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River basin ecosystem restoration: A comparison of conservation authority efforts (Ontario)

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River Basin Ecosystem Restoration:
A Comparison of Conservation Authority Efforts

By

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Abstract

This thesis reviews a series of river basin ecosystem restoration/enhancement projects carried out under the direction of three individual southern Ontario conservation authorities in their respective river basins. The three authorities are the Grand River Conservation Authority, the Maitland Valley Conservation Authority, and the Upper Thames River Conservation Authority.

A review from the published literature dealing with river basins, ecosystems, and environmental management supports the analysis of restoration projects. The criterion by which the literature articles were selected was that they have relevance to the type of environmental issues that are common to the river basins in the study areas.

Comparisons made between the three conservation authorities' restoration efforts are based on the investigation and assessment of a sample of four published restoration projects on file at each of the authorities' head offices. A five component conceptual framework was used to analyze each of the twelve projects. The accumulated assessment data formed the basis for comparison.

There are some observations and conclusions to be drawn from this thesis. The evolution of the conservation authorities' approach to ecosystem restoration has occurred in response to the development of new knowledge, changes in public attitudes, changes in government policies, and changes in available operating resources. Although all conservation authorities operate within a similar mandate, they exercise enough individual autonomy to address their individual basin's specific issues. The conservation authorities have demonstrated their resilience in response to current deep governmental financial constraints by recruiting volunteers, e.g. for the development of their sub-

watershed and watershed plans. Nearly all of their sub-watershed plans are administered through public stewardship organizations. They have successfully solicited funds from organizations that allot financial grants for environmental causes, e.g. for the Grand River forestry plan.

Ecosystem restoration is one of several conservation authority responsibilities. It represents a major advance in their operational evolution from their core mandate of soil and water conservation, stream flow control, and water quality, through applying the ecosystem approach at the sub-watershed level, and toward basin-wide management plans, e.g. GRCA's Grand River forestry plan, and MVCA's Maitland Watershed Partnerships project.

No doubt, the river basin has been shown to be the logical geographical area in southern Ontario on which to base conservation management strategies. Individual conservation authorities have accumulated over fifty years experience in successful management of environmental issues at the river basin level, through which they have gained a body of knowledge about their individual river basin that must surpass that held by any other organization. Such experience should qualify them for taking on an expanded role in crucial ecosystem restoration issues like those associated with groundwater, wetlands, waste management, public stewardship, and the development of ecosystem management strategies.

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To Wilfrid Laurier University, thanks for making lifelong learning something above the ordinary.

Dedicated

To the Memory of Elizabeth

Her spontaneous expressions of awe about the wonders of nature attuned the senses of those around her to nature's wonders.

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Chapter 1: Introduction and Methodology

Introduction

This thesis examines and discusses ecosystem restoration in three river basins. The geographical area includes the Grand River, Maitland River, and UpperThames River basins, located in Southwestern Ontario. (Fig: 1). This thesis exercise focuses on the ecosystem restoration efforts of the conservation authorities in the three river basins. The river basins are referred to here as the study areas. It is acknowledged that in a culturally developed geographical region, like the study areas, numerous individuals and agencies may be engaged in ecosystem restoration. This undertaking examines and discusses how the conservation authorities carry out their ecosystem restoration efforts within their mandate, how they interact with individuals and other agencies, and makes comparisons between the efforts of the three individual authorities. The comparisons are not made for the purpose of assessing interagency ratings, but for comparing the methods used and for comparing the outcomes of whatever methods that were employed. It is also acknowledged that the high rate of private land-ownership in the study areas may present some challenges to accomplishing basin wide ecosystem restoration. Except for lands occupied by First Nations Peoples and limited amounts of publicly owned lands, private land-ownership of lands is the norm. Under general private land ownership, basin wide ecosystem restoration depends on the aggregation of restoration efforts by all landowners working individually and in cooperation. It may be assumed that land-ownership is a strong incentive for environmentally friendly ecosystem management. It may also be assumed that the pride of land-ownership gets tested by, and has to adjust to the economic

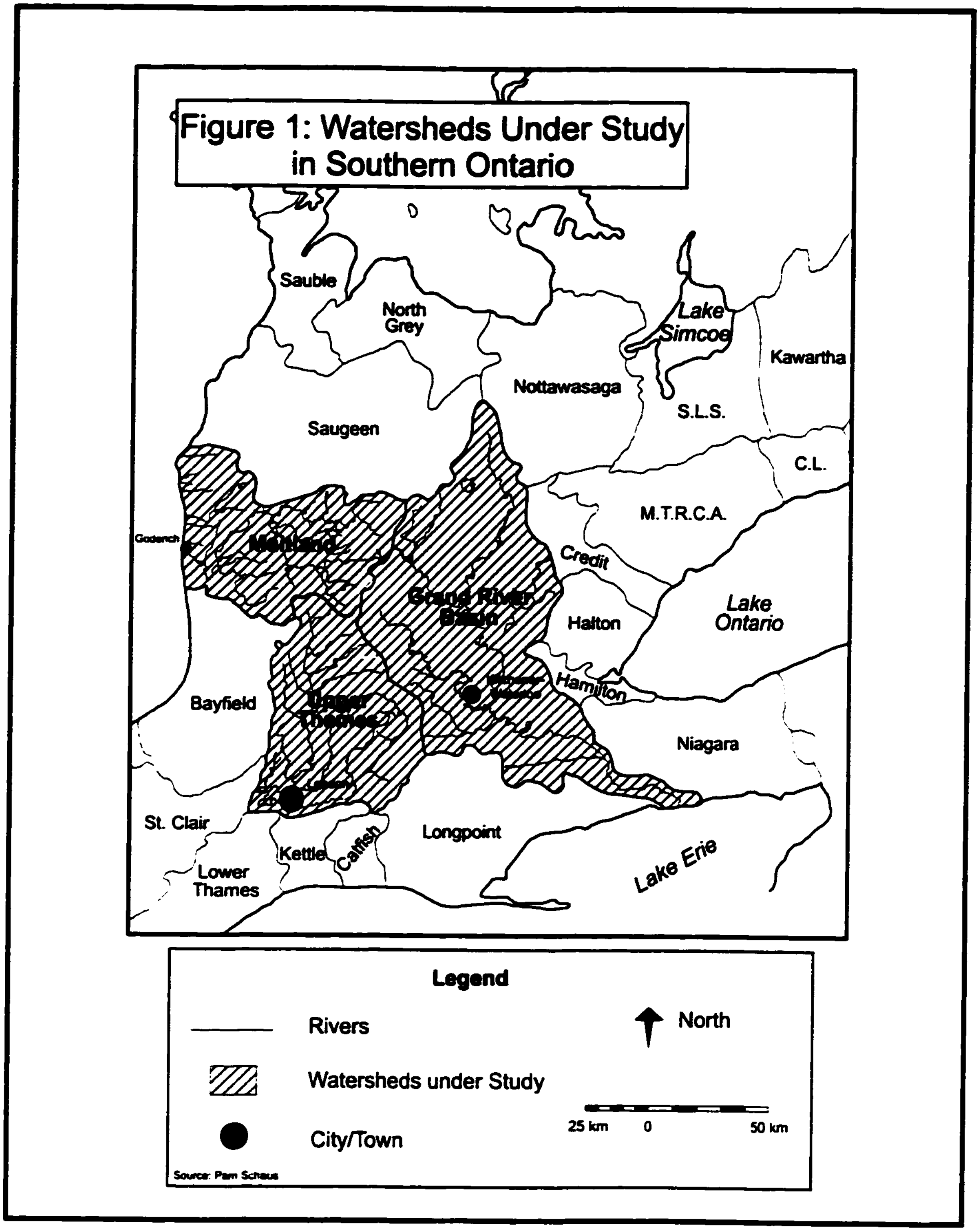


Figure 1: Watersheds Under Study in Southern Ontario

realities associated with gaining a livelihood from one's land holdings while operating within a competitive socioeconomic system. The needs for ecosystem restoration in the three river basins stem from fragmentation caused to the natural ecosystem in order to accommodate the present level of cultural land uses, and from the less than environmentally friendly application of those land uses.

Apart from individual landowner rights, certain powers of control over land use policies come under local municipal jurisdiction, which are sanctioned through the Ontario Planning Act. (See chapter 2). Landowners and stakeholders have been subjected to changing attitudes toward the nature of ecological processes and about approaches toward environmental management, especially after the 1920s, when people steadily became more aware about natural ecological processes. An adaptive ecosystem approach to environmental management has held prominence during the last quarter of the twentieth century. See chapter 2 for definitions. The ecosystem approach came into general use in Ontario in the 1970s (Mitchell & Shrubsole, 1992). Regardless of changing attitudes the Ontario public has shown an interest in, and has participated in conservation movements since the 1930s (GRCA, 1968 AR: 7, Richardson, 1974). While moving toward a more formal approach regarding conservation in Ontario, representatives of the Ontario Government and the public toured operations of the Tennessee Valley Authority (Mitchell & Shrubsole, 1992) and those of the Muskinghum Authority (Browning, 1949). The successes experienced by those American organizations, in dealing with conservation issues at the river basin level, along with experience gained by the Grand River Conservation Commission (a forerunner to the GRCA), influenced Ontario's decision to assign the river basin as the jurisdictional unit for conservation authorities (Mitchell & Shrubsole, 1992). The 1946 Conservation Authorities Act established the Conservation Authorities as the prime conservation agencies in the river basins. The conservation authorities in the study areas are the Grand River Conservation Authority (GRCA), The Maitland Valley Conservation Authority (MVCA) and the Upper Thames River Conservation Authority (UTRCA). The conservation authorities are a creation of the province and administered through the Ministry of Natural Resources. As such, they operate within a mandate that adheres to a set of founding principles and granted powers. They also operate in accordance with an array of inter-agency directives and a series of provincial policy statements issued under Section 2 of the Ontario Planning Act.

Objectives

The objectives of this thesis are to investigate and evaluate ecosystem enhancement and restoration efforts carried out under the direction of the conservation authorities in the three southwestern Ontario river basins, and to make comparisons among their ecosystem restoration efforts. The purpose of the comparisons is to compare methods and outcomes. The comparisons are not for assigning interagency ratings. There are obvious existing conditions that must be taken into account and for which allowances must made. The deeply rooted agricultural/urban industrial socioeconomic system in the three river basins has a tempering influence over the type of ecosystem restoration that can be realistically carried out. Post-European settlement development precludes ecosystem restoration to the pre-European settlement-state. It is also likely impossible to determine what the pre-European settlement-state of the ecosystem was at any particular geographical location. Present development conditions indicate that ecosystem enhancement and restoration successes are more likely to be achieved at a local rather than at a basin-wide level. Most of the three river basins' lands are under private ownership, and livelihood depends on gaining profitable return from the land. To gain more return from more land has likely been cause for converting lands that should have remained in a natural state to other land uses. The level of socioeconomic development common to the three river basins places their land use policies under the Ontario Planning Act, and is administered at the local level through municipal jurisdiction. The local municipal jurisdictions fulfill their mandate through Zoning Bylaws, and Secondary and Official Plans in accordance with Provincial Policies Statements under Section 2 of the Planning Act. Accepting the reality of existing conditions, the choice was made to study ecosystem restoration efforts at whatever level conservation authorities have found it possible to engage in during recent decades.

Study Areas

The Grand River Basin has an area of 6800 sq. km and a population of 800,000 (Woolstencroft, 2000). The Maitland River Basin has an area of 3266 sq. km and a population of 55-60,000 (Gaetz, 2001 est.), and the Upper Thames River Basin has an area of 3,433 sq. km, and a population of 398,919 (UTRCA, 1998, [1996, data]).

The Grand River was the first Canadian river that flows through several urban centres to receive the Canadian Heritage River designation (GRCA, 1994). The Grand River has received a "best-managed rivers in the world" award, called the "2000 Riverprize Award". The award was given to the Grand River Conservation Authority at a conference of river managers in Australia (Outhit, 2000). The Thames River received

Canadian Heritage River designation in 2000 (Thames River Coordinating Committee, 2000).

The General State of the Ecosystem

The landscape in the three river basins has become fragmented into a patchwork of islands inhabited by natural flora and fauna among the agricultural and urban development. The Grand River basin has 18% of its area under wooded coverage (GRCA, SOWR, 1997). The Maitland River basin has 19% of its area under wooded coverage (Gaetz, 2001). and the Upper Thames River basin has 7% of its area under wooded coverage (Merkley, 2001). Apart from whatever natural ecological events may have caused ecosystem fragmentation over time, the single-minded construction of the present socioeconomic system is no doubt the cause of the present fragmented state of the ecosystem.

In the Grand and the Upper Thames basins there is a concentration of urban landscapes in the vicinity of the main Quebec-Windsor transportation corridor. In the Grand River basin the major urban centres of Guelph, Kitchener, Waterloo, Cambridge and Brantford are clustered in the corridor. In the Upper Thames River basin, Woodstock, Ingersol, London, Stratford, and St Marys are located along the three corridor highways and the CN and CP corridor rail lines. Rural areas predominate, and smaller urban settlements are scattered throughout the remainder of the basins. The Maitland basin has a greater proportion of rural and smaller urban settlement landscapes. ("Smaller urban settlements" refers to town, village and hamlet development).

The Rationale for Selecting Three Adjacent River Basins for this Study

The geographical proximity of the three river basins, the similarity of the underlying bedrock and areas of similar physiography and soils (Chapman & Putnam, 1984) indicate the likelihood of similar environmental issues. The present socioeconomic systems in the three river basins evolved from European settlement based on family farm agriculture. This likely indicates similar human-caused environmental issues in all three river basins. It may also be expected that some of the environmental issues overlap their shared river basin borders. Three conservation agencies faced with similar environmental issues and operating under a similar mandate may still take different approaches. This provides potential for examining and comparing different approaches taken toward similar environmental problems. Environmental issues that overlap basin borders may provide for examining interagency cooperation.

The Methodology

An interest in the state of the local ecosystem, in its history, and how it has been managed influenced the selection of the thesis topic and the study areas. The operational framework for conducting the exercise was divided into six stages in line with the six chapters of the thesis.

Stage One-Chapter 1: Introduction: To begin with, acquiring some basic knowledge about the structure, function, lines of authority, and operating mandates surrounding conservation authority operations was the natural and basic starting point for the exercise. Being granted ready access to a contact person at each of the three conservation authorities, along with the privilege of browsing through provincial agency directives and provincial policy statements in authority libraries, provided a good learning opportunity. Publications authored by Richardson (1947), Mitchell & Shrubsole (1992) and Yu & Veale (1984) were sources of conservation authority founding history, founding principles and powers, and of conservation authority development. Without that access and learning process determining a methodology would have been extremely difficult.

Stage 2-Chapter 2: Literature Review: The literature reviewed in chapter 2 was chosen from among a wide range of published material that deals with the concept of ecosystems and the idea of managing the environment on an adaptive ecosystem level. The basis upon which the literature-review selections were made was that the chosen materials were likely to have relevance to the environmental issues within the study areas.

Stage 3-Chapter 3: The Basin's Biophysical Attributes and Conservation Authorities Background: The development and integrity of a natural ecosystem at a specific geographical location depend upon the geoiogical base from which it springs, the local climate, and the natural and cultural forces of disturbance. The level of agricultural and urban development in the study areas has greatly shifted the impact on the ecosystems from natural disturbances to that from cultural disturbances. The conservation authorities have been established as the leading conservation agencies with shared jurisdiction at the river basin level. The background of their establishment, the founding principles, their powers, and their evolution are outlined in chapter 3.

Stage 4-Chapter 4: Detailed Case Studies: Chapter 4 details four projects carried out by each of the three authorities. The individual projects, selected for case study examination, were selected from among published reports held in the authorities' libraries, and in their general files. Selection was guided by an attempt to examine projects representing a general cross-section of the types of projects carried out by each of the authorities. With the numerous recorded projects on file and in order to balance the selection between the three authorities a few minor arbitrary choices were made. The GRCA-Watershed Forest Plan for the Grand River was selected instead of their Watershed Fishery Plan because of its more direct relation to the terrestrial component of the ecosystem. Selecting the Vetrepharm project over one other farm project was the most arbitrary. The amount of physical reconstruction that was carried out on a parcel of land, within the context of what would normally be a family farm operation, but on a parcel of land that may more logically have been reforested raised a point to be pondered. It was selected to illustrate that nearly any type of physical land features can be re-engineered to suit agricultural land use purposes. It illustrates conservation authorities' expertise to oversee whatever task is requested of them. It also involved the Joint Agricultural Soil and Water Conservation Program, one of several examples of joint ventures between more than one conservation authority on file at the three conservation authorities in the study area. Notwithstanding this arbitrary selection I have confidence that, overall, the projects selected represent a balanced cross-section of projects among the three authorities.

Stage5-Chapter 5: Analysis and Discussion: The analysis process was determined by three elements within the overall structure of the thesis. First, the various parcels of information gathered from the published restoration reports describe, at a given time, the ecological state of some or all of the abiotic, biotic, and cultural aspects of a particular ecosystem. Therefore it is highly unlikely that point for point comparisons between restoration efforts of the various projects is possible. Second, the comparison factor contained in the thesis objectives demanded that comparisons of restoration efforts be made. Recognizing restoration value and accomplishments required some understanding of relevant published restoration literature, and therefore the need for a literature review. The purpose of making comparisons was to compare methods and outcome of whatever approach was taken by the authorities and not for assigning inter-agency ratings. Third, accumulating data and arranging it into a format that could be used for making comparisons required constructing an analytic-framework. Mitchell (1989) in his publication " Geography and Resource Analysis" declared that conceptualization is demanded when either designing or assessing research. He explained the purpose of conceptualization as "defining the nature of the problem as well as defining its components and their relationships" (Mitchell, 1989; 25)

The wide variation between research projects precludes a one-size-fits-all approach. The practical solution is a conceptual framework as complex or as ordinary as is required to define the research projects' components and their relationships. The leading challenges to constructing the conceptual framework for use here, were making it relevant to the objectives of the thesis and making it compatible with a recognized concept of the ecosystem in the study areas. The contemporary ecosystem paradigm (Parker & Pickett, 1997) as outlined in chapter two is readily applicable to the ecosystem in the study areas. The OMEE and OMNR (1993; 1.1) definition of an ecosystem, which has been adopted by the conservation authorities, is also compatible with the contemporary paradigm. Adherence to the contemporary paradigm requires that restoration activities give full consideration to the abiotic, biotic, and cultural aspects of an ecosystem within a general geographical area.

The following five component conceptual framework was decided upon:

1. Problem/Issues:
- The critical issues
- The management goals
- The incentives for proceeding

2. The scope:
- The spatial-area of concern.
- The abiotic, biotic and human concerns.
- Ecological/human interrelationships.
- Ecosystem or ecosystem attributes affected

3. The investigative process:
- Types of surveys or (and) studies conducted.
- Professional and stakeholder input
- Reported results of investigations

4. The action plan:
- Recommendations made
- What and how recommendations acted upon

5. The follow-up monitoring
- Type and interval of monitoring
- Reported monitoring results.

The first consideration was that the need for restoration implies the presence of a problem that causes disturbance to the ecosystem's natural resilience by which it maintains self-organizing integrity. It is possible that conflicting cultural perceptions develop into environmental management issues. Problem/issues was therefore chosen as the first framework component. The most likely relations between problem/issues and restoration were assumed to be the degree of criticality, the practicality of the management goals, and the anticipated benefits that would inspire incentive.

Though ecosystem management implies a holistic approach, Bradshaw (1997) stated that cultural attitudes, economic constraints, and lack of appropriate knowledge are factors that may limit ecosystem restoration to decided-upon ecosystem attributes or sub-ecosystem rehabilitation. Scope was therefore chosen as the second framework component. The relationships between scope and restoration are likely tempered by the way in which the spatial-area of concern, the manner in which the abiotic, biotic, and cultural aspects are handled, how the ecological/human relationships are played out, and how much of the ecosystem comes under attention.

Mitchell (1997) stated that monitoring is important at all stages of ecosystem management. Monitoring is an efficient investigative tool for determining the need for ecosystem restoration. Monitoring data forms the knowledge base for the important process of investigative discussion and decision-making by professionals and stakeholders for formulating recommendations for action. The investigative process was decided upon as being the only logical framework component between scope and the action plan. The relationships between investigation and restoration are most likely affected by the relevance of the accumulated data to the situation, the appropriate interpretation of the data, and the quality of the recommendations that come out of the process.

The action plan, the fourth component of the framework defines the action to be taken and how it is carried out. The action plan is the product of the processes of the first three framework components. The relationships between the action plan and restoration are not only affected by the recommendations made and how they are carried out but also by the quality and appropriateness of the recommendations.

The fifth framework component, the follow-up monitoring, reiterates Mitchell's (1997) claim that monitoring is important at all stages of ecosystem management. At this stage its purpose is to assess the transition from human intervention to ecosystem self-organization in the short term and assessing ecosystem integrity in the long-term.

The five-step framework exercise is detailed in chapter 5. Its product formed the data upon which the comparisons were based. The comparisons, as stated in the objectives, were not made for the purpose of assigning inter-agency ratings. They were made for comparing the methods and outcome of whatever variety of approaches that each of the conservation authorities had taken.

Stage 6-Chapter 6: Summary, Conclusions, and Recommendations: The summary outlines a short synopsis of the thesis exercise. Critical observations are made in the concluding section regarding the overall thesis exercise. The strengths and weaknesses inherent in the way the thesis was structured are discussed. The scope of influence by conservation authorities in ecosystem restoration is discussed. Other avenues that may be open to further the conservation authorities' role in ecosystem restoration are suggested.

Chapter 2: Literature Review

This chapter presents a body of literature that covers the developmental history of the ecosystem approach to ecological management practices and its application to ecological restoration. The criteria employed for selecting the literature were that it be relevant to the environmental management issues in the study areas. Within that context, literature that addresses restoration strategies aimed at restoring natural biodiversity reservoirs, such as were likely to have existed in the study areas' ecosystems at the beginning of European Settlement was emphasized. Within the concept of ecosystem, all the abiotic, biotic, and cultural entities within an ecosystem's geographical area form an integral part of the ecosystem (Bastedo et al., 1984). For that reason literature that reflects the cultural component of the ecosystem was also selected.

River Basin, Ecosystems Environmental Management

A river basin's biological community is a combination of many biological entities, existing at several levels. There are terrestrial flora and fauna. There are aquatic flora and fauna, and there are flora and fauna that exist in an environment that is a blend of the terrestrial and the aquatic environment. However none exists in isolation from the others. Terrestrial life forms depend on water for existence. Aquatic life forms depend on nutrients received from land.

A healthy river basin biological community indicates that there is a balance between all of its components. What constitutes a healthy biological community and how to measure its state of health has been viewed from differing perspectives. In his land ethic, Aldo Leopold (1949), as quoted by Karr (1993; 83), raised the concept of "biological integrity" and "ecological health". Karr (1993; 83) stated that Leopold claimed that, "A thing is right when it tends to preserve the integrity, stability, and beauty of the biological community. It is wrong when it tends to do otherwise" Karr (1993) added that this concept differed from Pinchot's consumption-oriented "resource conservation ethic", which espoused the greatest good for the greatest number for the longest time, and Muir's "preservation ethic" which held that spiritual needs take precedence over material needs. More recently, the concept of biological integrity has gained influence in gauging ecological health of an ecosystem. This reflects society's greater understanding of the human relationship to the physical, chemical and biological environment (Karr, 1993). This evolution in approach is evident in several conservation measure taken in the United States by organizations like the Environmental Protection Agency (EPA). In Canada a clear statement of ecological integrity is contained in the National Parks Act by way of its adoption of an ecosystem approach. On a bi-national level Remedial Action Plan projects to restore parts of the Great Lakes are based on ecosystem objectives (Karr, 1993).

In his 1994 "What is Ecosystem Management" Grumbine (1994) cites seven reasons for the evolution of ecosystem management:

> 1. There was a continuing biodiversity crisis. 2. No existing policy initiatives have as yet been shown to slow down environmental deterioration. 3. Calls for ecosystem management have increased along with the theoretical and empirical development of conservation biology. 4. The safety net of U.S. environmental laws are being stretched thin as industrial growth, population growth, and resource consumption exceeds environmental limits. 5. Environmental groups have challenged current resource management policies and practices 6. Federal forest management has failed legal tests and has left meaningful public participation unfulfilled. 7. Societal views are shifting toward wanting less development and more protection and restoration (Grumbine, 1894; 30).

"Successful ecosystem management calls for setting clear goals" (Grumbine, 1994). Within the overall goal of sustaining ecological integrity Grumbine cites five specific goals,

1. Maintain viable populations of all native species in situ
2. Represent, within protected areas, all native ecosystem types across their natural range of vegetation.
3. Maintain evolutionary and ecological processes (i.e. disturbance regimes, hydrological processes, nutrient cycles, etc.)
4. Manage over periods long enough to maintain the evolutionary potential of species and ecosystems.
5. Accommodate human use and occupancy within these constraints (Grumbine, 1994; 31).

The ecosystem management approach has come under some criticism. The fundamentally different biocentric versus anthropocentric views are the debate's focal points. Basic to the argument is whether it is human arrogance to assume the ability to manage the environment. Cairns (1990) as quoted in Stanley (1995) outlines three assumptions upon which humans base their ability to manage the environment:

1. Science can determine how ecosystems function.
2. Once ecosystem function is known, the social/political system will be able to protect ecosystems to the extent for the survival of human society.
3. Reality will take precedence over political expediency because nature cannot be fooled (Stanley, 1995; 257)

Stanley (1995; 257-59) argued that it would be appropriate to add a fourth assumption: "that humans possess or can develop technology needed to manage ecosystems". Stanley's (1995; 260) argument is that the foregoing assumptions are rooted in the human belief that they possess the knowledge and technological ability to manage ecosystems for the production of end-products that are primarily beneficial to humans. In his view land and resource management problems cannot be based on such a doctrine of humanism whose aim it is to determine final causes.

Following the 1984 Brundtland Commission the idea of ecologically sustainable development became another key term along with ecological integrity, and the ecosystem approach, in relation to environmental management. These three terms relate to long-term ecosystem management and to the inclusion of humans as an integral part of ecosystems (Munn, 1993). Ecological integrity and ecologically sustainable development suggest human aspirations or social goals. Key terms bear little relevance to a topic unless understandable definitions can be attributed to them. Munn offers the following comments. "Environmental development appears to be a contradiction since development is generally understood to mean growth in the sense of increase in quantity/yield (with prosperity for all)" (Munn, 1993). He suggests that evolution be substituted for development. If evolution is substituted for development, in the context that ecological evolution has taken place over millennia with success, it may be claimed that development has been sustained.

Integrity denotes successful ecosystem evolution. It attributes qualities to the existing state of an ecosystem that don't have a simple definition. Steadman & Regier, (1990; as quoted in Munn, 1993) stated that such a system (having integrity) should exhibit the following

1. strong, energetic, natural ecosystem processes and not severely constrained;
2. self-organizing in an emerging, evolving way;
3. self-defending against invasions by exotic organisms;
4. biotic capabilities in reserve to survive and recover from occasional severe crisis;
5. attractiveness, at least to informed humans:
6. productive of goods and opportunities valued by humans (Munn, 1993; 105, 106)

The term "ecosystem approach" refers to an environmental management method of dealing with complex, continually changing ecosystems in a holistic way. For definition of the ecosystem approach, Munn (1993) refers to IJC (1989) and to Harris et al. (1990). As an example, the International Joint Commission's (1989) definition as it is applied to the Great Lakes is: "an interdisciplinary approach, a systemic perspective of the natural and cultural ecosystem that are intertwined in the basin and adaptive management that seeks to achieve cultural and natural integrity of the basin" (Munn, 1993; 106).

The link between the three key terms of ecological integrity, ecosystem approach, and ecologically sustainable development as they are applied to ecosystem management may be illustrated. Take for example, an ecosystem approach that prevents loss of long - term ecosystem integrity and possible sustainability because of damages caused to a river basin due to conflicting piecemeal management. In this context an ecosystem approach may, mistakenly, be viewed as an end instead of a means, which is its true function. Open ecological systems can be extremely complex. They may contain a multitude of species interacting intra-specifically and inter-specifically, and interacting with natural physical and chemical variables. All of which takes place in the presence of an indeterminable amount of energy flow-through in a system in which material is cycled (Holling, 1987 quoted in Mitchell 1997). Adding to the complexity and uncertainty is that since ecosystems are open they may be set into reorganizational mode through disturbances caused by external forces as well as internal forces. Humans are normally also considered to be an integral part of the ecosystem in which they are present.

An ecosystem approach undertakes the management of an ecosystem as an integral unit that may exhibit all the complexity and uncertainty alluded to above. One approach fits all is unworkable. Clearly, interdisciplinary inputs are required because the complexity of the system surpasses the expertise of a single discipline. Ecosystem managers are also required to deal with what may be unreasonable expectations of the stakeholders. Another challenge is developing ecological principles that are useful to an ecosystem approach. Many principles are normative rather than having a ratio expressive value. Scientific principles tend to be condition specific and not generally transferable to other conditions. The unpredictable variation in ecological conditions defies formulation of definitive principles (Mitchell, 1997). In the absence of definitive principles Grumbine (1994) suggests proceeding on the assumption that there are ten prominent themes relevant to ecosystem management.

1. Hierarchical context: There has to be a multi-focused approach to address the interconnections between all levels in the biodiversity hierarchy. The hierarchy includes genes, species populations, ecosystems and landscapes.
2. Ecological boundaries: Resource and environmental management has to pay attention to biophysical and ecological rather than political boundaries. Ecological entities and processes do not recognize political boundaries.
3. Ecological integrity is a human term used to denote that an ecosystem possesses strong natural ecosystem processes; is self-organizing and self-defending against disturbances: has resilience and produces products of value to humans (Munn, 1993).
4. Data collection: Ecosystem management depends on research and data collection for assessing ecosystem function, habitat populations, disturbance indicators, and key species.
5. Monitoring is key for recording condition at all levels of ecosystem management for gauging results of actions taken and for making decisions regarding the need for action, and to determine appropriate action.
6. Adaptive management approach assumes incomplete understanding of ecosystems. Management is likely to face the unexpected and has to be open to a learning experience and to adjust to newly gained knowledge. Continuous monitoring plays a key role, and continues adjustments in strategy may be necessary (Mitchell, 1997).

