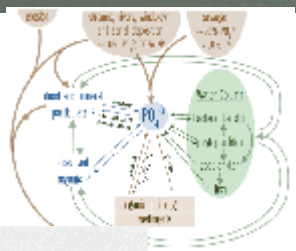
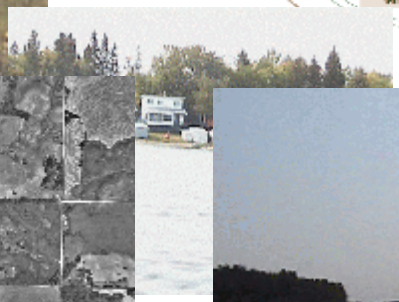
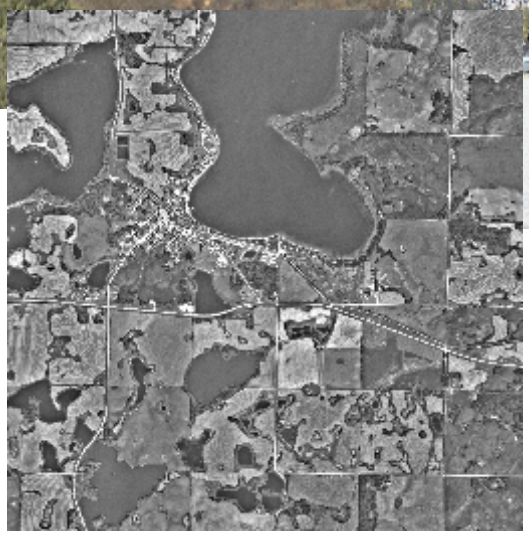
Sandy Lake Study and Action Plan for Water Quality Improvements







Prepared By
Aquatic and Environmental Consultants
2005

TABLE OF CONTENTS

List of Figures

Tables

List of Appendices

Sandy Lake
Study and Action Plan

1.0 Introduction

1.1 Study Background and Purpose

Sandy Lake is a small (567hectare) lake located south of Riding Mountain National Park in west Manitoba (Figure 1). Sandy Lake is heavily utilized for recreational purposes, with approximately 260 seasonal residences found around the border of the lake.

In 2003, Aquatic and Environmental Consultants (AEC) was contacted to undertake a study funded by the Fisheries Enhancement Initiative (FEI) for Sandy Lake. The study was initiated by a group of stakeholders who were interested in protecting and enhancing Sandy Lake. This group included representatives from local game and fish clubs, cottage associations, landholders, Manitoba Conservation, Manitoba Intergovernmental Affairs, and concerned citizens. The Little Saskatchewan River Conservation District acted as the primary project supervisor. One of the main issues driving the implementation of the study was the belief that water quality was gradually deteriorating on the lake. This was manifesting itself as increased algal and plant growth.

The study was to attempt to accomplish 4 main goals, namely:

- Gather background information pertaining to Sandy Lake
- Conduct field studies to obtain select data
- Identify factors that may be contributing to a deterioration of water quality
- Develop a prioritized set of actions to address water quality issues

This study recognized that many different interests needed to be included in the evaluation. The ultimate goal of the group was as follows:

"The principal goal is to ensure that Sandy Lake will remain a healthy water body for generations to come".

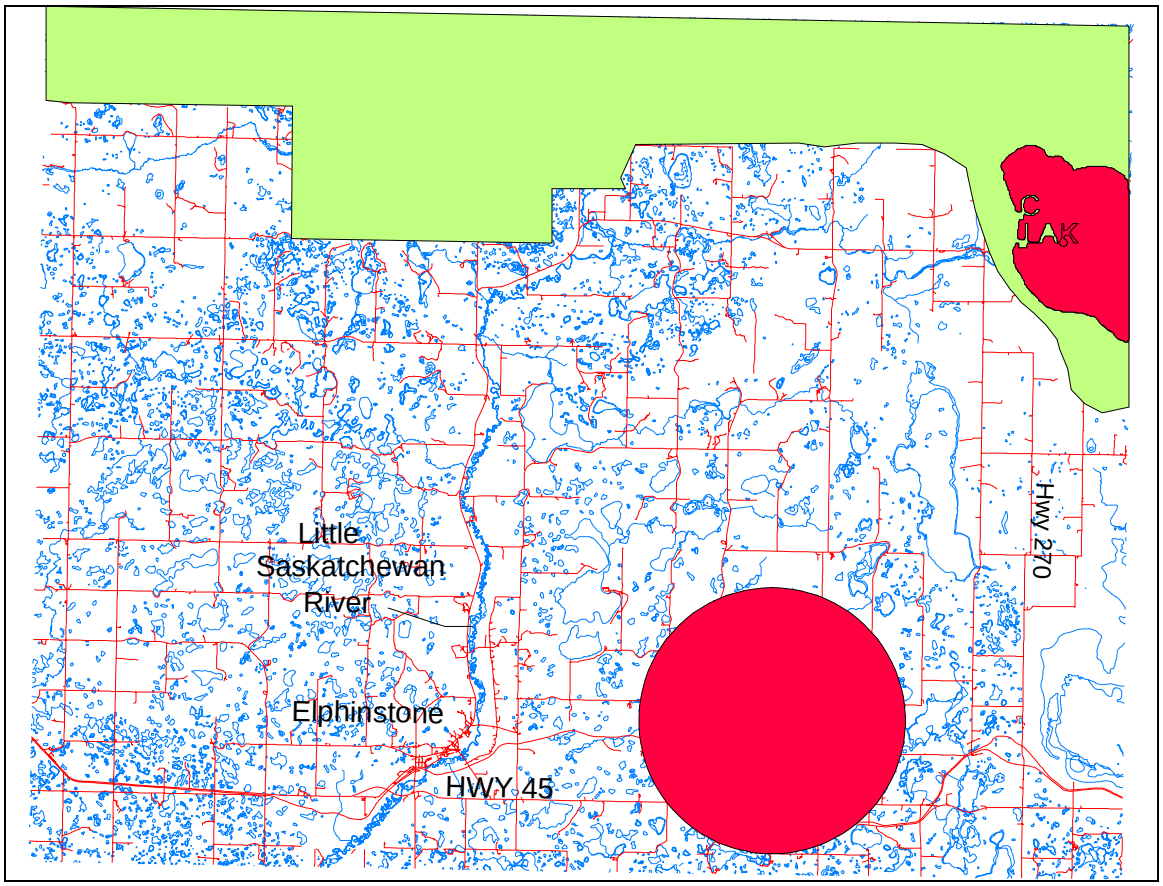


Figure 1: Study Location

1.2 Study Area

The study area is shown in Figure 2. Ukrainian immigrants originally settled the area surrounding Sandy Lake area in the early 1900s. The driving force behind the move into the area was the abundance of rich lands, and as a result the primary industry in the region remains agriculture. Common crops include rye, wheat, oats, barley, canola and alfalfa. Agriculture in the region also boasts several large-scale livestock operations. Beef cattle are the primary livestock, with some hog operations either constructed or under consideration.

Recreation and tourism provides the area with additional commerce. Sandy Lake and the Sandy Lake Golf Course draw tourists and visitors out, and help to support local businesses. The TransCanada trail runs right through Sandy Lake. Located along the old CPR line, the trail provides opportunities for hiking, snowshoing and cross-country skiing.

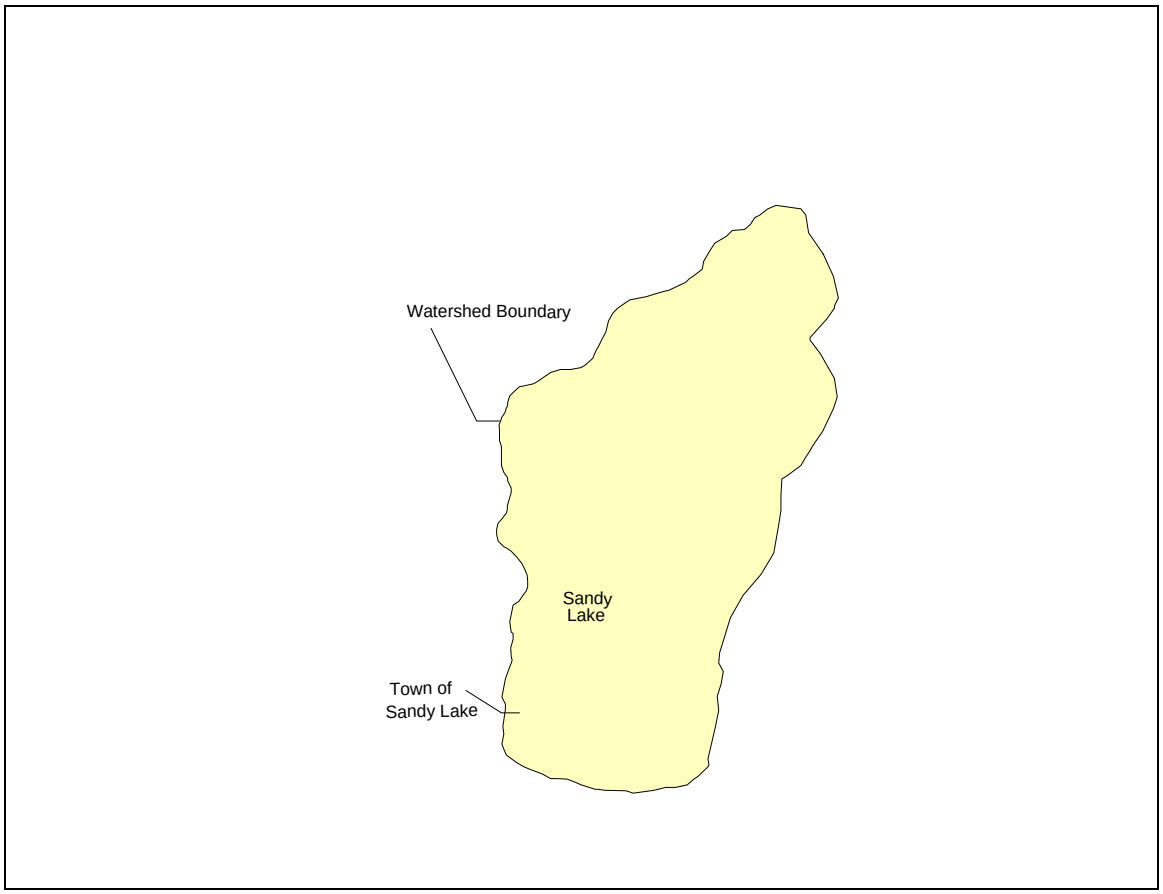


Figure 2: Study Area

Sandy Lake is one of several lakes in the area utilized for recreational activities. Other notable nearby lakes include Clear Lake in Riding Mountain National Park, approximately 30 km northwest. Outside of the National Park, Sandy Lake would be the most heavily utilized lake for activities such as cottage life and boating. Other uses of the lake include snowmobile use, ice fishing, cross-country skiing and curling during winter. (Note: above courtesy Manitoba Intergovernmental Affairs *Community Profiles* database.)

1.3 Sandy Lake – Physical Description

Sandy Lake is a relatively small lake with two distinct basins. The south section is by far the larger of the two basins, with a total area of 484 hectares. All residential development and the bulk of recreational use take place on the south basin. The north basin provides an additional 83 hectares of surface area. The north basin is a relatively undeveloped section connected to the south basin via a shallow, and sometimes intermittent channel.

The total drainage basin for Sandy Lake is 3900 hectares, with no outflow from the lake. These types of lakes were formed by glacial activity in the last ice age, and are known as seepage lakes (Lathrop et al 2004).

The mean depth of the lake is 2.6 meters (Bruederlin pers. com.) and the total volume of Sandy Lake is estimated to be 19 million cubic meters (Beck 1986).

Extensive cottage development has taken place on the south basin of Sandy Lake. The total number of cottages is now estimated to be in excess of 250 (Chemerika pers. com). Of these, between 30 and 40 of the cottages are connected to the municipal sewer and water system. As of the current time, further development is not allowed on Sandy Lake as the lake is considered to be over capacity for recreational development.

2.0 Study Design

In order to conduct the study in the context of the limited time and budget available, a general work plan was proposed to the Sandy Lake Advisory Committee. This plan was approved and entailed the activities listed below.

2.1 Background Data Gathering

In order to proceed with the study, an effort was made to gather existing information from a variety of sources. First of all, a complete search of the Manitoba Conservation Library was conducted for any past studies of the lake. This was followed by a similar search at the public libraries in both Winnipeg and Brandon. As well, government and municipal officials were contacted to obtain any factual information regarding Sandy Lake.

Three informational meetings were held with the Sandy Lake Advisory Committee regarding conditions and specifics for the lake. Notes of all meetings were kept and compiled.

During the course of field investigations, numerous local residents, tourists, annual visitors and other people provided feedback to informal questions regarding the lake and its various aspects of interest. Concerns were noted for later review.

Two public open houses were held for the study, one in June 2003, and one in February 2004. The June open house was used primarily to introduce the concept of the study and to ask what issues existed for Sandy Lake that could be included. The February open house concentrated on presenting findings to date, and requested feedback on the various results, in order that an action plan could be developed.

Reviews of information on lakes similar to Sandy Lake were conducted. Of most significance was a review of the Gull Lake restoration project. This lake had several similarities to Sandy Lake. Interviews with some of the landowners involved in the restoration effort were also held.

Concurrent with this study was an investigation by Manitoba Conservation – Brandon, on the various methods used by seasonal residences on Sandy Lake for sewage disposal. This investigation was conducted using students in the summer of 2003.

2.2 Video Reconnaissance

In order to evaluate the conditions on Sandy Lake and the surrounding area, it was decided that an aerial video review would be conducted. A total of two aerial surveys were conducted in mid-summer and fall of 2004. The rationale for the fall survey was that vegetative growth patterns in the riparian zone could more easily be distinguished at this time. All surveys were carried out from fixed wing aircraft, using a digital video camera coupled to a GPS unit (VMS 200 Red Hen System). This system provides digital video, fixed digital still photo and full positioning information. Further, the entire video was referenced to ArcView compatible mapping information, which allows users to select video clips by locating areas of interest on a live map, or to simultaneously show mapped tracking information integrated into the video replays.

It was further decided that an on-water video record be compiled. In early September of 2003, the digital video camera coupled to a GPS unit (VMS 200 Red Hen System) was mounted on a boat, and Sandy Lake was circumnavigated at a distance of 100 meters from shore. The purpose was to record use patterns and vegetation in the shore zone of the lake. All tapes were reviewed using computer assisted tracking software.

2.3 Field Surveys

Field studies were designed to collect information that would further an understanding of the dynamics and health of Sandy Lake, as they related to the concerns and interests of the residents. The following surveys were conducted. Nine sampling sites were selected at the outset of the study in the south basin of the lake, with one site added in the north basin (Figure 3).

