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THE CLEAN ANNAPOLIS RIVER GUARDIAN PROGRAM: EVOLUTION OF A VOLUNTEER BASED WATER QUALITY MONITORING PROGRAM

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ABSTRACT

The Clean Annapolis River Project initiated a volunteer based water quality monitoring program in 1992 which continues to this day. Volunteers have made more than 2500 site visits to the Annapolis River resulting in development of one of the most comprehensive volunteer generated water quality databases presently in existence. During the early stages of the program, more than ten water quality parameters were measured. As the database developed, it became obvious that many of the water quality parameters being measured varied little, either spatially or temporally, and that the major water quality problem in the River is consistently high coliform bacteria levels. This lead to modification of the original program and development of a Sub-Watershed Investigative Monitoring (SWIM) program designed to identify specific sources of coliform bacteria inputs.

RÉSUMÉ

Le Projet de nettoyage de la rivière Annapolis, l'un des divers sites du Programme d'action des zones côtières de l'Atlantique, a entrepris un programme de contrôle de la qualité de l'eau de nature bénévole en 1992, lequel programme existe toujours. Des bénévoles ont fait plus de 2 500 visites sur le terrain à la rivière Annapolis, qui se sont traduites par la mise au point de l'une des plus complètes bases de données jamais créées par des bénévoles en matière de qualité de l'eau et qui existe actuellement. Au cours des premiers stades du programme, plus de 10 paramètres touchant la qualité de l'eau ont été mesurés. Au fur et à mesure que la base de données grandissait, il devenait de plus en plus évident que de nombreux paramètres variaient très peu, soit sur le plan temporel, soit sur le plan spatial, et que le principal problème de pollution dans la rivière Annapolis est attribuable de façon constante à des taux élevés de coliformes. Cela a entraîné une réduction du nombre de paramètres mesurés à l'origine et a donné lieu à l'élaboration du programme Sub-Watershed Investigative Monitoring (SWIM), pour le contrôle du sous-bassin hydrographique, qui consiste également en un programme bénévole. L'objectif du programme SWIM est de déterminer les sources des taux élevés de coliformes, information nécessaire à l'élaboration et à l'adoption de mesures correctives, au moyen d'études sur le terrain en profondeur portant sur les taux de coliformes dans les sous-bassins hydrographiques du bassin Annapolis.

INTRODUCTION

The Clean Annapolis River Project (CARP) is one of eleven Atlantic Coastal Action Program (ACAP) sites. CARP initially began in 1990 as part of the Atlantic Estuaries Co-operative Venture, partly in response to the rejection of the local board of trade's application to have the River classified as a Heritage River, a result of the impression that is was seriously degraded. In 1992, shortly after CARP's invitation to become an ACAP site, a volunteer based River Guardians (RG) project was established, the first of its

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kind in Atlantic Canada (and perhaps in Canada), which continues to this day. The objectives of the RG project are to:

- establish a program of regular observations of the watershed that will provide an early warning system for the occurrence of environmental problems,
- produce a long term record of the health of the River,
- develop interest in and commitment to the Annapolis River and estuary, so that desirable qualities of the system may be perpetuated for future generations and,
- provide a knowledgeable group of local individuals in the communities surrounding the River who could promote the objectives of CARP.

The information gained through the RG program has become a valuable resource for numerous agencies and private resource industries. It is also extensively used to provide supplementary data for other CARP projects, particularly those related to fish enhancement and water conservation initiatives.

OVERVIEW OF THE RIVER GUARDIAN PROGRAM

Partnerships

Implementation of the RG program is accomplished through the coordinated efforts of a project manager, a volunteer project management team, and the volunteer River Guardians. The RG project is managed by a program coordinator and a volunteer project team. The coordinator and project team meet periodically to review the program, make decisions as to how the program should proceed, and assess the need for change as the database develops and more information becomes available on water quality and pollution problems in the River.

The heart of the RG program is the local volunteers and the main activities of the RG project include: soliciting local community members to become volunteers; holding workshops in which the volunteers are trained in the techniques used to sample and measure water quality; establishing sample schedules and locations; tabulating the data collected into a database, analysis and interpretation of the data; production of a River Guardian's newsletter and; periodic public meetings in which the Guardians are presented with the results of their efforts. To date, more than 100 volunteers have taken part in the RG program.

The funding required to support the RG program has come from a multitude of sources including federal and provincial agencies, private industries and businesses, and community service groups. In some years outside funding has not been adequate to support the project making it necessary to subsidise the program from CARP's special projects fund. The commitment on the part of CARP to provide

supplemental financial support when required is a result of the high esteem this program has among CARP's staff and Directors.