7. Inter-agency cooperation is called for because differing inter-agency jurisdictional policies are a likely cause for conflict in areas where an ecosystem's function and processes are present in more than one jurisdiction.
8. Organizational change from what was typically a single issues management approach to an adaptive ecosystem approach requires restructuring to involve broad interdisciplinary input. It is important that no discipline or stakeholder that has relevant knowledge to the situation is left out of the loop.
9. Humans embedded in nature gives recognition to humans being an integral part of the ecosystem in which they live. They cannot be separated form nature.
10. Values under an ecosystem approach require recognition of both scientific and traditional knowledge as well as human values. It is human values that play a dominant role in ecosystem management (Grumbine, 1994; 30,31).

Based on the ten themes, Grumbine (1994) defines ecosystem management as:

> Ecosystem management integrates scientific knowledge of ecological relationships within complex sociopolitical and values framework toward the general goal of protecting native ecosystem integrity over the long time (Grumbine, 1994; 31).

Mitchell (1997) suggests that the definition should include "traditional as well as scientific knowledge".

The ecosystem approach is thought of as a holistic management approach. There are two distinctive ecosystem approaches, namely, the comprehensive and the integrated approach. Comprehensive, meaning all-inclusive indicates that all relationships within a system should be examined. The integrated approach adheres to most of the core ideas associated with holism, but concentrates on the components that are considered to be key. It accepts the likelihood of limited crucial knowledge regarding some of the variables. Since a small number of variables, usually cause a large amount of variation working with fewer than all the possible variables will likely achieve acceptable resolution. Even if all the variables could be understood it is unlikely that many could be modified. An integrated approach is good for producing a plan that can meet expectations in a shorter time and at a lower cost than a comprehensive approach (Mitchell, 1997). The ecosystem approach as employed by the conservation authorities is compatible with the integrated model.

At the basic level ecosystem theories have developed from two assumptions that are grounded in the laws of thermodynamics. The classical ecosystem model assumed development through an ordered form of succession leading to a climax state of equilibrium. The system is closed, self-regulating, and deterministic. Disturbances are considered to be exceptional (Parker & Pickett, 1997). The contemporary paradigm, by contrast, assumes ecosystems to be open, influenced by external processes, and subject to natural disturbances. The open system influenced by external processes and natural disturbances does not necessarily progress to a stable successional endpoint. The system may experience multiple states of equilibria or it may remain in a state of flux. Its integrity depends upon its self-organizing ability. It looses integrity when its self-organizing ability lacks the resilience to overcome disturbances that lead to undesirable end points. Empirical studies and management failures based on older equilibrium assumptions have resulted in the general acceptance of the contemporary approach (Parker & Pickett, 1997). The contemporary approach applies well to the ecosystem in the study area. The ecosystem in the study area has undergone major disturbances by external forces caused mostly by human activity.

The ecosystem approach to ecological restoration is currently the preferred option. Human intervention is aimed at initiating and encouraging the natural ecological processes to regain an ecosystem's self-organizing capabilities after having been disturbed beyond the natural resilience of the system. McCloskey (1996; 23-9) claimed that ecosystem, as an idea exists as a concept of the human mind and not as something as it may be perceived by the human senses. From this, a reasonable assumption is that ecosystem restoration efforts are tempered by how accurately the human concept reflects the ecosystem issues at hand. The contemporary, open, self-organizing, ecosystem model makes the human setting of ecosystem borders an arbitrary exercise (Parker & Pickett, 1997). In the context of the contemporary paradigm a single leaf, which is a self-organizing glucose manufacturing plant, may be called an ecosystem. A very small, self-organizing, viable habitat, dominated by a single species may also be classed an ecosystem. A larger or very large self-organizing viable community containing multiple species and perhaps several small ecosystems may be classed an ecosystem as well (Parker &Pickett, 1997). An ecosystem whose boundaries are (arbitrarily) set along the outline of a river basin can display self-organizing integrity, as well as contain smaller ecosystems, which also display self-organizing integrity. It is also most likely that river basins share small ecosystems with bordering river basins. The three river basins in the study area are a part of the Great Lakes ecosystem.

The outstanding change in ecological restoration during the time since the conservation authorities were established has been a shift from dealing with single ecological issues to dealing with ecological restoration on an integrative ecosystem level. The river catchment basin, the authorities' management unit, is comprised of an integrated system that transforms precipitation, solar energy, various environmental elements, and labour (human, animal, and mechanical) into primary (vegetation) and secondary (animal) biological products, water resources, and aesthetic values. Reynolds (1985) stated that the only practical management approach to such a complex system, that encompasses the abiotic, biotic and cultural aspects of an environmental area, is an integrative ecosystem approach. The ecosystem approach came into use in Ontario in the early 1970s (Michell & Shrubsole, 1992).

Any river basin study must deal with the ecosystem at whatever level it is encountered and it must be accepted that the conservation authorities are working within arbitrarily set boundaries. The conservation authorities are guided by the OMEE and OMNR (1993) definition of an ecosystem:

> An ecosystem consists of air, land, water and living organisms, including humans, and the interactions among them. An "ecosystem" includes the community of living things and the complex of physical and chemical factors forming the environment. The scale of what is considered an ecosystem can be varied; there is a hierarchy of scales that are nested within each other and which overlap. A macro-ecosystem can be considered to be one with relationships among environment, society and economy. Ecosystem integrity is achieved when the environmental, social and economic relationships within ecosystems are balanced over the long-term (OMEE & OMNR, 1993:1.1).

That definition takes into account the abiotic, biotic, and cultural aspects of an ecosystem, and it defines ecosystem integrity. The definition places the conservation authorities' concept of ecosystem within the parameters of the contemporary open ecosystem paradigm as outlined by Parker & Pickett (1997).

The three parts of the abiotic, biotic and cultural triad involved in ecosystem restoration call for equally shared attention. However, the abiotic and biotic have no independent voice on the cultural stage, allowing the cultural socioeconomic system and its stakeholders to tailor the restoration budget and other commitments toward restoration projects. The consequences are that the conservation authorities' ecosystem restoration management must attempt to accomplish the most desirable ecosystem restoration endpoints within their operating means. The result may be that full ecosystem restoration goals have to be modified to restoration of certain ecosystem attributes or to reclamation or rehabilitation of an agreed upon sub-ecosystem (Bradshaw, 1997). Confronted with the complexity of a river basin ecosystem, conservation authorities must obtain and rely upon multidisciplinary input as well as on local knowledge input from those who live with an ecological situation and are, therefore, aquatinted with it.

Conservation authorities came into being at a time when ecological restoration decisions were commonly made from the top down and were based on empirical evidence regarding individual ecological issues. With the adoption of the ecosystem approach in the early 1970s the focus shifted onto the entire ecosystem. The focus now includes all the abiotic, biotic and cultural aspects within the environment of a given geographical place. The boundaries of that place are however still arbitrarily set. An important cultural factor is that local knowledge, aspirations and equitable cost burden be given equal consideration with scientific and professional input (McCloskey, 1996). The conservation authority founding principles of "Local Initiatives", "Provincial-Municipal Partnership", "A Comprehensive Approach" and "Cooperation and Coordination", although formulated in 1940s, place conservation authorities in a good position for the task.

Restoring ecosystems to their natural state is the desired goal. There are, however, many impediments in the way. If an ecosystem had been disturbed a long time ago it is likely impossible to determine what the present state of the ecosystem would be if disturbance had never taken place. It is also likely that there is no way of determining what its natural, pre-disturbance condition actually was. It is difficult or impossible to assure that a restored ecosystem will become self-organizing, self-maintaining, and attain ecosystem integrity (Cairns, 1998). This becomes especially problematic when choices have to be made to restore selected attributes within an ecosystem. Such choices usually involve specific habitats, recreational fisheries or flood control facilities. Such restoration undertakings involve specific issues within an ecosystem and are likely to ignore the particular issues' synergistic relationship with the rest of the ecosystem. The result is likely to be failure of becoming self-maintaining. Any success will then require on-going monitoring and maintenance commitments. In cases of severe disturbance to soil and change in slope, restoration to a natural state may be too costly. In such cases establishment of an alternative ecosystem that is as close as possible to a natural ecosystem in the particular geographical location is a practical solution. In cases where soil and moisture conditions have undergone minimal change and where there is a nearby supply of suitable invading species natural recovery is a practical solution (Cairns, 1998).

The physiography and ecological makeup of a river basin do not create a homogenous landscape. It resembles a series of ecological islands. The riparian zones along the rivers and streams resemble corridors more than they do islands. In the study area the natural island ecology has become greatly modified and fragmented due to forest removal, wetland drainage, and land division for urban development, agricultural, and road grid land uses. In Europe, where land division and intensive land management have a long history, a system of landscape ecology has been developed to deal with the situation. Landscape ecology has had some limited success in North America. Reconciling landscape ecology with the more integrative, adaptive ecosystem management style faces some problems that may not be easy to overcome (Malanson, 1993). Landscape ecology falls under the more direct influence of ecologists. Ecologists have directed much attention toward dealing with individual species within specific habitats (Malanson, 1993).

The study area presents a fragmented landscape in which agriculture, development, natural landscape, and the human desire for aesthetic values compete for space. The existing condition presents itself as a case that calls for a policy of protecting natural landscapes, and cultural areas while providing compatible working landscapes for other interests. A working example of such a policy exists in the Niagara Escarpment Plan (NEP). The 1973 Niagara Escarpment Plan Development Act led to approval of the NEP. The NEP plays a key role in support of the Niagara Escarpment's 1990 Biosphere Reserve designation. Biosphere Reserves are recognized under the United Nations Education Scientific and Cultural Organizations (UNESCO) Man and the Biosphere (MAB) Program. These areas are designed to deal with reconciling conservation of biological diversity and resources with their sustainable use (Ramsay & Whitelaw, 1997). NEP's management is directed at seven land use designations. They are Natural, Protection, Rural, Minor Urban, Urban, Recreation, and Mineral Extraction. The seven designations are viewed in a hierarchical order of importance. The Natural designation applies to the area containing the prime unique features of the escarpment. The Protection designation applies to the area located immediately adjacent to the Natural Zone. It serves as the main buffer for the Natural Zone. The other designations serve a diminishing buffering role depending upon their location in relation to the Natural Zone and blending into the general working landscape uses. An extensive parks and open space system has been developed on public lands. The Bruce Trail running the length of the escarpment winds its way through both private and public land. The protection of natural landscape blended with working landscape uses along with the parks and trails fulfill both the Biosphere Reserves and the 1968 Niagara Escarpment Study's recommended objectives. Non-compliant existing land uses were grandfathered into the plan. The NEP requires each application for change of land-use to be examined and evaluated on its own merit (Ramsey & Whitelaw, 1997).

The ecosystem approach gained wide acceptance in Ontario in the time period when the idea of sustainable development, which came out of the 1987 Brundtland Commission, was in full sway (Mitchell & Shrubsole, 1992). The ecosystem approach's contribution to sustainable development is tied to its application toward managing the ecosystem toward self-organization and development of integrity with sufficient resilience to overcome disturbances that would lead to undesirable reorganization. The challenge is for ecosystem managers to assemble the required amount of multi-disciplinary knowledge for formulating and initiating the appropriate intervention, when required, which may be difficult or perhaps impossible. Conservation authorities lean toward taking the precautionary principle approach to ecosystem management (see below) (Shrubsole, 1996).

All ecological restoration projects require an action plan. Individual ecological issues seldom exist in isolation from other issues within an ecosystem. It is evident that the complexity of ecosystems makes it difficult to formulate action plans. Through experience gained over time a selection of planning models have been developed that offer a variety of approaches for use in planning under a variety of situations. Among the approaches is "hedging and flexing" which is generally used to avoid taking action in the absence of credible knowledge upon which to base appropriate action. There is the "incremental" approach that is referred to as "muddling through". It aims to achieve acceptable goals, for the present, when the problem is not clearly defined. There is the "transactive" approach, which seeks input from people in general as well as from the experts. There is the "synoptic" approach. It defines the problem, establishes goals, identifies alternatives, outlines criteria, chooses and implements a preferred solution, and incorporates follow-up monitoring. There is also the "precautionary principle" approach. It emphasizes prevention, makes assumptions based on the anticipation of harmful impacts, and acts upon the assumptions in a way that does no harm to the environment (Mitchell, 1997).

Monitoring is of ongoing importance to all aspects of ecosystem management. Healthy ecosystems are monitored to detect any indicators of change. Monitoring data provides the key information upon which to formulate action plans if ecosystem restoration is required. Ecosystem restoration projects have a life cycle of their own. Human ecosystem restoration actions can set the process in motion, but long-term development requires natural ecological processes to take place. It is critical that early and long-term monitoring be part of the restoration process. Early monitoring is necessary for assessing the transition from human intervention toward ecosystem self-organization. Long-term monitoring is necessary for assessing system integrity (Mitchell, 1997).

Biodiversity, Woodlands, Wetlands and Restoration

The three river basins in the study area are home to a diverse selection of indigenous, natural mid-latitude vegetation. Before European settlement the abundant forest in southern Ontario (Riley, 1989) along with wetlands, and streams would have been the prime reservoirs of natural biodiversity in the region. Restoring the study areas' lost biodiversity reservoirs and those that are degraded is essential to the integrity of the ecosystems. Ecosystem biodiversity is also critical to the survival of the entire food chain, of which humans are at the top (Kim & Weaver 1994). Trees are the key species in forests and wooded wetlands, but they are only a fraction of the plant and animal species associated with forests and wetlands. Fragmentation of these natural reservoirs, as is the case in the study area, also makes them vulnerable to invasion by domestic and wild exotic species. Unless this situation is dealt with in early invasion stages it quickly becomes a severe threat to natural species diversity (Sauer, 1994). Reforestation, wetland restoration, and reintroduction of natural herbaceous and wildlife species are the logical approaches to restoring natural biodiversity.

Forest and wetland restoration implies restoring, as much as is possible, the former structure and function of the forest and wetlands in a given geographical area. The forest and wetland history in the study areas dates from about nine thousand years ago. The early forest and wetland landscapes likely resembled the present boreal forests in Canada's present boreal forests. It is apparent that present climate and soil conditions in the study areas support a different group of species. They are the species that are common to the area now and are considered to be native (Campbell, & Campbell, 1994). These present day species are descendants of the area's mother-stock common to the area over the past millennium, and of immigrant species from the south. Whatever their lineage it may be assumed that they have adapted to their environment and have developed into being the most genetically fit species for their particular habitat, and therefore the ideal species to be selected for restoration programs.

The natural forest exists in the form of a guild of species in cohabitation within the ecosystem, which is open to species emigration and immigration. Therefore in its environment of interspecific and intraspecific competition (Begon, et al., 1986) it may exist as an ecosystem that displays self-organizing integrity. However it is not isolated from natural and cultural disturbances, or from invasion by aggressive exotic invading species. It is likely that the presence of many of the exotic species may be traced to cultural activities. The cultural presence and its influence in the study area is recorded from the beginning of the Late Woodland period around 700 A D on through the present period, the Euro-Canadian period, which began with the European agricultural settlement in the area (Fox, 1990). The Ontario Iroquois people dominated the Late Woodland cultural period. They engaged in a mix of hunting and swidden agriculture activities. On 10 to 30 year cycles, they routinely occupied patches of land, cleared the forest, built shelters, cropped the land, and abandoned them to natural forest regeneration when the resources became scarce. Fire was likely used to a limited extent to maintain open areas for their form of agriculture, but then, as now, fire has never been a management tool in predominantly deciduous forests. It is estimated that about 5.2% of Ontario's land area, south of the shield, came under their swidden form of agriculture. The affected patches were widely scattered with some concentrations in the lower half of Grand River basin and in the present London area of the Thames River basin. The regenerated forests on these disturbed patches were not necessarily identical to the earlier forests. In the big picture, except in limited small cases, it is not thought that the overall structure and function of the forest was greatly affected (Campbell, & Campbell, 1994).

The present highly fragmented state of the study area's forest is the result of the land clearing for establishment of the present Euro-Canadian culture. Comparing the soil erosion rate indicators in areas where both agricultural methods were practiced is a good indicator of how each method impacted the environment. Results of sedimentation sampling on small lake sedimentation showed a 2cm/century sedimentation deposit rate prior to the Euro-Canadian period compared with a 100cm/century sedimentation rate after 1850 (Campbell. & Campbell, 1994).

Most of the present day southern Ontario forest is located on private land and only a limited number of the remaining fragments are large enough to contain interior habitat. The present day challenge is the prevention of total woodland ecosystem collapse. Merriam (1999) put forth the idea that small patches of woodland, ten acres for example, if isolated at a considerable distance from other patches, do not have self-organizing capacity to maintain ecosystem integrity over the long-term. Therefore many remaining patches in southern Ontario need to be enlarged or connected to other patches by wide corridors. Bowles (1999) in a study of richness and quality of forest patches in Oxford County, Haldimand-Norfolk, and the London area, found that larger patches in areas with more forest cover in general along with greater habitat diversity contained higher species richness. In very small patches, species richness increased if there were larger patches nearby. Floristic quality was not related to patch size. However patches of a given size with greater area relative to patch size displayed higher mean conservatism and lower invasion by exotics (Bowles, 1999).

It is only recently that attention is being given to seeking a better understanding of the relationships between all the attributes of the ecosystem and the overall structure, function and spatio-temperal dynamics of the forest ecosystem (Strobl, 1999). In Southern Ontario the valuable northern tolerant maple, beech, and eastern hemlock species formerly received much of the silviculturalists' research attention. The emphasis was on production for harvest. Since these species are shade tolerant the less shade tolerant species that are common to the natural forest in southern Ontario were placed at a disadvantage. Since a limited number of stems per acre of any species will reach full maturity, selective harvesting can assist the greatest number of valuable hardwood species stems reach full maturity while providing enough open canopy for less shade- tolerant species to flourish and provide desired species diversity (Strobl, 1999).

Forest ecosystem integrity depends on all of an ecosystem's attributes. Important among its attributes are its zoological attributes; they include those that fly, the birds, and the insect and moth pollinators. There are the mammals representing the secondary bio-products and predators, and there are the crawlers whose industry it is, along with the microbes, to return the detritus to the soil. Burke (1999) in a study of beetles and ovenbirds in upland woodlands determined that there was a positive relationship between increased patch size and increased habitat size and the health of the zoological community.

On the national scale Canada's forest management systems are different from most other developed countries because over 90% of productive land is government owned. However in agricultural southern Ontario the reverse is the case with most of the remaining woodlands being on privately owned lands. On the national scale the prime management focus is on the high volume marketable lumber of the conifer species. In Southern Ontario, and in particular in the study areas, deciduous species are dominant requiring management approaches adaptable to those species and the soils and climate in which they are native (Brand, 1991). Ontario's farm families own and manage thirteen and a half million acres of land, mostly in southern Ontario. Approximately 8.4 million acres of the privately owned land is in annual and perennial crops. The remainder is in pasture, wetlands, woodlands, and other natural areas (Graham, 1999). Woodlands benefit farm families in the form of building materials, fuelwood, and cash sale returns in times of economic stress. Ecologically woodlands enhance soil stability, water quality and quantity, and provide wildlife habitat. The two most prominent determinants of the level of woodland stewardship practiced by the individual farm family are the financial demands of the farm's operations and the farmer's attitude (Graham, 1999). Major woodland restoration projects on individual farms are likely beyond the expertise and financial resources of the farmer. Past history has shown that public/private and private/private woodland restoration partnerships can work for private land forestry (Boysen & Nielsen, 1999).

During the past twenty years there has been a heightened awareness surrounding environmental sustainability. There has been an increase in farm organizations cooperating with each other and with various governments. They have also developed and are operating their own programs. An example is the Ontario Environmental Farm Plan (EFP). The EFP is a coalition of thirty farm organizations. Their services include developing best management practices and developing action plans for individual farmers, including forestry action plans. A major problem for such organization is arranging for program funding (Graham, 1999).

The 1996 cutbacks within OMNR eliminated one-on-one on site services in response to forestry, shoreline, or fish and wildlife concern requests. The Ontario government through OMNR initiated the Private Land Resource Stewardship Program (PLRSP). The PLRSP contribution to forest management is through providing or assisting with the location of management expertise, conducting workshops, providing fact sheets, providing staff time for project organization, and collaborating in carrying out projects (Faught, 1999). (The PLRSP is further explained in chapter 3.)

The long-time and last remaining agencies delivering reforestation projects in southern Ontario are the Conservation Authorities (CAs). The CAs currently have 130,000 acres of woodlands under direct administration. Under the current financial constraints they still plant approximately 1.5 million seedlings per annum. Currently they concentrate on high priority areas such as riparian areas. They also increasingly engage in inter-watershed cooperative projects (Graeme, 1999). Those CAs that are located within the Carolinian vegetation zone cooperate with Carolinian Canada's "Big Picture Program". Gordon (1999) described the Big Picture Program as a cutting edge project for identifying unprotected sites, researching, developing and carrying out strategies to halt the loss of and increasing the size and quality of existing natural communities.

Woodlands in Ontario are provided protection under the Planning Act, which is administered by the Minister of Municipal Affairs and Housing. Section 16(1) of the Planning Act empowers municipalities through the development of Official Plans to develop policies regarding land uses. This includes identifying, protecting and managing woodlands. Under Provincial Policy Statement 2.3.1, which must be adhered to by planning agencies at all levels, requires that natural heritage features be protected in accordance with specific policies. Forests and wetlands fall under natural heritage policies. Under Section 223.2(1) of the Municipal Act, municipalities having populations greater than 10,000 have the ability to pass bylaws that protect or regulate the injury of or destruction of trees. Under the Forestry Act, which is administered by OMNR, municipal councils may pass and enforce bylaws that are consistent with good forestry practices (Johnson, 1999).

There is an irony of consequences in the way humans remove the trees when constructing their rural and urban infrastructures then surround themselves with planted trees. However, it is after the fact that ecological and cultural benefits are gained. Windbreaks, a common rural tree planting activity, usually referred to as agroforestry, decrease wind-driven soil erosion, provide wildlife corridors, edge habitat for birds in particular, check surface runoff, and shelter farmsteads from prevailing winds (Glasman, 1990). A developed urban forest may actually provide greater tree coverage per unit of area than is the case in many rural agricultural areas. Beside the obvious aesthetic values and bird habitat provided by the urban forest, it may be planned and engineered to provide human comforts and economic benefits (McPherson, 1994). Evergreen species planted on the windward side of dwellings contribute to heating fuel savings. Deciduous trees planted on the sunny side provide cooling energy savings in the summer. A choice has to be made with respect to the summer cooling issue. Several experiments have shown that the extra winter heating costs resulting from the shading of the sun's rays by the bare branches of the leafless trees in the winter more than offsets the cooling cost savings in the summer (McPherson, 1994). The individual dwelling heating and cooling issue aside, the accumulation of results of a very large number of strategically placed trees modifies the summer and winter temperatures in an urban area.

With the uncertainties surrounding global warming maintaining an urban forest to reduce fuel consumption and thereby reduce greenhouse gas emissions is highly warranted (McPherson, 1994). Secondary to reducing emissions of greenhouse gases, the idea of forests, trees in general, vegetation in general and the soil with its contents being considered to be a carbon sink is receiving considerable attention (McPherson, 1994). The onus placed on commercial and industrial companies encourages them to take responsibility for offsetting the effects of the emissions from their operations. The establishment of carbon sinks appears to be a leading option being taken by them (Leipold, 2000).

In general, urban forests exist under unnatural and stressful conditions that require extensive maintenance and die-off replacement costs. They are not self-regenerating. Total replanting along streets may be required on a cycle as short as twenty-five years (McPherson, 1994).

Opportunities for reforestation and wetland restoration throughout a developed river basin are most likely to be found along the margins of flood plains, on lands that are less suitable for agricultural uses, and on old fields that have been taken out of agricultural uses. Restored stream courses can provide wildlife corridors, edge type habitat, and trails for ecosystem friendly recreation. In the Grand River watershed, alone, there are approximately 70,700 acres of riparian landscape. Large more rectangular or round reforested areas provide edge and deep forest habitat as well as opportunities for diverse types of environmentally friendly recreation (Riley & Mohr, 1994).

Woodland and wetland restoration present specific challenges. The intention of establishing a base upon which a multi-species, self-organizing, self-sustaining ecosystem will develop is an ideal objective when undertaking woodland creation. Woodland creation is undertaken in the knowledge that forest maturation takes longer than the working life span of those who began the task. There is also the knowledge that during the maturation period the ecological process may well encounter disturbances that can cause the system to reorganize and proceed toward an endpoint that is different from what was originally intended. The practical approach is to plan for what will hopefully become an ecosystem that is natural to the geographical region. Selecting, for planting, a mix of species that are natural to the region and applying best-known forest management practices provide good assurance that the end result is at the least a semi-natural forest ecosystem (Spencer, 1995). Good forest management can have some influence over the type of harvestable wood products, recreational facilities, and natural habitat that may develop in a forest ecosystem. The larger the forested area the more likely it is to contain a mosaic of woodland types that support a diversity of flora and fauna. It can prove unwise to create a so-called fashion forest that will contain large stands of a monoculture, or a fashion forest planted to create a stylized landscape. Fashions change with the whims of the population. Whims have short life cycles placing fashion forests into jeopardy (Spencer, 1995).

Soil and moisture conditions must be considered when creating woodland. Agricultural and disturbed soils in urban areas differ from mature woodland soils. Mature woodland soils are more acidic, have more distinct horizons, have upper layers rich in humus, are dryer, and are more porous and structured. The soil fauna and microflora also differ. Agricultural soils usually have had their fertility artificially altered and are susceptible to weed proliferation. Disturbed urban soils are normally high in mineral content and low in humus, and are compacted which impedes root penetration. Artificial soil improvement is a costly and slow process (Moffat & Buckley, 1995). Wise species selection for planting and advanced silviculture husbandry can establish and nurse woodland plantations from most poor soil conditions to a point where natural processes will take over soil modification and maturation. Under favourable conditions natural reforestation is an option. Natural reforestation takes a longer time because it normally passes through successional increments that begin with invasion of disturbed areas by pioneer species, to be replaced over time by mature forest ecosystem species (Moffat & Buckley, 1995). Since woodland plants and animals are slow to colonize it is desirable to establish blocks of woodland throughout an entire general area along with connecting corridors. It is advisable to establish woodland coverage of 25% to 30% throughout a general area (Gilbert & Anderson, 1998).

Canadian Wildlife Service of Environment Canada, OMNR, and OME jointly prepared a "Framework for Guiding Habitat Rehabilitation in the Great Lakes Area" The framework of guidelines were prepared in relation to, and in support of the Remedial Action Plan (RAP) teams. Within the framework are guidelines on forest, wetland, and riparian rehabilitation that are appropriate for application in the study area. The three river systems drain a large land area into the Lower Great Lakes, and have the potential of having considerable influence on them. Each guideline is based on a critical parameter (Environment Canada, et al., 1998). (See Table 1)

Table 1:The Parameters and Guidelines for Forest Habitat Rehabilitation

Parameter	Forest Habitat Guideline
Size of largest forest patch	30% of watershed should be in forest cover.
Percent of the watershed that is forest cover 100 metres and 200 metres from edge	Greater than 10% forest cover 100 metres from edge. Greater than 5% forest cover 200 metres
Forest shape and proximity to other forest patches	Forest patches should be circular or square and in close proximity (i.e. 2 km) to adjacent patches.
Fragmented landscape and role of corridors	Corridors designed to facilitate species movement should be a minimum of 100 metres wide and corridors designed for specialist species should be a minimum of 500 metres wide.
Forest quality – species composition and age structure	Watershed forest cover should be representative of the fill diversity of species composition and age structure found in the ecoregion (Environment Canada, et al., 1998; tble. 7).

As with woodland restoration, the goal in wetland restoration is to achieve a multi-species, self-organizing, self-sustaining ecosystem. Wetland creation or restoration success is linked to the close association between hydrology, soil and vegetation, and depends upon maintaining a balance between the three. Water chemistry, nearly constant water depth, water inflow and outflow through discharge, infiltration and evapotranspiration are important factors. Soil saturation levels in wetlands cause them to be oxygen starved. If the condition is severe, the lack of oxygen impedes aerobic reduction of organic matter and the oxidation of metals. Lack of dissolved oxygen in the water and accumulation of decaying vegetation lower or in severe cases destroy the habitat of the aquatic life. Any lowering of dissolved oxygen places stress upon aquatic life. Colonizing wetlands with plants that grow in standing water will infuse atmospheric oxygen into the soil around their roots and aid aerobic reduction of organic waste (Hammer, 1997).

The leading determinants of the types of wetlands that naturally develop are climate and the geomorphologic characteristics of the ecoregion within which they are located. The study areas occupy portions of the Hurontario and the Erie ecoregions in southwestern Ontario. The occupied areas have undergone high levels of urban and agricultural development resulting in a 75 to 90% loss of natural wetlands and exceeding 90% in some areas (Detenbeck, et al., 1999). The mechanisms of impact due to disturbances and the potential response endpoints are similar in rural and urban areas. Typical responses are:

> 1. shift in plant species composition, 2. reduction in wildlife production, 3. decreased local or regional biodiversity, 4. reduction in fish and/or other secondary production, 5. increased flood peaks/frequency, 6. increased above ground production, 7. decreased water quality downstream, and, 8. loss of aquatic plant species with high light compensation points (Detenbeck, et al., 1999; 789)

The close relationships between natural wetlands and an ecoregion's natural attributes are central to wetland assessment for developing management and restoration strategies. Anthropocentric stresses must also be factored in when assessing wetland status. Three types of information are required when assessing wetland status and the need for restoration: 1. land use activities, 2. changes in wetland abundance and type (present versus historic), and, 3. changes in distribution of wetland-dependent species (current distribution of rare species and declining species and increase and extent of invasive species) (Detenbeck, et al., 1999).

Wetlands may be grouped into the following subclasses: wet meadows, emergent shallow and deepwater marshes, hardwood and softwood swamps, and bogs (Zoltai, et al., 1975). Swamps are the dominant wetland type in the Hurontario ecoregion. A limited number of bogs are scattered throughout the ecoregion. The inland wetlands in the Erie ecoregion are predominantly forested swamps with both softwood and hardwood represented. The Erie ecoregion also has a limited number of bogs and fens.