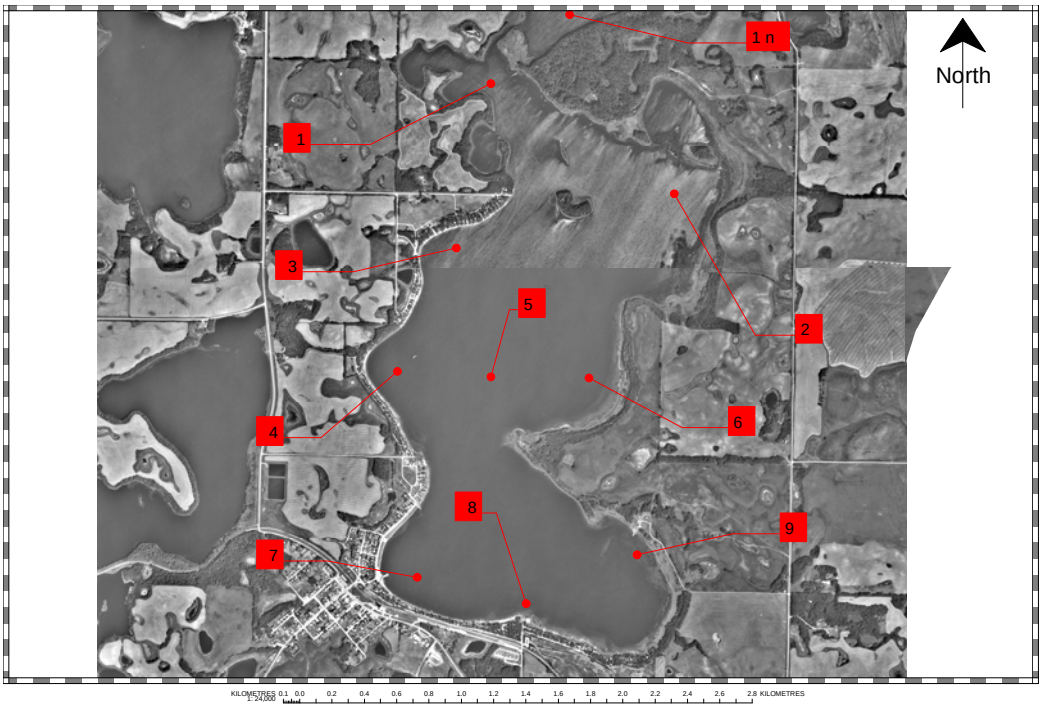


Figure 3: Water Chemistry and Benthic Sampling Sites

Riparian Surveys

Riparian zones are the important areas where land and water meet. All potential land use practices within the riparian zone, and which directly had an impact on the water quality and/or fish habitat in Sandy Lake were evaluated.. Using rating systems developed for other similar projects the riparian zone is rated as one of three conditions, namely non-impacted by activities of man, moderately impacted by activities of man, or severely impacted by the activities of man.

Using the video footage gathered by both the aerial and boat surveys, selected areas of interest were visited on the ground during the summer and fall of 2003, and an estimate of the health of the riparian zone was made. The resulting riparian zone ratings were plotted on a map of Sandy Lake.

Benthic Surveys

A minimum amount of benthic invertebrate work was done as part of the sediment gathering exercise for water chemistry (see below). Benthic invertebrates were gathered at stations 1, 5 and 8. While the exercise could not be described as quantitative, it never the less provided a qualitative listing of species found. All organisms were keyed to family.

Algae Surveys

As part of the work plan to gather algal species, algae tows were performed in the same three locations as the benthic invertebrate work. All organisms were keyed to family.

Water Quality Surveys

Water quality was the number one issue for all stakeholders on Sandy Lake. Historical water quality information was compiled and presented as part of this study. In addition, water quality measurements were obtained using Hach field analyzer for pH, conductivity, dissolved oxygen, TKN, and total phosphorus for 9 sites on Sandy Lake. Fecal coliform information was sent to North West laboratories for analysis. Field investigations on Sandy Lake led to a decision to later include a separate sampling station for water chemistry only on the north basin of the lake.

Water temperature profiles were attempted at one-meter intervals at station 5 in order to check for stratification.

Fish Surveys

Manitoba Conservation had undertaken a number of studies related to species composition on Sandy Lake, and this study did not anticipate repeating such studies. However, it was decided to gather information on small-bodied fish and spawning success by conducting beach seining activities at 4 locations on the lake. These locations are shown in Figure 4.

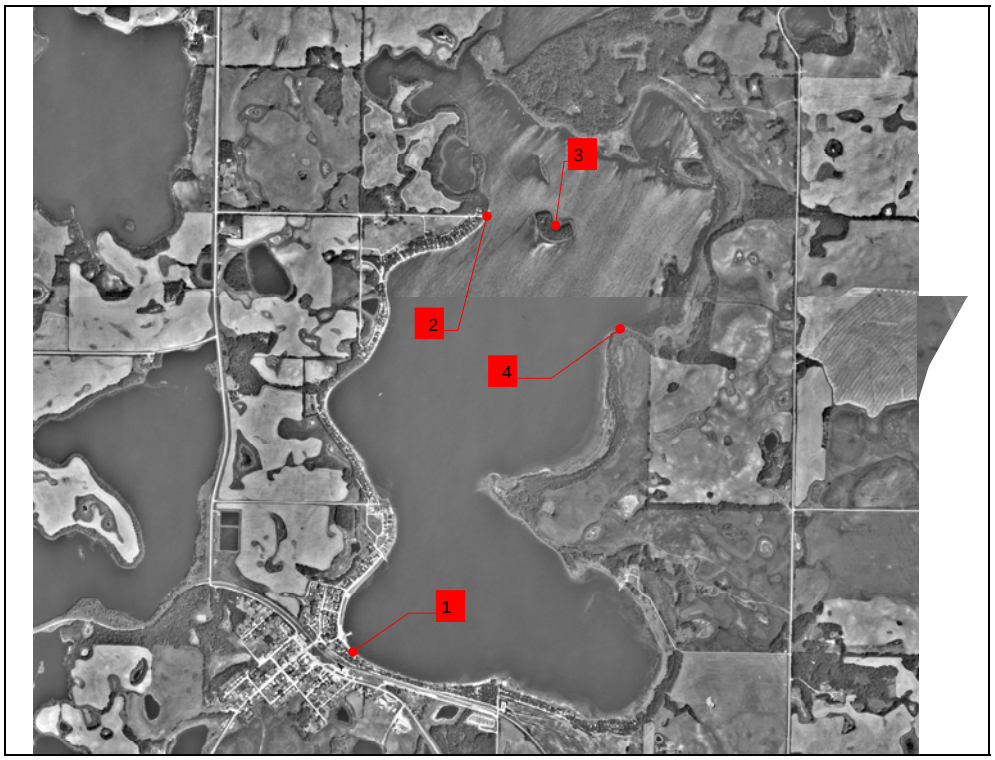


Figure 4: Seining Locations

3.0 Results

The following summarizes the results from the various interviews, background information searches, and the field investigations during the summer/fall of 2003.

3.1 Background Data

For a lake that provides the extensive recreational opportunities that Sandy Lake affords, there was very little published data regarding critical issues. There was a great deal of local knowledge, and some unpublished data regarding scientific fish collections.

The primary published information was contained in five sources. Two of the four published sources provided valuable information regarding the water quality of Sandy Lake. These were the *Recreational Development Capacity Study* (Beck, 1985), and a follow up study to the same (Beck, 1986). Neither of these studies was specific to Sandy Lake, but rather a compilation of information from several lakes in the nearby area. Very good water quality data were included in the reports. On the basis of this data, Beck (1986) concluded that Sandy Lake was borderline between mesotrophic and eutrophic, although later in the report he classified the lake as eutrophic. He suggested that the lake was actually much more eutrophic than indicated by the data. Interestingly, there were several mentions throughout both documents of the “extensive macrophyte growths in deeper areas of the lake, and the dense colonies of filamentous algae in shallower areas”.

The key conclusion of the two reports was that Sandy Lake had been developed to capacity, and that further development was not recommended.

A third published report was a limited distribution evaluation of some physical parameters of Sandy Lake by Wardrop Engineers (1996) that included some point in time water quality results. These results were consistent with earlier information provided by Beck (1986). The main descriptive results concurred with the view that Sandy Lake was a slightly eutrophic lake, with a high load of nutrients.

The fourth published report was the *Manitoba Community Profiles* (2002) data provided by Manitoba Rural Development (now Manitoba Intergovernmental Affairs). This document contained relatively complete data on population dynamics in the area, business use, and some historical description. There was no information regarding any physical parameters of Sandy Lake.

The fifth source of data, although not technically "published", was Manitoba Conservation, Fisheries Branch, *Fisheries Information System*. This system acts as a repository of all information collected in Manitoba by the various government and non-government agencies. Reports from this database could be generated on an ad hoc basis. This source provided excellent information on fisheries data for Sandy Lake, including species, water chemistry, stocking records and associated publications. Manitoba Conservation, Brandon Regional Office, compiled most data.

A survey had been conducted by Manitoba Conservation, Brandon, regarding the various sewage disposal systems found at Sandy Lake. This survey received replies from 98 seasonal residences. In general, the bulk of the residences examined were considered to be in compliance with existing regulations. There was no discussion relating to the plans to conduct further surveys. No results of this survey were made available for this report due to confidentiality issues.

The open houses and in person interviews done during the course of the study provided valuable information regarding Sandy Lake. The first open house was intended as an informational exchange regarding the project specifics. However, several attendees expressed concern over the water quality of the lake. The concerns could be broken down into three general categories as follows:

- The sewage disposal methods used by some residences on Sandy Lake
- The extensive development on Sandy Lake, and existing applications for further development
- The algal and emergent/submergent plant growth on the lake

Several people later repeated these issues in individual conversations over the course of the study. Other issues included the agricultural practices in the area, both crop and livestock, that may be impacting the lake, and the extensive use of the lake by boat traffic. The final issue raised during conversations was the golf course adjacent to Sandy Lake on the south east side. Several individuals expressed the view that the drainage

ditches and use of chemical fertilizers and pesticides were impacting the water quality in Sandy Lake.

Conversations early in the study planning indicated that Manitoba Conservation, Fisheries Branch, Brandon Regional Office, had conducted several fisheries studies on the lake (Bruederlin, pers com). This data was largely reflected in the Manitoba Fisheries Information System. No unpublished water quality information was noted.

3.2 Video Reconnaissance

The aerial survey of Sandy Lake along with the boat survey and ground truthing provided the information necessary for developing the riparian assessment later in this report. The aerial survey was of particular interest in that it provided a clear view of the algae bloom that was of concern to many local stakeholders (Figure 5).

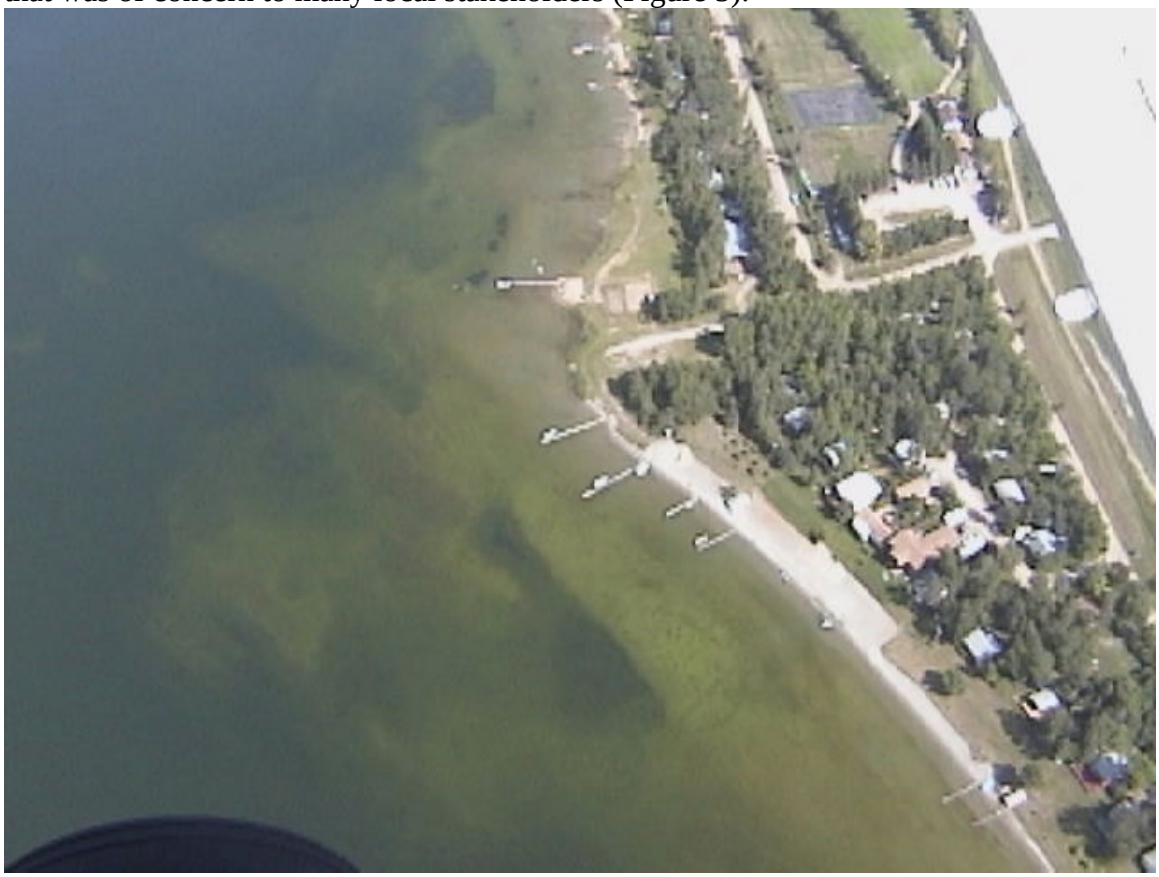


Figure 5: Aerial View of algal bloom on Sandy Lake

The video reconnaissance also provided an opportunity to observe any obvious situations that may have an impact on the water quality in Sandy Lake. It was immediately obvious how intensively utilized the lake was by seasonal residences (Figure 6). The area surrounding Sandy Lake was heavily used for agricultural purposes. Interestingly, only two relatively small cattle operations appeared to have any potential to impact the lake.

Figure 6: Cottage Density on Sandy Lake.

3.3 Field Surveys

Field data were collected over the mid-summer to mid fall period of 2003. The following outlines the findings of each specific field study.

Riparian Survey

As previously mentioned, the riparian survey was completed using a combination of aerial and lake level video footage, and ground truthing. Assessing the condition of the riparian area was difficult, as much of the western shoreline and southern shorelines were completely developed. Of particular concern were areas where shorelines were cleared to the edge of the water (Figure 7) and areas where road development allowed run off to flow unimpeded to the lake. Such areas were rated as highly impacted. Areas were rated as medium impacted where at least a degree of shoreline vegetation was maintained, and where some attempts at controlling runoff were made (Figure 8).

Those areas that were by and large covered with at least a 30-meter buffer zone of natural vegetation or had associated macrophyte growth along the shore area were rated as low impacted (Figure 9). In total, the southern basin of Sandy Lake had 18.1 km of shoreline of which 10.4 km (57%) was rated as low impacted, 2.2 km (12%) was rated as medium

impacted, and 5.5 km (30%) was rated as high impacted.

