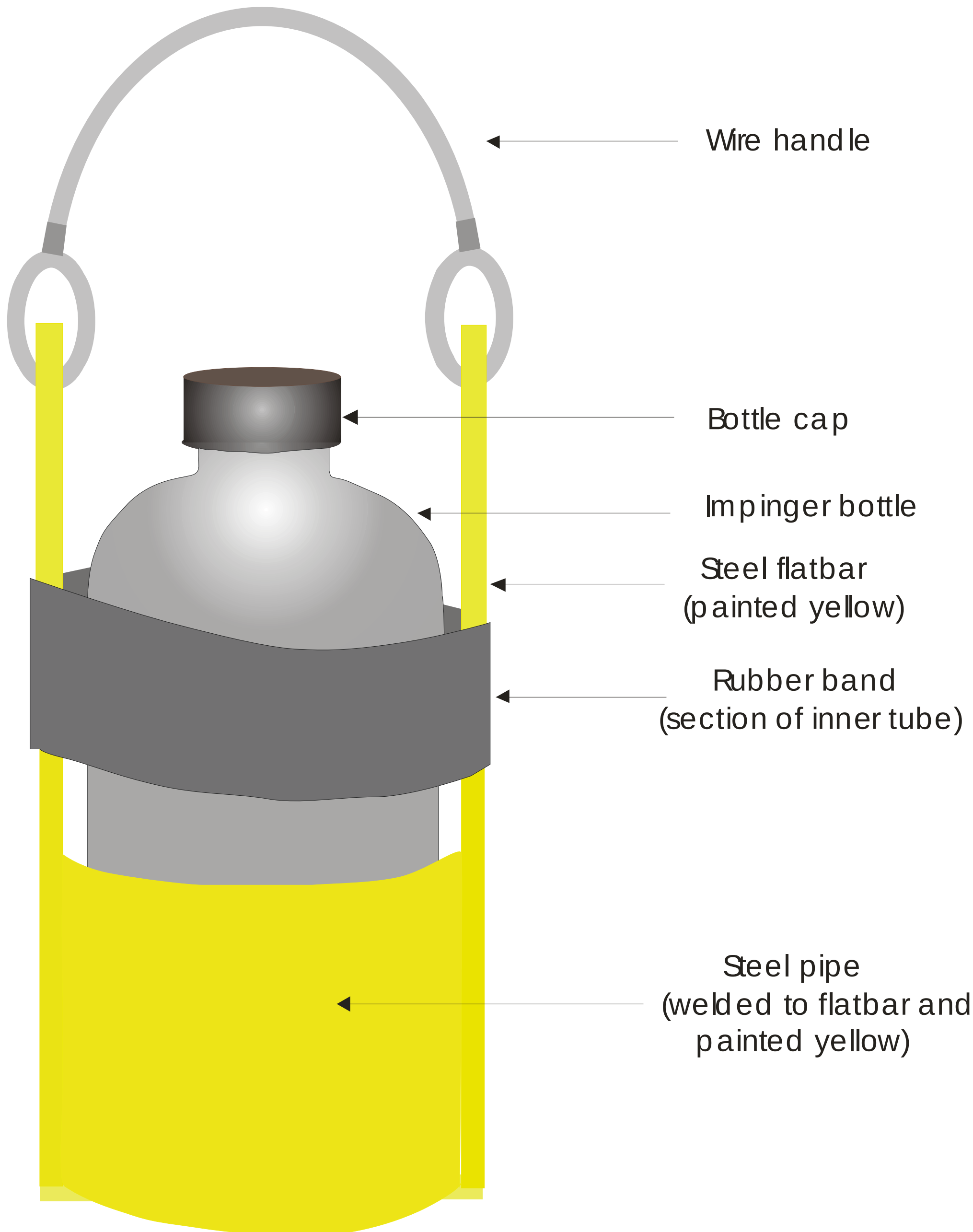

Figure 1: Diagram of a KISS sampler. The flatbar extends across the base of the sampler.

Zooplankton

Since numerous studies indicate that zooplankton community structure is influenced by the pH of a lake (Havens et al., 1993; Locke, A. and W.G. Sprules, 1993; Marmorek et al., 1993; Siegfried, C.A. and J.W. Sutherland, 1992: Sprules, W.G. 1975), zooplankton samples were taken with a simple vertical haul with a Wisconsin net at each sampling station. The water column was sampled from two meters from the lake bottom to the surface for lakes less than 22 m in depth. Lakes more than 22 m deep were sampled by a 20 m vertical hall. Zooplankton samples were preserved with Lugol's solution until they were prepared for counting.