Nearly all of the presently existing wetlands in the study area have been affected by farm or urban drainage systems. Artificial drainage systems affect more than the immediate wetland area. They break the synergistic links between the wetland and the greater surrounding ecosystem. More than half of the wetlands in the Hurontario and Erie ecoregions are impacted by hydrologically transported and non-point-source pollutants (Detenbeck, et al., 1999). As lake and wetland areas are reduced flood levels along with accompanying damage in the greater drainage basin increases. Several of the plants, insects, birds, amphibians, reptiles, and fish species that depend on wetland habitat for survival are of conservation concern, especially in the Erie ecoregion. They are not only stressed due to loss of habitat but also by changes in hydrologic and chemical alterations within the remaining habitat. Loss of a specific type of biodiversity accompanies the loss of wetlands. Exotic species invasion poses a serious threat to wetlands, in particular, wetlands that have undergone vegetation removal and site disturbance. Weirs and dams used for stream flow control have a direct effect on floodplain wetlands (Detenbeck, et al., 1999).

Since wetland characteristics tend to be ecoregion specific, formulation of management and restoration strategies necessarily require access to available adequate data at the ecoregion level, preferably augmented with data at the wetland's local level. Data on current and historic conditions as well as field investigation data are all required.

Data generated at the local planning department level are a source of finer than ecoregion level data. Ecoregion level data are generally available from OMNR and OMAFRA. A drawback to getting data from the various sources is that there is a lack of universal wetland classification standards across the various agencies (Detenbeck, et al., 1999).

The Maitland River/ Lake Huron shoreline and Grand River/Lake Erie Shoreline are areas where there is potential for the development of coastal wetlands. The potential is greater along the low slopes of the Grand/Erie shoreline than it is along many stretches of cliff type shoreline at the Maitland/Huron interface. Formation and development of coastal wetlands are determined by geomorphology, constant change in water level, wave and wind action, lake-currents, and deposition of material from both the lake and the land. Keough, et al., (1999) defined coastal wetlands as having one or more of: 1. at least periodically, the land supports predominantly hydrophytes, 2. the substrate is undrained hydric soil, and, 3. the substrate is non soil and is saturated with water or covered with shallow water at some time of the growing season of the year. There are three general types of coastal wetlands. There are open coastal wetlands that front directly on the lake along the shoreline. There are drowned-river mouth-flooded delta wetlands located at river mouths, and there are protected wetlands separated from the body of the lake by sand barriers or spits. Upstream riverine wetlands that are under substantial hydrologic influence from lake-water are classed as coastal wetlands. All three types are influenced by fluctuations in lake-levels. Open coastal wetlands are directly exposed to wave actions and along shore currents. Drowned river mouth-flooded delta wetlands have a narrow lakefront and are under influence from the lake and from upstream. Protected coastal wetlands are protected from direct wave and current influence and therefore develop more stable flora and fauna populations. Coastal flora and fauna species have adapted to the constant changes within their particular niche of their coastal wetland habitat. Within the coastal wetland habitat there is a gradient of species diversity with lower diversity at around average lake level becoming more diverse up slope away from the lakefront. Wetlands that expand and contract with change in lake-levels restrict species colonization (Keough, et al., 1999).

Coastal wetlands are individually complex and no two are alike. Developing coastal wetland management and restoration strategies requires consideration of many site-specific factors. Each wetland has a specific deposition storing capacity and nutrient assimilation and filtering capacity. Among the other site specific factors to be considered are: chemical properties of the water, water turbidity, eutrophic level, fluctuations in water level, water currents, prevailing winds, and types of organic, mineral, and nutrient depositions from the land side and from the lake side, and whatever anthropocentric stresses may be present (Keough, et al., 1999).

Water level fluctuations, organic and mineral storing and filtering capacity, and nutrient assimilation capabilities attributed to coastal wetlands in the above review appear to be readily attributable to river floodplain wetlands. It raises the notion of using existing and creating additional floodplain wetlands for capturing storing and filtering sediments that are being water transported from areas of soil erosion through floodplains to streams.

The RAP habitat restoration guidelines, referred to above, for wetlands as they apply at the river watershed level are summarized in table 2.

Table 2: Restoration Guidelines for Wetlands

Parameter	Wetland Habitat Guideline
Percent wetlands in a watershed or sub- watershed	Greater than 10% of each major watershed in wetland habitat; greater than 6% of each subwatershed in wetland habitat; or restore the original percentage of wetlands in the watershed.
Amount of natural vegetation adjacent to the wetland	Greater than 240 metres width of adjacent habitat may be herbaceous or woody vegetation.
Wetland type	The only two types of wetlands suitable for widespread rehabilitation are marshes and swamps.
Wetland location	Headwaters areas for groundwater recharge, floodplains for flood attenuation, and coastal wetlands for fish production are critical.
Wetland size	Swamps should be as large as possible to maximize interior habitat. Marshes of various sizes attract different species and range of sizes is beneficial across a landscape.
Wetland shape	Swamps should be regularly shaped with minimum edge and maximum interior habitat. Marshes thrive on interspersion, a term describing the irregular shape of the functional marsh habitats (Environment Canada, et al, 1998; tble. 7).

Soil, Water, and Restoration

Soil and water conservation is important to the prosperity of the prominent agricultural presence and to the health of people in the three river basins. Water and land do not exist in isolation of each other. The hydrologic cycle repeats itself in a sequence of precipitation, surface runoff, infiltration, dissolved nutrient-rich water uptake to roots of vegetation, and groundwater and stream water flow (in this case to the Great Lakes).

To complete the cycle surface evaporation and evapotranspiration return water vapour to the atmosphere to condense into precipitation.

River and stream corridors form a basic physical entity in a river basin. In their natural state they are zones of abundant biological production and therefore rich reservoirs of natural biodiversity. Along with that, the aesthetic values, access to water, and access to possible routes of transportation that they offer, have made them magnets for human development. The environmentally degrading impacts that accompanied development in the study area have been the cause of much remedial action by the conservation authorities to combat flooding, water pollution and erosion (GRIC, 1982).

River and stream corridor management has as a rule been divided into four stages. They are stream baseflow, bankfull flow, the riparian zone, and the greater river valley. The baseflow is the long-term sustained flow level that exists during prolonged dry periods. It is within this flow level that channel aquatic life ecosystem survival must be sustained. The bankfull flow is the within bank high water level that occurs regularly due to seasonal weather events. The bankfull flow plays a major role in shaping the channel morphology. The vegetation rich riparian zone acts as a major buffer and filtering zone as well as a deterrent of erosion. Strict definitions for the riparian zone limit it to bank areas in immediate contact with the channel. More liberal definitions include at least part of the riverside plain that becomes inundated during major flood events. The greater river valley includes the hill slopes leading from the uplands down to the floodplain. For practical flood management purposes it is common to refer to the floodplain as the zone within the projected high-water line that occurs at times of major long-term flood events, such as 1:25 yr., 1:50 yr., or 1:100 yr. floods (Petts, 1996).

The riparian and floodplain margins of a river or stream serve as ecotones between aquatic and terrestrial habitats. Seasonal over-bank floods are vehicles for the exchange of materials and organisms among the various habitats and thereby a factor in biological productivity and diversity. Such flood events are also a vehicle for nutrient distribution beneficial to both aquatic and terrestrial habitats. The variety of plants and animals that are native to the ecotone zones are adapted to, and benefit from, natural seasonal events, and they have adopted survival strategies for major long-term flooding events (Petts, 1996).

Over-bank flooding causes some natural levee formation, but severe channelization and large sized dykes cause physical habitat separation and fragmentation. The result is interruption of ecotone function. Terrestrial species that require inundation during part of their lifecycle and aquatic species that require occasional desiccation are placed at a disadvantage or may be completely separated from their lifeline (Petts, 1996). River corridor ecotone ecological function interconnectedness indicates that meaningful restoration must address issues concerning the river channel and the entire ecotone's environmental issues. (Table 3) Argument can be made that due to synergistic processes the entire catchment should be included in river channel restoration (Brookes, 1996).

Table 3: RAP Habitat Restoration Guidelines for Riparian Habitats

Parameter	Riparian Habitat Guideline
Percent of stream naturally vegetated	75% of stream length should be naturally vegetated.
Amount of natural vegetation adjacent to streams	Streams should have a 30 metre wide naturally vegetated buffer on both sides.
Total suspended sediments	Suspended sediment concentrations should remain below 21 mg/litre for most of the year.
Percent of urbanized watershed that is impervious	15% of imperviousness in an urbanized watershed should maintain stream water quality and leave biodiversity unimpaired.
Fish communities	Targets are set based on knowledge of underlying characteristics of watershed (drainage area, surficial geology, flow regime, historically and currently occurring fish communities, and factors presently impacting the system and their relative magnitudes (Environment Canada, et al, 1998; tble 7).

It is to the cultural component of the riverine ecosystem that flooding poses a hazard. It is past flood experiences and projected future events that drive flood control management. Among the common approaches to flood control are channelization, dykes, and construction of storage reservoirs. Reservoirs on streams and rivers serve many purposes. An early purpose, before internal combustion and electrical power, was to supply waterpower. More recently their main purpose has been flood control, channel flushing, waste dilution, facilities for urban water intake and recreation. Reservoirs, like all engineered facilities, are not self-maintaining and require ongoing maintenance and restoration. Structural maintenance, periodic reconstruction, sedimentation, eutrophication, and bank and channel erosion are common and ongoing reservoir maintenance and restoration problems that must be dealt with. Reservoir establishment usually results in flooding of valuable valley lands or forest. Fish ladders, especially in earlier times, have not been included with negative effects on fish populations (Cooke, et al, 1993).

River corridor restoration in the study area, as is likely common in developed countries, must find a compromise between cultural concerns that view flooding as a hazard and the natural beneficial role that flooding plays in the environment. Most of the land is privately owned. Private landowners may have a variety of conflicting views. Non-landowner organizations that have environmental concerns may bring lobbying efforts to bear upon the issue. Such organizations, of which Wildlife Habitat Canada is an example, have the ability to make a strong case for governmental policy changes aimed at harmonizing sustainable wildlife habitat with the idea of sustainable development (Girt, 1990). In a developed country like Canada, total restoration may have to give way to what may realistically be accomplished. A case in point is the Kissimmee River restoration project in Florida. Upstream flood control facilities along with severe channelization that converted 170 km of meandering channel into a 90 km canal destroyed most of the fish habitat and natural wetlands. Reintroduction of flow to 90 km of remnant river channels, closely managed upstream flood and stream flow control facilities to prevent intermittent flow, and backfilling 46 km of canal have created 11,000 ha of floodplain (Brookes, 1996).

Physically, under natural conditions, rivers are dynamic systems that balance input and output. The input is the totality of the water received from surface runoff and from groundwater along with the addition of erosional and other debris received from its drainage area. The output is the water and its carried sediment that, over time, passes the mouth of the river. Some of the output leaves the system through evaporation. Through gravity, the potential energy stored in the mass of the river's flowing water above the river's outlet is converted to kinetic energy. This kinetic energy provides the work by which rivers carve the natural river valleys, riverbanks, and river channels. Climate, geology, and physiography are modifying agents to the process (Press & Siever, 1986).

Outside of the riparian zone soil and water conservation, as related to agricultural practices in the study area, have the potential of greatly influencing river and stream health. Agricultural tillage methods that result in soil surfaces clear of any vegetation or vegetative debris cover, leave the soil vulnerable to wind and water erosion. Soil and water conserving tillage methods have been developed for many types of crop production (Gil, 1979). Many factors influence the type of agricultural tillage that develops and comes into general use in a geographical region. Some of the influences are climate, type of soils, topography, type of crops produced and scientific knowledge. However the final deciding factors are the operator's preferences combined with the economic situation. The Ontario Agricultural Training Institute (OATI) has developed a seven step Agroecological Farm Plan to aid the individual operator in developing a long-term program for managing the operator's particular farm as an ecosystem. Building upon a farmer's own knowledge about his/her particular farm, the farmer is guided through the steps of designing a plan that considers the impact of farm practices on land and water within and beyond the farm's boundaries. Some of the issues to be taken under consideration are loss of natural areas, habitats and species, as well as the intensive use of energy (Gwyn, Gwyn & Associates, 1998). The OATI literature makes direct reference to the advantages of energy reduction. Energy is a major input into agricultural and commercial/ industrial and a large contributor to non-point, source pollution.

The farm sustainability plan is developed and carried out in seven steps:

1. Determining goals.
2. Take stock: what's on the farm?
   Develop a map and two map overlays.
   Base map: Croplands, pastures, woodlots, miscellaneous areas.
   Overlay one: most/least productive areas, steepest areas, wind and water flow directions, changes in the landscape, areas immediately beyond farms.
   Overlay two: management plan for soil health, weed control, maintaining and improving water, woodland management, shelterbelts, windbreaks and buffers.
3. Determine areas of concern.
4. Evaluate areas of concern: moderate, severe, very severe.
5. Develop a plan: find options for dealing with each area of concern.
6. Setting priorities and developing action plans, and implementing action plans.
7. Plan review: determine how and how often to review the plan, and act in response to review findings (Gwyn, Gwyn, & Associates, 1998).

Sites in glacial out-wash zones in the three river basins where aggregates are extracted and where exposed rock quarrying takes place fall under the Pits and Quarries Control Act, which is administered by OMNR. Such sites have potential for restoration to some form of land use. Each case is likely to require a different approach. The volume of material extracted usually precludes restoring topography that resembles the pre-disturbed conditions. If enough nutrient rich overburden that was removed is available, it is possible to return the site to some level of biological production. If extraction extended below groundwater level there is opportunity to develop a sub-terrain wetland or recreation site (Harris et al, 1996). An example of such rehabilitation exists at the Dufferin Quarry site. The site is located a short distance north of highway 401 on the

Niagara Escarpment beside a natural area known as the Hilton Falls Complex. The complex is a natural area within which there are an Environmentally Sensitive Area (ESA), mixed forest of sugar maple, conifers, wetlands, deciduous swamps, cliff face and talus slopes and the headwaters of Sixteen Mile Creek (Van Osch & Nelson, 2000). The Dufferin Quarry operation is a non-compliant land-use that was grandfathered into the NEP. The major non-compliance feature is a large cut through the face of the escarpment. The strength of the economic component associated with mineral extraction presents strong competition to the NEP's and other's preservation efforts of the escarpment's natural features.

The economic component lies in the value of the high quality aggregate source provided by the deposits of middle and lower Silurian stratified sedimentary formations. The Clinton Cataract group, located in the upper stratum, is the more highly valued in the construction industry. The underlying Cabot formation also has a profitable market. The red softer shale stratum lies below the Cabot formation and is useful for making bricks (Tovell, 1992). Under agreement with OMNR, Dufferin Aggregates engages in a continuous rehabilitation program in an effort to restore a natural landscape within the quarry. The new landscape includes cliff faces, shorelines, wetlands, islands and natural vegetation reintroduction. Restoration progress is monitored to track growth of transplanted trees and shrubs, changes in bird populations, and soil and water conditions are monitored for changes (Van Osch & Nelson, 2000).

Planning and Planning Act Reform (1992-5)

The conservation authorities' operations involve them in matters that affect land use policies. They therefore operate within the policies of the Ontario Planning Act.

Some policies instituted by them may also, at their advisement, be incorporated into Planning Act policies. The effectiveness of the land use planning process came under study by a Commission on Planning and Development Reform in the early 1990s. In 1993 the OMNR (Ontario Ministry of Natural Resources) and OMOEE (Ontario Ministry of the Environment and Energy) published guidelines that came out of a round of hearings. The guidelines promoted more effective land use planning through sub-watershed planning. The commission maintained that:

> Conservation Authorities already have a strong track record for studying and attempting to protect health of watersheds. The experience and expertise should be used in preparing watershed studies and recommendations, in helping mesh the local concerns of municipalities with broader concerns for the natural environment, and for studying the long-term implications of changes (OMNR & OMOEE, 1993:79)

Government's response to the commission's report is reflected in a set of comprehensive policy statements under the Planning Act, which directed that municipalities would be required to follow. They require that municipalities prepare an Official Plan and they extent municipal powers to make development decisions that are consistent with provincial policy statements. The OMNR may assign increased responsibilities to conservation authorities and/or municipalities for administration of the Lakes and Rivers Improvement Act. Other changes included provisions that supported sub-watershed planning, the preparation and review of environmental impact statements, and the monitoring of environmental conditions and impacts. Conservation authorities are well placed to play a significant role in sub-watershed planning, impact assessment and environmental monitoring (Shrubsole, 1996). The application of the conservation authorities' experience and expertise in preparing watershed studies and making recommendations for meshing the concerns of local municipalities with the broader concerns for the natural environment, and for studying the long-term implications of changes works well with the commission's statement above.

In line with the above Planning Act reforms, sub-watershed planning became the prominent planning approach to ecosystem management issues in the 1990s. By redirecting the focus onto the sub-watershed, which is a smaller version of a river basin ecosystem, it facilitates understanding of the system and of applying the ecosystem approach (OMNR & OMOEE, 1993). Cumulative knowledge gained from individual sub-watersheds provides steps for moving from a micro level to an overall picture of the greater river basin ecosystem.

Accumulation of knowledge from the various sub-watersheds in a river basin allows for more directly focusing on the river basin ecosystem management approach in the following ways: 1. identifying the significance and sensitivity of the existing natural environment, 2. establishing management goals and objective, 3. identifying areas for development and how to mange the environmental impacts, 4. addressing cumulative impacts of future land use changes, and 5. providing appropriate conflict resolution mechanisms (OMNR & OMOEE, 1993).

The information gained at the sub-watershed level can be incorporated into municipal planning documents and those of other management agencies that are concerned with local issues. Conservation authorities with their watershed jurisdiction are ideally positioned to play a major role through their advisory capacity and cooperation with municipalities and other agencies (Shrubsole, 1996).

Natural heritage has gained conservation attention during the past decade. Protecting the remaining undisturbed natural heritage in developed areas is an advantage over restoring it, if that is possible, after it has been modified. Policy 2.3 of the Provincial Planning Policy Statement that deals with Natural features and areas outlines a Natural Heritage Approach, Addressing Impacts of Development on Natural Heritage Features and Areas.

The policy statement defines natural features and areas as:

> Significant wetlands, fish habitat, significant woodlands south and east of the Canadian Shield, significant valley lands south and east of the Canadian Shield, significant portions of habitat of endangered and threatened species, significant wildlife habitat, and significant areas of natural and scientific interest, which are important for their environmental and social values as a legacy of the natural landscape of an area (Provincial Policy Statement 2.3, 1999: 2.1).

> Significant means: Identified as provincially significant by the Ministry of Natural Resources using evaluation procedures established by the province, as amended from time to time...Criteria for determining significance may be recommended by the Province, but municipal approaches that achieve the same objective may also be used (Provincial Policy Statement 2.3, 1999: 2.1).

Lands adjacent to heritage features or areas that may impact upon natural heritage features and areas are also subject to the Policy Statement:

> Adjacent lands mean: Those lands; contiguous to the specific natural heritage feature or area, where it is likely that development or site alteration would have negative impact on the feature or area. The extent of the adjacent lands may be recommended by the province or based on municipal approaches, which achieve the same objectives (Provincial Policy Statement 2.3, 1999: 2.1).

Natural heritage planning is community based involving residents, landowners, NGOs, conservation authorities, and local MNR offices working cooperatively with the local planning authority (MNR, 1999).

Chapter Summary

The literature review describes the structure and function of ecosystems, including their self-organizing capabilities and their ability to maintain integrity within the limits of their resilience. It also defined ecosystem as containing all the abiotic, biotic, and cultural entities within its geographical area. Forestry, wetland, riparian, and aquatic/terrestrial ecotone zone restoration issues, all of which are pertinent to the river basin restoration issues in the study areas, are included. It outlines reasons why the ecosystem approach is the logical approach to managing geographical areas as complex as river basins.

With regard to environmental management and restoration issues being controlled by the cultural component of the ecosystem, it is to be expected that in an advanced socioeconomic system there will be some leading governmental body that sets guidelines and provides general directions. In the study areas the conservation authorities are the leading conservation agencies. The provincial government through OMNR administers them. The literature review contains a brief section on the Planning Act and some Provincial Policy Statements to which the conservation authorities adhere. The next chapter, which opens with a section on the biophysical attributes from which the study areas' ecosystems sprang, and continue to exist, goes on to elaborate on rise of conservation movements and the 1946 Conservation Authority Act that established the conservation authorities. As well, it chronicles the evolution in the conservation authorities approach to environmental management, changes in Provincial Policies, and changes in public attitudes.

Chapter 3: The Basins' Biophysical Attributes and Conservation Authority Background

Ecosystems occupy geographical space and consist of all the entities within that space (Bastedo et al., 1984). The environmental management practices within the ecosystem are controlled by the cultural component of the ecosystem in spite of the abiotic and biotic entities deserving considerations equal to those given to the cultural entity. This chapter presents an outline of the biophysical attributes from which the study areas' ecosystems sprang and continue to exist. This is followed by an outline of the socioeconomic system and conservation movements. The details of the cultural component include the socioeconomic system, conservation movements, conservation authority founding principles and powers, reviews and changes. Specific watershed issues, changing focus with changing times, and a peoples' partnership as it relates to stewardship are also included.

Biophysical Attributes of the Study Areas

Geology, geomorphology and climate all have an influence on the type of soil, the natural vegetation and the type of wildlife within a geographical area. These same factors also have a bearing on the type of cultural and economic development that takes place. Successful agricultural communities depend on the type of soil, sufficient moisture, kind of climate, and morphology that are conducive to the types of crops being cultivated. Market access is an added factor. Among the attributes that influence socioeconomic development are moderate climate, sufficient water supply of good quality, environmental aesthetic values, and access to transportation and markets.

The properties of the soil and other substrate materials on the surface of the earth depend upon the properties of the geological material from which they have weathered (Strahler & Strahler, 1987). The underlying sedimentary bedrock in the three river basins dates from the mid-Silurian through the mid-Devonian epochs of the Paleozoic era (Hewitt, 1978). The general regional dip of the surface of the bedrock slopes toward the southwest. Its deposition date is progressively later from east to west (Hewitt, 1978). The sedimentary rock is underlain by pre-cambrian igneous rock and in general has a thick glacial till overburden (Hewitt, 1978).

The physiography in the three river basins is defined by the weathered glacial till overburden. Predominant among the features are kames, outwash areas, kame moraines, and till plains. A dendritic river and stream network has been carved into the glacial till and in limited areas into the bedrock outcrop. There are limited areas of bedrock outcroppings in all three river basins. Gravel-rich outwash areas, exposed limestone in outcrops, and gypsum and salt underground deposits are sources of non-renewable natural resources (Hewitt, 1978). The gentle to moderately sloping till plains and their river and stream network, are readily adapted to agricultural and urban development land uses.

The climate is classified as humid continental with mild winters and cool summers in the northern and more upland portions ranging to warm summers in the southern portion (McKnight, 1992). The natural vegetation types range from broadleaf deciduous in the southern portion, to mixed broadleaf and needle leaf to the north (McKnight, 1992). The northern reaches of Carolinian vegetation extend northward to north of London in the Upper Thames river basin and to the mid-basin of the Grand River

(Riley, 1989). Small, protected areas with southern exposures create pockets where microclimates support more tender vegetation.

The soil taxonomy in the three river basins indicates a complex mosaic of interspersed patches of soil classifications. A broad general classification refers to the soils in southwestern Ontario as Alfisols (McKnight, 1992). Alfisols are described as soils with a mature profile that may develop in widely diverse climate and vegetation environments. They have gray-to-brown surface horizons, and commonly have clay accumulation in sub-surface horizons. They become modified when exposed to erosion on sloped lands. They also become modified through agricultural cropping and tillage practices, and modification through leaching of nutrients takes place (McKnight, 1992, Strahler & Strahler, 1987). In general, the slopes in the three river basin areas of Ontario are gentle to moderate along with limited areas of severe slope (Hewitt, 1978). While alfisols is a general classification for soils in the three basins, as is common in most geographical regions of Southern Ontario, the soils vary on a micro-scale due to variation in the regolith from which they develop. Soil variation on the micro-scale is common in the study areas because-the native regolith has been augmented by large amounts of glacial till Hewitt, 1978). Undisturbed wetlands slowly accumulate decaying organic matter forming an "A" horizon that is high in humus typical of the histisols (Strahler & Strahler, 1987). Variations in moisture, temperature and natural vegetation also affect soil development on a micro-scale. Variations in glacial till are largely due to the way in which it is deposited during a glacial event. Typically, outwash areas contain a high amount of gravel and coarse sand along with clay layers. Kames have a high sand content. Moraines and eskers normally contain a mixture of particle sizes ranging from clay to cobble (Strahler & Strahler, 1987).

The Socioeconomic System of the Study Areas

Beyond reserve lands that remain occupied by indigenous North American Peoples, immigrants primarily from Europe and the United States settled the three river basins. They took advantage of well developed, good agricultural soils, sufficient moisture, a temperate climate, dependable stream flow, and an aesthetically pleasing landscape with topographical relief that is amenable to agricultural purposes. Agricultural settlement created a demand for supplies and services (Watkins, 1963). Supply and service development naturally competed with agriculture for prime lands and locations along rivers and streams. In the early settlement period, apart from domestic needs, and driven by the staples mercantile trades, wheat for export to Britain was a major cash crop (Vance, 1970). Agriculture and urban industrial/commercial development, along with export of natural resources have expanded, changed and retrenched along with changing domestic and world economic conditions, demands, and restrictions (Fuller, 1994).

Bryant (1992) described the predominant post-World War Two demographic changes in the more rural areas of Southwestern Ontario in follow way. Continuing urban housing, industrial, and commercial development had absorbed much land in major urban centres. It has also sparked a counter urbanization move of people moving to more rural surroundings and commuting to the urban centres to work. Urban work opportunities lure the younger workers off the farm, leaving the farming to an aging population. Good transportation providing easy access to central shopping centres drains the vitality out of smaller service centres (Bryant, 1992). Caldwell (1995) with particular emphasis on the Huron County area, remarked on the availability of large post World War Two labour saving machinery, competitive markets, and the trend away from the 100 and 200 acre family farm toward larger land holdings and amounts of leased lands farmed per operator, and increased cash-cropping and agribusiness. He saw these changes as a threat to agricultural land and soil preservation (Caldwell, 1995). Dahms (1995) remarked on the difficulties experienced by small centres to survive, leading to the demise of some of them, especially in the northern, more agricultural areas of the three river basins. A limited number have survived by focusing on and developing recreational facilities (Dahms, 1995). Another few have developed retirement complexes aimed at retired local people who do not wish to retire to larger centres (Dahms, 1996). Derelict remnants of once proud cultural expression dot some rural landscapes as well as some urban landscapes. They are what remain of houses, barns, and urban structures – once trades-people's places of livelihood (McIlwraith, 1998). It may be speculated that the foregoing trends will continue. Agribusiness and large family compounds may well be expected to continue to assemble large acreages into single holdings.

Conservation Movements

In the study area, various initiatives, some as early as the 1930s, recognized the interplay between humans and the environment suggesting compatibility between the two. The transformation from humans seeing themselves as masters over nature and the prime benefactors of its bounty to their acceptance of being a part of nature with stewardship responsibilities does not appear to take place as the result of a single grand vision. Examples are early 1900s reactions in response to growing urbanization within a specific geographical region. How these responses play out is evident in the concern of several municipalities in the Grand River basin about the detrimental impacts of urban growth causing degradation of water and related resources, as well as resulting in much flood damage. It led to the 1938 Grand River Conservation Act and the establishment of the Grand River Conservation Commission (GRCC). The stated long-term objectives were to "provide a sufficient supply of water for domestic, municipal, and manufacturing purposes, and to control water in periods of flood (Yu & Veale, 1984). The Act authorized the GRCC to:

> Study and investigate...the Grand River Valley, and to determine a scheme whereby the waters of the said Grand River Valley may be conserved to afford a sufficient supply of water for the municipal, domestic, and manufacturing purposes of the participating municipalities during periods of water shortages and controlled in times of flood, and to undertake such schemes. ...erect works and create reservoirs by the construction of dams or otherwise (Yu & Veale, 1984; 5.1).

This beginning, which in the context of an ecosystem approach seems highly anthropocentric, was a major step toward accepting environmental stewardship responsibilities. The next step was the establishment in 1948 of the Grand Valley Conservation Authority (GVCA) under the Conservation Authorities Act. The purpose of the GVCA was to coordinate all aspects of conservation, besides water, in the Grand River basin. Since water and land resources are interrelated the GRCC and the GVCA were experiencing duplication conflicts. In order to streamline operations the two agencies were merged into the Grand River Conservation Authority in 1966 (Yu & Veale, 1984). The Maitland Valley Conservation Authority was founded in 1951 (Thompson, 2001), and the Upper Thames River Conservation Authority was founded in 1947 (UTRCA, 1996).

Conservation Authority Founding Principles and Powers

The conservation authorities original mandate was based on six founding principles: 1. Watershed Jurisdiction, 2. Local Initiatives, 3. Provincial-Municipal Partnership, 4. A Healthy Environment Required for a Healthy Economy, 5. A Comprehensive Approach, and, 6. Cooperation and Coordination.

The watershed, the local initiative and the provincial-municipal partnership founding principles were most outstanding in discussions leading to the creation of conservation authorities (Richardson, 1974). A Healthy Environment Required for a Healthy Economy, a Comprehensive Approach, and Coordination and Cooperation remained on the agenda but received less attention (Mitchell & Shrubsole, 1992). All six founding Principles are compatible with an ecosystem approach, even though they were formulated many years before the ecosystem approach came into use in Ontario. Along with the founding principles, the conservation authorities were granted ten specific powers as follows:

- Study and investigate the watershed and determine a program whereby natural resources might be conserved, restored, developed, and managed:
- Acquire by purchase, lease or otherwise and to expropriate any land they might require.
- Determine the proportion of total benefit afforded to all municipalities received by each of them:
- Erect works and structures and create reservoirs by the construction of dams and other works:
- Control the flow of surface waters in order to prevent floods or pollution or to reduce the adverse effects of them:
- Alter the course of any river, canal, brook, stream or watercourse, divert or alter, temporarily or permanently, the course of any river, stream, road, street or way:
- Use lands owned or controlled by the authority for such purposes considered proper and not inconsistent with its objectives:
- Plant and produce trees on Crown lands with consent of the minister, and on other lands with consent of the owner:

- Collaborate with departments and agencies of government, municipal councils, local boards and other organizations: and to,
- Cause research to be done (Mitchell & Shrubsole, 1992).