Figure 7: Lawns were extended to the edge of the lake

Figure 8: Some cottages attempted to maintain shoreline vegetation.

Figure 9: Natural Riparian Zones were present along much of the lakeshore.

Several issues were associated with the riparian zone. The main beach and boat launch area of the lake (Figure 10) was sloped directly to the lake. This allowed runoff from the town site to flow directly into Sandy Lake. Further, the municipal road ran for 0.6 km along the lakeshore, with no buffer zone between the road and water. At least two other roads on the west side of Sandy Lake also directly allowed runoff directly to the lake, with ditches facilitating the drainage. The golf course had one main ditch type drain constructed on the south east corner of the lake (Figure 11). This drain went directly to the lake. Along the southeast corner of the lake an agricultural operation had a small number of cattle, which had direct access to the lake. The landowner had fenced the riparian area off from the cattle, but had not yet provided off lake watering. This necessitated the occasional access via a gate to the lake by the cattle for drinking water. In all of these locations, the riparian zone was rated as high impacted. One other issue related to a small drainage ditch on the east side of Sandy Lake (Figure 12). This drained a series of small bogs and flowed across open field that appeared to be used for grazing purposes. Effectively, this drain bypasses the riparian zone, which in itself is rated as low impacted, and allows runoff directly to the lake.

Figure 10: Main dock and access point.

Figure 11: Golf course drainage ditch, visible in bottom center of picture.

Figure 12: Overland drainage ditch along shoreline directly to lake.

The largest impact to the riparian area around the lake was clearly from the recreational cottage activities. Some landowners are careful to retain as much of the riparian area as possible, whereas others had simply cleared land completely to the lakeshore. This certainly was increasing the nutrient loading in Sandy Lake.

Benthic Surveys

Only two duplicate benthic samples were keyed, although three were taken. The sample at station 5 was damaged in transit, and unusable. The other two samples provided general information on the species composition of the benthos in Sandy Lake. This is shown in Table 1.

Table 1: Benthic Sample Results (Stations 1 and 8)

SAMPLE LOCATION AND NUMBER	Tubificidae	Hydropsychidae	Caenidae	Ephemeridae	Heptageniidae	Gomphidae	Chironomidae	Empididae	Simuliidae	Sphaeriidae
Sample Site 1; Grab 1	2		12	22	2		17			1
Sample Site 1; Grab 2	1			11	2		9	1		1
Sample Site 8; Grab 1	8	1	3	16		1	23		1	2
Sample Site 8; Grab 2		2		9	4		28			6

Algae Sampling

During the open water period of 2003Sandy Lake exhibited evidence of algal blooms ranging from low to high. Samples of the algae during bloom periods were obtained. There appeared to be two distinct types of algae present. The first type occurred in the mid channel of the lake, and was prevalent throughout the lake, particularly along the bays and shoreline areas. Analysis of the samples showed that blue-green algae dominated the samples. The main species were *Aphanizomenon flos-aquae* and *Gomphosphaerium* spp. Also present in lesser numbers were *Microcystis viridis*, *Psuedoanabaena constricta*, *Anabaena* sp., and *Lyngbya limnetica.*

Numerous diatoms were also present in the sample, including *Stephanodiscus* spp., *Gomphonema* spp., and *Navicula* spp. These are all common to prairie lakes.

The presence of *Aphanizomenon* is significant in that it is usually an indicator of eutrophic lakes or polluted water. It can also be an indicator of high pH, which was the case for the sample (pH 8.6). When large masses of *Aphanizomenon* decompose, a foul septic odour can be present. This odour was occasionally evident while sampling on Sandy Lake. Dense blooms of the species found can be highly toxic to livestock and other animals.

Anabaena species and *Aphanizomenon flos-aquae* are frequently found in freshwater. Their greatest abundances are usually observed during the summer. These are filamentous cyanobacteria, capable of nitrogen fixation. *Anabaena* is one of four genera of bluegreen algae capable of producing neurotoxins along with *Oscillatoria*, *Lyngbya* and *Aphanizomenon*. *Anabaena flos-aqua* is a major producer of neurotoxins (Carmichael 1997 Advances in Botanical Research Vol 27:211-256).

Distribution of algal blooms and macrophyte production are controlled by two factors, namely the availability of nutrients, and the depth of light penetration. Within a basin such as Sandy Lake the light penetration is less affected by the water quality than by an algae bloom. These blooms tend to block light from penetrating and increase their production, thereby denying growth opportunity to rooted macrophytes. This of course makes more nutrients available for algae production. In Sandy Lake, light penetration (secchi disc readings) were unrestricted in the early spring, but reduced to 1.0 to 1.5 meters in the summer months. Aerial reconnaissance in August of 2003 was sufficient to produce a general distribution of the mid-summer dense filamentous algae bloom in the south basin of Sandy Lake. Depth contours (Figure 13) were closely matched by the distribution of the algae bloom (Figure 14).

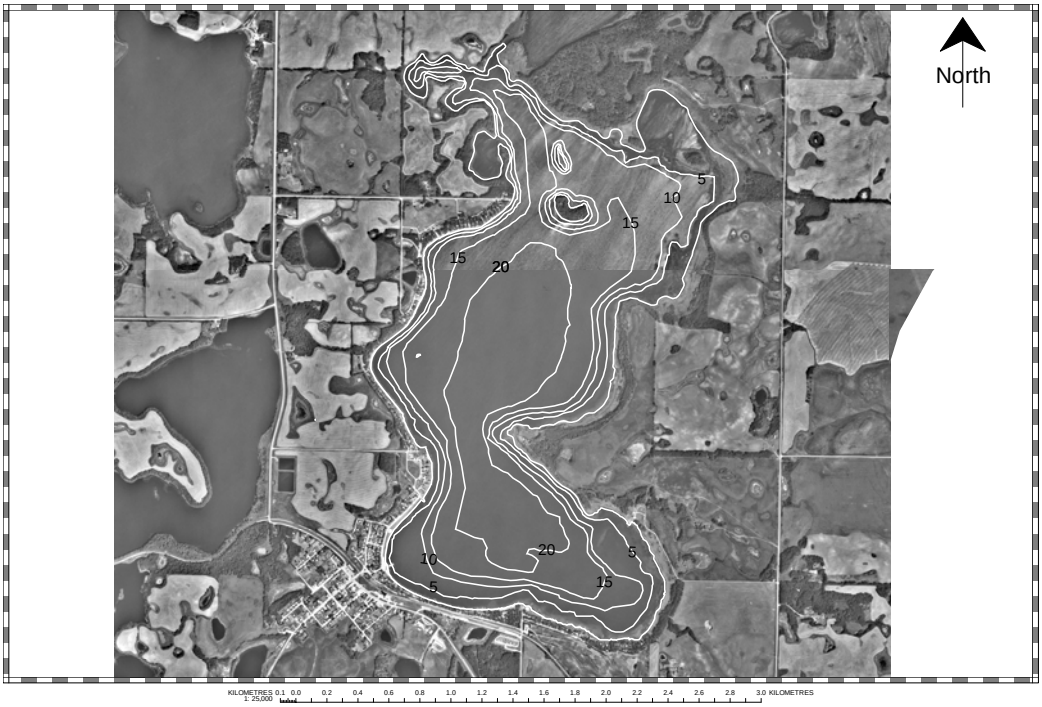


Figure 13: Contour Lines (From Manitoba Conservation, Mapping Branch)

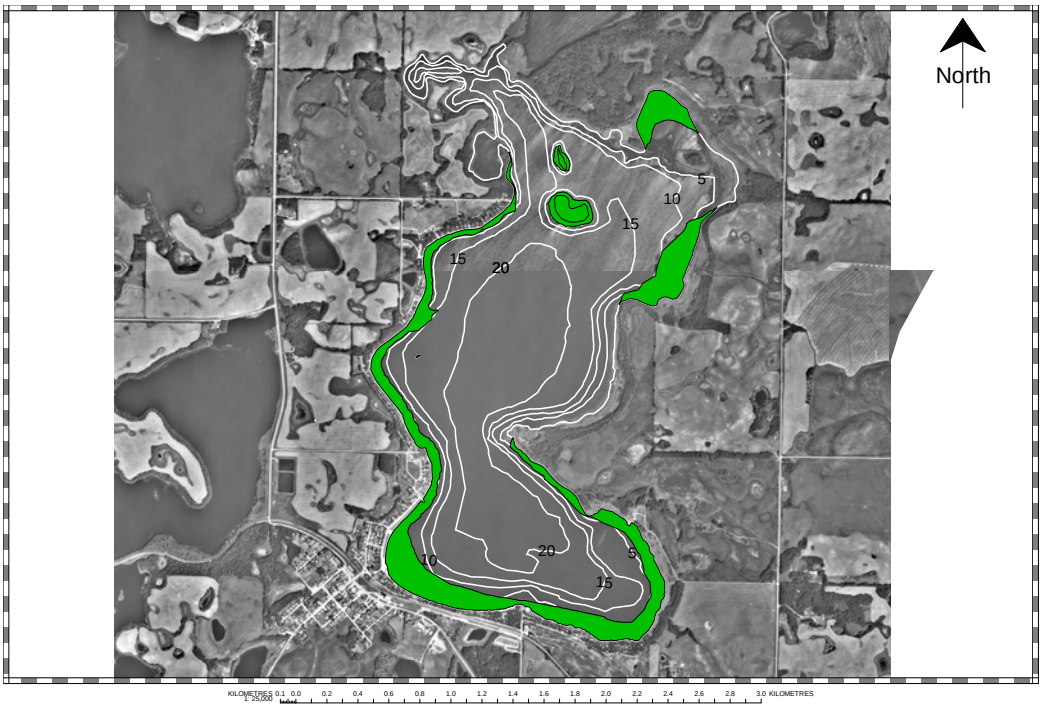


Figure 14: Areas of Algae Growth

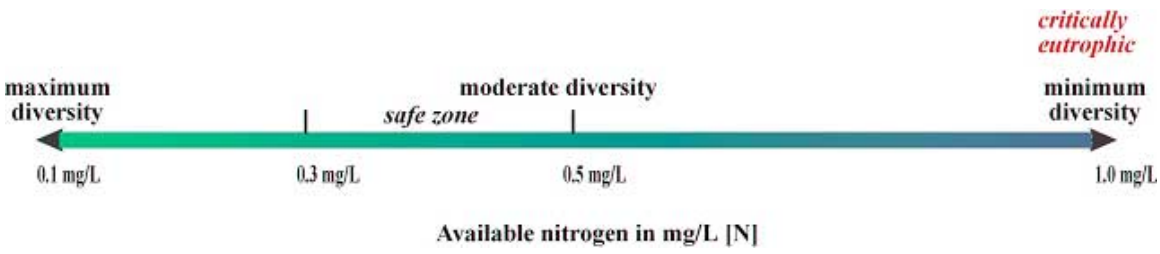
Water Chemistry

Sandy Lake was sampled for additional parameters relating to the concerns voiced by local citizens. These included fecal coliform counts, nutrient loading (nitrogen and phosphorus levels) and general water quality. Results in 2003 compared favourably with those reported by Beck (1986), although phosphorous levels appeared to be slightly higher. One sediment sample was tested for phosphorous levels from Station 4 in Sandy Lake. The result was a level of 2.5 mg/kg, or nearly 60 times the levels found in the water column. This clearly indicated the ongoing problems with continued cycling of nutrients in a closed system.

Water quality results in the north basin were very similar to the south basin. Nutrient levels were slightly lower, but not dramatically so. This was interesting in that there was no algae bloom in the north basin, whereas the south basin exhibited a summer long event.

The estimated level of available nitrogen to support maximum diversity in waters is 0.1 mg/L. The level at which eutrophication can be expected, is estimated at 1.0 mgN/L. Sandy Lake was double this level. The estimated range in which moderate diversity can be supported is 0.3-0.5 mgN/L (Jaworski, N.A., O. Villa, Jr. 1981). Levels above 0.3-0.5 mgN/L indicate progressively advanced stages of eutrophication, illustrated graphically in Figure 15.

Figure 15 Relative eutrophication scale based on available nitrogen concentration



The limiting nutrient to algae blooms in Sandy Lake was phosphorus. Sandy Lake has always displayed high nutrient levels, not uncommon with other prairie streams and lakes (Beck, 1985). The source of these nutrients is not known. It appears that phosphorus, once it is in Sandy Lake, becomes bound up in the sediments and is available for recycling in the environment. This cycle (Figure 16) perpetuates algae production.

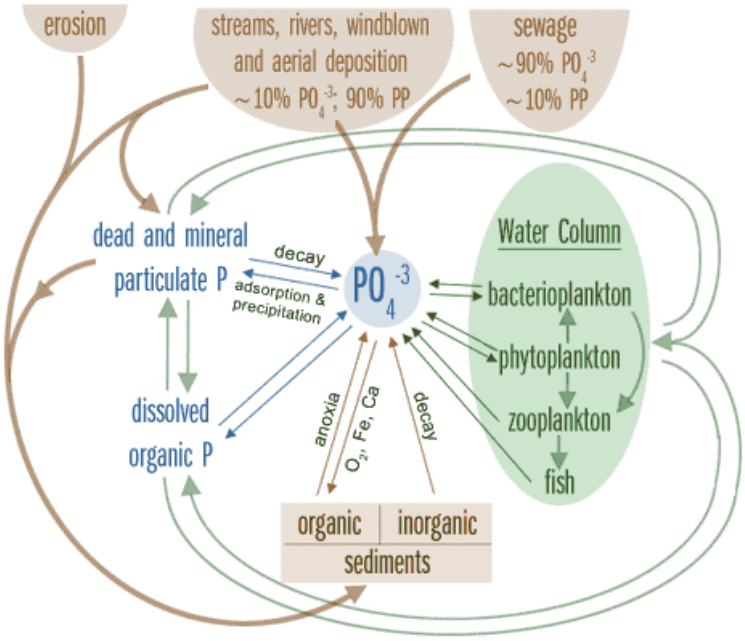


Figure 16: Phosphorus Cycle

As previously indicated, Beck (1986) considered Sandy Lake to be in a eutrophication stage of development. Eutrophication is most certainly accelerated by human activities that increase the nutrients entering the lake. Phosphorus levels influence lake productivity

because of their effect on plant growth. When nutrient levels become very high, algae populations bloom and cause the lake to become green and murky. Algal blooms are aesthetically unappealing, and ecologically detrimental. Lower levels of dissolved oxygen as a result of algal blooms can cause fishkills and decreased biodiversity (Chapman 1996).

The pH of Sandy Lake is quite high, averaging 8.8. This appears to be a natural condition. There is slight indication of plant and algae growth contributing to the high pH. When the rate of atmospheric CO2 diffusing into the water is less than the rate of photosynthesis, aquatic plants use dissolved carbonates (H2CO3, HCO3-, CO32-) as their source of carbon. This is responsible for the increase in lake water pH during photosynthesis. pH is also raised because photosynthesis consumes protons (H+). However, pH in Sandy Lake is only marginally lower in the winter months than the summer months, making the contribution of photosynthesis to this situation seem insignificant.