Limited resources necessitated the use of a very simple protocol for analysis. We attempted to get a representative subsample from the zooplankton containers by swirling those containers immediately before removing approximately 1 ml of the sample with an eye dropper. The contents of the eye dropper were then deposited into a Petri dish situated on top of a piece of paper divided into numbered 1 cm^2 squares situated under a dissecting microscope. One of the numbered squares was then randomly selected using a calculator and all of the zooplankton in that square centimeter were identified and counted to the order level. Additional square centimeters were selected and the zooplankton within them counted until a total number ≥ 50 was reached. All of the zooplankton in the last cm^2 examined were included in the final count.

STREAMS

Site selection

Stream sampling procedures were adapted from the "Stream Assessment Protocol for Southern Ontario". (Stanfield et al. 2001) This protocol was developed to apply to southern Ontario streams that are flowing through erodable material, streams that, at least to a large extent, are responsible for their own morphometric characteristics. The physical characteristics of streams on the Canadian Shield tend to be determined by the topography of the bedrock. There are places in some of the streams were the streams ran through erodable glacial till, and these sites were selected where possible, but in many instances the "wadable" stretches of these streams flowed over bedrock Sites that did flow over glacial till were often the least expensive places for roads to be built across the stream. Stream sampling sites were therefore often near roads or, in instances where there was no viable alternative, the road crossings had to be included in the sampling station. There was no attempt made to randomly establish these stations as required in the Southern Ontario Protocol. Rather than using crossovers for the beginning and the end of the stations, easily recognizable physical features in or near the stream were often chosen as the downstream and upstream end of the sampling sites. In summary, sites were simply selected on the basis of having a 40 m stretch of "wadable" stream.

Benthic Macroinvertebrates

Benthic macro invertebrates were collected and analyzed as described in the "Stream Assessment Protocol for Southern Ontario". (Stanfield et al. 2001) The "Haprogs" database that accompanies the protocol was even used to calculate the "Hilsenhoff" values for the macroinvertebrate populations sampled.

Fish Community Sampling

In most instances the selected stream section was sampled with one pass with an electrofisher. The upstream and downstream ends of the sampling site were not blocked with a net so there is some possibility that some fish avoided being collected by swimming out of the sampling area. In most instances captured fish were identified, counted and returned to the stream. Occasionally a few fish were kept and brought back to the lab for identification purposes. There was no attempt made to weigh the fish caught to estimate the productivity of the stream section. An inventory of fish species present was all that was attempted.

In one small, turbid stream (Shelbourne Creek) and one remote creek (Holtz Creek) the fish community was sampled only using a dip net. In Shelbourne Creek, the dip net was placed on the downstream end of a small stream section (the dip net along with the legs of the person supporting it took up the entire width of the stream). Another crew member then splashed as they waded downstream towards the waiting dip net, frightening the fish into the net. This was repeated for successive stream segments until the entire stream section was sampled. An electrofisher was not used on this stream because of the turbidity of the stream. Many of the fish immobilized by the electrofisher would have sunk to the bottom of the stream beyond the sight anyone trying to net them.

Water Chemistry

Oxygen, temperature, conductivity and pH measurements were made using a "minisonde multiprobe" in 2001 and a YSI multiprobe in 2002 and 2003. Air temperatures were taken with a standard alcohol thermometer.

Stream Discharge

In 2001 stream discharges were calculated using the hydraulic head method (Stanfield et al., 2001) and the values were checked using a Pygmy Gurley flow meter on the same stream cross section. In the remaining two years of the study only the hydraulic head method was used. In one stream (One-a-day) the entire discharge was expelled through a perched culvert. The discharge was small enough that it could be collected in a graduated pail for a period of time measured with a stop watch. This method is likely the most accurate of the three techniques used.

It should be mentioned that these streams did seem to exhibit the “base flow” characteristic of Southern Ontario streams. Most of the water in these streams appears to originate from lake outflow, lakes that tended to become shallower and shallower as the summer progressed. Stream discharges from the lake outflows naturally decreased as the water levels in the lakes went down. One-a-day creek, a stream that had held brook trout earlier in the year, dried up completely in the summer of 2001.

Thermal Stability and Site Features

The thermal stability information was collected in 2001 following the protocol of Stanfield et al. (2001). Conflicting sampling schedules precluded the collection of these measurements in 2002 and 2003. Site features were collected as described by Stanfield et al. (2001)