Reviews and Changes

Since 1946 the conservation program has been reviewed three times. There was the 1967 Report of the Select Committee on Conservation Authorities (Select Committee, 1967). There was also the 1979 Report of the Working Group on the Mandate and Role of Conservation Authorities of Ontario (OMNR, 1979), as well as the 1987 Review of the Conservation Program (MNR, 1987). Conservation authorities have also had to shift initiatives due to ongoing changes and amalgamations of other provincial agencies that they cooperate with. Since the inception of conservation authorities the Ontario Clean Water Agency was formed. The Environmental Protection Act and the Environmental Assessment Act have been introduced. Regional Government was introduced in 1969 along with necessary changes to the Planning Act. The Ministry of Natural Resources (OMNR) and the Ministry of Agricultural Food and Rural Affairs (OMAFRA) have undergone major changes (Shrubsole, 1996).

The 1987 Review of the Conservation Program

The 1987 review by an inter-ministerial committee was the widest ranging of the above mentioned reviews. It concluded that: 1. except for flood control, there was a lack of consensus about specific responsibilities for conservation authorities, 2. there was inconsistent program delivery and large variability of financial resources among the 38 conservation authorities, 3. the membership was often too large, and, 4. the grant structure created difficulty for conservation authorities (OMNR, 1987). The committee made several recommendations: 1. Conservation authorities should continue to operate on a watershed basis with strong local initiative and through municipal provincial cost sharing, 2, All conservation authorities in Southern Ontario should operate on a specific-programs basis (individual projects basis), 3. The number of conservation authorities in Southern Ontario should be reduced from 33 to 18 through amalgamations, 4. Some authorities should reduce their membership, and, 5. The grant structure should be altered and the province should contribute an additional $5 million to meet present and future funding needs. Decisions based on the recommendations included designation of conservation programs as core and non-core projects. Public information programs, small-scale erosion and sediment control on private land (with the local share of cost to be wholly or partially shared by the benefiting land owner), flood and in-stream erosion control, and operation of conservation area operations (parks) were all designated as core projects. Outdoor education programs were to be designated non-core projects. Cost sharing was set at 50% for capital programs and 50 to 70% for operating programs. Conservation authorities with low populations and low assessments were to receive the 70% grant rate (Shrubsole, 1996).

In the 1990s all levels of Government have reduced funding for resource management activities. In its November 1995 financial statement the provincial government announced the scaling back by 70% of conservation authorities' operating funds, over a two year time period, and the elimination of capital works funds (Shrubsole, 1996). As a result conservation authorities have had to scramble to fund existing programs and responsibilities and have had to apply restraint toward taking on new initiatives. They focus more on their role as resource organizations by lending their expertise to other agencies and individuals.

Specific watershed Issues

While all conservation authorities adhere to the same founding principles and powers, they practice sufficient autonomy to deal with issues that are specific to their particular river basin. Undue stress placed upon one element within an ecosystem will no doubt have rippling effects throughout the entire system. With such an occurrence within a river basin, conservation authorities must concentrate on the offending cause of stress without short changing other elements in the ecosystem. In the Grand River Basin the main cause of stress is the high demand placed on the water resource. Between 1977 and 1981 the Grand River Basin Water Management Study was carried out under the Grand River Implementation Committee (GRIC), an organization that was formed in 1972. The overriding purpose of the study was to recommend water management plans to deal with flood damage reduction, provide adequate water supply, and to maintain adequate water quality. The study examined 26 different water management plans and assessed their relative economic, social and environmental costs and benefits. The number was narrowed down to 5 and then to 3 for detailed study. Finally a plan designated as plan A4 in the study was recommended. The plan recommendations included flood damage reduction using dykes and channelization, better water quality through additional sewage treatment, water supply through additional ground water supply, infiltration wells from surface water, recharging aquifers from surface water and direct river withdrawal. It also called for optional flexibility through reservoir construction at West Montrose, if required (GRIC, 1982). With steady urban growth in the middle basin region of the Grand Valley long-term water use planning will remain a major concern. The planning foresight that went into the 1982 recommended plan resulted in a system that was sustainable into the 2000s but the resource remains constant while the demand keeps increasing.

In the Maitland River basin, where there is a lower concentration of urban development, the need for conservation efforts is more evenly distributed among rural, urban and Lake Huron shoreline issues. The MVCA currently takes a balanced approach to conservation issues in accordance with a set of Policies and Procedures developed and published in a 1992 Manual (MVCA, 1992). It outlines policies and procedures under the headings of: Upland Forests, Flood Plain, Headwaters Areas, Areas of High Water Table, Wetlands, and Lake Huron Shoreline. The guidelines are specific as to their application in the case of Rural, Urban or Lake Huron Shoreline issues.

In the Upper Thames River basin the demands on the water resource by the urban and agricultural sectors, as well as their contribution to pollution, also place water issues high on the UTRCA's list of environmental issues. London, the major urban centre, draws its water from Lake Huron via a pipeline. Stratford, Woodstock and St. Marys are the other major urban centres and rely on surface and groundwater. They are less clustered than the major urban centres in the Grand River basin allowing more room for flexibility of approaches. A large portion of the upper branch of the Thames River and its headwater streams are located on the Stratford Till Plain physiographic region. The high clay content in the till plain's soils reduces water infiltration and poses risk of groundwater depletion during periods of drought making water and soil conservation an important factor, (UTRCA, SOWR 2000).

In 1976 the Thames River Implementation Committee (TRIC) was established in response to an OMOEE and OMNR Thames River Basin Water Management Study.

Water quality and flood control were the leading points of focus for the TRIC. Since flood control and municipal servicing were receiving considerable attention by existing agencies, the TRIC concentrated on improving agricultural land management in an effort to reduce impacts from rural diffuse sources (TRIC, 1982). Conservation tillage, fertilizer uses, cattle access to streams, farm waste discharges, headwaters areas management, and soil erosion and conservation measures were investigated. Demonstration projects were carried out and recommendations were forwarded. Implementation strategies included public education, continued demonstration projects, and active participation by municipal, provincial, and federal agencies, along with voluntary participation of farmers (TRIC, 1982).

Changing Focus with Changing Times

The bottom-up rather than the top-down nature of the conservation authorities is supported by the Local Initiatives and Watershed Jurisdiction founding principles, as well as to some extent by the Provincial-Municipal Cooperation founding principle. The province does not force the establishment of an individual conservation authority. It is dependent upon majority acceptance by the local municipal entities (Mitchell & Shrubsole, 1992).

A key purpose for founding conservation authorities in Ontario was the conservation, development, and management of natural resources other than gas, oil, coal and minerals. The Ontario Conservation Branch prepared an environmental survey, report to aid establishment of each conservation authority. These survey reports became a guide for the authorities: early planning and operations (Mitchell & Shrubsole, 1992).

Water management, especially flood control, and soil erosion received much of the conservation authorities' early attention. The socioeconomic system in the three river basins depends upon water for its agricultural, industrial, commercial, and domestic water needs and for the basins' ecological health. Water management therefore, is and will continue to be an important factor for conservation authorities and other water management agencies.

By the early 1970s conservation management focus began to shift away from concentrating only on single ecological issues toward an open space concept taking, what may be considered, a step toward an integrated ecosystem approach. Open space was defined as space open to the sky and not built upon. Open space became valued for its potential to establish attractive community design, a visually pleasant landscape, and for maintaining natural resources and supplies. Conservation authorities along with municipalities were able to preserve open space by including an open space policy in official plans, by regulating dumping of fill, and by regulating building construction through zoning bylaws. The conservation authorities played an active role in another facet of the open area concept. They carried out research to accumulate inventory data for establishing environmentally sensitive protected areas (areas of natural scientific interest [ANSIs]) that were created under the heritage clause of the Ontario Planning Act (GRCA, 1973). The conservation authorities may also be called upon to advise with regard to the feasibility and desirability of development in certain areas (GRCA, 1971). During the early and mid 1970s conservation authority land management, which had been focused on soil erosion, expanded into land acquisition on flood plains, acquisitions of wetlands, and on reforestation along with development of recreation areas. The reforestation efforts were expanded on acquired lands as well as through agreements on privately owned lands (GRCA, 1976).

The Coordination and Cooperation founding principle is apparent in the authorities' interactions with the public, with municipalities, with sister conservation authorities and with other government and non-government organizations (NGOs). They cooperate on the municipal, provincial and federal levels, and with other agencies. Soil conservation is carried out in cooperation with the provincial Ministry of Agriculture Food and Rural Affairs (OMAFRA). Reforestation and wetlands involve the OMNR. Livestock and manure management involves the Ontario Ministry of the Environment (OMOE). River basin mapping is carried out in cooperation with Environment Canada. In Ontario, water management functions involve several agencies. Conservation authorities are primarily assigned the duties of flood and erosion control, low flow augmentation and water quality sampling. The OMOEE is responsible for water quality. The OMNR has fisheries, forestry, public lands and the conservation authority program. OMAFRA deals with diffuse pollution sources. Municipal Affairs (OMMA) oversees land use policy. The Ontario Clean Water Agency (OCWA) is responsible for water supply. Local municipalities have responsibility for local land use planning and supply, and for sewerage (Shrubsole, 1996).

In the early part of the 1990s the small valleys' concept became transformed under the heading of Sub-watershed Planning (OMNR & OMEE, 1993) (see above). This recognized the sub-watershed as an ecosystem within the greater river basin ecosystem. Studying, planning and carrying out sub-watershed ecosystem preservation and restoration have, no doubt, been a major step in conservation authorities' adoption of the comprehensive adaptive ecosystem approach to environmental management.

> In 1993 the OMEE and the OMNR issued a comprehensive outline regarding watershed management for implementation of an ecosystem approach to aid resource managers, planners and stakeholders in watershed planning. It outlines the process from an ecological perspective, water management and land use planning, and watershed planning through the groundwork phases, plan development, plan implementation, and follow-up monitoring (OMEE & OMNR, 1993; 1.1).

Three of the case studies in the next chapter indicate some movement from individual ecosystem management toward basin wide management plans.

While conservation authorities are guided in their mandate by the founding principles and allotted powers, in their daily operations they are under obligation to adhere to a series of Provincial Policy Statements. In their exercises as an authority that affects planning matters, they are required to regard the Policy Statements issued under Section 3 of the Ontario Planning Act. A 1997 Provincial Policy Statement, under Section 3, has a direct bearing on "a healthy environment required for a healthy economy" founding principle and on the conservation authorities' responsibility as resource managers. The policy statement promotes a policy-led system, which recognizes that there are complex inter-relationships among environmental, economic, and social factors in land use planning. The apparent aim is to attain sustainability by managing growth in communities that are economically and environmentally sound with regard to the province's resources. The position taken in the Policy Statement is the protection of the agricultural land base, the wise use of mineral resources, natural heritage resources, water supply, and cultural heritage resources that provide economic, environmental and social benefits. The Policy Statement also declares that long-term health and safety, along with financial well-being of the province and municipalities are of major provincial interest (Ontario Planning Act, Sect. 3, 1997: Feb 1)

A People's Partnership

With reduced public funding it has become increasingly necessary for conservation authorities to concentrate on acting as information and advisory resource organizations. Their present ecosystem restoration role is primarily fulfilled by researching, formulating, and coordinating implementation of such diverse plans as sub-watershed plans, river basin plans, soil and water management plans, fisheries management plans, recreational land use plans, reforestation plans, and natural heritage conservation plans. These plans form guidelines for municipalities in constructing their secondary and official plans. For individual landowners they research, and formulate plans and offer advice on individual environmentally friendly farm plans, woodlot restoration plans, agricultural waste management plans and stream buffer zone plans.

In 1995 the Ministry of Natural Resources was faced with financial constraints and changes in relationships between landowners, government, corporations, and NGOs with interest in land stewardship. OMNR withdrew from many of its on-the-ground management programs. Private land and crown land forest management was a prime area that was affected. In the study area this resulted in declaring County Forests surplus. Overall the thrust was toward shifting land and environmental stewardship into the hands of NGOs and private landowners (Smitka, 2001). The ministry responded by initiating the Private Land Resource Stewardship Program (PLRSP). The program is set up to operate under the form of Stewardship Councils, one council per county or regional government jurisdiction. Each council is assigned a Stewardship Coordinator who is an employ of

OMNR. The coordinator works for the council to ensure that it gets scientific and technical information and to facilitate project development (Faught, 1999). The initiatives of the PLRSP are to respect the following principles:

> The program will jointly involve landowners and people with interest in the land to attain private stewardship goals,
> The program will respect landownership (i.e. the rights of the landowners to manage their land).
> The program is not a government control program, but rather a program based on influence at the community level.
> The program will encourage resource agencies to work together to provide complimentary services and support to landowners, while avoiding duplication.
> The program will emphasize awareness of incentives and self-help support (Smitka, 2001).

Conservation authorities' primary role in connection with Stewardship Councils is that of a resource organization for providing expert advice and for coordinating the facilitation of restoration projects. Stewardship takes on many forms. References to private landowner stewardship, stewardship in relation to conservation authority activities, and stewardship in relation to Stewardship Councils create an element of confusion. In relation to the twelve projects investigated for this thesis there were several projects in which multiple organizations participated without distinction between individual stewardship, community stewardship, conservation authority driven stewardship, and Stewardship Council inputs. It was only in the Lower Maitland River Project report that any direct reference was made to a Stewardship Council's direct involvement.

Chapter Summary

The opening section of this chapter outlined the biophysical attributes of the geographical study areas. That is the base from which their ecosystems sprang and continue to exist. The literature in this chapter supports the idea of the biophysical attributes of a geographical area being the determining factors of the type of ecosystem that develops. The founding members of the presently existing socioeconomic system in the study areas, no doubt, found an ecosystem that was amenable to human habitation due to its bioproductive capabilities, aesthetic values, and relatively moderate climate.

However, by the 1930s it was realized that to taking all possible from nature without concern for responsible stewardship was not sustainable. The realization sparked a series of conservation movements (Yu & Veale, 1984; 5.1). A major step in the sequence came in 1946 with the establishment of the conservation authorities through the Conservation Authority Act. The authorities' six founding principles and ten powers are listed in this chapter. The evolution of the conservation authorities approach to environmental management during their fifty-six year existence from the early top down approach, through the ecosystem approach, and toward the basin wide management plan approach is discussed. Financial constraints imposed during the latter half of the 1990s have been a challenge to maintaining an accustomed-to level of service. Employing the general public through involvement in stewardship commitments is one strategy that is coming into use to ease the situation.

The case studies in the next chapter were undertaken with the information gleaned from the literature review in the previous chapter and the information gleaned from this chapter being uppermost in mind.

Chapter 4: Detailed Case Studies

The case studies contained in this chapter are based on projects described by printed published reports on record at the three conservation authorities. The selections were made with the intention of examining projects that represent a broad cross-section of the numerous projects carried out by each of the three authorities. The authorities' annual reports and consultation with their staff through the intervention of an individual contact person at each authority were the sources of information by which the selections were made. Four projects were selected from each authority's records. Though the projects were selected to represent a cross-section of projects by each authority, they fall into three general categories.

One category is represented by sub-watershed plans within the greater river watersheds. In this category are, the Canagagigue Creek Watershed Plan for a sub-watershed of the Grand, the Avon Valley Plan for a sub-watershed of the Upper Thames and The Lower Maitland Project, a valley sustainability project for the Lower Maitland. There is also the Cedar Creek Watershed Project, a sub-watershed of the Lower Thames. The Cedar Creek project was developed as a Global Rivers Environmental Education Network project. A fifth project in this category is the Eramosa River-Blue Springs Watershed Study, a sub-watershed in the Grand River watershed. Selecting sub-watershed projects that were generally representative of sub-watershed projects was complicated by the numerous project reports on file.

A second category is represented by four projects that deal with a variety of agriculturally related issues at the farm level. They include the MVCA- Agroecological – Wildlife Enhancement Farm Plan Program, the UTRCA- Vetrepharm Inc. Soil and Water

Conservation Farm Plan, the UTRCA- Kintore Creek Paired Watershed Project, and the MVCA- Pilot Woodland Swamp-Upland Restoration Project.

The third category is represented by projects that typify the movement by the conservation authorities to broaden their core mandate of soil and water conservation, water quality, and stream-flow management, beyond sub-watershed management to a more basin-wide ecosystem approach. Among these projects are A Watershed Forest Plan for the Grand River, the Watershed Plan for the Upper Grand River Watershed, and the Maitland Watershed Partnership.

Selecting the GRCA- Watershed Forest Plan over their Watershed Fishery Plan for this exercise was a personal choice based on the close relationship between ecosystem fragmentation and cultural development in the study areas. The Upper Grand River Watershed Plan represents the development of a comprehensive plan whose intended future includes being developed into a comprehensive basin-wide plan. The Maitland Watershed Partnership represents a cooperative effort between the general public and the conservation agencies, in particular MVCA, with the potential for developing a basin-wide ecosystem management plan. The case studies are each detailed under six sub-headings: Introduction, Biophysical Attributes. Cultural History, Planning Process, Research Process and Results, and Restoration. A comments section is added when it helps to clarify specific features.

GRCA – Canagagigue Creek Watershed Plan

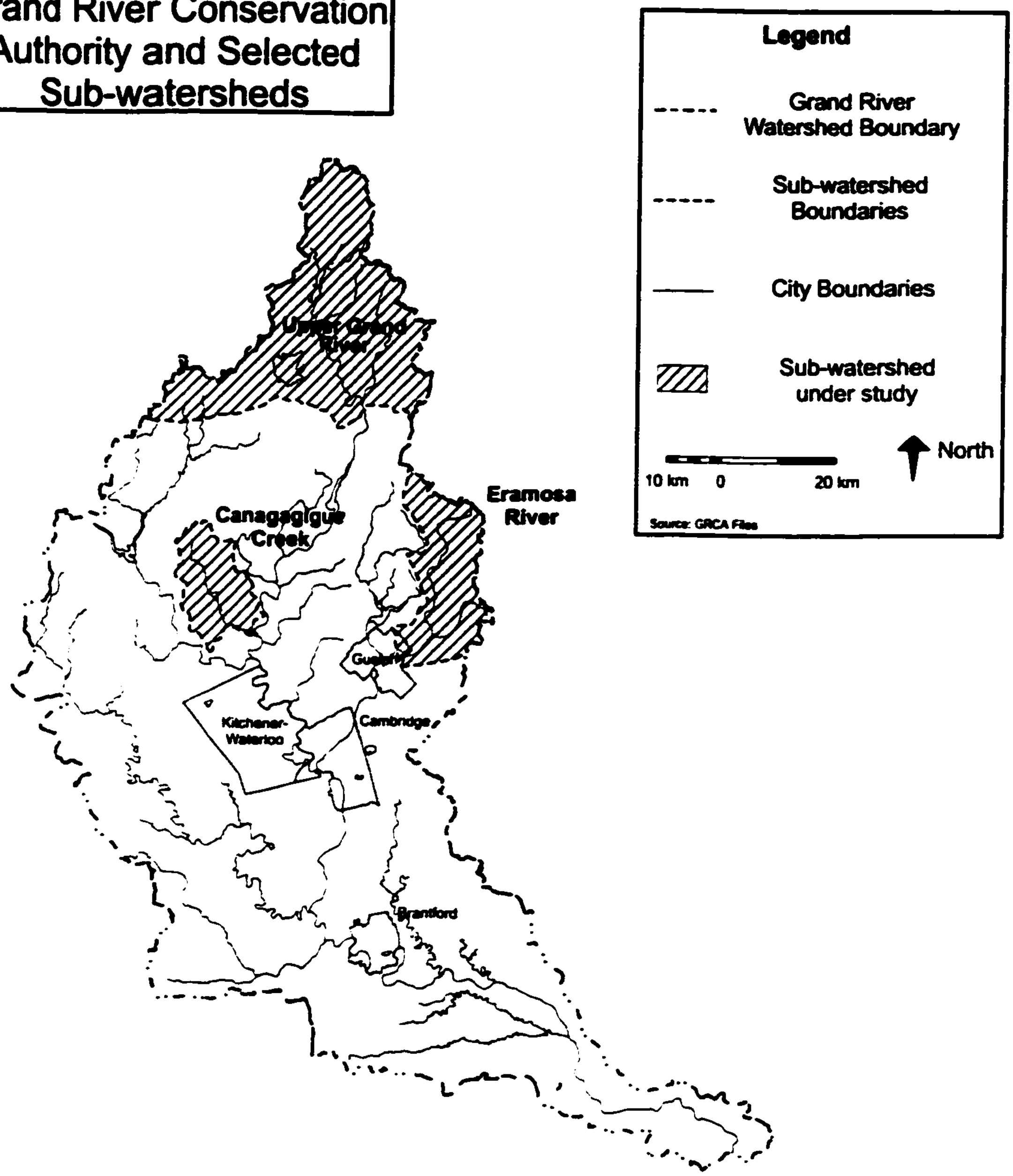
The Canagagigue Creek Watershed has an area of 153 sq. km. It is mostly rural and intensely cultivated. Elmira, the major urban centre, is located in the lower part of the basin. The creek empties into the Grand River above the major urban cluster in the central portion of the Grand River basin (Fig. 2). The creek basin has been identified as one of the most environmentally degraded in the Grand River basin (King, 2000). The GRCA staff coordinated a study together with interested parties to address the situation through the development of a creek watershed plan and undertook a comprehensive study of the watershed. A prime purpose was to develop guidelines within a watershed plan to inform local, regional and provincial governments regarding appropriate rehabilitation methods and planning policies for future development and land use decisions that minimize impacts on the natural environment (King, 2000).

The Biophysical Attributes

The dominant surficial features of the northern and western areas of the watershed are sandy hills, ridges, kames, and kame moraines. Deposits of outwash sands are present in the low areas. The southern and eastern parts of the watershed are within the limits of the Guelph drumlin field having the presence of many oval shaped hills. The steep slopes in the northern area make it an area of high erosion potential. Soil textures vary widely throughout the basin due the types of till deposited in the drumlins, kames, kame moraines and outwash areas (King, 2000).

The watershed climate is humid continental with mild winters and warm summers. There is a long growing season and there is reliable rainfall. The watershed receives an average of 900-1000 mm precipitation annually. Yearly evapotranspiration averages 520-540 mm, roughly one half of the precipitation. Approximately 12% of the watershed area is forest covered. Approximately 2% of the 12% is reforested area and an

Figure 2:
Grand River Conservation Authority and Selected Sub-watersheds



additional 3% of the 12% of the natural vegetation is scattered in small wetlands along tributary streams. There are two regionally significant areas in the northeast. Most remaining natural heritage exists along stream corridors and in back-of-farm woodlots (King, 2000).

Cultural Influences

The environmental issues have accumulated over nearly 200 years from less than adequate environmental concern by agricultural and urban/industrial operators. On the agricultural scene, the sources of pollution entering the surface and groundwater were identified as including: barnyard and milk-house runoff, field fertilizer and pesticides, improper manure handling, erosion prone types of tillage methods, poorly sealed wells, faulty septic systems, livestock access to streams and inadequate buffer zones. Field tile systems provide direct pollutant transportation routes to the creek. Steep slopes in the northern portion of the watershed that are under unsuitable types of tillage practices have been a cause of stream bank and farm field erosion. On the urban scene, the Elmira water pollution control plant (WPCP) has been the main contributor of effluent to the creek. Uniroyal Chemical contributed 18% of WPCP's total effluent discharge to the creek, prior to the 1989 discovery of Elmira's groundwater aquifer being destroyed as a viable water source. Uniroyal's contribution has since been reduced to 4%. Residual DDT and Dxxz2,4,D compounds present in stream sediments, and to a lesser degree in ground water seepage, present long-term concerns. The municipal surface drainage system delivers a mix of industrial, commercial, and street flushing pollutants. The watershed's natural heritage is being compromised and the possibility of natural hazards due to encroachment of development and agricultural cultivation onto the floodplain is being ignored (King, 2000). The Woolwich reservoir was built to counteract some of the negative effects that have been left in the wake of creek deterioration. Its leading function is augmenting low stream flow, which in drought periods could result in more than 10% of stream flow below Elmira being sewage effluent. Its present flood hazard control function is minimal but could become greater due to industrial development in Elmira. As a cultural asset the reservoir is a day camping and picnic area and provides very limited fishing (King, 2000). Aggregate extraction for the local and the KW urban market has resulted in seven sizable licensed aggregate sites and twelve smaller privately owned unlicensed sites. Fourteen of the sites are non-operational in various states of being overgrown (King, 2000).

Planning Strategy

Identifying the environmental issues and monitoring their existing state formed the basis for the research upon which planning for the development of the watershed plan began. A key planning focus was on how improving the existing state of the ecosystem could be accomplished by factoring in the capabilities of the existing abiotic, biotic and cultural entities within the watershed's ecosystem. A second important planning strategy was to incorporate present and previous ecosystem enhancement projects into the watershed Plan. The planning process was undertaken in the knowledge that private land ownership and municipal jurisdiction over land use and zoning plays a key role in implementation of such a plan. Implementation hinges on landowner cooperation and on the inclusion of the plan's policies in municipal Secondary and Official Plans. The conservation authority's role ranges from advisory to inspection and enforcement (King, 2000).

The Research Process

Central to the research on the abiotic entities and indirectly to the biotic entities were the creek itself, its tributaries, the stream morphology, its relationship to the hydrological cycle, its relationship to the land in the basin, its biological productivity and its cultural encumbrances. Study observations indicated a low proportion of riffles with oxygenating ability, long stretches of shallow slow flowing flats, a limited number of pools for larger aquatic organism protection during droughts, and long stretches of stream bank without riparian vegetation. There was evidence of movement of water to the stream via surface runoff, artificial drainage systems, and ground water seepage, along with many springs. There is also water movement from the stream into groundwater between rain events. GRCA monitors and compiles data on flow regimes and water quality on an ongoing basis. With regard to water/land and cultural activities on the land, soil erosion, sediment transport and a low 10% of remaining natural woodland coverage stand out. Sedimentation problems are most severe in the northern part of the basin due to lack of vegetation cover, greater slope, and common tillage practices on silty soils. The lack of buffer zones between streams and areas that are cultivated, or on which livestock are pastured, are common throughout the basin. Benthic and fish monitoring data indicates that sedimentation abatement could be the key to re-establishing a coldwater fishery above the reservoirs. Elevation of standing water temperature in the reservoirs, lack of riparian vegetation to shade the stream, slow shallow stream flow containing a low amount of dissolved oxygen below the reservoirs, and high effluent content below the Elmira treatment plant restrict the fishery possibilities in the lower corridor. The Floradale reservoir, a former mill pond, and the Woolwich dam reservoir impact the fishery at their location and downstream. The standing water loses dissolved oxygen and becomes warmer, ruling out a cold water fishery. The reservoirs also cause a decrease in stream velocity and increase in sediment deposition, resulting in turbidity and a decrease in biological productivity. Stream sediment deposition is high in the creek in general and in the reservoirs in particular. Silt deposition is the leading cause of the loss of gravel spawning beds and decrease in fish populations (King, 2000). Benthic and fish monitoring data indicate that sedimentation abatement could be the key to re-establishing a coldwater fishery above the reservoirs. Additional thorough investigation into the reservoir's functions may provide clues to improvement in preventing some of the elevation of standing water temperature and sedimentation in the reservoirs. Lack of riparian vegetation to shade the stream, slow shallow stream flow containing a low amount of dissolved oxygen below the reservoirs, and high effluent content below the Elmira treatment plant would, at any rate, still restrict the fishery possibilities in the lower corridor (King, 2000).

The swampy bog areas in the low-lying areas in the north and northeastern hilly section of the watershed were assessed as significant at an earlier time. To the west of the swamp area lies an 85.4 hectare protected conifer plantation. The plantation site is a significant earth science site, being located on the line where the Georgian Bay and Ontario ice lobes interfaced (King, 2000).

The Natural Heritage Framework Project (NHFP), a project that aims to investigate the integrity of natural areas in the Grand River watershed, is gathering natural heritage data in the Canagagigue sub-basin. As the "big-picture" emerges from the exercise, maps are updated providing guidance for identifying where among woodlands, GRCA rated wetlands, waterbodies, streams, slopes, rail lines, roads and houses restoration and enhancement actions can achieve desired results (King, 2000).

Restoration Actions and Recommendations

In late spring 2001 a draft of the Canagagigue Creek Watershed Plan was presented to the various concerned agencies and stakeholders for public examination, and comment. As of late January 2002 the process is winding its way toward a conclusion and GRCA is working on a second draft dealing with such specifics as problem solving and determination of green belts (MacMillan, 2002). After final approval the plan's policies await incorporation into the various local municipalities' Secondary and Official Plans. Ongoing restoration projects like the NHFP are slated for incorporation. The Regional Municipality of Waterloo already has protection policies in place for 248.4 hectares and has applied Environmentally Sensitive Policy Area and Restricted Land Use status to them. The 85.4 ha conifer plantation site is designated as a significant earth science site (King, 2001).

Among the recommended actions are establishing proper buffer zones, creating interior forest habitat, corridor connections between water courses and other natural areas, reforestation of less productive agricultural lands and conservation tillage. Areas recommended for tree planting and corridor improvement have been identified in the creek watershed (King, 2000).

Long-term restoration ideas suggested for involvement by GRCA based on the investigation process include finding financial aid and offering advice with regard to rehabilitating the abandoned aggregate extraction sites, conservation tillage, reforestation, developing natural corridors, establishing buffers, riparian rehabilitation, and giving advice to municipalities regarding planning policies and aiding policy enforcement. GRCA should be active in advising how to take advantage of the favourable climate, good soils, and a long growing season along with selection of native species for reintroduction and restoration (King, 2001).

The Woolwich Clean Waterways Group formed in 1991 as a "means to begin discussing how to best preserve and rehabilitate area rivers and streams and how to educate the community about issues affecting water quality" has made a sizable contribution. After an initial rehabilitation project in an Elmira Park, the farming community was targeted for participation in projects. To date, riparian improvement projects, planting of hundreds of native tree species, buffer establishment, creek bank stabilization projects, and fencing for restricting livestock from the creek have been completed and continued maintenance of completed projects is continuing. A teacher resource guide designed for grades four and seven has been compiled. An "adopt a creek" initiative is set up for the spring of 2001. The group is also active in aiding farmers to apply for available grants to participate in farm projects. GRCA acts as a resource organization to the group. Since the majority of the land is privately owned, landowner and public cooperation are important (King, 2000).