Fecal coliforms in the lake were an item of major concern for stakeholders. However, samples did not indicate excess amounts of fecal coliforms in the water column, with a maximum reading of 10 mpn/100ml. Measuring fecal coliforms is a difficult task, due to the short duration of their presence under sunlight conditions. Likewise, sampling is spatially and temporally specific, and finding organisms in the sample is sometimes a matter of luck. However, results were consistent with both the concurrent study on sewage disposal systems and the Manitoba Conservation Beach Test Results, which post *e. coli* counts at Manitoba's major beaches. Counts in samples were too low to permit the laboratory to perform a type specification of the organisms. This test would have indicated the source of the coliform, such as avian, animal or man.

Fish Survey

As indicated earlier in the report, Manitoba Conservation, Fisheries Branch, Brandon Regional Office had acquired excellent data on fish species utilizing Sandy Lake. Sandy Lake was clearly successful at sustaining sport fish populations, with walleye being a much sought after species. During the course of the field investigations, numerous boats were found to be targeting the species with a varying degree of success. Natural spawning within Sandy Lake for walleye was enhanced in the 2002 and 2003 seasons with the stocking of 350,000 walleye fry. Sandy Lake has been stocked annually with walleye fry or sometimes fingerlings since 1933 (Bruederlin pers. com).

This study concentrated on located small bodied and young of the year fish. Only 4 locations were seined. Within these four locations, a total of six YOY walleye were found, with perch being the only other game species found. The primary catch consisted of fathead minnows, longnosed dace, emerald shiners, perch, Iowa darter, and spot tail shiners (Appendix 1).

4.0 Action Plan and Discussion

Results from the investigation and discussions with stakeholders produced a clear picture of the concerns related to Sandy Lake. The lake is becoming nutrient rich based on the activities of man, and this increase in nutrients is speeding the eutrophication process. It is also clear that the majority of the stakeholders on Sandy Lake are prepared to take the steps necessary to protect and enhance Sandy Lake. The ultimate goal of the working group is to ensure that Sandy Lake would remain a healthy water body for generations to come. With this goal in mind, the following Action Plan is suggested.

4.1 Objective 1 – Reduce and control the amount of nutrient being put into the lake.

The amount of nutrient in Sandy Lake has historically been high. However, threshold limits can be exceeded with even the smallest increases in concentrations. With Sandy Lake, the nitrogen levels are so excessive, that even a tiny increase in phosphorus concentrations can initiate an algal bloom. Once begun, the decaying organisms provide further nutrient to the sediment, which later can be re-circulated through a variety of processes. The evidence of how close the threshold limits are is illustrated by the fact that the north basin, with only marginally less nutrient loading, did not exhibit the same algal blooms as the south basin. The only difference in the two basins is that the south basin is heavily developed, whereas the north basin is not.

With the assumption that even minor increases in nutrient loading can visibly cause deterioration of the water quality of Sandy Lake, the following steps are suggested.

Step 1 – Manage Sewage Waste

- Task - Sewage Management Plan

The fact that only 30-40 of the more than 250 cottages on Sandy Lake are hooked to closed sewage systems is cause for some speculation about the effectiveness of existing conditions. The study by Manitoba Conservation in the summer of 2003 generally concluded that the examined residences were in compliance with existing regulations, but further work is required in this important issue. It is encouraging that of all the people interviewed during the 2003 study, very few were opposed to improving the lake water quality.

It is therefore suggested that the cottage owners be encouraged to sign on to a formal Sewage Management Plan. This plan would outline the preferred methods of disposal of sewage, guidelines for maintenance of existing septic fields and holding tanks, and compliance with regulations that eliminate grey water pits. Under Manitoba regulation, records for pump outs must be kept. Under a sewage management plan, these records would be routinely published, along with the records from disposal haulers, in order to locate discrepancies. Such a system would be voluntary and would require the

cooperation of cottagers and haulers. This is common on some southern Ontario lakes, particularly in the Halliburton area.

Failing septic systems have been linked to water quality problems in streams, lakes, shellfish beds and coastal areas. Improvements in system operation and maintenance should be a strong element in watershed plans for those areas where septic systems are used for wastewater treatment (Maine Department of Environmental Protection. No Date). As with all pollution prevention measures, public unawareness about the suggested practices may be the biggest limitation to septic system source control. Many residents appear to be either unaware of how to implement the necessary steps to ensure the proper operation and maintenance of their septic systems. Sewage management plans can help clarify issues, and make people recognize practices that will benefit the lake.

- Task - Removal or Refurbishment of Outhouses

Outhouses or pit privies are generally considered to be relatively harmless to lakes, as they are closed systems. However, the observation is only valid when considering what the goal is for a water body. In most cases, the goal is to prevent the introduction of biological factors and bacteria, such as *e. coli* into the water column. Outhouses have proven to be very effective at this task. However, when it comes to leaching of nutrients into the water, outhouses are less effective. This is also true to a degree of septic fields. In particular, the soils and the closed nature of the Sandy Lake basin make the likelihood of nutrients leaching into the lake all the more serious. Holding tanks that can be pumped are proving to be more effective for near water use.

Similar situations existed at Gull Lake, Manitoba and Devil's Lake, Wisconsin. In both cases, all outhouses were removed from the system (Gull Lake) and in the case of Devil's Lake all outhouses and septic fields. While it is unclear how much the removal of these outhouses contributed, it is clear that both lakes exhibited a marked reduction in nutrient levels and subsequent algal blooms once the removal occurred.

- Task - Eventually hook all dwellings to sewer and water

Ultimately, the best sewage management plan would be to have all residences bordering the lake hooked into a closed and professionally managed sewage and water system. It is recognized that the reality of the costs associated with such an undertaking are enormous.

In spite of the difficulties, it should be a long-term plan to eventually achieve this goal. This would eliminate the increases in nutrient loading that take place now, and ensure protection against any further degradation to water quality from any biological agents that may enter the aquatic system.

Step 2 – Manage Runoff

- Task - Maintain riparian area

It was encouraging to find that over half (57%) of the shoreline riparian area was intact or low impacted around Sandy Lake. One of the chief goals in maintaining the aquatic health of the lake will be to ensure that the existing conditions are not allowed to deteriorate any further.

It is therefore recommended that a strategy limiting the types of activity that can be carried out on the existing low impacted areas of Sandy Lake. This can include vegetation management measures and no clearing policies.

It is also recommended that restrictions on the use of herbicides in the riparian zone be enforced as much as possible.

- Task - Review municipal roads

As previously mentioned, the main access road to Sandy Lake beach and boat launch acts almost like a large drain funneling run off water directly into the lake. During rain events, water was observed flowing unimpeded down the road.

Roads are a source of excessive surface runoff if they are poorly designed or maintained (Michaud 1992). Different road types have varying levels of nutrient loading potential. In general, roughly 80% of the nutrient loading problems are caused by only 20% of the culverts or crossings. Furthermore, roads and driveways leading to shoreline areas or tributaries can cause runoff to flow directly into a lake.

Berming and diverting flows could help in reducing the effects of the runoff in an area where little buffering capability exists.

- Task - Remove cattle from the lake

Sandy Lake does not have an excess of cattle or livestock operations impacting on the lake. However, the fact is that thresholds and incremental impacts are the primary concern with inputs. Cattle have long been documented to have negative effects on water quality, particularly through increases in nutrient load and turbidity.

The fact that only one operation exists on the lake, and the fact that the landowner is willing to restrict cattle from the lake should make this an easily accomplished task.

- Task - Investigate overland drainage at east side and golf course

The small drain on the east side of Sandy Lake flows through an area that has previously (and possibly currently) been heavily utilized by cattle. In addition, nutrients from surrounding farmlands can access this drain directly and bypass the excellent riparian zone in this area, thereby depositing nutrients directly into the lake. To an extent, this occurs with all streams flowing directly to a larger water body – if the stream does not have its own good riparian zone it will act as a direct conduit for pollutants to a water body. It appears that at one time this drain was a small overflow stream from a series of small wetlands to the east of Sandy Lake. However, these have largely been drained over time, and the effectiveness of these wetlands reduced. Investigations should focus on the feasibility of restoring these wetlands, and controlling overland flow to the drain.

Similarly, there is a large ditch system designed to drain the surface water from the golf course. This drain appears to extend across PTH 45 to the south into another area where cattle operations are being contemplated. This allows a relatively large area direct drainage access to the lake during large rain events. Investigations should focus on methods to distribute and regulate flows from overland sources, such as the golf course.

Step 3 - Manage inputs

- Task – Chemical Use

The use of chemicals for a variety of reasons ranging from better lawn and garden growth to cleaning and washing is common. In locations where a water body is close by this can cause problems. The heavy use of fertilizers on lawns, gardens and fields can provide excess nutrients to the lake. Some chemicals used in household cleaning and maintenance can cause biological communities in septic systems to die, thereby eliminating the effectiveness of the system.

Excellent guidelines exist from the Department of Fisheries and Oceans and Manitoba Conservation that give good information on the use of chemicals near water bodies. Ensuring that all cottagers at Sandy Lake are in possession of this information should be a goal.

- Task – Discuss options for golf course management

Golf courses are thought to be relatively benign environmentally, primarily because they do provide green space. However, when golf courses are closely associated with water bodies, their appeal can be less than excellent.

The U.S. Audubon Society (1990) recognized that golf courses could contribute significant amounts of nutrient to surrounding water bodies through excessive use of fertilizers, weed control methods, drainage design and landscaping. They could also affect the habitats of local animals, birds and fish. To this end, the Audubon Society developed a "green golf course" certification program. The Audubon Society Cooperative Sanctuary Program for Golf Courses provides advisory information and certification to golf courses that promote ecologically sound management and proactive environmental projects. Currently, more than 1,600 courses are enrolled throughout Canada and the United States. Included at these courses are programs to enhance public/member involvement, wildlife habitat management, controlled pest management, water quality management and water conservation. Subsequently, several other agencies and organizations began publishing golf course management practices that essentially removed harmful effects caused by golf courses.

In general these methods include changes in practices for course maintenance. Most often these changes have no associated additional costs, but can provide large benefits. It is recommended that the Sandy Lake working group initiate discussions with the golf course management to see if there is a level of interest in pursuing any such actions.

- Task – Eliminate washing in lake

On several occasions people were observed to be using Sandy Lake to bath in, complete with soaps and shampoos. On at least two occasions, people were observed to be using pressure washers along the lakeshore to clean boats and ATVs with soap solutions.

Such activities should be eliminated. Although most soaps and solutions have limited or eliminated the phosphate content, it is not a good practice. Cleaning greases and dirt into the lake can only be detrimental.

- Task – Control fueling of boats

On several occasions, boats and PWC were seen to be fueling at the main dock. On most of these occasions, some petroleum products were inadvertently spilled directly into the lake.

It is essential that all fueling activities be conducted clear of the water as much as possible. Such practices are commonplace on several lakes in Canada. When on water fueling is required, all appropriate measures should be taken to ensure containment of fuel products.

4.2 Objective 2 – Manage the existing use of the lake

Step 1 – Control further development

- Task - Moratorium on cottage development

It is abundantly clear that Sandy Lake is a desirable location for cottage ownership. Cottages are rapidly sold on the rare occasion that they come to the market. The R.M. Office is continuously fielding requests for further development of land parcels around the lake.

In spite of the appeal of the lake, further development is not recommended by both Beck (1986) and the R.M. (Chemerika, pers com). Several changes have happened over the past decades to make cottage capacity on lakes a more critical issue. For example, at one time usage was restricted to a few weekends per year. However, modern cottages are much better equipped, and the use of the family cottage to more than one season is common. Indeed, it is common for many long time cottage owners to "retire" to the cottage, and make it their principle residence.

Along with increased residency, more modern features such as laundry facilities, dishwashers and showers are constructed. More permanent residents are more likely to undertake landscape and garden improvements.

All of these activities have the potential to impact the health of Sandy Lake. It is suggested a policy to restrict further development on the lake become a cornerstone of this action plan.

- Task - Reduce access points to the lake

Sandy Lake is a relatively small lake, with access to any part easily accomplished by powerboats, PWC and even sailboats in a short time. However, there are several access points or "boat launches" that are used around the lake. Some cottagers even have the luxury of launching on their front yards, due to the relatively low slope and stable shoreline conditions.

Each such access point has the potential of causing impacts to the lake, both through the removal of the riparian zone and the disturbance to sediments caused by launching a boat. Further, well established boat launches can and do provide uncontrolled access to the lake for overland drainage, thereby increasing nutrient loading.

It is recommended that the group investigate the possibility of allowing boat launching at only one main location to reduce impacts from this activity.

Step 2 – Reduce and control lake disturbances

- Task - Implement no wake zones

Instantaneous boat counts for Sandy Lake were 44 units (Beck, 1986). This is a fairly significant number for a water body the size of Sandy Lake, but not over the calculated capacity of the lake.

Of interest when discussing lake impacts from boating is the wake generated by the boats. Table 3 shows the approximate wake size generated by a variety of watercraft at different distances from shore.

Table 3: Boat Wake Estimates

Vessel Type	**Distance from Sailing Line**		
	0 to 30 m	**30-100 m**	**100-200 m**
Sailboats	**N/A**	**N/A**	**N/A**
Jet Skis	**8 cm**	**4 cm**	**0**
Fishing Boats	**16 cm**	**8 cm**	**4 cm**
Pontoon	**8 cm**	**4 cm**	**4 cm**
Medium Power	**24 cm**	**20 cm**	**10 cm**
Large Cruisers	**50 cm**	**40 cm**	**20 cm**
House boats	**8 cm**	**4 cm**	**4 cm**

Wake size diminishes significantly as craft are further from the shoreline. For example a medium powerboat reduces its wake height from 24 cm to 10 cm with an additional 70 m of distance from the shoreline. Activities such as water skiing can cause large wake events near the shoreline, causing increases in erosion and sediment disturbances. Both of these can cause increased nutrient loading and sediment suspension that can last for some time. Table 4 shows the duration and effects of such events.

Table 4: Effect of Wave Height on Sediment Suspension

Wave Height (cm)	**Equilibrium sediment concentration (mg L-1) at various inter-arrival times**					
	1 min	5 min	10 min	20 min	30 min	60 min
10	1.0X10-3	4.1X10-4	2.8X10-4	2.0X10-4	1.7X10-4	1.3X10-4
20	325	110	78	58	50	38
30	865	230	160	110	95	75

In point of fact, a single 20 cm wave can re-suspend significant sediment concentrations for up to an hour after passing, whereas a 10 cm wave would have virtually no effect.

The south and west shores (heavily developed areas) are particularly susceptible to the erosional and sediment suspension effects of boat traffic. It is therefore recommended that a “no wake” zone be established at 100 m

offshore to minimize any such effects from the normal types of boats used on Sandy Lake.

- Task – Adopt standards for in-water works

In water works can be defined as permanent docks, breakwaters, boathouses and ramps that may have a permanent effect on the lake habitat. Sandy Lake is a difficult location to build dock structures due to level fluctuations and severe ice events. The flat lakeshore profile makes the use of floating docks difficult if not impossible.

