The development of ecosystem objectives for the Laurentian Great Lakes

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Abstract. Historically management of human use of ecosystems has been based around engineering and chemical approaches and through the construction of treatment facilities, effluent controls and setting chemical concentrations, both at end of pipe and in the aquatic environment. However, the general continued degradation of many ecosystems shows these approaches alone are insufficient. In the Laurentian Great Lakes the Great Lakes Water Quality Agreement was first signed in 1972 and ratified in 1978 and in 1987 tacitly acknowledged the problems with a chemical only approach by requiring the development of ecosystem objectives in the 1978 agreement. Furthermore, the agreement specifically identified numerical ecosystem objectives in the 1987 agreement. The evolution of ecosystem objectives in the Great Lakes has expanded from the strictly numerical objectives such as production of lake trout and abundance of the amphipod Pontoporeia hoyi. More recent developments in ecosystem objectives have been the inclusion of indicators for wildlife, habitat, human health and stewardship.

1. Introduction

In 1972 the Prime Minister of Canada and the President of the United States of America signed the first Great Lakes Water Quality Agreement. The impetus for the signing of this agreement was the perceived degradation of Lake Erie, a result of eutrophication from excess nutrients in land runoff and municipal effluents (Burns, 1985). The results of this eutrophication were an excessive growth of phytoplankton and attached algae and, as the plant growth died, anoxia and consequent fish kills. The 1972 agreement primarily addressed nutrient control and set in motion massive studies to investigate the processes affecting water quality in the Great Lakes. A consequence of these studies was the signing of the much more comprehensive 1978 Great Lakes Water Quality Agreement.

In the 1978 Agreement, Canada and the United States committed themselves ‘to restore and maintain the chemical, physical and biological integrity of the waters of the Great Lakes ecosystem’. The agreement undertook to adopt an ‘ecosystem approach’ to the problems facing the waters of the Great Lakes and acknowledged linkages between air, land, and water. The mechanism for evaluating progress and reporting on needs and actions relevant to the provisions of the agreement has been the International Joint Commission (IJC) with its two main advisory boards. One of these boards, the Research Advisory Board (now the Science Advisory Board) produced a special report to the Commission (Great Lakes Research Advisory Board, 1978) that described the concepts and premises of the ‘ecosystem approach’ which was based on a man in environment concept as opposed to a system external to man concept.

Among the provisions of the 1972 agreement was a requirement for the development of specific objectives for various properties of Great Lakes water quality. These were defined as ‘concentrations or quantities of substances that are recognized as maximum or minimum desired limits for defined bodies of water or portions thereof’. In other words the traditional chemical and physical concentration based approach to water quality objectives with all the associated
weakness of, being laboratory based, using limited species, compounds tested singly, having insufficient data, and using direct effects.

With the adoption of the ecosystem approach in the 1978 agreement, the weakness of the specific objective approach was recognized and great emphasis was placed on assuring the biological integrity of the Great Lakes basin ecosystem.

2. Ecosystem objectives

A major component of the 'ecosystem approach' in the revised 1978 agreement was the requirement to develop ecosystem objectives and through the auspices of the IJC it was concluded that such objectives should specify the level or condition of certain biological properties that could serve as indicators of the overall condition or health of the ecosystem. It was also concluded that the development of such indicators would require a detailed specification of the desired state of the ecosystem. Through discussion under the auspices of the IJC it was determined that the requirement of the 1978 agreement to 'restore and enhance the water quality of the Great Lakes' could best be met by setting a general objective directed toward the restoration and maintenance of a Great Lakes biological community as similar as was practical to that which was present before the influence of human intervention (Ryder & Edwards, 1985), and language to this effect was proposed for the agreement but was not adopted in the 1987 revision. However, the concept of ecosystem objectives was reaffirmed and a commitment to their development made.

The IJC co-ordinated the first efforts to develop ecosystem objectives. It was quickly recognized that objectives could not be applied to the entire Great Lakes system. Physical and chemical properties in various parts of the Great Lakes are quite different from historical values. The communities of organisms are not the same throughout all areas of the lakes and communities now are different to historical ones. Therefore, no one indicator or objective can be expected to be sufficient. When initial steps were taken to develop ecosystem objectives and indicators it was recognized that offshore waters, particularly of the upper lakes, have a similar community and that this community was probably present in much of the lower lakes prior to European colonization. The major exceptions to this being the separate offshore communities which have probably always existed in western and central Lake Erie and the large embayments such as Green Bay, Saginaw Bay, and the Bay of Quinte. Accordingly, initial efforts to develop an objective and indicator for ecosystems focussed on the open waters of the upper Great Lakes. This community is characterized as cold and nutrient poor and was defined as the oligotrophic community of the Great Lakes. Subsequent efforts (Ryder & Edwards, 1990) were directed at the mesotrophic portions of the Great Lakes and most recently ecosystem objectives are being specifically derived for Lake Ontario. The first two efforts, oligotrophic and mesotrophic were specifically concerned with the offshore portions of the lakes. The effort on Lake Ontario is to address both the offshore and the more complex nearshore, as well as the land-water interface, and human and societal health.

This has clearly been an evolutionary process and there is great need to be specific about language and differentiate between goals, objectives and indicators. Each is a very different process requiring quite different approaches. The goals are broadest and least defined by natural processes and are largely a result of political discussion. They have, by and large, been set by the Lakes Water Quality Agreement itself and have been agreed to by the Governments’ of Canada and the United States and are stated as ‘... to restore and maintain the chemical, physical and biological integrity of the waters of the Great Lakes Basin Ecosystem.’ The development process for Lake Ontario incorporated a public component and more specifically stated the goals as:

1. The Lake Ontario ecosystem should be maintained and as necessary restored or enhanced to support self-reproducing diverse biological communities.
2. The presence of contaminants shall not limit the use of fish, wildlife and waters of the Lake Ontario basin by humans and shall not cause adverse health effects in plants and animals.
3. We as a society shall recognize our capacity to cause great changes in the ecosystem and