A Rural Water Quality Program developed in conjunction with representatives from 22 government and agriculturally oriented partners is funded through 2003 by the Region of Waterloo, County of Wellington Municipal Bodies, and some agriculturally oriented corporations. Monetary grants are available under the program. Grant approval depends on a set of priorities tied to three group types of projects that are supported by the program. Group one receives grant money only within the range of 50 to 75% of cost, for projects dealing with livestock waste management, projects for farmstead water quality improvement, and erosion control structures. Group two receives grant amounts tied to performance, and supports projects dealing with livestock waste management, cropping methods, and fragile agricultural land retirement. Support ranges from 50 to 75%. Group three gives performance incentive support, only, for projects dealing with cropping practices such as residue management and cover crops. Performance incentives are assessed on annual performance or on per acre performance. Some of the farms in the Canagagigue Creek basin are considered high priority for Rural Water Quality Program projects. The program is accessed by application through the Environmental Farm Plan (EFP), and is delivered locally by the Ontario Soil and Crop Improvement Association in partnership with OMAFRA. The GRCA acts as a resource organization by assisting in project planning, in application procedures, and by doing site inspections. . A long- term chemical pollution cleanup program is ongoing by the chemical company in Elmira under the direction of the Ministry of Environment (King, 2000).

UTRCA – The Avon River Valley Plan

In 1952 the UTRCA in cooperation with landowners of the Upper Avon River Valley, who expressed an interest in conservation, undertook development of an Avon Valley Plan. In spite of consistent long-term average precipitation, improved crop strains, better tillage machinery and high fertilizer input, yields had shown no expected increase. The intended purpose of developing a valley plan was to introduce some conservation ideas for the health of the river and to insure long-term farm production in the Valley (Merkley & Glasman, 1996).

The Biophysical Attributes

The Avon River is a major tributary of the north branch of the Thames River (Fig. 3). The Avon drains a part of the Stratford Till Plain Physiographic Region. Soils with high clay content are predominant, which impedes water infiltration somewhat. Most of the valley landscape is flat or has low slope. Some of the Avon's headwaters tributaries are intermittent streams. The climate is humid continental with mild winters and warm summers. It is located at the extreme northern edge of the Carolinian vegetation zone (McKnight, 1992).

Cultural History

The Avon Valley has been an area of intense agricultural land use since the European settlement era. Its good soils, favourable climate, and topography make it ideal farming country. As a result the landscape has had much of its natural forest cover removed. The City of Stratford is a major urban centre on the rural agricultural landscape (UTRCA, 1952).

The Planning Process

The Avon Valley Plan was developed by UTRCA with the assistance of the Technical Staff of the Ontario Conservation Branch, Department of Planning and Development of Ontario. It was common practice for the Ontario Conservation Branch to participate in projects during the early years of the conservation authorities' existence.

The Avon Valley Plan was an early exercise in sub-watershed planning and became the reference base for other sub-watershed planning exercises. It was an early

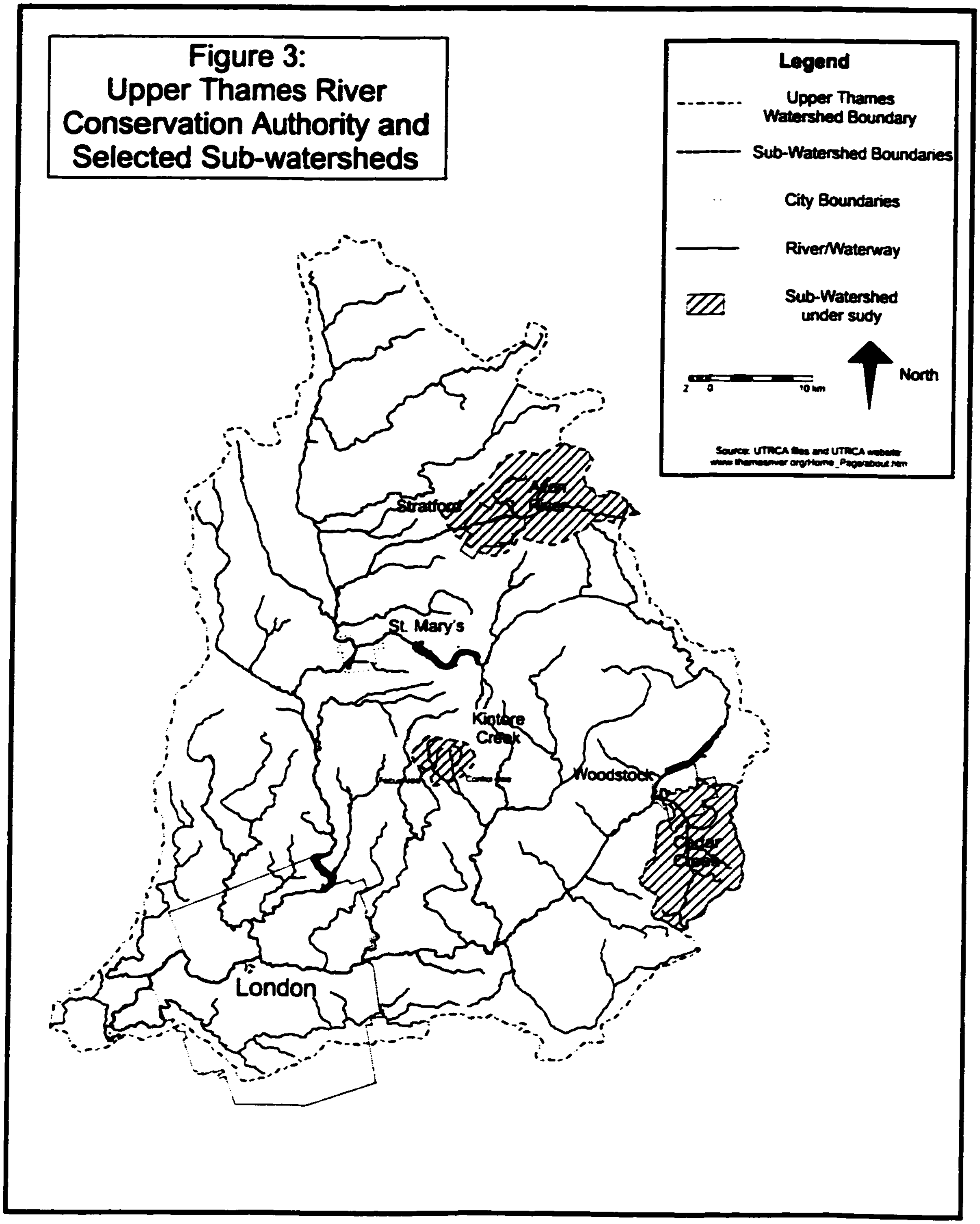


Figure 3: Upper Thames River Conservation Authority and Selected Sub-watersheds

step by conservation authorities to broaden their core mandate of managing stream-flow, water quality, and soil and water conservation into developing plans for public and landowner involvement. The Soils Department, Ontario Agricultural College contributed technical input for developing individual farm plans. Agriculture in the Avon Valley is almost entirely carried out on privately owned land. Therefore, planning ecosystem restoration and enhancement projects, and soil and water conservation measures had to focus on soil and water conservation as it may apply to the individual farm, and on how the farmer could manage his/her farm within a conservation plan (UTRCA, 1952).

The Research Process

Mechanical and cultural conservation strategies available to the farmer were investigated for feasibility and for beneficial likelihood. Among the mechanical strategies investigated were contour tillage and contour strip cropping as methods to manage sheet and rill erosion. Construction of terraces for reducing the length of slopes was considered to be a leading strategy for managing gully erosion on long slopes. However on most slopes, common in the Avon Valley, grass waterways were considered sufficient for managing gully erosion. Tile drainage for wet spots could be expected to aid tillage and to draw down the ground water level encouraging deeper root development so crops will withstand drought periods in the hot, dry part of the growing season. Open ditch drains were considered to have limited use due to bank maintenance and silt control. Among the cultural strategies researched were crop rotations that alternate soil building crops with soil depleting crops, and pasture improvement through the use of improved strains of grass and rotation grazing. Forest management practices for the remaining forests were found deficient. In some cases there was livestock pasturing in forest areas and a lack of management for gaining production returns and for providing wildlife habitat.

Livestock has had free access to the river corridor. Low infiltration rates result in above average surface runoff to streams carrying with it animal wastes. Heavy deposition of silt was common along the river channel. Frequent periods of drought conditions marked with flood episodes have shown the failure of valley lands to absorb precipitation and to give it up slowly to evapotranspiration and natural drainage streams (UTRCA, 1952).

Since the goal of the Avon Valley Plan was to obtain watershed-wide benefits through the aggregation of benefits gained on the individual farms, it meant that in addition to research on a basin wide scale, each individual farm plan had to be based on research data generated for that particular farm. The research for each farm plan had to determine soil capability for each part of the farm in order to match types of crops and types of crop rotations to soil capability. Decisions about everything from erosion control management to about how a farm plan can be made compatible with the overall farm operation and be financially beneficial to the farmer have to be based on comprehensive research data. Such undertaking may well be beyond the landowner's resources. Conservation authorities and agricultural agencies were available for developing individual farm plans and provide follow-up technical support to the individual farmer (UTRCA, 1952).

Restoration Ideas

The Soils Department, Ontario Agricultural College developed a model farm plan as a guide for developing individual farm plans. Under agreement the landowner bore sole responsibility for implementation of an individual farm plan and any future required upgrades. UTRCA, Ontario Agricultural College, and Provincial agricultural agencies would provide continued technical aid. General recommendations were made to improve forest management in the area of zero livestock grazing, management for production, improving species quality by removing misshapen trees for firewood, windbreak planting to form corridors between remaining patches, and establishing buffer strips (UTRCA, 1952).

Sub-watershed planning and management did not become a preferred approach to river basin ecosystem management until the early 1990s (OMNR & OMOEE, 1997; 79). The 1950s were a time of major change in Ontario farming. There was a shift toward larger farms and a reduction in the number of workers per farm. The availability of larger and higher-powered farm machinery and more specialized farming turned away from mixed farming with a broad mix of livestock and crops. The small field, rigid crop rotation regime, that was common to the type of farming at the time that the plan was developed, yielded to the use of large machinery and efficiency. Almost as soon as the Avon Valley Plan was developed it was outdated (UTRCA, 1997).

Nearly four decades later a small group of conservation minded landowners grouped together to form The Upper Avon Conservation Club who along with UTRCA revisited the Avon Valley Plan. Working together under the slogan "Neighbours Helping Neighbours" and aided by some local grants and financial aid from a federal project called "Action 21 Projects" they are fulfilling some of the conservation ideas contained in the 1952 plan. Over nearly a decade, local schools, the University of Western Ontario, University of Waterloo and volunteers have been involved in water and benthic life monitoring and accumulating data that informs restoration decisions. The group concentrates on one of the Avon's headwaters tributaries at a time. Apart from shoreline naturalization on a lake shoreline in Stratford their restoration work has been carried out on privately owned land. Among projects carried out are: restricting livestock access to streams, planting native hardwood species along streams to enhance stream life, establishing natural buffers between tilled fields and streams, re-establishing fence-rows for wildlife habitat and corridors, and stream bank revetment (UTRCA, 1997).

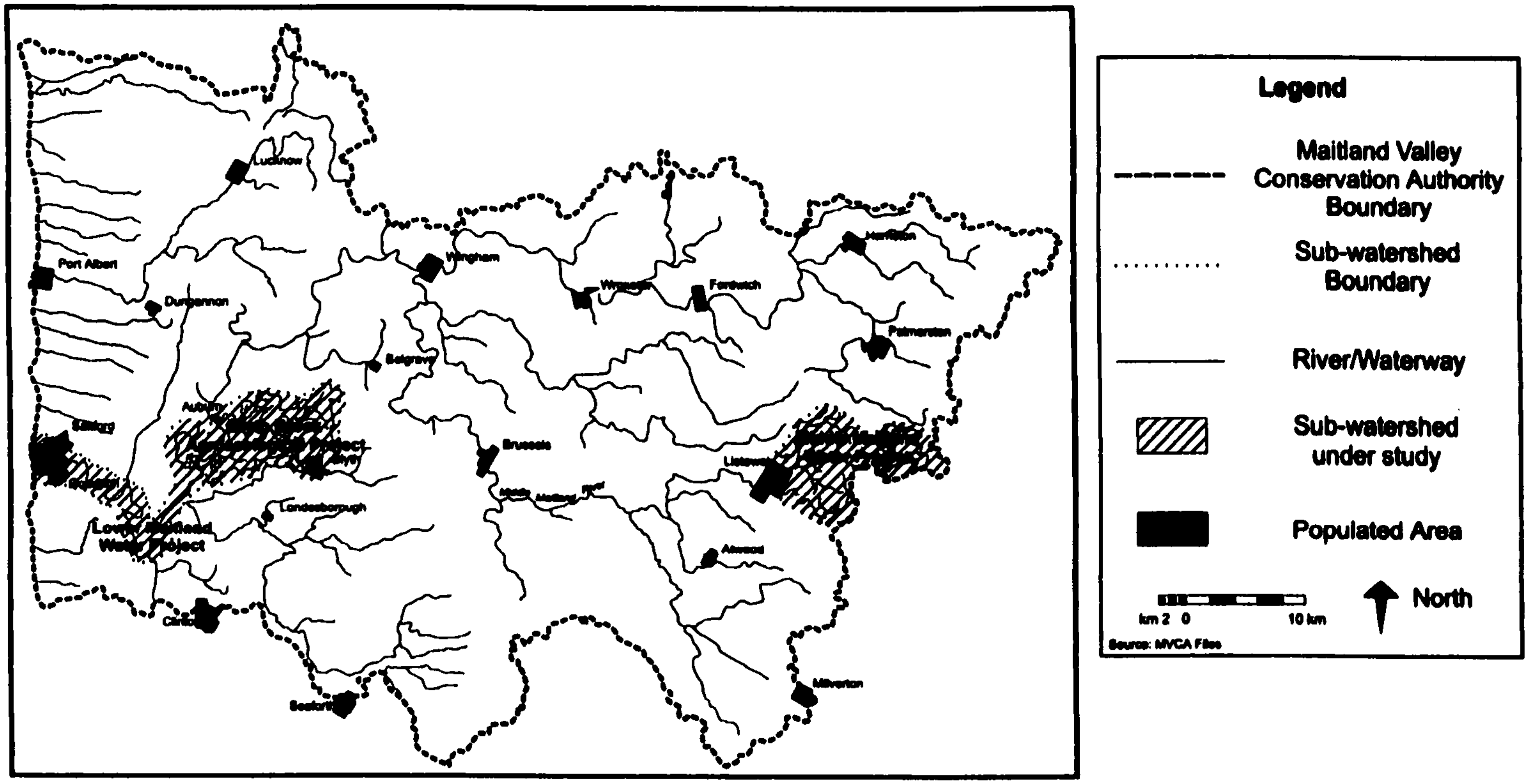
Comments

The Avon Valley Plan is an example of conservation authorities' early adaptation to fulfilling their mandate. It dates from a time when the authorities adhered closely to their core mandate of managing stream flow, water quality, and soil and water conservation while at the same time moving into addressing those ecological concerns on a broader scale. They depended largely on directions from the Ontario Conservation Branch, Department of Planning and Development of Ontario. The Adaptive Ecosystem Approach to environmental management on an adaptive ecosystem level was still about two decades into the future. Then as now, the final success or failure of any program that involves landowners rests with the will of the landowners and their capacity to deal with it.

MVCA – The Lower Maitland River Project

In 1998 a resource group was formed for the purpose of developing a program that focuses on enhancement and sustainability of the Lower Maitland River Valley (Fig. 4). The group consisted of: the MVCA, OMNR, Huron Stewardship Council, University of Guelph, Nature Conservancy of Canada, and the Huron County Planning and

Figure 4:
Maitland Valley Conservation Authority and Selected Sub-Watersheds



Development Department. The group transformed itself into a Stewardship Council of committed individuals representing landowners, stakeholders, government agencies and NGOS. MVCA filled the role of leading advisor and resource organization.

They developed a detailed mission statement, set of values, and goals:

Mission Statement:

> "To maintain and enhance natural ecosystem features of the Lower Maitland River Valley" (Szczerbak, 2000; 2).

Values:

1. We envision a community that enables owners to manage their land for the mutual benefit of themselves and the community.
2. We believe that most landowners holding valley lands do so because they appreciate the beauty and potential of the valley and the adjoining landscape.
3. We believe that many non-landowners have an interest in preserving and enhancing the valley's natural qualities, and that
   a) The energy of these supporters can be harnessed to provide support for landowners interests and;
   b) If landowners and non landowners come together as a group they will assure and increase the future values of these of these lands for both their interests (Szczerbak, 2000; 2)

Goals:

1. to encourage direct research on natural features of the valley,
2. to advocate responsible stewardship of resources by landowners and resource users through:
   a) providing information on natural features, their presence, status, and management options,
   b) providing educational opportunities too learn about and develop an appreciation for valley resources,
   c) encourage a sense of community and cooperation among landowners and resource users through providing a forum for them to interact, share ideas, and develop an understanding of each other's viewpoint,
   d) provide information on the protection method presently in place,
3. to profile existing protection measures, i.e. legislation, and encourage their enforcement
4. to investigate other opportunities for protection, including recommendations
5. to learn about approaches in other areas, regulators, special designation, and
6. to foster sustainable use of the valley and its resources (Szczerbak, 2000:2).

Biophysical Attributes

The paleozoic sedimentary bedrock is exposed along some sections of the Lower Maitland River due to down-cutting during rapid post-glacial, isostatic rebound. Generous deposits of gravel and cobbles occur at inside river meanders. Areas of wide bottomlands between the river and the valley wall have been formed. Soils on the flood plain and valley terraces are well sorted, gravely, outwash material. Low-lying portions have recent alluvial deposits with immature soil profile. Exposed bedrock is devoid of soil. Steep riverbanks and rock walls confine the river corridor, In the Benmiller area the river cuts through the Wyoming Moraine on its way to Lake Huron (Szczerbak, 2000).

Between Goderich and Homesville 82% of the valley is in natural vegetation. Between Homesville and Wingham only 47% is in natural vegetation with gaps up to 2.8 km. Some of the larger forested areas in the valley are inhabited by bird species that are normally found in interior woodland habitat. A diverse assembly of migratory birds visits the area during the spring and fall migration seasons. Wild mammals include, deer, raccoons, and coyotes, and also include beaver, muskrat and mink. Reptiles and amphibians have a 19 species representation. A pond in the Falls Reserve Conservation Area is one of the richest amphibian breeding sites in southern Ontario. The area is also home to one fish, one bird, and two reptile species that are on " the species at risk" list.

The natural vegetation in the Lower Maitland Valley is typical Great Lakes – St. Lawrence forest of mixed deciduous species dominated by maple and beech, along with eastern Canada needle-leaf species. Except on steep riverbanks, the valley has undergone logging. The only old growth is likely represented by eastern white cedar clinging to cracks in bedrock outcrop and relying on liquid nutrients that seep into the cracks. A few Carolinian zone species at their extreme northern boundary are present in the valley, but in limited numbers. A small number of northern species that are more common to the Lake Superior region are also present. Forbes and grasses common to the Great Lakes-St. Lawrence vegetation zone are well represented (Szczerbak, 2000).

Cultural History

Historically, present day settlement in the Maitland Valley is associated with crown land grants to the Canada Company early in the nineteenth century. As early as 1626 AD a Recollet missionary described lands within the Goderich Harbour area and along the Lower Maitland River as very abundant in wildlife, birds, vegetation and having particularly fertile soil. Archaeological investigation into approximately 10,500 years of indigenous peoples' cultural presence in the region is ongoing. Except for the 230 acre Falls Reserve Conservation Area, near the village of Benmiller, the Lower Maitland Valley lands are mostly privately owned. The Maitland River basin is in the midst of prime agricultural country (Szczerbak, 2000).

Planning

The group's prime planning strategy was to support restoration and enhancement action decisions through the assembly of recorded data in combination with newly researched data regarding stream health, the river's connections to the drainage basin, and its cultural connections. Channel morphology and the factors that shape and supply the hydrologic and nutrient inputs to the channel have a strong influence on stream health. Low-flow, bank-full flow, and riparian quality are key to this part of stream health. Sufficient low flow, in periods of drought, is essential for maintaining water depth in pool habitat areas and rapid flow in riffle areas for oxygenation. Bank-full flows that occur annually or biennially cause the natural adjustments to river morphology necessary for maintaining a healthy river. Riparian vegetation is essential for supplying cast-off biological production, which supplies nutrients to the stream. The quality of the riparian zone and the floodplain is controlled by large flows that occur at widely spaced intervals like 1:100 years. Recreational surveys were to be conducted to gauge future social carrying capacity. Long–term recorded aquatic life and water quality monitoring data were to inform future fisheries and pollution management (Szczerbak, 2000).

Research

Accumulated data gathered in accordance with planning criteria revealed that the main-stem of the Maitland is relatively stable due to three major characteristics; 1) It has healthy, undamaged riparian and floodplain vegetation composed of deeply rooted grasses, forbes, reeds, shrubs, and trees. 2) There are sustained high flow patterns in the watershed in drought periods, which are related to the high infiltration, due to soil texture of the moraine and other till materials, which act as good aquifers. They readily allow infiltration during rain and snowmelt periods and discharge water to stream flow during dry periods. Seasonal rain and melt events cause bank full flows, and weather conditions at long-term intervals cause moderate over-bank flows. The infiltration characteristics in parts of the system temper the river reaction to flood events, causing a long delay in the recession limb of the stream flow curve on its return to base flow. This resembles the reaction of stream flow in heavily wooded basins. 3) The local geology of gravel, cobbles, and bedrock provides good substrate material (Szczerbak, 2000).

The downstream location of the Lower Maitland River places its water quality issues at the mercy of everything that goes on upstream. MVCA in conjunction with OMOEE has been monitoring water quality in the basin's rivers and streams for over 30 years. The source of lower river pollutants has been shown to originate upstream. While bacteria, particularly *E.coli*, have been of special concern, the monitoring results indicate that poor water quality is an extremely complex problem that stems from multiple sources. Runoff from manure storage and manure handling techniques, faulty septic systems, milk house wastewater, sewage treatment plants, urban runoff, livestock access to watercourses and agriculture chemicals have all been identified as pollution sources. The impacts from the various sources fluctuate during the year and they vary between sub-basins Environmental management practices, loss of forest and riparian vegetation and drainage tile systems all increase the rate at which pollutants reach the stream. Nitrate levels toxic to fish and amphibian eggs are increasingly common. Lack of buffers allows high pollutant inputs during rain events. Consistent rise of phosphates in the water induces algae blooms. Some water quality indicators show improvement. Among them is lowering of water temperature. In recent years some successful water quality services have been eliminated, including the highly successful Clean Up Rural Beaches (CURB). The only remaining local programs are the Environmental Farm Program, the Best Management Practices guideline issued by Agriculture Canada and OMAFRA, and the Water Quality Assessment Service offered by MVCA (Szczerbak 2000).

In general the Maitland River supports a warm-water fishery with localized zones of coldwater habitat where ground water seepage or cold-water pools and fast flowing riffles provide a good aquatic life habitat. Monitoring indicates a stable number of species over a period of 25 years. Surveys indicate that most angling is directed at small-mouth bass, migrating Chinook salmon and migratory Rainbow trout. Lower Maitland River boulder/cobble or bedrock substrate and pools of 3.5 m and more depth and of large size and complexity provide a rare high quality fish habitat (Szczerbak, 2000).

Recreational uses survey data indicate that there are a limited number of regular visitors. A viable fishery and a better than average remaining natural state of the river valley provide an attractive recreational site. Its recreational value attracts anglers, hikers, bird watchers, day campers, and canoeing, kayaking, biking, horse riding, hunting, trapping and snowmobiling activities. So far the social carrying capacity has not been exceeded (Szczerbak, 2000).

Ecosystem Enhancement

Some sustainability and ecosystem enhancement measures are being planned and some are already under way. In relation to lower Maitland and basin wide water quality issues MVCA has undertaken and in the year 2000 neared completion, of an Ecosystem Health Project (EHP). The project focuses on identifying characteristics of sub-basins, such as surface watercourses, forest cover, and amount of artificial drainage. Stream water quality is monitored and assessed on the basis of stream invertebrate health, with the intent of measuring long-term stream health rather than in the moment chemical analysis. With approximately 80% of the land base in Huron County being used for agriculture, much of the blame for water quality has been placed on the farming community. Investigation concerned with water quality indicates that water pollution comes from a variety of sources. Public awareness about management practices and cooperation at the individual and the community level, necessary for a solution, must be addressed. Water quality in the study area of the Maitland River is described as relatively good for a large agricultural watershed. The large amount of groundwater that enters the stream, in the lower part of the Maitland at all times, is a large factor in its good water quality. Improving water quality in the headwaters and tributaries is in the planning stage. Environmentally friendly Development Policies and Master Plans aimed at controlling encroaching development, intensive recreation use and poor water quality and quantity issues from the remainder of the watershed are in the formation stage (Szczerbak, 2000).

UTRCA - The Cedar Creek (GREEN) Watershed Project

The Cedar Creek watershed project was initiated in 1996 in response to a request from the Woodstock Environmental Advisory Committee (WEAC). The intent of the request was to establish a Global Rivers Environmental Education Network (GREEN) project. GREEN originated in Michigan in 1984 as a watershed monitoring and education program for elementary and secondary students (UTRCA, 1997).

Biophysical Attributes

The 93 sq. km Cedar Creek watershed is a sub-watershed of the lower branch of the Thames River. The creek empties into the Thames at the western limits of the city of Woodstock (Fig. 3). Several layers of sedimentary rock overlay the deep precambrian bedrock. The texture of the glacial till that lies on top of the sedimentary rock reflects the way in which it was deposited and its postglacial weathering and mixing. Moving melt water deposited sand and standing melt water deposited clay rich till. Approximately 50% of the watershed's soils are rich in clay. The remainder of the watershed's soils has a mixture of clay and sand with small wetland areas having organic soils (UTRCA, 1998).

Cultural History

European settlement occurred early in the nineteenth century. Since European settlement the leading land use has been agriculture. Sixty percent of the land area is presently under intensive agricultural use, ranging from dairy and beef farming to tobacco. The city of Woodstock was established and developed in the lower creek watershed around its confluence with the Thames River.

The Planning Process

The planning and development of the Cedar Creek GREEN project involved twenty-four interested groups and UTRCA. Through their joint deliberations and in keeping with GREEN's ideals they developed the Cedar Creek GREEN project's management goals and stated them as "to improve the health of the Cedar Creek watershed and educate and involve the community". It was decided that as the project progressed subcommittees would be set up to oversee various aspects of the project, i.e. education, research, and restoration. Each subcommittee would develop a written plan of action within the parameters of GREEN and upon general approval would proceed with it. The education subcommittee undertook the development of a community education and volunteer involvement program. The research subcommittee undertook investigating the state of and the concerns surrounding the abiotic, biotic, and cultural resource aspects of the watershed. They used as their guide the ABC method, which analyzes the abiotic (A), biotic (B), and the cultural (C) information as separate components of the ecosystem as set out by Bastedo et al. (1984). The restoration subcommittee would react to the findings of the research subcommittee and within the ideals of GREEN (UTRCA, 1998).

The Research Process

The abiotic resources were evaluated on the basis of the geological foundation (bedrock, glacial till) including the type of deposition and weathering. Groundwater was recognized as a very important abiotic resource because the city of Woodstock and all other watershed residents and operations depend on it for all their needs. The natural biotic resources are mostly contained in the limited remaining 12% of natural vegetation coverage. The existing natural vegetation lies in relatively large patches within wetlands and in one Provincial Reserve Woodland. At least eight of the patches have some interior habitat. The aquatic life is represented by 22 fish species but the absence of trout indicates the lack of a cold water fishery and poor water quality. A wildlife survey showed the presence of deer, mink, muskrat, and raccoon species. Migratory birds stop over during spring and fall migration. A reintroduced wild turkey population remains steady at about 50 members. Cultural resources remain rooted in agriculture but have evolved to accommodate the major urban centre of Woodstock and some rural hamlet development. Land use zoning shows 60% land area in agriculture, 14% residential, 12% urban – City of Woodstock, 8% EPA/open space, 4% industrial/commercial, and 1% other. Major highway and railway corridors traverse the watershed. Recreation opportunities exist in the form of canoeing, walking trails, camping, golfing and fishing. Poor water quality prohibits swimming and water skiing in the creek (UTRCA, 1998).

Restoration and GREEN Project Accomplishments

Through the education program students and volunteers continue to learn about river systems and watersheds, about Cedar Creek and its importance to the ecosystem, about food webs, and about human impacts on the environment. Groups monitor sites in the watershed and compare data with other groups. Students develop action plans for protecting and enhancing the health of the watershed. The educational subcommittee is developing an educational book for classroom use. Several landowners have volunteered their properties for monitoring sites and for carrying out in-the-field evaluation learning exercises by students and volunteers (UTRCA, 1997).

The prime focus of GREEN is on educating and involving the community in learning about river basins. Since it does not have resources to carry out any large-scale restoration projects, its restoration efforts are limited to whatever can be achieved by the number of available volunteers. Its contribution to actual restoration lies in developing and promoting restoration ideas that compliment and expand upon local existing municipally administered restoration measures. Existing measures in the watershed include identifying that 50% of the watershed as groundwater recharge area with specific land use policies relating to buffer strips, building setbacks from riparian zones, fill regulations, and control of livestock operations. Aggregate extraction is covered under the County Official Plan (UTRCA, 1998). Recommended restoration opportunities include improving habitat by "bulking up" narrow woodlots that have irregular shapes, filling in gaps, and establishing corridors for wildlife travel, edge habitat, and providing areas that are good for seed dispersal. Planting native trees along the stream corridor is also recommended. It will be several years before long-term assessment will be able to attribute true value to the program. Enthusiastic participation has marked the early years of the project (UTRCA, 1998).