Some cottage locations had developed removal docks on wheels, and some had established more permanent crib structures. Yet other cottagers had constructed a variety of structures, including breakwaters to protect beaches. These can cause permanent detrimental effects in lakes if not properly installed and maintained. Such works should be discouraged.

4.3 Objective 3 – Restore the lake.

Step 1 - Restore the Riparian Area

- Task – Develop and Implement a Cottage Owner Code of Conduct

Ownership of a cottage is a tremendously significant undertaking. As with all things, it becomes the responsibility of the owner to help to preserve those very items that made cottage ownership such an attractive proposition in the first place. Sandy Lake, like other lakes, has a variety of cottage lot practices that owners undertake in relation to their personal preferences.

When examining the developed area of Sandy Lake, it quickly becomes apparent that many of the lots are cleared of natural vegetation to the shoreline, and disturbances such as removal of plant growth in the water, and rock removal were common practice. Several residences stated that they routinely used chemical methods to control weed growth in the water. Several others stated they used lawn and garden fertilizers on a regular basis.

Such activities have deeply impacted the riparian zone, and more importantly, are serving to accelerate the process of eutrophication in Sandy Lake.

Several excellent guidelines have been developed that essentially form the basis of a general code of conduct for cottage owners. One such publication is the DFO Prairie Shore Primer, included here as Appendix 5. This publication outlines steps, that if followed will help restore the riparian area of Sandy Lake and implement long term practices that will serve to protect and enhance the water body.

Step 2 – Other Restoration Techniques

High phosphorus concentrations were found in Sandy Lake sediments. This is primarily because Sandy Lake is a seepage lake with no outlet to naturally dilute and flush out the phosphorus. Even once inputs are significantly reduced to Sandy Lake, the lake's bottom sediments will recycle each year increasing the overall fertility level of the lake.

"Studies by researchers show that the phosphorus temporarily binds to iron compounds in the lake's sediments at times of the year when the overlying water is oxygen-rich. From late spring through early fall as the water warms up, the lake stratifies with a less dense warm water layer near the surface. By mid-summer, the denser colder water on the bottom can lose its oxygen (anoxia). The phosphorus is then released from the sediments and builds up in the bottom waters from late summer through about mid-October. At that time the surface waters have cooled causing the lake to "turn-over" and allowing the phosphorus to mix throughout the entire lake" (Lathrop et al 2004).

Efforts to restore Sandy Lake through controlling inputs will be effective, but only over a long period of time. Unfortunately, shortening the time period required depends on the implementation of intensive measures, each of which presents its own series of impacts. The following lists possible methods to address this issue.

- Dredging

When excessive amounts of nutrient become bound up in the sediments on the bottom of a shallow lake, the opportunity for these nutrients to find their was back into the water column are very high. Removing these sediments through dredging is a common practice in certain small lagoons and reservoir lakes. Nutrient rich soil is prevented from re-entering the water body.

The impacts of dredging a natural lake system are severe. Such an operation has the potential to severely impact the aquatic community to a far greater extent than the current situation of high nutrient recycling. Added to this is the high cost of such an operation.

- Water Draw offs/inputs

Henderson-Sellers and Markland (1987) noted that several other in-lake mitigation techniques besides dredging exist to deal with the problem of excessive nutrients once they are present in a lake . All of these techniques

have disadvantages, but for lakes with serious algal growth problems they may be necessary (Henderson-Sellers and Markland 1987).

One technique used to eliminate excessive nutrients is to rapidly decrease the water level of the lake. A lake controlled by a dam can quickly be flushed by releasing a large volume of water. Naturally this is not the case with Sandy Lake, and the ability to restore the water level would be slight. This would lead again to more serious depletion of the natural habitat, and severe impacts would follow.

Another approach to nutrient reduction involves removing the nutrient rich hypolimnetic water (the lower water layer between the sediment layer and the upper water layer or epilimnion). This is done by inserting a large pipe into the hypolimnion and pumping the water out (technically called "hypolimnetic withdrawal") in such a way that it would not go directly back into the lake, thereby reducing nutrient levels in the water (Henderson-Sellers and Markland 1987). Such an approach is expensive, and would require a nearby source of alternate water to replace the amounts taken out. Such an approach was used successfully at Devil's Lake, Wisconsin (Lathrop et al, 2004).

- Aeration

Aeration of the hypolimnion is a process that operates on the principle that an increase in the oxygen levels in the lower strata of the hypolimnion will reduce the amount of dissolved phosphorous (DP) released from the sediments. If there is oxygen present where the sediment and water interface, there will be no conversion of iron to its reduced form, and therefore, no DP will be released from the ferric phosphate complex (Henderson-Sellers and Markland 1987).

Aeration has been used successfully in Manitoba, although the main purpose has been to provide oxygen for aquatic life to avoid winter kills among fish. Gull Lake implemented aeration and has had success in controlling both oxygen depletion and recurring algal blooms.

5.0 Conclusion

Sandy Lake is a desirable location for cottage activities. The popularity of the lake is partially what led to this study, as residents and landowners wish to ensure the lake survival for years to come. Clearly, the members of this committee were motivated to implement changes.

It needs to be clearly stated that Sandy Lake is not in severe straits, or in dire need of desperate restoration measures. In fact, Sandy Lake is typical of other small prairie lakes, in that nutrient levels are leading to unwanted events, such as algal blooms. However, there should be no doubt that the lake is undergoing an accelerated eutrophication process, as the result of several impacts on the system. There can also be no doubt that the bulk of these impacts are caused by the activities of man. While some external factors prevail, the over riding source of impacts is the intense use of the lake and the surrounding land base.

Fortunately, several options exist for initiating improvements to the lake. These are primarily divided into three groups as follows:

- stopping harmful inputs into the lake
- utilizing the lake in a manner that does not incur adverse effects
- undertaking restoration activities as opportunities present themselves

Almost all of these activities involve stakeholders, and almost all require modifications from current patterns of behaviour.

Without doubt, implementing some or all of the items in this report will lead to improvements in the water quality of Sandy Lake. It is unrealistic to expect all changes to be implemented, at least over the near term. However, changes that have brought the lake to its current state have taken many decades to occur. Expectations of overnight or immediate fixes are unrealistic. Other similar lakes have effected significant meaningful changes in as little as 5 years, but most take considerably longer to show progress.

The key to restoration activities will be to convince landowners and cottagers to participate in the steps necessary to effect change. This will lead to a co-operative approach to restoring lake health. Forced changes tend to be less successful, and often lead to unproductive confrontation. During the study, the overall assessment was that people wished to protect and enhance Sandy Lake.

Taking action will provide an opportunity to meet the committee's goal which is "to ensure that Sandy Lake will remain a healthy water body for generations to come."

SEINING RESULTS

General Notes:

- Seining difficult in Sandy Lake. Started with 50m seine and reduced to 20m
- Some beaches do work, but several locations were tried and found to be unworkable
- Electro-shocking was not tried
- Seine pulls were in early fall (September 8, 2003), some fish may be in deeper water, however there were YOY walleye caught in 3 sites

SITE 1

	SET #/SPECIES		Iowa Darter	Perch	Emerald Shiner	Spottail Shiner	Common Shiner	Longnose Dace	Pearl Dace	Johnny Darter	Fathead Minnow	White Sucker	Walleye	Log Perch
	Set 1	n/a												
Trap Net	Set 2	n/a												
	Set 3	n/a												
SEINE	Sweep 1		1	4	1					1				
HAUL (20m)	Sweep 2			1						2				
	Sweep 3		1	4		2					4			

Notes:

- Easy to seine, haul 3 snagged on boulder, water drops off in depth about 2 m offshore
- Beach is relatively sandy, with some larger gravel. Net bottom did come back muddy

SITE 2

	SET #/SPECIES		Iowa Darter	Perch	Emerald Shiner	Spottail Shiner	Common Shiner	Longnose Dace	Pearl Dace	Johnny Darter	Fathead Minnow	White Sucker	Walleye	Log Perch
	Set 1	n/a												
Trap Net	Set 2	n/a												
	Set 3	n/a												
SEINE	Sweep 1			1		4								1
HAUL (20m)	Sweep 2			12		5	1	1		1			1	
	Sweep 3					1							1	

Notes:

- Easy to seine, many fish visible
- Beach is relatively sandy, with some larger rocks, emergent vegetation to north, silty bottom

SITE 3

	SET #/SPECIES		Iowa Darter	Perch	Emerald Shiner	Spottail Shiner	Common Shiner	Longnose Dace	Pearl Dace	Johnny Darter	Fathead Minnow	White Sucker	Walleye	Log Perch
	Set 1	n/a												
Trap Net	Set 2	n/a												
	Set 3	n/a												
SEINE	Sweep 1					4			1		2			
HAUL (20m)	Sweep 2					12					2		1	
	Sweep 3					18						2		

Notes:

- Difficult to seine, emergent and submergent vegetation
- Beach is rocky, muddy bottom

SITE 4

	SET #/SPECIES		Iowa Darter	Perch	Emerald Shiner	Spottail Shiner	Common Shiner	Longnose Dace	Pearl Dace	Johnny Darter	Fathead Minnow	White Sucker	Walleye	Log Perch
	Set 1	n/a												
Trap Net	Set 2	n/a												
	Set 3	n/a												
SEINE	Sweep 1			2				1		1			2	
HAUL (20m)	Sweep 2			6				8	1					
	Sweep 3		1	8		1		4		3			1	1

Notes:

- Emergent vegetation, and submergent vegetation, used boat to pull seine, bottom loose
- Shore is relatively sandy, with some gravel

Water Chemistry Results

Date	Parameter	1	2	3	4	5	6	7	8	9	1n
15-Jun	pH	8.8	8.8	8.7	8.7	8.8	8.8	8.8	8.8	8.7	8.6
	Conductivity (uS/Cm)	1530	1610	1550	1580	1560	1610	1580	1540	1520	1400
	TKN (mg/l)	2	2	2	2	2	2.1	2	2	2.2	1.6
	Phosphorus (mg/l)	0.04	0.035	0.04	0.035	0.035	0.04	0.035	0.035	0.04	0.025
	Oxygen (ppm)	10	11	11	12	12	11	11	11	11	11
	e. coli (mpn/100 ml)	0	0	0	0	0	0	0	0	0	0
12-Aug	pH	8.7	8.8	8.9	8.8	8.8	8.8	8.8	8.8	8.8	8.6
	Conductivity (uS/Cm)	1630	1600	1500	1730	1620	1680	1660	1660	1510	1510
	TKN (mg/l)	2.1	2.1	2.1	2	2.2	2.1	2.1	2.1	2.2	1.8
	Phosphorus (mg/l)	0.035	0.035	0.035	0.035	0.03	0.04	0.045	0.04	0.04	0.025
	Oxygen (ppm)	10	11	11	10	10	10	10	11	12	9
	e. coli (mpn/100 ml)	1	4	4	6	6	8	12	1	4	0
15-Sep	pH	8.8	8.8	8.8	8.9	8.7	8.4	8.6	8.8	8.6	8.1
	Conductivity (uS/Cm)	1710	1700	1750	1690	1700	1700	1820	1630	1630	1540
	TKN (mg/l)	2.2	2	2	2	2	2	2.1	1.9	2	1.5
	Phosphorus (mg/l)	0.035	0.035	0.03	0.03	0.035	0.04	0.035	0.035	0.04	0.02
	Oxygen (ppm)	11	10	10	10	10	10	10	10	10	10
	e. coli (mpn/100 ml)	0	2	3	0	1	0	0	0	1	0

Fisheries and Oceans Canada
Pêches et Océans Canada

PRAIRIES EDITION

THE SHORE PRIMER

A COTTAGER'S GUIDE TO A HEALTHY WATERFRONT

Cottage Life

Canada

Produced by
Fisheries and Oceans Canada
in association with
Cottage Life

FISHERIES AND OCEANS CANADA
Fish Habitat Management Program - Prairies Area
7646-8 Street NE, Calgary, AB T2E 8X4
Web Site: www.dfo-mpo.gc.ca/oceans-habitat/

COTTAGE LIFE
54 St. Patrick Street, Toronto, ON M5T 1V1
Web Site: www.cottagelife.com

DFO/2008-1429

Cat No. Fs23-507/2-2008E-PDF
ISBN 978-0-662-48025-9

Cette publication est également disponible en français.

Printed on recycled materials.

THE SHORE PRIMER

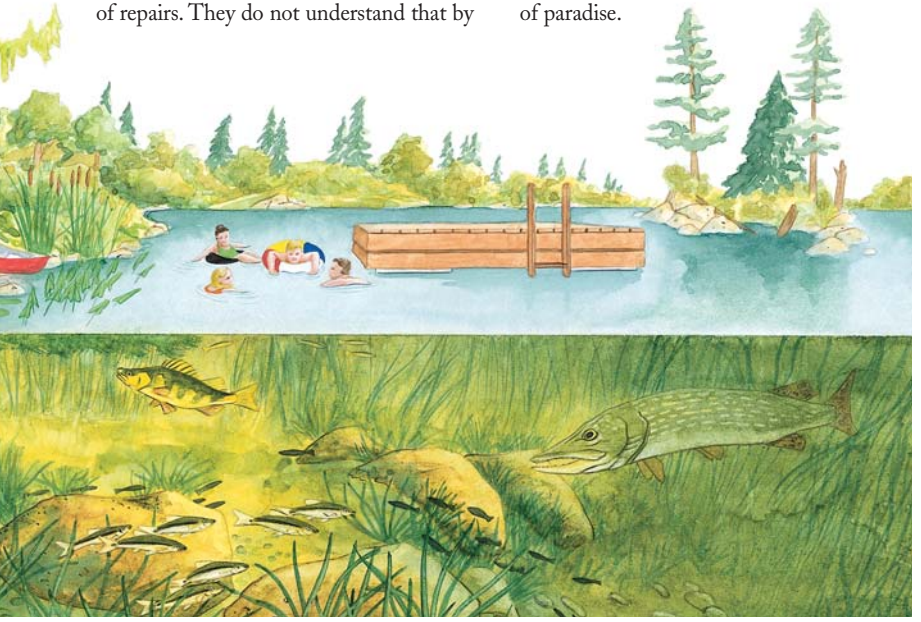
TABLE OF CONTENTS

YOUR SHORELINE: A NATURAL WONDER

For many cottagers and other waterfront residents, the quiet spot by the lake is a little bit of paradise where we can relax, play, and enjoy being closer to nature. But it is a special place for another reason too. The zone where the water meets the land is the richest natural environment that most of us will ever come into contact with, and almost certainly the most complex piece of the earth that we will ever have the opportunity to live near and share. Equally important, the waterfront is crucial to your lake's health, providing oxygen, food, cover and a barrier to contaminants, as well as a living retaining wall for the shoreline.