In addition to direct financial support, a great deal of in-kind support is provided by various agencies. The cost associated with processing coliform bacteria samples, for example, is borne largely by the Nova Scotia Department of Environment. Staff and students of the College of Geographical Sciences in Lawrenceton, N.S. and the Acadia Centre for Estuarine Research of Acadia University often assist in data interpretation and presentation. A number of government agencies, particularly the Department of Fisheries and Oceans, Environment Canada and the Nova Scotia Department of Environment, have had representatives as members of the project team. In a number of instances, local schools have carried out monitoring projects using the same procedures as the volunteer River Guardians.

Table 1. Water quality parameters measured as part of the River Guardians program

Parameter	Measurement Technique
Weather Conditions*	Observation
Air Temperature*	Thermometer
Water Temperature*	Thermometer
Suspended Particulate Matter*	Filtration and Gravimetric Analysis
Transparency	Secchi Disk
Apparent Colour	Visual Before Filtration
True Colour	Visual After Filtration
pH	Meter
Conductivity	Meter
Dissolved Oxygen*	Winkler Titration
Percent Dissolved Oxygen Saturation*	Calculation
Chlorophyll *a*	Filtration and Spectrophotometric
Coliform Bacteria*	Filtration and Plating

Parameters Monitored

When the RG program was initiated very little information was available on water quality in the Annapolis River. The Nova Scotia Department of Health had collected most of what was available, and this was largely limited to periodic measurements of coliform levels. As a result, the number of water quality parameters initially selected for monitoring was large and included numerous physical, chemical

and biological parameters (Table 1). As the program progressed and more information became available on the status of the River, it became obvious that some of these variables varied little, either spatially or temporally, or proved difficult to measure adequately. Chlorophyll *a* concentrations and conductivity, for example, showed little variation between sites or years. Water transparency, as measured by Secchi Disk depth, proved to be too difficult to measure when the river was high and currents swift, and at many sites the bottom was always visible. Water colour was another parameter that proved to be difficult to evaluate objectively with the resources available. As a result, the number of parameters being measured was gradually reduced and at present only those marked by asterisks in Table 1are routinely measured.

Volunteer Training

Each volunteer is provided with a detailed manual explaining the objectives of the water quality monitoring program and the proper procedures for collecting, processing and storing samples. The manual also provides information on how to interpret results. Each volunteer is equipped with a field and laboratory kit containing all equipment necessary to carry out the sample collection and analyses. Among other items, this kit includes a locally made Van Dorn type water sampler, all the laboratory equipment for performing dissolved oxygen measurements using the Winker titration technique, and filtration equipment for processing water samples for chlorophyll *a* and suspended particulate matter (SPM) concentrations. In most cases the equipment provided allows the volunteers to carry out complete analyses on their own. In other cases, such as chlorophyll *a* measurements and weighing of filters for SPM determinations, further analysis is carried out by the project coordinator at the CARP office laboratory.

Volunteers receive hands on training in each procedure at a yearly workshop, or individually by the project coordinator. Many of the River Guardians attend the training workshop every year to keep abreast of new procedures or modifications to existing procedures. During the training, special emphasis is placed on the importance of collecting accurate and reliable data.

Sites Monitored and Frequency of Monitoring

In the early fall of 1992, when the RG project was first initiated, 17 sites were monitored by 26 volunteers. As a result of the great community interest in the program, this quickly increased to 24 sites and 50 volunteers in 1993, and 37 sites and 58 volunteers in 1994. Most of the sampling is done at sites located on the main stem of the River, but there have also been a number of sample sites located along the various tributaries entering the River. During this period sampling was carried once per week, except for coliform samples which were collected biweekly. The rapid increase in the scale of the program during its early years was not without its problems. Despite the increased level of monitoring, the level of funding did not increase proportionally and the program had to be altered to suit the resources

available. Subsequently, in 1995 the frequency of monitoring was decreased from weekly to biweekly and fewer sites were monitored.

Data Management, Analyses and Interpretation

A major task of the project coordinator is to maintain a reliable and accurate database of the monitoring results. Initially, this was a relatively easy task requiring only a simple spreadsheet. However, as the program progressed and the diversity of sites monitored increased, the database became very large and now considerable effort and computer power are required for its maintenance. The RG database, which now contains in excess of 2400 records each of which contains at least ten data entries, is currently managed using a relational database and the accuracy of the data is periodically verified to ensure its reliability.

The effort required to analyse, interpret and present the data has also increased along with the size of the database. While simple graphical analyses were sufficient during the first few years of the program, this became inadequate once several years of data had been collected. The type of information most useful in any monitoring program is how a particular parameter varies spatially, seasonally and annually. The most obvious way to present this information graphically is by three-dimensional plots of the parameter value, location along the River, and time. However, plots of this type become difficult to understand when the number of sites and years is large. Data presentation has been one of the major problems for this program. It has proven very difficult to devise a data presentation format that is both simple to generate and easily interpretable by the volunteers. This is a serious shortcoming since volunteers must continuously be presented with the results of their efforts in order to maintain their interest in the program.