GRCA – Eramosa River-Blue Springs Watershed Study

In 1992 the GRCA along with local municipalities, OMOEE, OMNR, and OMAFRA initiated a linear corridor study for the valleys of the Eramosa–Blue Springs Watershed. In response to recommendations of the Linear Corridor Study the initiative was expanded into development of a Watershed Plan. The reasons given in the recommendations were that a number of key issues were identified that could only be addressed in a comprehensive watershed context:

1. Available watershed data was outdated and incomplete.
2. There was public concern that water quality was deteriorating.
3. There was demand in recreation that exceeded opportunities available on public land.
4. Landowners were concerned that their rights may be co-opted in the greater public interest of protecting watershed resources.
5. There was consensus among landowners and the general public that watershed protection and enhancement plans should be implemented through incentives and stewardship programs not regulations (Beak International Inc., 1999; 1.4).

The GRCA was, simultaneously, coordinating the Grand River Watershed Study, and the findings of the Eramosa-Blue Springs Report needed to be integrated with that umbrella document (Beak International Inc., 1999).

The Biophysical Attributes

The Eramosa-Blue Springs watershed covers an area of 270 sq. km within the Grand River Watershed. It empties into the Speed River, in the city of Guelph (Fig. 2). The Speed, along with the Nith, and Conestoga is one of the three main tributaries of the Grand River. There is some unique physiography in the Eramosa-Blue Springs watershed: in particular karst, glacial spillways, and irregular terrain associated with moraines. There are excessive slopes in the northwest, poor drainage in low-lying areas, stony soils along the Paris Moraine to the east, and sandy soils in the Hillsburg Hills area to the north. Areas less suitable for agriculture have undergone wind and water erosion. Many of the low-lying areas do not have surface runoff to natural streams resulting in extensive wetlands, low runoff, and high groundwater recharge. The underlying fractured bedrock is of the Amabel formation. The areas with fractured bedrock are good aquifers, readily receiving water and readily discharging water to the stream throughout long stretches where the stream is incised into the bedrock. The glacial till overburden has a high sand and gravel content further enhancing groundwater recharge. Blue-Springs creek receives 70% of its annual flow from groundwater. The high infiltration rate, natural lowland ponding, and high natural vegetation coverage, 30% forest, act as tempering mechanisms in times of heavy rain events or snowmelt. Flash floods are therefore prevented and stream flow is sustained in drought periods. In the lower portion of the basin there is net stream loss to natural and artificial groundwater recharge (Beak International Inc., 1999).

The better soils in the watershed are generally CLI Class 3 soils, suitable for sustained field crop production. Although the watershed is dominated by an agricultural/human settlement ecological pattern, extensive natural vegetation features remain and continue to sustain a natural ecosystem function. The following are some of the watershed's unique features:

1. A 21% proportion of introduced plant species to total species compared to a 27% provincial average;
2. The watershed valleys are considered one of the best representations of natural floodplain and valley features in the province and are designated as ANSIs and ESAs;
3. Class 1 wetlands cover over 1,500 ha;
4. High quality, extensively used winter deer yards;

5. Forest resources and natural features comprise 40% of watershed, similar to the amount in agriculture;
6. Grasslands and old fields equal to 9% of watershed (Beak International Inc., 1999; 3.7).

There are seven ESAs and eight wetlands, four of which are classed provincially significant. Conifers have been the leading species chosen for reforestation. The aquatic life habitat in the Eramosa-Blue Springs watershed accommodates three general types of fish communities. There is a coldwater community, dominated by brook trout. There is a cold/cool water community with fewer brook trout and a few other species. There is a cool/warm water community with a dozen or more species (Beak International Inc., 1999).

The Cultural Influences

The dominant land use is agriculture. Urban land uses represent about 10% of the watershed's area. The greatest amount of urban land use is associated with the city of Guelph. Guelph is also where the most expansion of urban land use is taking place. Smaller settlements, Rockwood in particular, experience expansion to some degree. Ground water is the sole water supply source for all urban and rural development. Aggregate extraction in the form of sand, gravel, and limestone quarrying has been an economic contributor of long standing, and are ongoing (Beak International Inc., 1999).

The Planning Process

Though considerably altered from its pre-settlement state, the Eramosa-Blue Springs Watershed ecosystem still retains a considerable amount of its earlier characteristics. The challenge in planning the formulation of the watershed plan was primarily in devising methods of protection and management that would sustain the present day natural heritage over the long-term. Achieving long-term sustainability was assumed to require the following four actions:

1. Understand the interdependencies among the features of the natural heritage system and their susceptibility or resilience to human activity;
2. Have a clear vision of what constitutes the natural heritage system and its boundaries;
3. Implement an aggressive program of stewardship measures to protect, enhance, restore components of the natural heritage system to a self-sustaining state.
4. Manage human activities within and adjacent to the natural heritage system, to the limits necessary, for allowing natural processes that sustain the natural heritage system to continue (Beak International Inc., 1999; 2.1).

Research Findings

A background study on the existing state of the watershed ecosystem found several shortcomings in conservation management. Past overgrazing and unsuitable tillage practices have occurred on sandy soils with steep slopes in the northern part of the basin. Limited cases of inappropriate woodland livestock grazing have been observed. Channel and stream-bank erosion is limited to localized areas. It has resulted from livestock access, municipal drainage and bridge construction, channelization, and reservoirs, and there are some areas of high sediment delivery. Several previous, and some present aggregate extracting operations are contrary to present-day rehabilitation methods. Land severances throughout the watershed for individual residences, mostly in upland forest, are a cause of ecosystem fragmentation. Increasing demand for recreational facilities including the development of golf courses is becoming a problem. The City of Guelph withdraws 10% of the Eramosa stream-flow to recharge its municipal supply from the Arkell aquifer. It has approval to withdraw up to 24% if required. A weir at the recharge location is one of several weirs along the stream corridor without fish ladders.

The reservoirs affect sedimentation deposition, raise water temperature and impede fish movement. There is some concern that the predominant choice of conifer species for reforestation is changing the character of the watershed's natural features (Beak International Inc., 1999). The watershed's natural forests have a strong representation of Carolinian hardwood species.

The Plan's Recommended Restoration Actions

Several issues came in for individual recommendations. ESAs and ANSIs should be re-examined for updating to current criteria. Reforestation activity, other than for establishing narrow belted windbreaks, should concentrate on reestablishing native hardwoods in keeping with historically typical woodlands. The Arkell springs recharge area, the major groundwater source in the watershed, should receive special attention from municipalities and GRCA for addressing long- term water quality and quantity.

Land use control policies should be developed through the planning component of the watershed plan in regard to golf course development, rural land severances, sewer trunk servicing issues, and potential for groundwater contamination in areas of karst topography, shallow/exposed rock and sand and gravel deposits. Many of these issues overlap municipal boundaries. Therefore municipalities, GRCA, OMNR, OMOEE and OMAFRA should act as a joint land use group.

Development of a regional trail network is recommended to serve as a recreational facility and as a means for informing and educating the public about natural heritage. It is recommended that GRCA in consultation with municipalities and provincial resource ministries set up a watershed coordination program in the form of a shared GIS database (Beak International Inc., 1999).

The watershed landowners have demonstrated a good conservation ethic over an extended period of time. Their actions have resulted in land retirement from agricultural land use. Reforestation and conservation tillage have been successfully applied to many of the problem areas, in particular on steeply sloped sandy soils in the Hillsburg Hills area. Reforestation along the headwaters tributaries has enhanced the coldwater fish community. The aggregate extraction industry is showing a growing interest in environmental sensitivity and partnerships are developing between industry and environment interests aimed at developing operation guidelines and restoration. GRCA is actively involved in developing environmental sustainable resource extraction practices (Beak International Inc.1999).

Jurisdictional action on plan policies depends on having the policies of the plan included in municipal Secondary and Official Plans. After adoption into municipal plans the policies may be implemented through regulation, stewardship, or some combination of the two. The community at large indicated a preference for stewardship. Voluntary stewardship by individuals, community-based organizations, municipalities, and the conservation authority can be effective in fulfilling their respective roles, and responsibilities. Stewardship does demand fair treatment of all stakeholders. Landowners must be satisfied that they are not making an unfair contribution by having some of their land removed from production. Any financial compensation must be fairly applied. Sensitive natural features must be identified in accordance with scientifically supported criteria and given appropriate regulation backed protection, in addition to stewardship initiatives. Appropriate regulations exist under the Conservation Authority Act, the Ontario Planning Act (in particular under the Heritage Clause), the

Environmental Protection Act, and the Fisheries Act. It is incumbent upon municipalities to incorporate the watershed plan's policies into their secondary and official plans, and to require that an Environmental Impact Statement (EIS) accompany all applications for land use change (Beak International Inc., 1999).

In acknowledgement of the community's expressed preference for the stewardship option, administration of the plan was assigned to a stewardship implementation committee, which has the responsibility to define implementation mechanisms, ensure conformance, assess effectiveness, and update and monitor plan implementation. The composition of the committee is to include representatives from the municipalities, GRCA, community organizations, the public, naturalist-groups, landowners, industry and development interests. The committee may organize itself in ways to best deal with its multifaceted obligations. It should meet at regular intervals and host an annual workshop/conference to highlight its activities and goals (Beak International Inc., 1999).

A list of priorities accompanied the delegation of administration responsibilities to the stewardship committee. A groundwater protection strategy is strongly emphasized in the plan's policies. The management strategy has three components; protect groundwater function, (i.e. recharge areas); monitor appropriate indicators, (i.e. water quality), and protect public health (Beak International Inc., 1999). For rural areas a stewardship program is required with a focus on non-point and point source contamination from agricultural, and non- agricultural sources. In rural/urban areas the required focus is on the hydrologic cycle in general, on septic systems and on private wells. In urban centres the required focus is on wellhead protection, stormwater management, types of development (residential only in recharge areas) and on an extensive monitoring program within and beyond the water supply facilities. The groundwater quantity management strategy must be gauged by the amount of water that may be withdrawn without impacting on stream baseflow and wetlands. Protection of recharge areas requires control over volume of groundwater that is withdrawn, and continuous monitoring of groundwater levels and baseflow. Development of a stewardship manual and education program for protection of recharge areas, and development of a groundwater monitoring program are recommended. Strategies are required for maintaining infiltration at the existing level, for providing infiltration controls as close to a source as possible, and for utilizing storm-water infiltration at the subdivision level in urban areas (Beak International Inc., 1999).

MVCA – Agroecological – Wildlife Enhancement Farm Plan Program

MVCA's commitment to the enhancement and protection of the ecological health of the largely agricultural/rural Maitland River basin is displayed by its leading role in development of an ecologically friendly farm planning program. The Agroecological – Wildlife Enhancement Farm Plan Program (A-WEFPP) was developed in cooperation with the Ecological Farmers Association of Ontario (EFAO), Scientific Advisors: Terrestrial Ecosystems – Jane Bowles, Plant Ecologist, Aquatic Ecosystems – University of Guelph, and nine original farm family participants (MVCA, 1994).

A two hundred acre parcel of land located on Lot 9, Concession X, in Turnberry Township-County of Huron, one of the nine original pilot participants, was selected for this write-up as being representative of the original nine participants.

The Biophysical Attributes

The selected land is part of the 340 acre Jeffray farm. The property has a rolling landscape with a variety of characteristics. At the beginning of the planning exercise one hundred and thirty acres of the 200 acre parcel were being cropped. The croplands are surrounded by or interspersed with upland forest, soft maple swamp, and lowland marshes. Windbreak planting and limited reforestation had supplemented the natural vegetation.

The soil of the eastern half of the plot is Dumfries loam. It lies on rolling topography. It has well defined horizons with a six-inch layer of topsoil. It has good drainage and is moderately stony. Along the western side of the lot, the soil is Parkhill loam and muck. It is poorly drained. The terrain is level. The surface horizon is dark brown on top of highly mottled horizons. In between the Dumfries and Parkhill soil areas is a ridge of Harrison loam on rolling and hilly terrain. It has good natural drainage and is slightly stony, with a six-inch gray-brown surface horizon over well-defined lower horizons, (MVCA, 1994).

The Cultural History

Brian and Bev Jeffray, the current landowners, have farmed the land since 1982. They began as a dairy cow operation and have converted to a milk-goat operation with 200-250 goats in active milk production. The Jeffrays are organic farm operators. Their intention is to minimize cropping and become a predominately grass/hay system operation, which along with other improvements should enhance the soil and water conditions. They had previously planted windbreaks and carried out reforestation on slopes in the western quarter. The plantings along with a dug pond have enhanced wildlife and bird habitat and corridors (MVCA, 1994).

The Planning Process

The program format requires that an individual farm plan be developed for each participating farm operation. The farmer is guided through a seven-step, objectives, research, planning, and implementation process that build on his/her knowledge about his/her particular farm. The impact of farm practices on land and water within and beyond the farm's boundaries are taken into consideration.

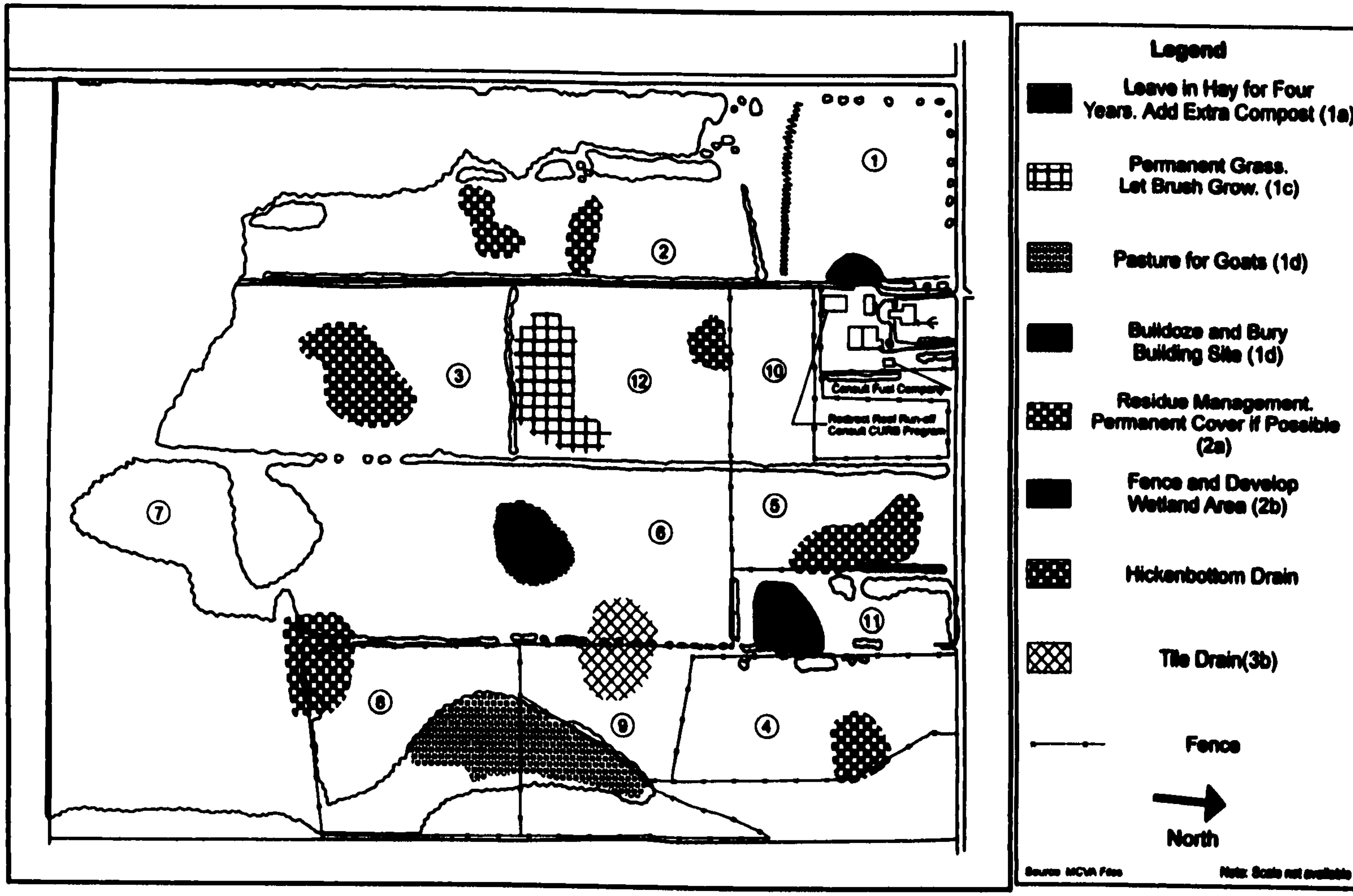
The seven-step process for each farm is as follows:

1. Determine goals.
2. Take stock: what's on the farm? Develop a map and two map overlays. Base map: croplands, pastures, woodlots, and miscellaneous areas. Overlay one: most/least productive areas, steepest areas, wind-flow and water-flow directions, changes in landscape, and areas immediately beyond farm. Overlay two: management plan for soil health, weed control, maintaining and improving water, woodland management, shelter belts, windbreaks and buffers.
3. Determine areas of concern.
4. Evaluate the areas of concern.
5. List different options for changing your farm system. Choose the best option of dealing with area of concern.
6. Set priorities and develop action plans and implement action plans.
7. Plan review: determine how and how often to review the plan, and act in response to review findings, (Gwyn, Gwyn & Associates, 1998).

The Research Process

As the program requires, three maps were prepared to illustrate the starting condition, the research and planning steps, and the action plan decided upon. Fig. 5 illustrates the layout of the Action Plan developed for the Jeffray farm. It is based on the

Figure 5: The Jeffray Farm
Agroecological Action Plan



landowner's knowledge supplemented with the soil and water sampling data below.

> Soil samples from four sample areas tested for % of organic matter showed: 1 at 4%, one at 11.9%, one at 3.7% and one at 4.4.2%. Aquatic evaluation of stream bordering the farm on the eastern side indicated: a) nutrient-nitrate levels within tolerable levels for aquatic life. b) Habitat – buffers are developing along the watercourse. In1993, the startup year, the cropland was divided into eleven fields of the following sizes and types of crops:

Field #	Acres	Crop
1	10	permanent pasture
2	15	permanent pasture
3	18	spelt
4	10	1st year red clover, hay
5	7	permanent pasture
6	25	mixed grain
7	6	mixed grain
8	6	permanent pasture
9	10	permanent pasture
10	10	permanent pasture
11	1.5	clover, hay
12	12	permanent pasture

The farm also had approximately 60 acres of diverse wildlife habitat, mostly wet or intermittently wet, (MVCA, 1994).

Restoration Options

Restoration options are shown on Fig: 5 (Action Plan Map). The options were decided upon by working through the seven steps of the A-WEFPP. They are the options that were perceived to be the best response, to what were the existing conditions, in order to reach the desired goals and that fit in with the overall farm operations. Under the program it is the responsibility of the landowner to implement the plan. In order to accommodate restoration within the overall farm operation the landowners scheduled action on a priority basis as shown on Fig: 5. Priority 1a) bulldozed gravel hill, priority 2a) six eroded hills, Priority 1b) barnyard runoff, priority 2b) milk-house wastewater, priority 3b) poor drainage, 1c) duck pond area, and priority 1d) surface seepage and swamp. The priority ratings were intended to place available action where it deals first with the more severe conditions and results in the earliest possible benefit to the farm operation and to wildlife habitat improvement (MVCA, 1994).

Participants and MVCA consider A-WEFPP a success in implementing a new approach to the identification of farm management problems and solutions. "It has illustrated the potential of a participatory approach and as an educational tool". The farmer as expert throughout the process reinforces the sense of ownership and commitment (MVCA, 1994). With respect to education, the seven-step A-WEFPP format has been incorporated into the Ontario Agricultural Training Institute's (OATI) farmer training program (Gwyn, Gwyn & Associates, 1998).

UTRCA – The Vetrepharm Inc. Soil and Water Conservation Farm Plan

The Vetrepharm farm plan was prepared by UTRCA at the request of Vetrepharm Inc., an animal health products researcher and developer, and the owner of a 177acre farm located on the north side of Highway 401 south of Putnam, Ontario. Vetrepharm Inc. expressed the desire to project an image of being a responsible member of the agricultural community. In 1988 Vetrepharm Inc. approached the Joint Agricultural Soil and Water Conservation Program (JASWCP) with a request to generate a farm soils and water conservation plan. JASWCP is a cooperative program of UTRA, the Kettle Creek and Catfish Creek Conservation Authorities, and the Ministry of Agriculture and Food (OMAF, now OMAFRA).). The company requested the development of a management plan that would effectively control and reduce the visible soil erosion by both wind and water (UTRCA, N.D.).

The Biophysical Attributes

The farm's soils are predominantly silty clay-loam. The rolling acreage has slopes that vary between 4 and 10%. Reynolds Creek along with its surrounding riparian zone and lowlands occupies the eastern third of the farm. The elevation of the farm ranges between 260 and 290 m a.s.l. There was visible evidence of long-term soil erosion (UTRCA, N.D.).

Cultural History

The farm's croplands had been cropped under a lease arrangement and operated separately from the research facility. General non-conservation tillage typical to the region at the time was practiced on the cropland (UTRCA, N.D.).

The Planning Process

Technical and financial assistance was made available from OMAF and UTRCA (UTRCA, ND). The Joint Agricultural Soil and Water Conservation Program's approach to generating a farm plan considers how the plan fits into, and how it may be coordinated with the overall operation of the farm. Technically, both the Federal and Provincial Department of Agriculture Best Management Practices are used as a guide. Best management practices strategy works toward developing soils that have consistently high yields, minimal erosion by wind and water, minimal nutrient loss and minimal pesticide residue. Sheet and rill erosion by water and surface erosion by wind must be managed. It is essential to have standing crop or crop residue cover on the land's surface to impede erosion and rapid evaporation. A porous texture is required for water infiltration. Below the surface a mix of large and small pores is essential for healthy root growth. Well-structured soils are made up of about 50% empty space, 45% mineral material and 5%

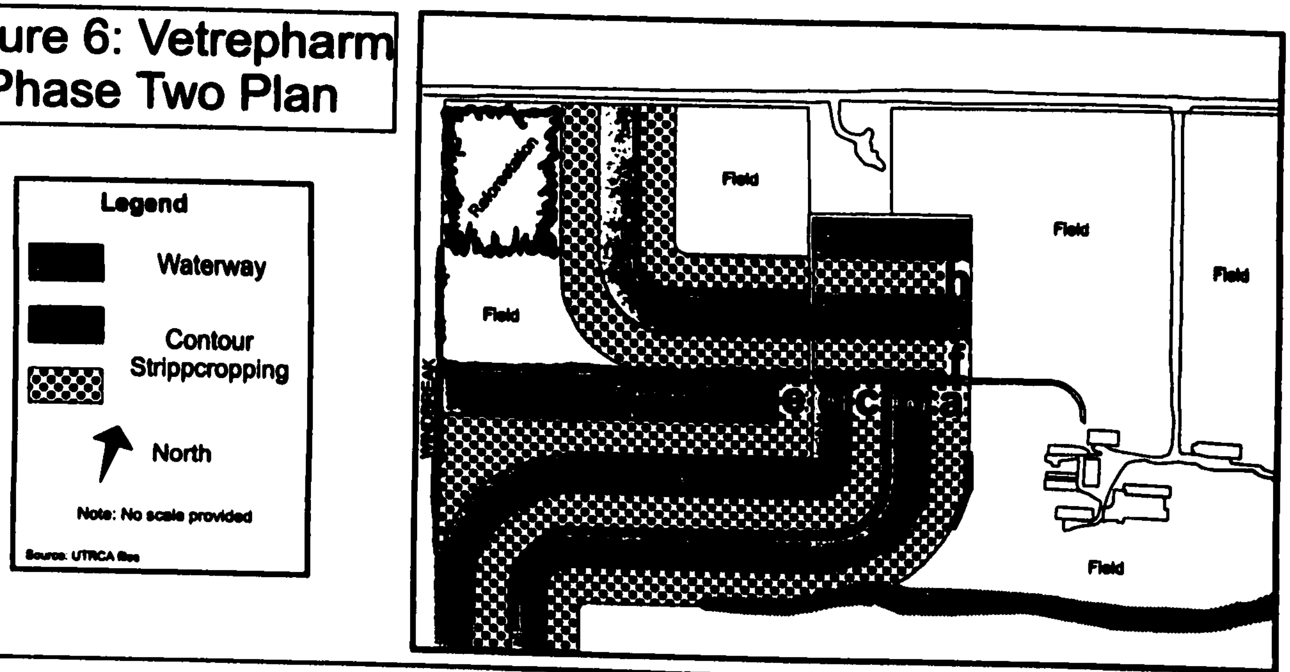
organic matter. Ideally one half of the empty space is occupied by air and the other half is occupied by water. The organic matter along with a healthy soil life, including bacteria, fungi, earthworms, insects, etc, help in cycling nutrients (UTRCA & OMAF, N.D.). Technical and financial assistance was made available from OMAF and UTRCA. The planners used the Universal Soil Loss Equation (USLE) formula to arrive at estimated soil erosion potential as caused by water. It is commonly assumed that calculations will provide a rough estimate of soil loss. Planners try to achieve management that will limit erosion loss to 2 tons/acre/yr., which is considered to be difficult even under good farming practices.

The Research Process

The research process took into consideration the possible need for crop rotations, contour tillage, erosion control structures, and windbreaks individually and for combining more than one of them if necessary (UTRCA, N.D.). Analysis of assembled data led to the conclusion that a combination of management strategies was required. Among the strategies required were field terrace construction to decrease erosion by cutting slope length, underground drainage from terrace standpipes to natural drainage ways, windbreaks, reforestation, contour strip cropping, crop rotations, and mulch tillage. Field terraces were to be in the form of a narrow base ridge with permanent sod cover and designed for 10 year storm event capacity plus sediment allowance and a 24 hr drain-down time through infiltration and standpipes connected to underground drainage. Total length of the two terraces is 1000 m.

The cropping area was divided into nine (A through I) alternating contour strip-cropping sections with a total of 23 ha. (Fig. 6) A total of 1050 m of white ash and

Figure 6: Vetrepharm Phase Two Plan



VetrePharm
Phase Two

1990
- -Windbreaks
  - -white ash and norway spruce
  - -1050 Meters
- -Reforestation
  - -white pine and black walnut
  - -2.2 hectares

-Contour Stripcropping
- -9 strips at 43 meters wide
- -23 hectares in total
- -alternating strips of corn or soybeans with cereal grains or hay

strip a - 2.9 ha. f - 3.0 ha.
b - 2.9 ha. g - 2.5 ha.
c - 2.9 ha. h - 2.2 ha.
d - 2.9 ha.. i - 0.8 ha.
e- 2.9 ha.

- farm lane gives access to each individual strip
- contour stripcropping combined with the terrace work offers a further 50% reduction, which brings potential erosion to tolerable levels

1991
- introduce alfalfa into rotation
- adopt a mulch tillage program
- establish hardwood plantings and wildlife shelter belts
- systematic tile drainage as required
- establish a long-term lease arrangement with tenant

spruce windbreaks shelter were required along the western edge of the farm and along the west of the northern wing of strip H. A combination of white pine and black walnut in a 2.2 ha reforestation plot in the northwest corner of the farm may appear to be a contradiction. The idea is that the white pine will act as a nurse crop forcing the shade intolerant walnut into rapid apical growth free of trunk branches, producing highly valuable timber. As the walnut trees mature their production and deposition of the chemical called juglans in the earth around their root system will retard the white pine's growth, and afford the walnut trees canopy predominant exposure to the sun (UTRCA, N.D.).

Restorative Measures

Implementation of the prepared farm plan is the sole responsibility of Vetrepharm Inc. UTRCA is available for giving technical advice as needed. The implementation was scheduled over a three year time period with extra time if required to harmonize crop rotations. Additional windbreaks, wildlife shelterbelts, and any required modifications to systematic tile drainage, and any other modifications that may be required are also the responsibility of Vetrepharm. Establishing a long-term lease arrangement with the tenant of the cropland is essential for long-term continuation of the farm plan (UTRCA, ND).

UTRCA – Kintore Creek Paired Watershed Project

A paired-watershed project, with a ten-year commitment, involving two tributaries in Kintore Creek's headwaters was initiated in1984. The Kintore watershed had been identified as contributing significantly to impaired water quality. The selection of Kintore Creek for a conservation project was based on the Environment Canada-Lands Directorate erosion delivery maps (Merkley & Glasman, 1984). The purpose of the project was to evaluate the benefits to water quality and soil erosion management through conservation tillage and other conservation practices. Groundwater and manure management concerns were added part way through the project. The project site included a focus area of 1500 acres on which experiments were carried out and an adjacent control area of similar size (Fig. 3).

The Biophysical Attributes

Nature and cultural activities inject some flaws into an in-the-field focus/control experimental model. The silty soil texture in the study area is clayey silt in the focus area whereas in the control area there is a greater presence of sandy silt. The slope in the focus area ranges up to 5%. In the control area it ranges up to 9%. The focus area has a lower amount of forested area. The focus area agriculture is more specialized with a higher proportion of row crops like white beans with accompanying bare surface exposure and high agricultural chemical use. The potential annual average delivered sediment for the entire study area ranges from 2 tonnes/ha/yr. up to greater than 11 tonnes/ha/yr. depending on slope, soil type, and cropping practices (Merkley & Glasman, 1984).

The Cultural History

The land use in the project area has remained agricultural since European settlement early in the nineteenth century. The land is almost entirely under private ownership. The nearby small rural/urban settlement of Kintore delivers a much smaller amount of local agricultural services than in an earlier time. The city of London is the nearest major urban centre.

The Planning Process

The UTRCA planned the project with the aim of encouraging landowners within the focus area to undertake conservation soil tillage and other practices for the purpose of reducing soil erosion, sediment transportation, agricultural chemical residue pollution and to try to re-establish a fishery. UTRCA cooperated with the federal agency which was interested in the project for accumulating additional data for calibrating its mapping methodology and the Ontario Ministry of Environment who was interested in water quality monitoring (Merkley, &Glasman, 1984). It was planned that the control area would remain under existing types of tillage and form the basis for comparisons. Voluntarily signed-up landowners in the focus area would engage in decided upon conservation measures. UTRCA would aid and direct participating landowners to obtain any available monetary aid. Work in the field would begin following liaison with landowners. The in-the-field work would begin with the establishment of a systematic monitoring program that would monitor weather events and do weekly water monitoring at seven sampling stations. Technical aid and aid in procurement of expensive low-till and no-till machinery, for cooperative use by participants, would be offered. Close observation of progress and emerging trends would form a basis for discussion leading to possible future change in direction of the project (Merkley, & Glasman, 1984).