When a natural shoreline is altered, often by well-intentioned projects meant to improve waterfront living, the intricate balance between vegetation, aquatic organisms, and the shoreline is toppled. A typical scenario goes like this: After purchasing their new cottage lot, the new owners want to enjoy an unobstructed view of the water so they organize a weekend logging bee and clear out the thicket of plants, shrubs, and trees lining the shoreline. However, once the trees and shrubs are gone, the soil that their roots held in place begins to erode. Now the cottager family spends uneasy weekends watching their frontage erode into the lake. Worried about the erosion of their property and investment, they spend a great deal of money to build a breakwall. In a few years, the wall, undermined by the constant pounding of the waves, begins to list or crack. Again, the owners fund a new series of repairs. They do not understand that by retaining the shoreline vegetation, their shoreline would enjoy the benefits of natural erosion control. What began as a bid to have a view of the lake turns into a grudge match between the cottagers and the waterfront - and both sides are taking a beating.

Why not declare a truce and weave your cottage needs into the natural shoreline? This primer will show you how to protect and nurture the qualities that make it such a special location. It also offers cottagers and other landowners constructive solutions for restoring an altered shoreline to its former health and beauty. *The Shore Primer* is the second in a series of primers on waterfront stewardship published by Fisheries and Oceans Canada (DFO) in association with Cottage Life. In combination with *The Shore Primer*, this series of primers can help you become a better caretaker of your own little piece of paradise.



HOW TO PRESERVE YOUR SHORELINE'S TRUE NATURE

Take a good look around your property and familiarize yourself with the features of your waterfront. The natural shoreline has four components, beginning underwater and extending upland (farther than you would think). Shoreline experts call these four components the *littoral zone*, the *shoreline*, the *riparian zone*, and the *upland zone*, and each plays a critical role in keeping your lake healthy. As important as these separate zones are however, it is vital to remember that the shoreline is a natural progression - each area transforms into the next in a gradual, almost seamless transition. Altering any portion of this region affects the whole, diminishing its ability to support life on the lake.

THE LITTORAL ZONE: PERFECTLY PRODUCTIVE HABITAT

Sitting on your dock, you are perched in the *littoral zone*, the area from the water's edge to roughly where sunlight no longer penetrates to the lake bottom. As much as 90 percent of the species in the lake either pass through or live in this zone. Algae floats freely in the water or attaches to twigs, stones, and plants. Microscopic water bears (freshwater invertebrates that look like tiny lumbering bears - if you ignore the two extra legs) graze on aquatic plants. Yellow perch spawn in the shallows, while northern pike lurk among the sedges. Ducks forage in the pond weeds, and turtles loaf on the trunks of fallen trees.

The water in front of the shoreline provides spawning areas, cover, nursery habitat and food for

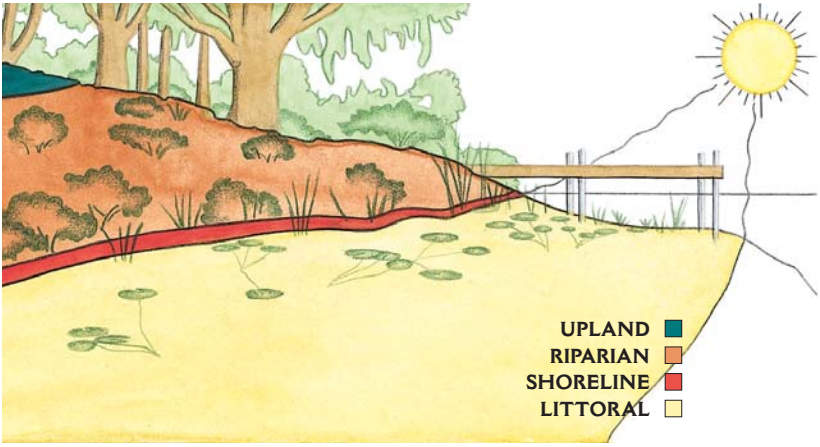
Building a sand beach is tempting, but it can easily erode, smothering aquatic life.

a range of species, offering foraging areas and hiding spots and a shallow, relatively protected area for young fish and amphibians to grow. Aquatic plants and downed trees are a crucial part of the system, with the plants acting as the lungs of the lake, converting sunlight into food and releasing oxygen in the process, and providing food and shelter for other creatures. Once submerged, wood becomes a major source of food for aquatic insects, crayfish, and small fish, its surface covered with tiny plants and invertebrates. Downed trees and woody debris also act as hiding spots for small fish and their predators, and are good spawning zones for yellow perch.

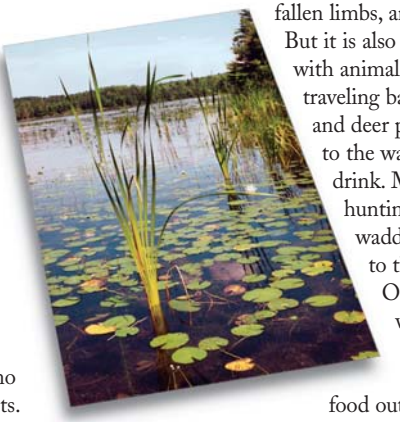
How we can help the littoral zone stay healthy: The water's edge is also a focal point for human activity. While we do not intend to, it is easy for humans to interfere with the delicate operations of the littoral zone. If you accidentally spill two-stroke fuel for example, the juvenile perch will be looking for a new home.

The simplest way to keep the littoral zone vibrant and healthy is to tinker with it as little as possible:

- Use your dock as a bridge over the weedier shallows, and moor a swimming raft out in deeper water, rather than removing fish and amphibian habitat by ripping out aquatic plants to make a swimming area.
- Leave trees where they fall, unless they are a hazard to boats or swimmers. Typically, only a few trees along a kilometre of waterfront will tumble into the water during a year. When a cottager removes all of the trees lining the waterfront, habitat formed by the fallen trunks and branches that took decades to accumulate is destroyed in a single summer.
- Before the impact of creating sandy beaches on lake habitats was well understood, many cottagers liked to "improve" their swimming areas by bringing in a few truckloads of sand and dumping them on the shoreline.



So what is the harm in that? When the sand erodes, as it almost certainly will, it smothers spawning areas for smallmouth bass and other fish, buries mayflies in their burrows, and covers the vegetation where frogs and toads lay their eggs. The impact ripples through the food chain. Without frogs and tadpoles and other aquatic species to eat decaying aquatic plants and insects, more oxygen-depleting algae fills the lake and more insects swarm the shoreline. The blue heron moves on when amphibians grow scarce. While a beach may be fun for sunbathers, it is no picnic for littoral residents.



Despite these problems, sometimes a compromise is possible. You may be able to have a sandy area if, for example, it is well above the ordinary high water mark and there is little or no disruption to natural shoreline vegetation. (On a lakeshore, the ordinary high water mark is the highest point to which water customarily rises, and where the vegetation changes from mostly aquatic species to terrestrial). (For guidance, check DFO's "Operational Statements"; see p. 14).

THE SHORELINE: GLUE FOR THE WATERFRONT

Thanks to thousands of years of practice, the existence of natural shoreline vegetation provides one of the world's most effective, least expensive erosion controls. The mix of plants, shrubs, and trees forms a complex web of roots and foliage that knits the waterfront together, holding the bank in place and fending off the impacts of wind, rain, waves, ice, and boat wake.

The barricade against erosion is the *shoreline*, the place where land and water meet. In its natural state, the shoreline is a profusion of stones, plants, shrubs, fallen limbs, and tree trunks. But it is also a busy intersection, with animals, insects, and birds traveling back and forth. Moose and deer pick their way down to the water to forage or drink. Mink skulk about on hunting trips. Water birds waddle from their nests to the water. Overhanging vegetation shades and cools the water, and acts as a fast-food outlet for fish by producing a rain of aphids, ants, and other insects that slip from their perches above.

How we can help keep the shoreline together: Things start to come apart when people remove the vegetation whose roots act as the glue that holds the shoreline together. The resulting erosion sends silt and sediment into the water where it damages spawning areas. For example, the eggs of northern pike

cling to vegetation in the shallows. Water circulating around the spawning bed carries oxygen to the eggs, but when silt covers them, the unhatched fish are suffocated.

A method often used to protect against shoreline erosion is to replace the natural shoreline with a breakwall made of wood, rock, concrete, or steel. In environmental terms, this converts a lively waterfront into a sterile environment. By imposing a sharp vertical drop-off on the shoreline, a breakwall limits the ability of plants to re-root up or down the bank as water levels rise and fall, typically reducing waterfront vegetation by one-half to three-quarters. The decline in the number and diversity of aquatic plants has a ripple effect, reducing habitat for fish, birds, and amphibians. As well, this kind of erosion control is almost always an expensive temporary fix. Because artificial materials lack the resilience of the natural shoreline, a homemade vertical breakwall often lasts only a decade or so before cracking and falling apart.

To maintain a healthy shoreline:

- DO leave the natural vegetation on the land and in the water.
- DO NOT replace the shoreline with a hardened surface like rip rap or breakwall.
- DO NOT dump fill along your waterfront. Not only does this destroy part of the littoral zone where fish live, but it may alter water currents and increase erosion on adjacent properties.

THE RIPARIAN AND UPLAND ZONES: THE LAKE'S BUFFER

Just like the mat laid at the cottage door that welcomes muddy feet and shoes, lakes have a similar "contaminant" barrier: the riparian and upland zones.

There are a lot of nasty things waiting to catch a lift down to the lake with rain runoff, including seepage from septic tanks, fertilizers and pesticides, deposits from family pets, and oil or gas spilled on the driveway. One of the main contaminants from cottage runoff is phosphorus, a "nutrient" that occurs both in nature, as well as in human-made products, such as fertilizer and detergent. On its own, phosphorus helps to nourish life in the lake, but when we add to that natural load, phosphorus over-feeds the lake, causing algal blooms that consume the water's oxygen, and that results in poor water quality.

Fortunately, the jumble of trees, shrubs, and grasses along a natural shoreline forms a "buffer" that helps filter out undesirables. In the *riparian zone* - the section of land closest to the shoreline - the thick layer of low foliage controls erosion and sifts impurities out of surface runoff. Leaves and branches break the force of falling rain, which is further slowed by the rough surface of leaf litter, pine needles,

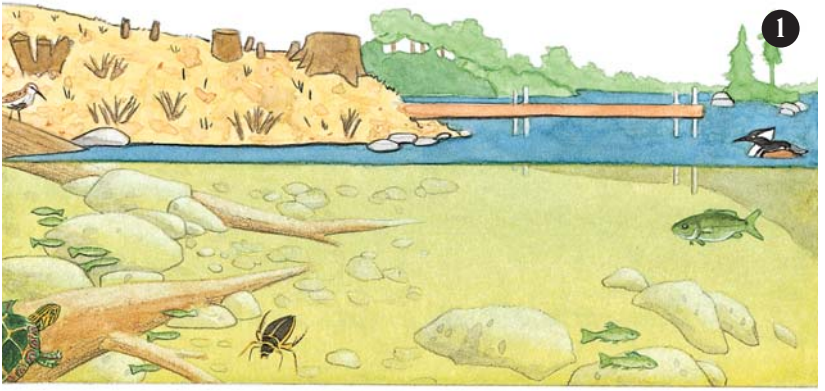
and broken twigs. The water is then absorbed by plant roots or the soil. As well as being a filter for the lake, the riparian zone is a refuge for wildlife: water birds nest in the tall grasses near the water; and red-winged blackbirds flit among the cattails. When the area is flooded during the high water period, even if there is only 18 cm of water, pike will thrash their way over the spring-flooded banks, scattering their eggs in the lake-edge nursery.

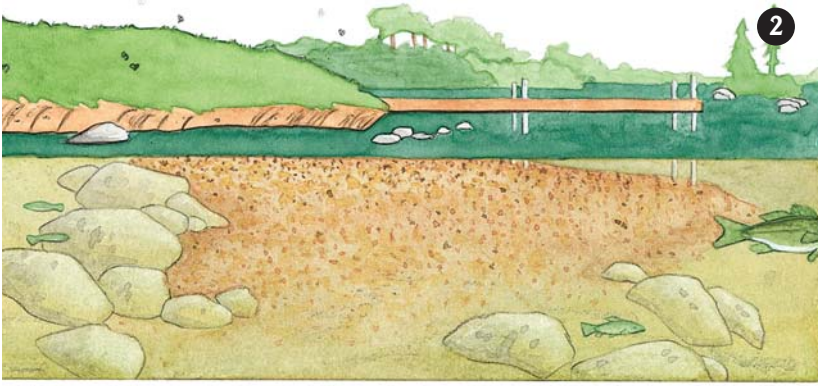
The higher, drier ground called the *upland zone* is typically forested with the kinds of trees that take advantage of better drainage, including Manitoba maple, poplar, spruce and white birch. The deep roots of the trees stabilize the slopes, while their foliage buffers the *shoreline* from winds. The forest canopy also cools the area by maintaining shade and boosting humidity in the summer. In winter, it shelters deer, chickadees, porcupines, grouse, and rabbits.

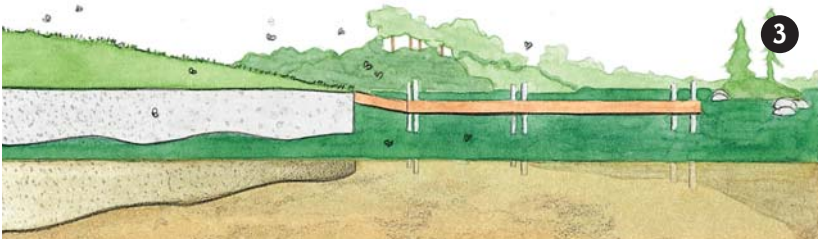
Together, these two zones form a buffer so effective that many experts estimate *only 10 percent* of the runoff actually makes it into the lake, and much of the sediment and other pollutants are filtered out before reaching the water. If the lake bottom does not drop off too quickly, then the remaining run-off will tangle with another barrier of aquatic plants in the littoral zone, where the jumble of bulrushes, arrowhead, and cattails slows the influx of runoff and consumes many of its nutrients.

How to keep the riparian and upland zones in place: Almost any kind of development can weaken the lake's buffer, and some projects can ruin it altogether. Even in the upland zone, the hard surfaces of paved driveways, shingled roofs, and patios shed water, increasing runoff and heightening the danger of erosion. Sediment carried into the water is also a concern during construction when land is being cleared for a cottage, a garage, or even just a lawn. Here are a few ways you can assist the lake's natural filtering system:

- Eliminate potential pollutants by being careful with gas and oil around the cottage, avoiding the use of fertilizers and pesticides, and maintaining your septic system with regular pump-outs. Be careful not to overload the septic system with too much water; something to consider when running the dishwasher or washing machine, or hosting a big crowd for the weekend. Working the septic system too hard shortens its life, and can send some unpleasant things seeping toward the lake.
- Maintain as much riparian and upland vegetation as possible.
- Opt for softer or more permeable surfaces (gravel or wood chips) rather than concrete and asphalt.
- Replant disturbed areas as quickly as possible, and landscape grassed swales or depressions around the cottage to catch and encourage infiltration of rainwater







(1) When vegetation at the water's edge is cut down, wildlife habitat is lost and more polluting runoff reaches the lake.
(2) Clearing woody debris and aquatic plants from the shallows means fish no longer come to spawn nor herons to feed.
(3) A concrete breakwall is a sterile barrier, extinguishing shoreline vitality.

flowing off of the roof. Be especially careful in the riparian zone, where any soil dug up is apt to be washed straight into the lake during the next rainfall. Leave the riparian plants, shrubs and trees in place.