It is beyond the scope of this paper to present the results of the RG program with respect to the details of water quality and how it varies spatially and temporally within the River. However, a few generalisations are presented to illustrate what has been learned. When the RG program first began it was assumed, based on the limited data available at the time, that the River had serious water quality problems. After nearly a decade of monitoring, it has become obvious that the only serious common water quality problem is that associated with high coliform levels. With the exception of a few instances of low dissolved oxygen levels (<50 % saturation) recorded during the early years of the program at the very head of the River, dissolved oxygen concentrations have always been well within acceptable levels. There is also little evidence that excessive nutrient inputs are a problem since chlorophyll *a* levels have always been quite low. Acidification is also not a problem as much of the River drains areas having geological formations that impart significant amounts of buffering capacity. Erosion and sedimentation, as indicated by SPM concentrations, have not been shown to be serious problems in the main stem of the

River. However, this type of monitoring program is not really designed or suited to adequately monitor sedimentation events. These tend to be episodic, being associated with major precipitation or run off events and, since monitoring is carried out at predetermined times, the probability of the two coinciding is low.

Providing Feedback to River Guardians

Volunteer based programs only work if the volunteers participating feel that their efforts will make a difference. This means that RG volunteers have to be informed as to the fate of the data they are generating and, in particular, assured that it is being delivered to both the public and those responsible for enforcement of water quality regulations. Failure to do this is often the main reason for failure of a volunteer based program as it results in a high turnover of volunteers, lack of consistency in the monitoring program and a reduction in the quality of the database generated.

CARP has used various means to present the results of the RG program. Group River Guardian meetings are held periodically to discuss the results and to solicit ideas on how the program can be improved. A newsletter, prepared specifically for the Guardians, is distributed bimonthly and contains summaries of selected portions of the monitoring data as well as general articles on water quality and related issues. Local newspapers carry articles on water quality and the activities of volunteers, and periodically publish simple diagrams illustrating recent measurements of coliform levels at various sites along the River. Volunteers, together with CARP staff, have also made presentations to local government officials on the status of the River. River Guardians are also presented with wall plaques in recognition of their individual contribution to the program.

In a number of instances data collected as part of the coliform monitoring program have identified specific problem areas along the River which were subsequently traced to such things as leaky sewage pumping stations. When the data was brought to the attention of the proper authorities, the problem was quickly corrected. This kind of result is perhaps the most rewarding to volunteers.

THE SUB-WATERSHED INVESTIGATIVE MONITORING PROGRAM

As indicated earlier, the major pollution problem in the Annapolis River is the consistently high coliform bacteria levels. Analysis of the coliform data has revealed that, in all but a few instances, inputs of coliform bacteria appear to be associated with tributary rather than point source inputs associated with, for example, sewage treatment plant inputs along the main stem of the River. This made it difficult, based on the data available, to develop remediation programs designed to decrease coliform inputs. What was required was a more investigative, as opposed to simple monitoring, approach to better identify the input sources. In 1997 the River Guardian program was modified to include the Sub-Watershed

Investigative Monitoring (SWIM) program. This program, also volunteer based, involves carrying out intensive coliform measurements along selected tributaries of the River. Volunteers, together with the program coordinator, develop a strategy to monitor coliform bacteria at various points along a tributary in a manner that allows more precise identification of the location of coliform inputs. The original RG program, which involves routine biweekly monitoring, is still in existence but has been reduced to ten main River sites. The data collected at the main sites is considered essential to maintaining a baseline database of water quality in the River.

Initiation of the SWIM program required that CARP have the ability to carry out its own coliform analyses and this capacity has been developed. Samples collected by the SWIM volunteers are analysed within the required 24 hours and the results discussed to determine if more sampling is required. Since its inception more than ten sub-watersheds of the River have been investigated. The data collected are still being analysed, together with land-use information, to determine if the exact coliform source can be identified. Preliminary results suggest a diversity of coliform sources including run-off from farm manures, leaky septic systems and beaver colonies.

SUMMARY

The CARP River Guardians program is approaching its ninth year of operation and has accumulated a great deal of information on water quality in the Annapolis River. The database developed has become a valuable resource for various government and non-government agencies as well as private industry. The program has been paramount in raising public awareness of water quality problems in the River. In many instances the efforts of the volunteers have lead to remediation actions and improvement of water quality in the River. Perhaps the greatest outcome of the program has been the education of the volunteers and general public with respect to factors that lead to poor water quality, the complexity of the problem, and the potential solutions, as well as barriers, to implementing activities to improve the River's water quality. The SWIM program is an example of how further monitoring having a more investigative nature can lead to better understanding and assessment of the local factors responsible for contributing to poor water quality.