The Research and Experimental Process

A farm plan was developed for the individual participating farms. On-site research began with installation of three monitoring stations in the focus area and four stations in the control area. Stream bank revetment was carried out to prevent in stream erosion, which could skew test results. Comparisons of before/after conditions were based on three parameters. The parameters were phosphorus, soluble reactive phosphorus, and suspended solids. Pre-startup monitoring results showed the levels of phosphorus well above the 0.03 mg/litre M.O.E. guidelines in the two sub-watersheds. Suspended solid levels verified Environment Canada's model, which identifies the study area for high delivery of sediment to the watercourse (Merkley & Glasman, 1984).

In the seventh year of operations, the intensive water monitoring program results showed a 20% reduction in phosphorus and sediment load to the creek in the focus area. No data are shown for the control area. The reason was that many farmers in the control area had already adopted several focus areas conservation measures on their own, destroying the area's validity as a control (Merkley, 1990).

In 1988 separate monitoring was undertaken to determine the delivery rate of pesticide causing stream pesticide loading relative to total amounts of pesticides used. The program concentrated on atrazine and metolachor, which are commonly used on crops grown in the area. A pesticide use survey was conducted to establish the base amount of chemical used. Biweekly and storm event runoff samplings were carried out at the sampling stations. Five variables were reviewed as follows: total application, percent of application to high delivery lands, percent to conservation land, percent conservation tillage, and total rainfall. Concentrations at base flow exceeded suggested guidelines three times in three years in the eastern branch (control area). Guidelines for storm event runoffs were exceeded in both branches in each of three years. Rainfall amounts and the amount of pesticide used appeared to have some relationship to each other. The specific influence of conservation practices relative to the other four variables remained unclear.

Long-term monitoring and rigorous analytic procedures would be required to define relationships between the variables (Wilcox, 1992).

In 1988 and again in 1991 invertebrate monitoring was used as an indicator of stream health. After years of no fishery in the creek due to spawning-bed silting and poor water quality, indications were that a coldwater brown trout fishery could be re-established. Additional improvement in water quality, spawning bed desilting, and further reduction of sediment delivery to the stream would be required.

In 1990 a ground water component was added to the project. Well water quality became one of the general public's concerns. A monitoring program was set up using several multi-level peizometre nests to collect data from selected field tiles. Seepage meters were also placed in the western branch of the creek. The Waterloo Groundwater Research Centre, working in cooperation with UTRCA conducted an organic carbon denitrification experiment on the creek. Laboratory analysis results were not available at report publishing time (Merkley, 1992).

In 1990 landowners in the control sub-basin indicated an interest in adopting conservation measures that were implemented in the focus sub-basin. Some of them had already adopted some conservation measures on their own. Due to their expressed interest and their individual initiatives it was decided to re-focus the project's technical support to include the control sub-basin. Indications pointed to an equal or greater participation rate by landowners in the control area compared with participation in the focus area, where it had reached a plateau of around 70%. Along with the shift in focus it was decided to shift the purpose of the monitoring program from comparisons between groups to identifying indicators of improvement in soil and water conservation (Merkley, 1990).

In 1990 a livestock manure management investigation was undertaken aimed at tracing manure runoff and migration through soil and was conducted on silt-loam soils with a tile system installed 45 cm below of surface. The experiments were conducted under normal weather conditions and under 1:25 year simulated rain events. Liquid swine manure, spiked with tracer *E.coli* was applied at the rate of 800 gal/acre. On no-till-plots three different types of application methods were used: 1) surface application, no cultivation, 2) conventional injection without cultivation, and 3) injection by a prototype method that cultivates the soil immediately ahead of injection. On low till plots two additional types of treatment were applied: 1) surface (sprayed on) followed by cultivation and 2) conventional injection followed by cultivation. The 1:25 year simulated rain event was staged one day after manure application.

There is a significant formation of macropores in no till and low till soils over time, which allow easy flow of water and liquids into the subsoil horizons. Manure contamination reached the tile system 5 out of 8 trials within 1 hr of application. Test results from samples taken from the tiles showed bacteria and nutrient concentrations equal to that of the applied manure. On surface applied then cultivated plots 30% of the manure was collected from the tiles almost immediately. Surface runoff and tile drain waters sampled on the day of application exceeded *E.coli* guidelines, and samples taken on the 40^{th} day exceeded water quality guidelines for nitrates. The no till prototype manure injector system proved superior, as did the injection followed by cultivation method on the low till plots. Physical disturbance of soil macropores reduced downward movement of contaminants. It was concluded that results of the experiment suggest the superiority of innovative methods like the prototype injector system. But, the experiment should be considered to be preliminary to a great deal more required research (Merkley, 1993).

The experience gained from experimenting with low-till and no-till machinery showed that beside their high cost they also require modification to make them adaptable to the wide variety of conditions encountered in field applications. They are not readily adaptable to some types of soils. Some weather conditions limit their use. Crop types dictate the degree of conservation tillage and limit the amount of mulched material that can be assimilated (Merkley, 1987).

Based on field observations, upland gully erosion control management measures were implemented through construction of water impoundment and sediment retaining structures. Sheet and rill erosion impeding measures were implemented by way of conservation tillage. The expensive and modified low-till- no-till seeder, chisel plow, and mulching machinery used on a cooperative basis were the basic conservation tillage tools. UTRCA's involvement in the project ended with termination of funding at the end of the 1993 season (Merkley, 1993).

Restoration Measures

In tandem with the various conservation tillage experiments, chemical and manure seepage and runoff experiments, and in keeping with the idea of observing and responding to emerging ideas and trends during the project, a number of restoration activities were carried out. Windbreaks were planted to help manage wind erosion and to shelter farm buildings and farm homes. Carolinian zone type shade trees and shrubs were planted along the length of the western stream bank to shade the stream with the intention of improving the possibility of recreating a coldwater fishery. A secondary benefit provided through the stream bank planting is wildlife and bird habitat. Except for the reforestation of one eight-acre plot, tree planting was limited to extensive windbreak and stream corridor planting. Some fenced buffers were established restricting livestock access to the stream. Solar charged, battery operated pumps were employed in remote areas to supply livestock with drinking water (Merkley, 1992).

MVCA - Pilot Woodland Swamp-Upland Forest Restoration Project

In the late 1980s MVCA established a "Resource Land Restoration Mapping Project (RLRMP)". Its purpose was to identify and prioritize lands throughout the Maitland River watershed for restoration. RLRMP concentrated much of its effort on developing sound methods for restoring wooded swampland and upland forest habitat. It was expected that although sites identified by RLRMP would differ from each other, it would be possible to develop a set of universal guidelines that could be applied basin wide (MVCA, 1992).

Landowners Tom and Dianne Perry of Howich Township, Huron County entered into a RLRMP pilot project in cooperation with MVCA and OMNR.

The Biophysical Attributes

The site, a southeastern field of the Perry farm, includes a lowland area and an adjacent hillside. It is located within a greater horseshoe-shaped hill. The site slopes down toward the NNW. The surrounding area includes drumlins of the Teeswater Drumlin Field among a moraine landscape and an outwash plain to the NW, through which Salem Creek flows. The upland soil is gray-brown podzolic loam with cobles up to 25 cm in diameter. The lowland soil is dark-gray medium-texture till with poor natural drainage. The central lowland area has a 40 to 60 cm organic horizon. The natural vegetation is Great Lakes-St Lawrence forest. Hardwood trees dominate the forest adjacent to the southern property boundary (MVCA, 1992).

The Cultural History

The Project acreage had undergone the typical agricultural land use practice of tillage extension into marginal lands. In the past 50 years 80% of the Maitland River basin's wetlands have been lost to drainage systems along with their capacity to store, infiltrate, and purify water. Previous landowners of the project site tried several approaches to improve crop productivity without apparent success. In 1989 MVCA prepared a conservation farm plan for the current owners, who along with MVCA recognized part of the farm as a potential site for developing woodland swampland restoration that would be in keeping with the objectives of RLRMP (MVCA, 1992).

The Planning Process

The planning process produced a list of objectives considered necessary for realizing the primary goal of the project and its value to RLRMP:

First: to develop an understanding of wooded swampland and upland forest forms and function.

Criteria: A. Review relevant literature.
B. Preliminary site inventory and study.
C. Study of similar regional habitats under a variety of disturbance regimes and natural conditions.

Second: to create and implement restoration plans for areas, which have proven unsuitable for agricultural purposes.

Criteria: A. Develop design concept(s) based on general approaches, and a range of conditions and needs.
B. Include design guidelines and criteria for both lowland and upland vegetation restoration.

Third: to create vegetation assemblages which foster the development of natural forest associations through successional processes.

Criteria: A. Vegetative transplants are successfully established.

B. Mid-successional perennial species successfully colonize the site.

C. Existing ground cover vegetation suppressed by establishing nurse crop canopy.

D. Establish canopy species that successfully seed into the site.

E. Closed canopy of preferred species, similar to those in adjacent woodlot, successfully established with natural sub-dominants and secondary species becoming naturally established.

Fourth: to restore hydro-periodicity to poorly drained areas, which is similar to that of regional swamplands.

Criteria: A. Natural pulsed hydro regime corresponding to regionally established precipitation patterns.

B. Continuous positive drainage maintained.

C. Continuous standing water maintained in site for a period similar to that in regional swamp ecotypes.

Fifth to develop management techniques necessary to ensure the continued viability of naturalized vegetation communities.

Criteria: A. The developing habitat may be manipulated as necessary to aid in establishment of desirable species and to suppress those found to be undesirable.

Sixth to assess the success of techniques applied to a test case through the process of ongoing monitoring,

Criteria: A. Subject areas for monitoring will include:

i) vegetative assemblages
ii) hydroperiod
iii) water quality
iv) soil character
v) site form

Phases of monitoring will be:

i) an initial baseline assessment
ii) ongoing assessment during site maturation
iii) determination of post-project compliance
iv) description of long-term project status (MVCA, 1992).

The Research Process

The list of objectives defined through the planning process guided the investigation into the various project possibilities. As a result a conceptual plan was developed along with an implementation schedule. The physical layout of the plan is illustrated on Fig. 7. It shows the plan view of the constructed water management facilities and the layout of the vegetation components.

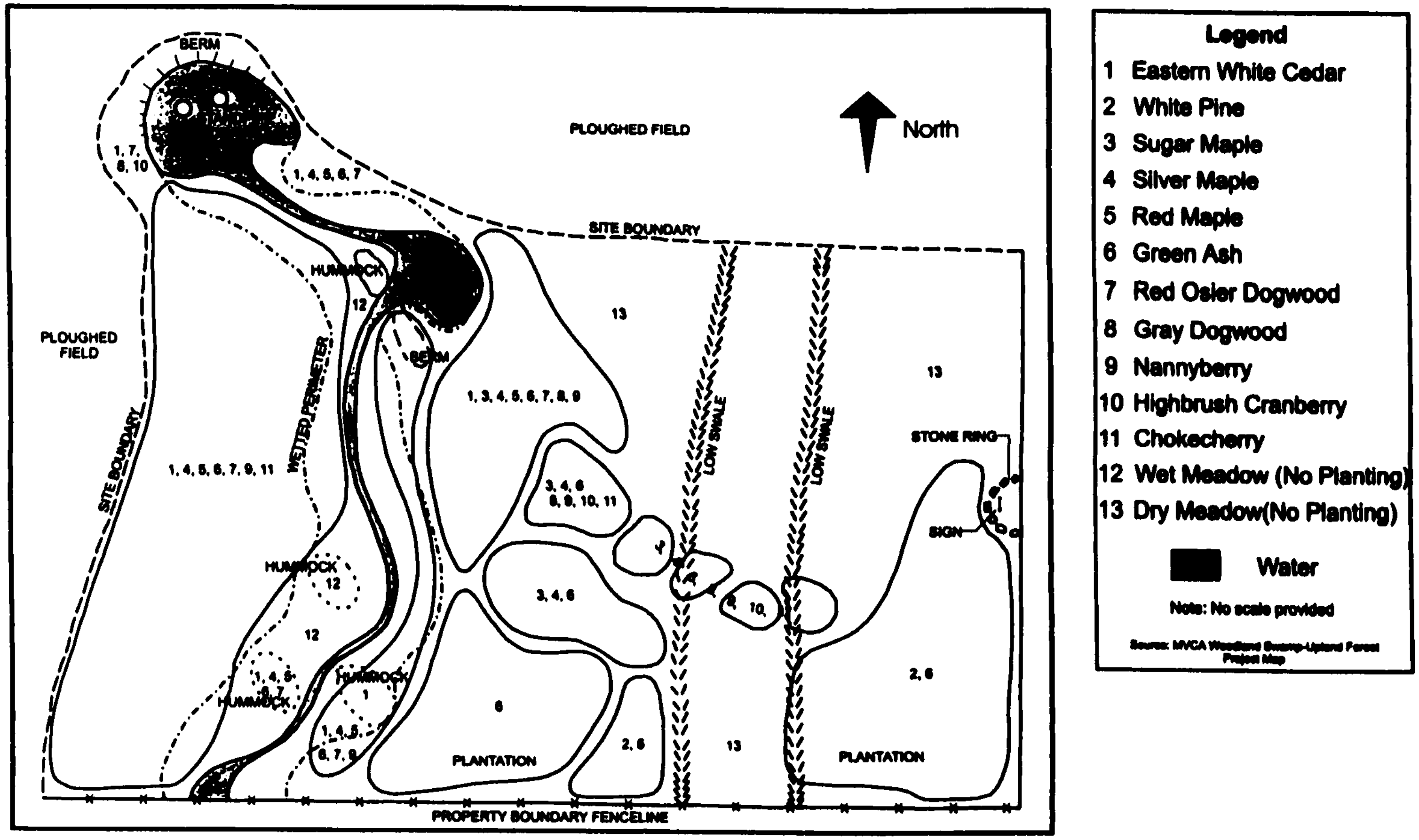
The Physical Restructuring and Restoration

Extensive reshaping of the surface features for preparing the site was the first activity. Surface water was channeled through a meandering ditch and to an impounding area. A constructed berm contains the water. Two standpipes connected to an underground drain running to Salem Creek are used to control the water level. For natural re-colonization the existing forest to the south would have to be depended upon for supplying desirable invading species. Due to the prevailing NW wind direction, which would hinder natural seed transfer, and the time natural colonization by woodland species takes, a planting program was decided upon (MVCA, 1996)

Project design took into consideration the requirement of the least amount of maintenance. Pond capacity is controlled through simple adjustment of standpipe height. Periodic debris removal is required from around the standpipes. After original vegetation establishment, vegetation was left to natural self-maintenance. MVCA carried on a five-year monitoring program, which concentrated on survival rates of planted species and general development of the site (MVCA, 1996).

The monitoring reports listed some mixed results. The yr.2 of the project (1992) monitoring report indicated rapid colonizing species types were becoming established. The yr.3 (1993) report indicated rapid development in all wetter area communities. Of 88 trees tagged for monitoring 11% had died and several others showed dieback or were browsed by animals and were sprouting new stems from the same root. The yr. 4 (1994)

Figure 7: Maitland Valley Conservation Authority Woodland Swamp - Upland Forest Project Map



report listed another 11% of the trees tagged for monitoring as having died. The analysis of the yr. 5 (1995) report was incomplete at publishing time, but indicated that the trends were similar to 1994 (Bowles, 1995).

GRCA - A Watershed Forest Plan For The Grand River

The GRCA's objective was the development of a basin wide Forestry Plan that is supported by appropriate information about up-to-date forest management and basic silviculture knowledge to guide municipalities and landowners in developing forestry best management policies and practices (GRCA, 2001).

Biophysical Watershed Features

Because of the extensive north/south distance of the Grand River watershed, that portion of the watershed above the mid-basin lies in the Great Lakes – St. Lawrence, mixed deciduous/needle/leaf vegetation zone. The portion below the mid-basin lies in the Carolinian vegetation zone. The Grand River system drains portions of eleven physiographic regions and therefore has a wide variety of soils and topography. Types of soil, drainage, elevation, and topography that distinguish the physiographic regions have a direct bearing on an area's microclimate within the greater basin-wide humid continental climate that has mild winters and a range of warm to cool summers throughout the basin. Colonization and long-term integrity of naturally vegetated ecosystems, in particular wood species within an ecosystem, favours species whose genetic makeup has developed adaptability to the climate, soils, and physical conditions of a particular physiographic region (GRCA, 2001).

Natural and Cultural Forestry History

Paleopollen deposits in deep lakes and in bogs indicate that early post-glacial forests were dominated by spruce and resembled present day northern Canadian Forests. Podzolic soil development under early forest along with continued mild climate led to deciduous broad leaf colonization around nine thousand years ago. Continuous seed dispersal and natural and culturally caused disturbances are ongoing causing forest complexity and diversity to be in a state of constant flux. Natural and cultural disturbances as well as physical weathering processes trigger natural ecosystem recovery reactions. Natural disturbances and cultural disturbances of limited magnitude may actually promote diversity by providing colonization opportunities to native shade intolerant species (GRCA, 2001). A living legacy passed down from limited cultural disturbances caused by pre-European swidden (slash and burn) agriculture exists in the lower Grand basin in the form of remnant patches of prairie (Rodger, 1998). Post European settlement cultural disturbances have left the watershed forest cover at between 10 and 40%. Areas with less than 30% forest cover fall below what is considered the threshold for recovery through the mechanisms of natural ecosystem resilience (GRCA, 2001).

In southern Ontario the vast majority of forest exists on private land. The prime rural land use is agriculture resulting in extensive forest fragmentation. Agricultural land-use on land unsuitable for agricultural use is not uncommon. A variety of public/private reforestation partnership programs have attempted to address the problem. The 1946 Conservation Act brought the conservation authorities on as consistent reforestation participants. More recently, the 1992 Project Tree Cover (PTC) federal/provincial partnership, a carbon sequestering initiative, survived for five planting seasons. A very modest stewardship tree planting program began in 1995 (Puttock, 2001). It is against this historical background that GRCA with support from Friends of the Environment (Canada Trust), The McLean Foundation, and The Shell Environmental Fund undertook development of a basin wide forestry plan (GRCA, 2001).

The Planning Process

The planning process for developing a plan such as a basin wide forestry plan is dictated by the functions that the plan is intended to serve and by the environment within which it will function. Private land uses regarding agricultural land use and natural heritage come under section 3.2 of the Planning Act. Administration of the Act, at the local level, comes under the jurisdiction of the local municipalities and is guided by land use policies contained in their Secondary Plans, Official Plans and zoning bylaws, which are required to be compatible with or exceed the minimum standards required in the Planning Act Policies (Provincial Policy Statement, 1997:3.2.1&3.2.3). Conservation authorities occupy a unique position in the development of basin wide plans such as a forestry plan. They do the research and planning in cooperation with landowners, stakeholders and municipalities. The recommendations coming out of the plan are then accepted or ignored within the land-use planning policies of the municipalities and the Provincial Policy Statements under the Planning Act. It is after the recommended practices are included in planning policies that the conservation authorities may be called upon to aid in enforcing the policies (GRCA, 2001). The challenges, therefore, are that a basin wide forestry plan must be developed in a way that embodies forestry best management practices, is acceptable to landowners, stakeholders and municipalities. It must take advantage of local knowledge, both current and historical, as well as the backing of current scientific knowledge. From the accumulated data it must assemble a set of recommended forestry best management practices that will address the ecological situation in a way that is acceptable for inclusion into Municipal and Provincial Planning Policies that are then meant to guide them toward future environmentally friendly development decisions (GRCA, 2001).

The Research Process

Accumulating appropriate data upon which to base informed plan formulation decisions required researching the ecological aspects of the forest system, the existing forest management, as well as the socioeconomic and jurisdictional capacity and attitudes upon which successful implementation of any basin wide plan depends. At present, late in the plan's drafting stage, limited resources have prolonged the projected time line for final completion of the research (GRCA, 2001). The research completed to date affirmed forest fragmentation throughout the basin. The most severe fragmentation exists in the areas of intense agricultural and urban development. There is considerable wetland loss and there is the less obvious loss of genetic and species diversity. The Grand River basin makes up 0.6% of Ontario's land area, but 84 (38%) of Ontario's species at risk occur in the Grand River basin (GRCA, 2001). There are many examples of less than best forest management practices. For several years much emphasis has been placed on windbreaks and corridors because of their physical contribution to wind erosion control and edge type habitat. The current thinking is that unless the corridors connect patches large enough to contain interior habitat overall forest ecosystem integrity does not occur (GRCA, 2001).

On the positive side there have been some successful tree planting programs on ecologically sensitive lands. Tree planting attained its high mark in 1972. It is however, presently in a deep slump due to cutbacks and the closing of the OMNR tree nurseries (Puttock, 2001). The Grand River basin has a strong remaining representation of Carolinian species. The Six Nations Lands in the McKenzie Creek sub-watershed and the Speed River sub-watershed have strong Carolinian species representation. The uneasy relationship between forestry and agriculture is experiencing some turn around as a result of greater understanding of how forestry compliments agriculture by way of shelterbelts, ground water infiltration and retention, soil regeneration, and monetary return. Gains in agroforestry (trees grown to produce harvestable crops) have been slow but steady. Natural Heritage preservation and tree cutting policies by municipalities are having some effect. This is evident in the quality of the urban forest in some communities.

Restoration

GRCA holds 18,935 hectares of preserved lands for various conservation reasons. Nearly all of it has come under some form of forest management. However most of the land in the basin is privately owned and therefore requires approaches to forestry management that recognize landowner rights. In line with the conservation authorities' core mandate of managing the flow of water, conservation of soil and water, and improving water quality they can in cooperation with other agencies play a major role in riparian rehabilitation on stream floodplains. Long-term natural rehabilitation on the mapped floodplains would provide natural corridors between virtually all forest patches within the basin. It would connect the Carolinian vegetation patches in the basin and could through interagency cooperation establish corridors with the remaining Carolinian patches in neighbouring river basins (GRCA, 2001). While corridor establishment is likely the most productive short-term route to increase natural vegetation coverage, the long-term ecosystem integrity requires landscape level thinking and actions that will eventually result in large patches that contain interior habitat and have corridor connections to other large patches. The GRCA must be active in promoting a standard set of forestry policies at the municipal and provincial level. Wetlands, bogs and savannahs should be included in forest restoration policies. GRCA must maintain a basin wide monitoring program and an educational program that informs landowners and the public. There is a need for greater awareness at all levels that forest management objectives cannot be met if they are not consistent with the silvics of the species in the forest. GRCA bears an educational responsibility in this regard. Basically silvics encompasses how trees grow including:

1. soil, site, moisture and nutrient requirements
2. flowering, fruiting, seeding and regeneration characteristics,
3. early stand growth, development, and longevity,
4. response to competition for water and nutrients, light, and physical and chemical competition within own or other species,
5. pathogens, insects, and animal predation (GRCA, 2001:3.2.1).

The question arises about the value of present tree cutting regulations based on the single minimum diameter criteria, which leaves the misshapen and those with stunted growth standing to be the genetic mother-pool of the future forest. When attempting to re-establish, as closely as it is possible, a native forest in a particular location it essential to plant stock grown from the seed of local native species. Over a long period of time native species evolve and develop genetic traits that make them genetically fit for their particular environment. The closing of MNR's area tree nurseries creates a major problem in this respect. During the present time of cutbacks at all levels of government, GRCA along with other agencies like OMAFRA and in particular OMNR, who is directly responsible for forest management, must be active in obtaining contributing partners in forest restoration. Completion of the research process, which is nearing its end, may in all likelihood add more restoration recommendations (GRCA, 2001).

GRCA – Watershed Plan for the Upper Grand River Watershed

The purpose was the development of an integrated watershed plan that will provide guidance to local, regional, and provincial governments in planning future development and land use decisions in a way that minimizes impacts on the natural environment. The plan will be incorporated into and will become a part of the larger Grand River Management Plan as that plan progresses. Being a headwaters plan it attempts to assure an environmentally positive contribution to the rest of the downstream Grand River basin (GRCA, 1999).

The Biophysical Attributes

The Upper Grand River Watershed drains a 655 sq. km headwaters area of the greater Grand River Basin that lies north of Highway 9, (Fig. 2). Its area represents 9.6% of the greater river basin and 1.1% of the Lake Erie Basin. The major hydrologic features are two major headwaters tributaries of the Grand River and the Luther Marsh. The Upper Grand Watershed is located on the Dundalk Till Plain physiographic region. Numerous small swamps, bogs and poorly drained depressions are common in the region. Most of the area has a layer of windblown silt over underlying boulder clay till. Due to higher elevation and exposure to lake effect winds, the winter temperatures are 4 to 5 degrees C lower, and the summer temperatures are 2 degrees C lower, than in the mid basin of the Grand River. There is reliable rainfall but with the lower temperature its natural vegetation lacks the presence of the Carolinian species common to the lower basin. Forest coverage amounts to 23% of the landscape with only 12% of the forest consisting of maple. Though it is the headwaters area, only 9.5% of the area is wetlands (GRCA, 1999).

The Cultural History

The landscape is open space/rural/agricultural. Dundalk and Grand Valley are the leading rural service centres. There are no major urban centres. Agricultural operations reflect climate and soil conditions with greater emphasis on forage and grazing crops than in the lower river basin. There is a sizable amount of old-field abandoned farmland (GRCA, 1999).

The Planning Process

The study for developing the plan was coordinated by the GRCA staff under the direction of a locally based steering committee, which had representatives from GRCA, the six local municipalities, and the Upper Grand River Coalition. Their task was to develop a plan that would fulfill the purpose as outlined in the leading paragraph above. Implementation of any of policies contained in the plan depends on inclusion of the policies in the individual municipalities' Secondary and Official Plans. This points out the importance of participation in plan formation by municipal representatives. Representation by an organization like the Upper Grand Coalition with openness to the public is important to public understanding and acceptance. GRCA staff bore responsibility for various technical studies (GRCA, 1999).

The Research Process

Issues of concern taken under investigation included:

> Farm drainage, peat extraction, commercial water taking, fisheries, remaining natural areas, water quality management, ecotourism, environmental health, and the public's role and access to information (GRCA, 1999:4-6).

There were several findings. Often the limited agricultural benefits gained through artificial drainage systems in the Upper Grand River basin do not justify the alterations caused in the hydrologic response. It is therefore most important that drainage projects not be undertaken without careful evaluation. Farm drainage falls under the Drainage Act through which financial aid is allotted subject to permit and review. Cutbacks in funding raise the possibility of unauthorized drainage projects (GRCA, 1999).

Peat extraction does not fall under either provincial or municipal jurisdiction at the present time. Therefore there is no tool for capturing revenue from a peat extraction operation for offsetting restoration costs or other maintenance costs such as maintaining access roads. Presently fill line regulations are being used to limit peat extraction activities into wetlands and floodplains (GRCA, 1999).

Surface water taking for irrigation was not identified as being a problem at the present time. Ground water extraction under permit from OMOEE to the amount of 50,000 litres /day from a single property could have long-term effects on a wetland and local wells (GRCA, 1999).

The fishery came under complex investigation because of its wide variety of environmental interrelationships. Water quality, farm drainage, peat extractions and the connection between ecotourism and angling all have a direct impact on the fishery. Benthic monitoring was used to gauge habitat health and water quality. Fish species inventory revealed the presence of 33 species in 1996 an increase of 7 compared with the 1983 inventory. Investigation raised concerns regarding over-harvesting by the bait fishing industry (GRCA, 1999).

Several natural areas remain in the Upper Grand Watershed. Sustaining their existence depends on managing to a sustainable level the increasing pressures by drainage projects, tourism, peat extraction and water taking. The Luther Marsh area supports 134 species of breeding birds. It also has fens and bogs that are sensitive to nutrient loading and intolerant of the effects of drainage. There are several upland woodlots in the Upper Grand with internal habitat.

Water quality management is linked to all the other issues identified in the investigation. Point source pollution from sewage treatment and landfills was readily identified and can be regulated. Non-point source pollution, though more difficult to identify was found to enter the watercourse through runoff from barnyards, from fertilized fields, improper manure handling and storage and more than sixty properties where livestock had direct stream access. Inadequate buffers are common. There are some Township landfills in Provincially Significant Wetlands (GRCA, 1999).

The good air quality is likely incentive enough to attract city-dwelling ecotourists. Opportunities exist for developing passive recreational ecotourism activities like hiking, bird watching, nature appreciation, and angling that appeal to an aging population. Eco-tourism requires management that assures sustainability of fisheries and wildlife carrying capacity (GRCA, 1999).

The steering committee assumed that access to information was vital for gaining a voluntary active role by the public. It was assumed that the public requires knowledge regarding all issues in order to arrive at informed choices. It was also assumed that the public would willingly participate in monitoring programs, thereby making more valuable information available. It was pointed out that a public information opportunity was being passed over by not utilizing the Luther Marsh Conservation Area for school group outdoor education, (GRCA, 1999).

Based on the study of the above nine issues and in consideration of the Grand River Watershed's impact on the Lake Erie basin, it was decided to include the policies contained in the Habitat Restoration Guidelines as set out in the "Framework for Guiding Habitat Rehabilitation in Great Lakes Areas of Concern", which was formulated in support of Great Lakes Remedial Action Plans (Environment Canada, OMNR, OMOEE, 1998). (See "Framework for guiding Habitat Rehabilitation in the Great Lakes of Concern" in chapter 2.)