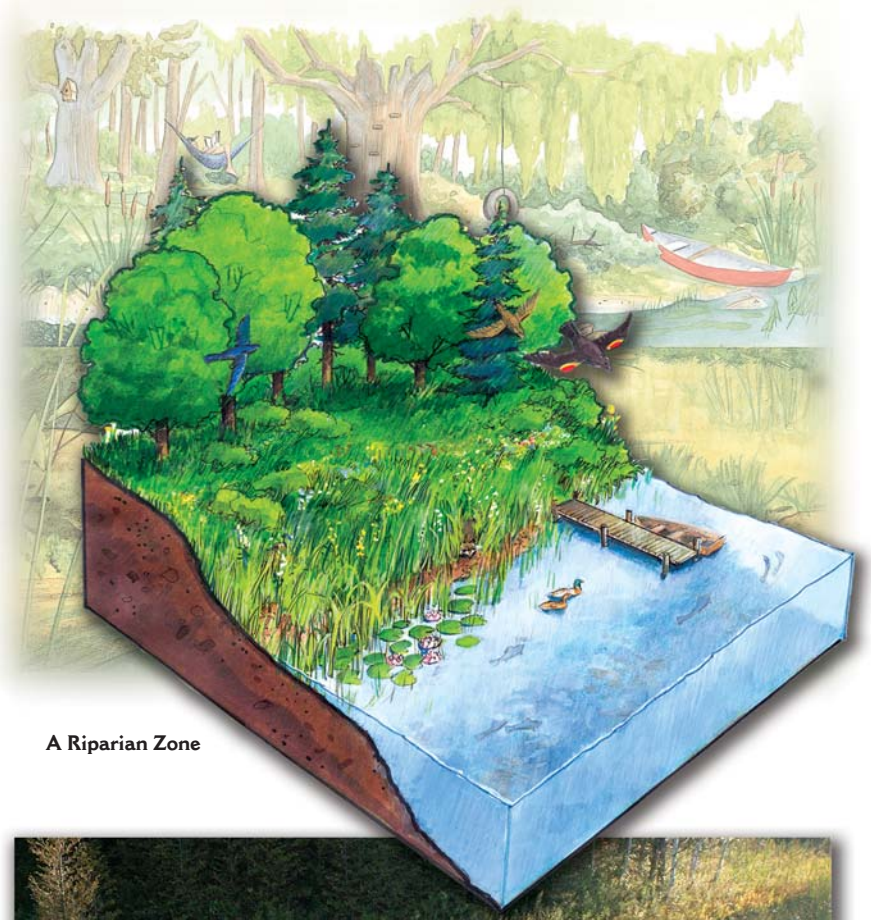
- Keep flower and vegetable gardens well away from the lake.

YOU CAN SAVE YOUR LAKE FROM PREMATURE AGING

Like any cottager, a lake ages in a natural process called *eutrophication*: the increase in nutrients due to run-off from the surrounding area and the growth and decomposition of aquatic plants over time. Eventually (thousands of years later), so much decomposing plant and animal matter builds up that the lake bottom fills in, converting it to a bog and eventually, dry land.

On the geologic time scale, this is a good and normal thing - a healthy eutrophic lake supports all sorts of warmwater fish such as largemouth bass, catfish, and pike. But when humans fast-forward the process by tearing out the shoreline buffer zone and dumping too many nutrients such as phosphorus into the lake, the water begins to change too rapidly for the life that depends upon it. The water becomes murkier as plant and algae growth explodes, the added vegetation decomposing and consuming the oxygen normally shared with other aquatic creatures. Sensitive species like trout can suffocate in the oxygen depleted environment, interrupting the food chain and causing fish with a higher tolerance of lower oxygen conditions (like carp) to flourish. The lake ages before its time.

Because eutrophication is often the result of a lot of small actions - poor septic systems, using high-phosphate soaps, removing shoreline plants - it can also be arrested by the efforts of landowners. By understanding how a natural shoreline functions and then acting collectively to preserve, not destroy, that critical balance, individuals *can* make a difference.



A Riparian Zone

MAKING AMENDS: WAYS TO RESTORE AN ALTERED SHORELINE

The trouble with the natural shoreline is that there is not as much as there used to be. The extravagant native greenery that once sprawled along the waterfront has been cut down, boxed in, built over, and otherwise shoved aside on many lakes. It has been replaced by the ordered and angular world of docks, grass, beaches, and breakwalls. However, a "developed" shoreline is not a lost cause. Restoring the beauty and integrity of your waterfront need not cost a lot of money or require a lot of labour - after all, working with nature is cheaper and easier than working against it.

Because each stretch of shoreline is distinct, there is no one generic prescription for bringing an altered waterfront back to health. But the following scenarios and suggestions will help you begin to make amends with your shoreline.

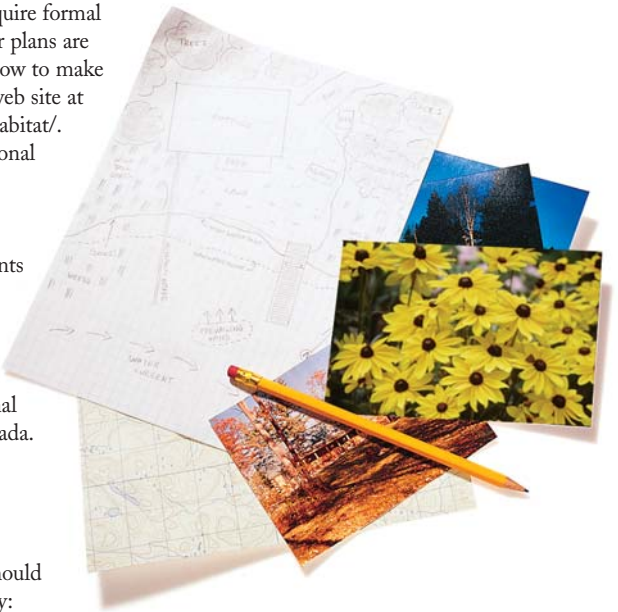
BEFORE YOU RESTORE: THE APPROVALS PROCESS

A number of federal, provincial, and municipal laws and regulations influence shoreline work across Canada. Whether you want to restore your shoreline, or build from scratch, check well in advance of your project to see what approvals you may require. Under the federal *Fisheries Act*, the onus is on property owners to ensure that shoreline work does not harmfully alter, disrupt, or destroy fish habitat without the required authorization from DFO.

The first step is to check whether your project meets the criteria of an Operational Statement - DFO's guidelines for works around water that pose a low risk to fish habitat. If your shoreline plan meets the conditions laid out in an Operational Statement and you incorporate the measures it advises to protect fish habitat,

then your project does not require formal review by DFO. To see if your plans are lake-friendly (or to find out how to make them better), visit the DFO web site at www.dfo-mpo.gc.ca/oceans-habitat/. Once there, click on "Operational Statements" (for dock and boathouse construction, beach creation, etc.).

If the Operational Statements do not relate to your project, or they do not apply in your province, call your local DFO office. If your lands are on or adjacent to a National Parks area, contact Parks Canada. On regulated waterways, you should also consult with the authority responsible for water levels.



Here is another stop you should make on the approvals journey: If your project is in an area where there are aquatic species at risk, as defined by the federal *Species at Risk Act* (SARA), get in touch with your local DFO office to make sure that what you have in mind is in compliance with SARA. A visit to www.sararegistry.gc.ca will help.

If you are in doubt about what process to follow, contact your nearest DFO office for help. DFO staff can guide you through the approvals process, provide some options, and help you select the best approach for your shoreline, possibly saving you time and money. Projects that involve hard materials such as stone, steel, or concrete are more apt to become tangled in shoreline regulations, but it is a good idea to call the government experts even if you are just mulling over a restoration.

Keep in mind that obtaining approval from one agency does not guarantee that you will get the okay from another. Make sure that you have *all* necessary approvals before starting work.

How to prepare for your project:

Make a plan for your shoreline-friendly property, including an inventory of existing plants and features, the different waterfront zones your project will involve, and a notion of your final objectives. Find some graph paper (to make it easier to draw to scale) and draw up a map of your property, including buildings and structures, the shoreline, high and low water points, water intakes, vegetation on the land and in the water, wildlife habitat (fish spawning places, areas where ducklings swim), and prevailing winds and currents. This map will come in handy if you discover that you require formal approvals or permits for your project, so make several copies.

Next, note problem areas on your shoreline: places that have been clear-cut, eroding banks, failing breakwalls, ailing docks, and so on. Include high-activity areas, such as the patch of lawn that acts as the badminton or volleyball court, and the pathways to the shoreline. Brainstorm with your family, neighbouring cottagers, and shoreline-care experts to find natural, environmentally friendly solutions.

When you have come up with the best approach, discuss your project with your provincial natural resources management agency or DFO. If you need to make a formal application, be sure to include:

- Your name, address, telephone number, fax number, and e-mail address;
- Your water body's name and location, including lot and concession number, municipality, county or district, and even the latitude and longitude coordinates if you have them (the coordinates are available off a good topographic map or a Global Positioning System receiver);
- A copy of your hand-drawn lot map, signed and dated;
- An outline of your plans, including construction details, schedule, techniques, materials and goals; and
- Photos of the work site and the surrounding shoreline. Photos throughout the seasons (summer, winter, and during spring breakup) may be helpful.

Do your planning the summer before you want to begin the work, and file your applications (where required) in the fall. That way, you will have all of the paperwork taken care of in time for the spring thaw.

What happens if you ignore all of this good advice? Not taking the proper precautions to ensure that your project meets provincial and federal requirements may result in a violation under the *Fisheries Act* and related legislation. First time offenders under the *Fisheries Act* can receive a maximum fine of $300,000, and possible jail time for subsequent conviction. As well, the courts often order restoration of the property to its original state.

RESTORATION #1: LESSENING YOUR LAWN'S IMPACT

How many lawns can you count around your lake? Probably more than you used to, as increasing numbers of people are retiring to live full time at their cottages. While turf has its place, lakes and lawns have a relationship that is uneasy at best, and poisonous at worst. Lawns displace the hard-working native plants that protect the lake, and when a heavy rain comes, they do little to protect the lake from sediment or chemical-laden run-off. According to one study, 90 percent of the rain falling on a natural shoreline is

absorbed before reaching the water, while *up to 55 percent* of the rain falling on hard surfaces, including lawns, flows right into the lake.

All that runoff hastens erosion, sending silt and sediment into the water where it damages spawning and feeding areas. Pesticides and fertilizers lavished on the lawn also play havoc with the aquatic ecosystem. Weed and bug killers may harm fish or destroy the plants and insects that fish feed on, and fertilizers promote algae growth, leading to a greener, murkier lake. A kilogram of phosphorus fertilizer washed off of the lawn and into the lake fuels the growth of 500 kg of aquatic plants, snaring boat propellers and choking shorelines.

If you must have a lawn (over the septic bed, for example), use natural methods to maintain it and avoid chemical fertilizers and weed controls. Try leaving the grass clippings where they fall to mulch and fertilize the sod, but only if the lawn is far enough away from the water that the clippings will not be washed into the lake. Let the grass grow at least seven centimetres long between trimmings to conserve soil moisture. Another option is to let the grass grow all season; knocking it down once a year with a trimmer or scythe will keep trees and shrubs out, while permitting wildflowers to put down roots.

Buffering Your Lawn from the Lake: Because lawns are the last thing a lake wants beside it, you will be doing the shoreline and yourself a big favour by getting rid of the tidy plot once and for all. But if that is too radical a notion for first-time restorationists, take the next best step: Keep them apart with a buffer zone of natural vegetation to filter contaminants in runoff, provide homes for wildlife, and enhance your cottage privacy. (For more detail on buffer function, see p. 9.)

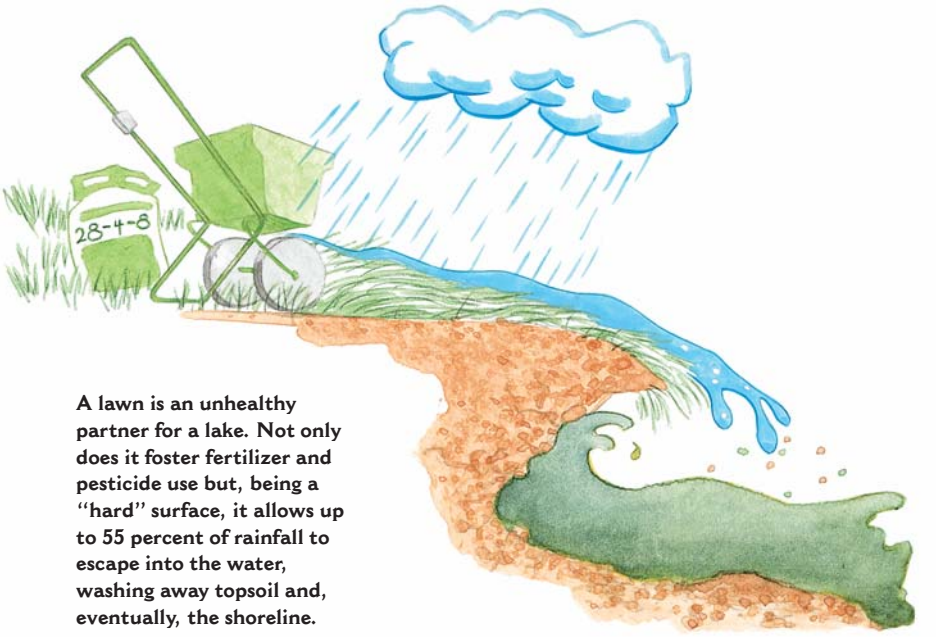
The deeper a buffer is, the better it works. As a rough rule of thumb, a buffer extending back 30 metres from the top of the bank is sufficient for most coldwater lakes (whose fish suffer more from nutrient runoff), while 15 metres will protect a warmwater lake. The natural area should be even deeper on properties with steep, erosion-prone slopes. The key thing to remember is that any amount of buffer is better than none at all. If 30 metres sounds like too much, consider going *au naturel* in stages, adding a bit more each year by working back from the shoreline in two-to-three metre strips.

Replace a hardened walkway with a more absorbent one made of wood chips, gravel, or wooden slats spaced apart so that rainfall can soak into the soil.

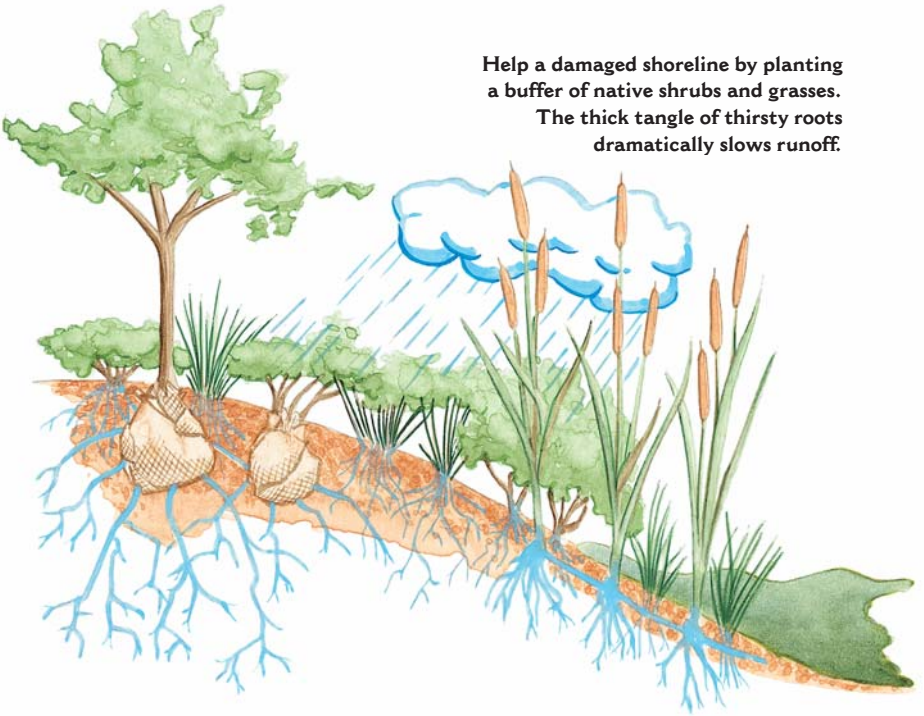
How to Build a Buffer: The easiest approach to building a buffer, especially for lots with patches of healthy native vegetation or erosion-prone soils, is to stop mowing the lawn. Native grasses, shrubs, and trees will colonize the area, with the wildflowers and grasses moving in during the first year, and shrubs and trees following a year or two later. Troublesome invaders, such as leafy spurge or stinkweed, can be selectively cut or hand pulled.

Restoring a heavily clear-cut area is a little tougher, but not beyond the skills of anyone who can handle a shovel and a watering can. Start by looking at the foliage covering natural areas of the lake and try to duplicate it on your lot. By planting a mix of native plants and shrubs - willows and dogwood - in the riparian zone, you can protect the soil, buffer the waterfront, and entice birds and other wildlife. In the upland area, you can add species that thrive on well-drained slopes, such as maple, poplar, spruce and white birch. Avoid pilfering wild plants (unless they are going to be built on or paved over) because you are simply denuding one area to clothe another. Do make sure that the species you purchase are native to your area - consult with the various shoreline experts, local gardening centres, horticultural societies, and naturalists' clubs.

A natural area often looks more appealing to the eye if you plan a transition zone between it and the more manicured areas of your property. If you like, consider softening the shift from lawn and gardens to a wilder-looking buffer with a mix of



A lawn is an unhealthy partner for a lake. Not only does it foster fertilizer and pesticide use but, being a "hard" surface, it allows up to 55 percent of rainfall to escape into the water, washing away topsoil and, eventually, the shoreline.



Help a damaged shoreline by planting a buffer of native shrubs and grasses. The thick tangle of thirsty roots dramatically slows runoff.

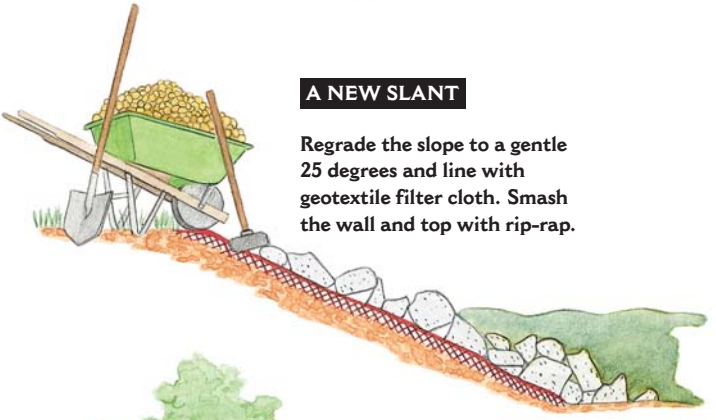
showy native plants, such as black-eyed Susan and bee balm. Adopt flowing, curving borders rather than straight lines to promote this natural aesthetic. Preserve a view of the water through judicious pruning, grouping taller trees to allow sightlines, or building an elevated viewing deck behind the cottage.

Use a meandering trail - angled along the slope, not running straight down to the shoreline - to lead visitors from the cottage to the dock. The path will look more natural and will allow rainwater to infiltrate the soil if it is covered with pea gravel or bark chips.

Another option is a wood walkway, with slats wide enough to let rain and sunlight through. Creative types might also consider adding an elevated walkway or bridge over sensitive areas, built on posts rising 15 - 30 cm above the ground. The bridge protects vegetation and provides cover for ground-hugging woodland creatures such as frogs, toads, snakes, and salamanders. On slopes, it is best to opt for raised wooden stairs built on posts. Cutting into the slope to install steps only encourages erosion. Concrete steps and sidewalks will circumvent your buffer by channelling runoff towards the lake.

A HARD EDGE

Over time, wave action turns a breakwall into a crumbling eyesore.



A NEW SLANT

Regrade the slope to a gentle 25 degrees and line with geotextile filter cloth. Smash the wall and top with rip-rap.

A SOFT TOUCH

With nature's waterfront re-created, evicted shoreline residents happily return.

RESTORATION #2: SWITCHING TO A SHORELINE-FRIENDLY DOCK

Docks are so much a part of lakeside living, you probably see them as extensions of the shoreline. The truth is, ill-designed shoreline structures fragment the habitat that is so critical to lakeside creatures. When the time comes to replace the rickety, old dock you have inherited, select one that suits your purposes but that also does the least harm to the lake. Cottagers can find all that they need to know about shoreline-friendly structures in *The Dock Primer* (to get a copy, see p. 24) but here are a few key factors to keep in mind:

• **Type of dock:** A floating dock is among the top fish-friendly choices because it causes the least disturbance to the lake bottom, provides fish cover, rides out fluctuating lake levels, and does not alter water currents. But it is not perfect. Floating docks shade some of the littoral zone, reducing the aquatic life that many fish, insects, and animals depend on. They also pose problems for ducklings. The waterfowl cling to the shoreline as they learn to paddle, and may shun an area where they have to circumnavigate a lot of docks jammed up against the land. You can easily fix this problem by pushing the dock a bit further out and using a gangplank to bridge the short stretch of water between it and the shoreline. This gives mama duck and her brood a marine underpass, while allowing you to access your dock.

Pipe or pile docks may be an equally good option for lakes with more stable water levels. Resting mostly out of water on pipes or posts, both types of dock have a small footprint on the littoral zone. They also provide some structural habitat, and allow more sunlight to penetrate through to the lake bottom. Cantilever, suspension, and lift docks are anchored by their base to the shoreline and overhang the water. They are gentle on the environment, but they are expensive and fairly complex to build. Less preferred are crib docks, usually built on a base of square-cut timbers filled with stones, covering parts of the littoral zone. Last and definitely least, a concrete pier is a disaster in environmental terms, crushing the life in the littoral zone.

• **Building materials:** The safest option for waterfront construction is untreated wood, such as cedar, fir, hemlock, and tamarack. Plastic wood, if installed properly, offers long life, but may sag between spans or split during installation if you are not careful.

Treated wood is definitely a second choice. Wood preservatives kill the organisms that cause rot, but what destroys fungi can also harm other organisms (including you if you breathe in too much sawdust or get too much preservative on your skin). If you must go this route, buy lumber that is pressure treated at the factory rather than doing it yourself with a paintbrush. Approved wood preservatives most commonly used are alkaline copper quaternary (ACQ) and copper azole (CA). Creosote-treated wood should not be used in or near water. Before you buy, ask your local building supply outlet for more information about environmentally friendly wood products.

• **Choose your site carefully:** You can reduce the impact of waterfront development by selecting dock or boathouse sites with little or no vegetation, and developing 25 percent or less of your total frontage. If, for example, you own 30 metres of lakefront, pick the three to eight metres where development will do the least harm, and set that section aside

for a dock or swimming area. Keep the fish, ducks, and other wildlife happy by leaving the rest in its natural state. DFO's Operational Statements provide good advice about protecting fish and fish habitat when building a dock or undertaking other shoreline projects; (see p. 14).

RESTORATION #3: SOFTENING A HARDENED SHORELINE

Take a look along your waterfront - wherever you see a breakwall, that stretch of shoreline looks almost lifeless. "Hardened" shorelines are like hardened arteries: Left without treatment, they can have serious health consequences.

When a shoreline is bounded by concrete, steel, or stone, the flow of life along the waterfront is constricted. In serious cases, the biological components of the waterfront are removed altogether, as plant habitat is destroyed and fish, birds, and amphibians move on.

Worse still, hardened shorelines are only a temporary fix for an erosion problem usually caused by removing shoreline vegetation. When wave action slams against a vertical wall, the energy is deflected upwards where the wave breaks against the top of the wall, and downwards, where currents scour out the earth at its base. As the ground beneath it washes away, the wall begins to list and break up. Eventually, it topples over.

If you own a breakwall, there are a few things you can do to reduce the pounding it takes and improve habitat along the shoreline. First, plant a buffer zone (see p. 17), including a lot of deep-rooted native shrubs, to hold the soil together and prevent gullies from opening up behind the wall. The next step, which requires the approval of government authorities, is to improve the habitat in the littoral zone. Stones piled at a 45-degree angle in front of the wall will add more places for fish to hide and feed, and may trap enough sediment to encourage the growth of aquatic plants. As a bonus, the stones will also absorb much of the force of the waves, extending the life of the wall. "Shore ladders," made by piling up enough stones to reach from the lake bed to the top of the wall, allow frogs, snakes, and mink to travel back and forth from land to water.

If the breakwall is already falling apart, view it as an opportunity to replace the crumbling eyesore with a new, more natural shoreline. After receiving the appropriate approvals and advice, dig out the bank behind the failing wall to restore a slope of 25 degrees or less, and line it with geotextile filter cloth to keep the soil in place.

Ideally, you should remove the breakwall, but if that is not practical, you can pull it back onto the new slope and break the

concrete into cobble-sized pieces of rubble. Be sure to add a veneer of appropriately sized stones commonly known as "rip-rap" (usually 15-20 cm in diameter) to cover the filter cloth. Just behind the riprap, plant woody vegetation and shrubs, such as willow, dogwood, and poplar. Eventually, the plants will grow into the spaces between the stones. You will have a shoreline-friendly waterfront that controls erosion and provides wildlife habitat.

Most shorelines can be held together by their natural vegetation. In erosion-prone areas, the existing plants can be augmented by shrub willows. The experts with the various provincial and federal agencies can also explain how to "bio-engineer" a shoreline to resist erosion with a tough and resilient combination of stones, wood, willow, and poplar cuttings.

Finally, if you have a serious erosion problem, you will need good advice on protecting your shoreline. Consider consulting with an engineer or erosion control specialist. Well-engineered erosion controls that balance shoreline protection and habitat maintenance will cost more than a do-it-yourself job, but the investment pays off in longevity, peace of mind, and preservation of the waterfront environment.

THE NEW-LOOK WATERFRONT

Depending how developed your lake is, with lawns, breakwalls, and the like, a cottager opting for the "natural" look may be viewed by the neighbours with varying degrees of interest, curiosity, and bemusement. As you begin your restoration project, get other lake residents onside by explaining why you are forsaking the lawn in favour of poplar, spruce, and yarrow, and perhaps offering them a copy of this booklet. Explain that you are concerned about the health of the waterfront and that you want to preserve the lake and its inhabitants for your kids - or their kids - to enjoy. On a wider scale, try contacting like-minded lake lovers through the local lake association. Forming an unofficial shoreline support group is a good way to share shoreline restoration information.

Then, having ensured your reputation as a thoughtful, concerned lakeside resident - maybe even a visionary! - you can spend more time relaxing and enjoying your waterfront.

FURTHER READING

The Dock Primer
Co-published by Fisheries and Oceans Canada and Cottage Life
The Dock Primer is an invaluable guide to waterfront-friendly docks, covering all the essentials from best building designs to the approvals process.

The Fish Habitat Primer
Fisheries and Oceans Canada
The Fish Habitat Primer is an essential guide to recognizing and respecting the environment on which fish depend to keep their - and our - waterways vibrant with life.

Working Around Water? – a series of fact sheets.

Operational Statements - a series of documents developed to streamline DFO's regulatory review of low risk activities.

These publications, and more, are available electronically on the Fisheries and Oceans Canada (DFO) web site at www.dfo-mpo.gc.ca/oceans-habitat/. For a copy of any of these DFO publications, please contact your local DFO office (see "Contacts", p. 27).

Aussi disposible en français.

ACKNOWLEDGEMENTS

Fisheries and Oceans Canada wishes to thank the following individuals and organizations for their assistance in the research of *The Shore Primer*: Ray Ford (Author); Canadian Museum of Nature; Federation of Ontario Naturalists; Linda Hellas, Bird and Hale Ltd.; Neil Hutchinson, Gartner Lee Ltd.; Paul Keddy, Southeastern Louisiana University; Lake Simcoe Fisheries Assessment Unit; Lake Simcoe Region Conservation Authority; Ontario Ministry of the Environment; Ontario Ministry of Natural Resources; Rideau Valley Conservation Authority; The Living by Water Project; Upper Rideau Lake Association; and Watershed Science Centre, Trent University. Illustrations by David Wysotski. Photography by Kevin Hewitt.

NOTES:

CONTACTS

Fisheries and Oceans Canada - Prairies Area Offices

Alberta District

Calgary
7646-8 Street NE
Calgary, AB T2E 8X4
Tel: 403-292-5160
Fax: 403-292-5173

Edmonton
4253-97 Street
Edmonton, AB T6E 5Y7
Tel: 780-495-4220
Fax: 780-495-8606

Lethbridge
J.D. Higenbotham Building
204, 704-4 Avenue South
Lethbridge, AB T1J 0N8
Tel: 403-394-2920
Fax: 403-394-2917

Peace River
9001-94 Street
Peace River, AB T8S 1G9
Tel: 780-618-3220
Fax: 780-618-3235

Saskatchewan District

Regina
1804 Victoria Avenue East
Regina, SK S4N 7K3
Tel: 306-780-8725
Fax: 306-780-8722

Prince Albert
125-32 Street West
Prince Albert, SK S6V 8E2
Tel: 306-953-8777
Fax: 306-953-8792

Manitoba District

Winnipeg
501 University Crescent
Winnipeg, MB R3T 2N6
Tel: 204-983-5163
Fax: 204-984-2402

Dauphin
101-1 Avenue NW
Dauphin, MB R7N 1G8
Tel: 204-622-4060
Fax: 204-622-4066

See inside back cover for complete listing of DFO Offices.

Fisheries and Oceans Canada
Pêches et Océans Canada

Canada

March 2008