The Plan's Restoration Recommendations

The plan outlines specific opportunities for environmental improvements in relation to all nine studied issues. In relation to farm drainage it recommends establishing buffers, restricting livestock access and addressing environmental concerns surrounding municipal drains. On peat extraction the plan states that municipalities are considered under obligation to adopt the "Inventory, Rehabilitation and Extraction Operations Peat Policy" developed by GRCA. Provincial Policies are required for stabilizing the situation province wide. On commercial water taking, the least requirement should be that residents have an opportunity for input when water-taking applications are made. With regard to fisheries the recommendations of the basin wide Grand River Fisheries Plan are considered to be essential. The basin wide plan identifies cold water, mixed water and warm water habitats in the Upper Grand. Restoration guidelines outlined in the "Framework for guiding Habitat Restoration in Great Lakes Areas of Concern" are recommended, (GRCA, 1999). Preserving the remaining natural heritage presents the opportunity for landowners, the agricultural sector, local naturalist clubs, and stewardship councils to cooperate. Together they can identify, evaluate, and catalogue the natural heritage features. Resource material and guidelines are available to them from OMNR, OMAFRA, GRCA and in Provincial Natural Heritage Policy Statements, (GRCA, 1999). Water quality management requires constant vigilance by all residents and stakeholders. Ongoing public education, continuous acceptance of responsibility by all individuals, and adherence to best management land use practices are vital. Ecotourism requires an overall business plan that is based on providing tourist satisfaction, economic benefit to the community and puts no unsustainable stress on the ecosystem. The Upper Grand's headwaters location within the greater river basin makes its community environmental health important to the entire downstream basin. The greatest community health benefits are to be gained by selecting and carrying out ecosystem enhancement projects that address the greatest possible number of environmental issues. Steering committee meetings found an expressed interest by the community in having an active role. The public's role is linked with access to information. To fulfill its role, access to information must work in two ways. It must dispense information freely, gather local knowledge, and process and assimilate resource information, (GRCA, 1999).

Implementation of the plan as a whole or of a number of its policies depends on adoption into the Secondary or Official Plans of the local municipalities. There are seven municipalities, each with its own jurisdictional powers. The GRCA has the ability to act as resource body during the development process and in its administration after implementation, (GRCA, 1999).

MVCA – Maitland Watershed Partnerships

The Maitland Watershed Partnership (MWP) is the successor to, and continues the work of, the Watershed Stewardship/Sustainable Development Project, which began in March 1999. The MWP focuses on increasing the capacity of the organizations in the watershed to become more self-reliant when dealing with the issues they face. It is funded with seed money from Human Resources Development Canada and MWP. It serves in the preparation of the public toward greater environmental management in a time of government cutbacks. It became activated through the appointment of a steering committee in March 1999. With the coming together of 27 organizations, the steering committee's first task was to recognize existing similarities and to reconcile a variety of agendas (Ter Woort, 1999).

The Biophysical Attributes

The organization was confronted by the lack of up-to-date data from which to determine the existing ecological state of the watershed. The existing available information indicated 80% of Huron County's land area is in agricultural land use and 18% of the watershed area has forest cover. The landscape displays a wide range of physiographic features, including till plains, moraines, drumlins, a dendritic drainage system and Lake Huron shoreline. The climate is humid continental with mild winters and cool summers. The soils fit into the broad classification of alfisols, excellent for agriculture (McKnight, 1992).

The Cultural History

The modern cultural history of the watershed stems from European type agricultural settlement in the first quarter of the nineteenth century. Goderich, Wingham and Listowel are the main urban centres. Numerous rural/agricultural service centres dot the rural landscape (Ter Woort, 1999).

The Planning Process

In June 1999 it was determined that planning for basin wide management strategies should be divided into three priority topic areas – "Agroecological, Terrestrial and Water." Three service teams were formed, one for each priority area, and instructed on natural resources management. MVCA was appointed the lead agency for each team. Each service team was responsible for identifying issues relative to its priority area having social, economic, and environmental elements and to carry out research and develop action plans. The long-term planning strategy is that a basin wide management plan will be developed through the work of the MWP (Ter Woort, 1999).

Each service team began its task by developing a mission statement to provide direction for its undertaking. The Agroecological Service team's mission statement directs it to "encourage responsible use and regeneration of the watershed's agricultural resources". Identifying specific issues was difficult due to the absence of available data related to the watershed's agricultural system and to the natural resources as related to agriculture. The team chose three issues for further development because of their importance to agriculture in general and therefore likely to all of agriculture in the watershed. The three issues are:

1. Nutrient management practices and associated impacts on soil and water quality.
2. Cropping/tillage/drainage practices and how they can adversely impact soil and water quality.
3. Improving the viability of family farms (Ter Woort, 1999: 1).

The Terrestrial Service team's mission directs it as follows:

> "We recognize natural areas as essential to the community. We will foster partnerships towards balanced approaches to their care and uses" (Ter Woort, 1999: 1,2).

The issues deemed priorities in the watershed by the Terrestrial Service Team were:

1. Loss of natural areas.
2. Landscape fragmentation
3. Poor woodland harvesting practices (Ter Woort, 1999: 1,2).

Forest cover in the watershed ranges from 5 to 23% whereas it is estimated that a healthy watershed requires 30% forest cover (Ter Woort, 1999:2).

The Water Service Team's mission statement directs the application of its efforts toward developing:

> "An informed and active watershed community, including all residents and their associated economic activities, that cares about water quality and quantity issues and that promotes the effective use of a watershed-based conservation strategy through visioning and positive community action" (Ter Woort, 1999:2).

The chief goals of the Water Service Team are: the maintenance of potable water and the sustainability of water-based recreation. Two major issues were identified as:

1. Aquatic health, nutrient and bacteria loading of surface water.
2. Protection of groundwater quality (Ter Woort, 1999:2).

The Research Process

Investigation into the agroecological priority topic area revealed that nutrient management is a rural and urban issue right across the watershed. Cropping, tillage, manure, agricultural chemicals and drainage systems impact soil and water quality through rural/agricultural operations. Domestic and industrial pollutant inputs, and municipal drains contribute from urban sources. Very little data exists about the current health of the watershed's soils. Many farm-service businesses in rural/urban communities have cut back or ceased offering services. The decline of these communities is of concern (Ter Woort, 1999).

Investigation into the terrestrial priority topic area raised concerns that there may not be enough remaining natural areas to maintain the health of the remaining forests and watercourses. The present forest cover is greatly fragmented with few patches larger than 40 ha. Many of the native species cannot survive in isolated patches. Establishing corridors, buffers and smoothing out irregular shaped patches would increase forest interior and edge habitat. Current poor forest harvesting practices and rates of harvesting are threatening sustainability (Ter Woort, 1999).

A limited amount of long-term surface water quality data was available for investigation. It did indicate increasing nitrate contamination suggesting increasing stress on aquatic life. Sewage treatment plants, septic systems, manure, sludge, livestock and other contamination sources were identified. Amounts of heavy metal and pesticide contamination in surface and groundwater are unknown. Shallow and deep wells were found to need protection from nitrates and bacteria (Ter Woort, 1999).

Each Service Team has recognized that proceeding with any action plan requires the employment of resource people to collect information on the key knowledge gaps and has undertaken to do so. Ongoing consultation between organizations and opportunities for their contribution is actively pursued. The "partnerships" concept embodied in MWP aims at maximizing stakeholder participation, incorporation of local knowledge, discovery of new knowledge and distribution of knowledge to the general public. Demonstration projects are ideal for that purpose.

Restoration Measures

The Agroecological Service team has selected the Lower Blyth Brook catchment area, (Fig. 4), for a demonstration site. The project is being conducted as a fact-finding exercise. The project is designed to develop a better understanding of the barriers to the use of farming best management practices and to educate farmers and the public about best management practices. Particular emphasis is on nutrient management, soil quality, cropping methods, tillage methods and drainage.

The terrestrial service team's long-term on-the-ground projected aims are to establish a community nursery as a source of local native reforestation stock. Reconnecting and restoring forests that border watercourses, including the Lake Huron shoreline is another goal (Ter Woort, 1999). A completed exercise into investigation of woodland health in the watershed has made a series of recommendations as follows:

A Forestry Plan should:

1. Be based on the forest health indicators such as basal area, mean conservation coefficient (Base area (at cutting height) over 25 cm dbh VS mean tree dia. for all sites), course woody debris, species richness, disturbances, alien species, and logging intensity and practices,
2. Promote long-term investment over short term economic gains,
3. Encourage land owner involvement and increased education, and
4. Impose sound silviculture guidelines especially in connection with tree cutting, (Gaetz & Bowles, 2001:5).

On-the-ground demonstration projects are to follow.

The Water Service team has selected a portion of the Middle Maitland River, (Fig. 4), as the site for an on-the-ground demonstration project. The project is designed to develop methods for assisting the community to improve surface water quality, improve conditions for aquatic life and to increase summer flow. Many headwaters streams located on the Stratford till plain, which has clay soils and has lost most of its natural vegetation, are intermittent. Benthic invertebrates, stream morphology, geology, and vegetative cover are being studied. On-the-ground projects within the overall project site are being designed to include: restoration and enhancement of natural wetland areas to gain groundwater recharge, and bioengineering of surface drains including channel modification, and plantings to counteract erosion and provide stream shading (Ter Woort, 1999). A demonstration project has been started. A series of small wetlands, designed to intercept surface and tile drainage water and filter it through the wetlands on its way to the river or to the groundwater have been established (Gaetz, 2001).

Chapter Summary

This Chapter contained a case study for each of the twelve projects that were selected for making comparisons. The projects represent three general types of projects. The three types are farm plan projects, sub-watershed projects, and projects that represent a movement toward basin wide management plans. Each of the twelve case studies includes an introduction, the biophysical attributes, the cultural history, the planning process, the research process, and the restoration or restoration recommendations for its respective project. The five-step conceptual framework used in the analysis section of the next chapter is applied to the case study information, of each project, that is assembled in this chapter.

Chapter 5: Analysis, Comparisons and Discussion

The analysis, comparisons and discussion regarding the three general groups of case studies are presented in three separate sections. For each group there is an analysis section, which summarizes key parts of each case, followed by an overall comparisons and discussion section.

The individual conservation authorities' case studies (projects) that were examined in this thesis were detailed with supporting references in chapter 4. They are analyzed and discussed in this chapter. As indicated in chapter one, the analysis for each case within each of the three general categories (groups) is based on a five-step assessment. A key requirement of the thesis was making comparisons of conservation authority efforts in the context of comparing approaches and outcomes. This may appear to be a simple task since all the projects were undertaken in response to similar issues of landscape fragmentation, soil and water conservation issues, ecologically unfriendly agricultural practices, and loss of natural biodiversity. Despite these general similarities, Mitchell's (1997) declaration that change, uncertainty, complexity, and conflict are four core themes in connection with environmental management raised the question of how the four core themes play themselves out among such apparent similarities. It may be expected that the four core themes play themselves out differently with regard to each of the three general groups in the case studies.

Analysis - Sub-watershed Group

Project: GRCA - Canagagigue Creek Watershed Plan

1. Problems/Issues: 1a) the critical issues, 1b) the management goals, 1c) the incentives for proceeding.

1a) The creek was identified as being in a state of severe environmental degradation. The Elmira area groundwater aquifer and the creek below Elmira were contaminated with toxic chemicals.

1b) The goal is restoration of the creek to a state that sustains a broad representation of aquatic life and that is compatible with recreational uses.

1c) The upper part of the creek, above the reservoirs, still supports an aquatic life base that can be expanded with improvement in creek health. Human and environmental health concerns demand the cleanup of the chemical pollution.

2. The scope: 2a) the spatial area of concern, 2b) the abiotic, biotic, and cultural concerns, 2c) ecological/human interrelationships, 2d) ecosystem or ecosystem attributes affected.

2a) The plan is for the entire creek watershed.

2b) Concerns: abiotic: water quality, soil and water conservation,
biotic: absence of aquatic life in lower creek, and
cultural: water quality is unfit for human consumption or for recreational uses and is a threat to downstream health in the main branch of the Grand.

2c) The creek's ecological state and the state of its immediate environment prohibits the normal human interactions with the ecosystem of which they are a part of.

2d) The entire lower basin's aquatic attributes are degraded. It impacts the relationships between the creek and the cultural component of the ecosystem.

3 The investigative process: 3a) types of surveys or (and) studies conducted, 3b) professional and stakeholder input, 3c) reported results of investigations.

3a) Creek-water and groundwater was investigated under OME supervision. GRCA has conducted creek-water monitoring on a long-term basis.

3b) Residents, GRCA, and OME were involved.

3c) Upper creek health is below acceptable standards. The lower creek and the Elmira area groundwater are condemned for general uses.

4. The action plan: 4a) recommendations made, 4b) what and how recommendations acted upon.

4a) Improved agricultural tillage, buffer strips, isolating livestock from the creek, riparian planting, and creek and groundwater cleanup are all recommended.

4b) Implementation depends on adoption of the plan's policies into municipal planning policies. OME is directing cleanup in the Elmira area.

5. Follow-up monitoring: 5a) type and interval of monitoring, 5b) reported monitoring results.

5a) OME is supervising and monitoring the cleanup in the Elmira area.

5b) GRCA conducts ongoing creek-water monitoring.

Project: UTRCA - The Avon River Valley Plan

1. Problems/Issues: 1a) the critical issues, 1b) the management goals, 1c) the incentives for proceeding.

1a) The main critical issue was the inability to improve farm crop yields in-spite-of improved crop strains, advanced farming methods, and the use of large amounts of fertilizer. There was also heavy river-channel silting.

1b) The management goals were to improve river health and assure long-term farm production.

1c) The incentive for proceeding was the expressed interest in conservation by landowners.

2. The scope: 2a) the spatial area of concern, 2b) the abiotic, biotic, and cultural concerns, 2c) ecological/human interrelationships, 2d) ecosystem or ecosystem attributes affected.

2a) The spatial area of concern was the Upper Avon river basin from below the City of Stratford to the top of the headwaters.

2b) The concerns: abiotic: soil and water conservation, and water quality, biotic: farm crop yields, loss of forest and forest habitat, and natural corridors, and cultural: low crop yields relative to inputs, and

2c) There were strained ecological/human relationships due to fragmentation of the natural ecosystem and due to intensive production oriented farming with the lack of environmental considerations.

2d) The natural ecosystem was highly fragmented due to removal of most of the natural vegetation for agricultural land use.

3. The investigative process: 3a) types of surveys or (and) studies conducted, 3b) professional and stakeholder input, 3c) reported results of investigations.

3a) They investigated the mechanical strategies including types of tillage, terracing, and strip cropping. They also investigated cultural strategies including crop rotations, grazing strategies, and forest management.

3b) UTRCA and the Technical Staff of the Ontario Conservation Branch, Department of Planning conducted the investigations.

3c) With respect for the ideals of private land-ownership it was decided to base watershed wide accomplishment on developing a farm plan for each individual landowner's farm.

4. The action plan: 4a) recommendations made, 4b) what and how recommendations acted upon.

4a) The individual farm plan was recommended.

4b) The Ontario Agricultural College Staff prepared a model farm plan as a guide, and they along with UTRCA were available to give technical assistance to individual farmers.

5. Follow-up monitoring: 5a) type and interval of monitoring, 5b) reported monitoring results.

5a) Major changes in Ontario farming during the 1950s overtook the type of farming practices compatible with the Avon Plan's ideals and no appreciable action is recorded.

5b) Nearly four decades later a group, the Upper Avon Conservation Club, along with UTRCA reactivated some of the plan's ideas and are putting them into action on a neighbour help neighbour and one sub-watershed at a time basis.

Project: MVCA - Lower Maitland River Project

1. Problems/Issues: 1a) the critical issues, 1b) the management goals, 1c) the incentives for proceeding.

1a) There was concern that the integrity of the relatively healthy ecosystem of the lower river valley may be compromised due to lack of conservation and preservation measures.

1b) The goal was to form a local group committed to working together to promote conservation of the natural ecosystem entities of the lower valley.

1c) The incentives for proceeding were the expressed willingness of the landowners, stakeholders and the conservation agencies to undertake conservation procedures to protect the existing ecosystem.

2. The scope: 2a) the spatial area of concern, 2b) the abiotic, biotic, and cultural concerns, 2c) ecological/human interrelationships, 2d) ecosystem or ecosystem attributes affected.

2a) The prime area of focus is the Maitland River Valley between the village of Auburn and Lake Huron. The secondary area of focus is all upstream locations from where pollutants and sediment may originate.

2b) The concerns: abiotic: the preservation of the complex river corridor morphology, and the high existing water quality in the lower river resulting from high volume of water movement from the moraine aquifer to stream-flow during drought periods,

biotic: the preservation of the healthy ecosystem which is related to the above average amount of natural vegetation, and the existing high quality aquatic and flood plain wildlife habitat, and

cultural: the preservation of the aesthetical values, and recreational opportunities within the ecosystem's carrying capacity.

2c) With regard to the ecological/human relationship the valley ecosystem exists within an agricultural working landscape, and some urban development.

2d) There are four species on the species at risk list. The lower valley's location places it in the position of receiving any pollutants or sediment transported from upstream.

3. The investigative process: 3a) types of surveys or (and) studies conducted, 3b) professional and stakeholder input, 3c) reported results of investigations.

3a) A series of water quality and recreation use surveys along with existing on record river valley data formed the investigation base.

3b) With MVCA acting in an advisory capacity OMNR, Huron County Staff Huron Stewardship Council, University of Guelph, Nature Conservancy of Canada, and local stakeholders were involved in the process.

3c) The investigation indicated good ecosystem integrity and recreational land use within ecosystem carrying capacity.

4. The action plan: 4a) recommendations made 4b) what and how recommendations acted upon.

4a) The group's mission statement "to maintain and enhance natural ecosystem features of the Lower Maitland" was supported.

4b) At report time the group was engaged in planning strategies as well as in early implementation of their program. MVCA was in the final stages of a basin wide Ecosystem Health Project on upstream sub-basins to determine required preventative actions to control the transport of pollutants and sediments to the lower river.

5. Follow-up monitoring: 5a) type and interval of monitoring, 5b) reported monitoring results.

5a) A recreational land use survey is continuing.

5b) Premature.

Project: UTRCA - The Cedar Creek (GREEN) Watershed Project

1. Problems/Issues: 1a) the critical issues, 1b) the management goals, 1c) the incentives for proceeding.

1a) At issue was a request from the Woodstock Environmental Advisory Committee to establish a Global Rivers Environmental Education Network (GREEN) project.

1b) The goals of the project are defined in the mission statement: "to improve the health of Cedar Creek watershed and to educate and involve the community".

1c) The main incentive for proceeding was to involve and educate primary and secondary students, and volunteers concerning river basin ecosystems.

2. The scope: 2a) the spatial area of concern, 2b) the abiotic, biotic, and cultural concerns, 2c) ecological/human interrelationships, 2d) ecosystem or ecosystem attributes affected.

2a) The spatial area of concern is the 93 sq. km Cedar Creek watershed.

2b) The concerns within the context of the GREEN project are the abiotic. biotic, and cultural aspects of a watershed:

abiotic: the geological foundation, and the surface and groundwater,

biotic: the watershed's remaining 12% of natural vegetation cover, the habitat, and the existing fish and wildlife species, and

cultural: the consequences of peoples' connections to agriculture and urban enterprise.

2c) The human/ecological interrelationships are tied to 60% of the land area in agricultural use, 14% residential, 12% urban, 8% EPA/open space, 4% industrial/commercial, and the remainder other.

2d) The water quality is degraded especially in the lower creek. The natural ecosystem is fragmented. There is sediment delivery to the creek.

3. The investigative process: 3a) types of surveys or (and) studies conducted, 3b) professional and stakeholder input, 3c) reported results of investigations.

3a) Students and volunteers conducted a series of surveys in accordance with the GREEN project.

3b) Students, volunteers and GREEN sub-committees provided the input.

3c) Continued concentration on educational and directed public participation of the GREEN project were stressed, Fifty percent of the watershed was identified as groundwater recharge area.

4. The action plan: 4a) recommendations made, 4b) what and how recommendations acted upon.

4a) Expansion of educational services and continuation of surveys were recommended.

4b) The educational sub-committee is developing classroom educational material. Opportunities for habitat restoration have been identified.

5. Follow-up monitoring: 5a) type and interval of monitoring, 5b) reported monitoring results.

5a) The student and volunteer monitoring, under the direction of a sub-committee is ongoing.

5b) The ongoing monitoring and surveys have identified areas for various types of restoration actions including habitat enhancement, groundwater protection and establishment of natural corridors.

Project: GRCA - Eramosa River-Blue Springs Watershed Study

1. Problems/Issues: 1a) the critical issues, 1b) the management goals, 1c) the incentives for proceeding.

1a) Increasing demands for non-agricultural land uses was causing concerns about water quality and about fragmentation of the remaining natural heritage. Landowners were concerned about their rights being co-opted in the greater public interest of protecting watershed resources.

1b) The goal was development of watershed protection and enhancement plans and to have them brought under the management of stewardship programs rater than under municipal bylaw regulations.

1c) The public expressed a need for a watershed management plan and a preference for having such a plan administered under a stewardship program. It was anticipated that the plan would become incorporated into the overall Grand River watershed plan that was in the works for the near future.

2. The scope: 2a) the spatial area of concern, 2b) the abiotic, biotic, and cultural concerns, 2c) ecological/human interrelationships, 2d) ecosystem or ecosystem attributes affected.

2a) The geographical area of concern includes the 270 sq. km Eramosa River-Blue Springs sub-watershed.

2b) The concerns: abiotic: soil erosion and related sedimentation, unique karst geology along with its high groundwater infiltration capacity, unique topography, aggregate extraction, and high urban groundwater extraction,

biotic: conservation of the higher than average remaining natural heritage, conservation of the existing wildlife habitat, and the viable existing fishery, and cultural: about 10% of the watershed area is in agricultural land use, and about 10% is in urban land use. Much additional urban development would put a strain on groundwater supply.

2c) Present level of cultural development has not upset the ecological balance. More recently land severance in upland forests has been cause of forest patch fragmentation. Recreational demands on natural areas are also increasing.

2d) The city of Guelph's demands on water are affecting the Arkel aquifer. Land severances and increasing recreational demands threaten to increase ecosystem fragmentation.

3. The investigative process: 3a) types of surveys or (and) studies conducted, 3b) professional and stakeholder input, 3c) reported results of investigations.

3a) The existing outdated watershed data was augmented in cooperation with a Grand River Watershed Study that was simultaneously being carried out.

3b) GRCA, Beak International, and stakeholders participated in the study.

3c) A comprehensive state of the watershed report was prepared.

4. The action plan: 4a) recommendations made, 4b) what and how recommendations acted upon.

4a) Administration of the sub-watershed's management was assigned to a Stewardship Implementation Committee made up of representatives from GRCA, community organizations, the public, naturalist groups, landowners, industry, and development groups. Adoption into municipal policies is required.

4b) The stewardship committee is required to operate within the requirements of the Conservation Act, the Ontario Planning Act, the Environmental Protection Act, and the Fishery Act.

5. Follow-up monitoring: 5a) type and interval of monitoring, 5b) reported monitoring results.

5a) Monitoring is the responsibility of the stewardship implementation committee.

5b) Premature.

Comparisons and Discussion – Sub-watershed Group

When making comparisons among the five sub-watershed projects there are a few basic circumstances of which to be mindful. Sub-watersheds occupy diverse geographical areas that contain all the attributes of a natural drainage basin along with the good and bad inputs of its cultural community. A basic element of a drainage basin is running water assuring that there is constant change. Periodic and prolonged period weather events impose uncertainty. Synergistic interactions between the riparian zone, the ecotone zone (between the riparian and the uplands zones), and the uplands zone inject complexity. Differing attitudes toward environmental management issues, landowner rights and financial interests, and a variety of stakeholder interests are all fuel for conflict.

From the conservation authorities' standpoint, the sub-watershed projects represent a major step in the evolution of their operations from dealing with individual or a limited number of issues to the adoption of an adaptive ecosystem approach. The values assessed through the five-step framework convey different meanings from project to project, e.g. the Canagagigue Creek Plan's assessment evaluates efforts applied to restoring creek health and cleaning up pollution. By contrast, the lower Maitland River Project's assessment evaluates ecosystem sustainability and enhancement efforts. In both cases the emphasis is on manipulating selected ecosystem attributes for the purpose of gaining and maintaining ecosystem integrity.

The Canagagigue Creek Watershed Plan stands out as an overdue response to a severe case of ground and surface water pollution, upper stream degradation, and a lower stream that was almost biologically dead. Recommendations coming out of a long investigative process resulted in development of a watershed management plan. The plan addresses, on a long-term basis, cleanup of the industrial chemical polluted water problem, the less than best management agricultural practices, installation of buffers, and natural vegetation regeneration. As is the case with all conservation authority developed plans its policies must be adopted into municipal secondary and official plans to become enforceable.

The state of ecosystem in the Lower Maitland River is in sharp contrast with the state of the Canagagigue Creek's ecosystem. The Maitland project was initiated by the coming together of a broadly based resource group with an interest in and a commitment to enhance and conserve the sustainability of the lower Maitland River Valley. The conservation concerns were for the river's unique and complex corridor, the above average water quality, and the above average integrity of the ecosystem given its geographical location amidst an intensive area of agriculture. With MVCA acting as leading advisor, the resource group has undertaken, on a long-term basis, the task of reconciling the cultural demands on the valley with its sustainability in a manner that is of benefit to the landowners and the stakeholders within the ecosystem's sustainable carrying capacity.

Among the five sub-watershed projects, the Avon Valley Plan stands out because it represents a very early approach to environmental management at the river basin level. The process used to develop the plan reflects the single or limited issues along with the top-down approach that was common before the adoption of the adaptive ecosystem approach as defined by the OMEE and OMNR in 1993 and presently adhered to by the conservation authorities. It did address the basic abiotic, biotic attributes of the Avon Valley, but along with the cultural concerns they were dealt with in a top-down approach under the direction of the experts. Fast changing mechanization and changing farm practices of the time overtook its implementation but some of the plan's ideas were revisited decades later.

The Cedar Creek Watershed Project presents yet another project objective. It is the establishment and operation of a Global Rivers Environmental Education Network (GREEN) project. GREEN projects operate at the grass roots level and are driven entirely by voluntary participation. Their goal is to improve the health of the watershed through the involvement of the community and through education. Most of the educational effort is aimed at the primary and secondary school level by way of developing classroom material and by ongoing group survey and monitoring projects. In the intensively farmed Cedar Creek watershed sensitive areas for aquifer protection and opportunities for restoration projects have been identified.

The Eramosa River-Blue Springs Project has some of the same characteristics as the Lower Maitland project. It also has above average ecosystem integrity for its location. A strong positive feature is the presence of a high level of Carolinian species. It is in an area of higher population and urban development and faces greater recreational use demands, land separation demands, and urban water extraction demands. The landowners were concerned that their ownership rights would be overlooked in an effort to address the demands of other stakeholders.

A thorough study into the diverse aspects of the watershed was conducted by a consulting organization under the direction of GRCA and a watershed management plan was developed. The plan is designed to become an integral part of a future Grand River Watershed Plan. The sub-watershed is to be administered by an appointed Stewardship Committee that adheres to all the normal Conservation Act and Planning Act policies. As with all plans developed under conservation authority direction, the plan's policies must be adopted into municipal secondary and official plans to become enforceable.

Each of the five projects displayed some outstanding features that set it apart from the other four. The Avon Valley project was a pioneering project that broke ground into river basin management. It lacked taking into consideration all of the abiotic, biotic and cultural entities in the manner that an ecosystem approach does. Severe water pollution and severs stream degradation set the Canagagigue Creek project apart. The Lower Maitland and the Eramosa River-Blue Springs displayed the greatest commonality having similar high integrity ecosystems and committed resource groups for carrying out long-term stewardship commitments. The Cedar Creek's GREEN project may give a first impression of being a novel way to approach watershed management. Its educational focus on the primary and secondary schools may be expected to pay handsome environmental enhancement dividends in the future.

There are also common features among the five projects. The natural ecosystem within which each of them is located has undergone varying degrees of fragmentation and degradation. The projects were initiated in response to environmental issues and with a goal to achieve. Whatever the issues or goals the project's restoration operative methods were based on manipulating one or more of the ecosystem's abiotic, biotic, and cultural entities for conserving or regaining ecosystem integrity. All of the projects appear to be rooted in a compelling issue or combination of issues that arouse interest and commitment to be involved by the general public. The conservation authorities became partners in the projects by contributing expert technical advice and support, and acting as general resource organizations

Analysis – Farm project Group

Project: MVCA - Agroecological-Wildlife Enhancement Farm Plan Program

1. Problems/Issues: 1a) the critical issues, 1b) the management goals, 1c) the incentives for proceeding.

1a) At issue was the development of an ecologically friendly farm program for individual farms that could be applicable to individual farms basin wide.

1b) The management goal was to employ the farmer's knowledge of his/her farm in conjunction with a standard seven step developed program in order to manage his/her farm in an ecologically enhanced manner employing an ecosystem approach.

1c) The incentives are embodied in the farmer's pride of ownership, a feeling of being in control, and the anticipation of environmental enhancement and monetary gain.

2. The scope: 2a) the spatial area of concern, 2b) the abiotic, biotic, and cultural concerns, 2c) ecological/human interrelationships, 2d) ecosystem or ecosystem attributes affected.

2a) The individual farm is the special area of concern with expectation that success will spread from farm to farm.

2b) The concerns: abiotic: soil degradation, loss of moisture in the soil, and the results of agricultural tillage on unsuitable soils,

biotic: loss of wildlife habitat, poor crop yield on unsuitable soils, and loss of aesthetic values, and

cultural: inefficient practices, low return for efforts, and loss of aesthetic values.

2c) The ecological/human relationship is grounded in conducting agricultural enterprise in a culturally modified ecosystem.

2d) Modern agriculture is foreign to the natural ecosystem. It removes large areas of land from the ecosystem impacting its self-organizing characteristics.

3. The investigative process: 3a) types of surveys or (and) studies conducted, 3b) professional and stakeholder input, 3c) reported results of investigations.

3a) A seven step investigation, planning, and review program is applied to each farm.

3b) The seven-step program along with descriptive literature is the prime investigation guide. The conservation authority is available as a resource organization. The Ontario Agricultural Training Institute is available for consultation.

3c) The investigation's results are produced by applying steps 1 through 4 of the program.

4. The action plan: 4a) recommendations, 4b) what and how recommendations acted upon.

4a) The action plan is developed and illustrated on three maps: a Base Map illustrates the program starting conditions of the farm, (overlay 1) illustrates the Areas of Concern/ Wildlife Sightings Map illustrates the conditions that require attention, and (overlay 2) an Action Plan Map illustrates the required restoration actions.

4b) The plans of action are prioritized to a time scale that blends in with the farm's overall operations plan and in accordance with financial considerations.

5. Follow-up monitoring: 5a) type and interval of monitoring, 5b) reported monitoring results.

5a) Review intervals are timed to coincide with natural seasonal cycles and the farmer's work schedule.

5b) Landowner makes necessary adjustments to plan based on results of reviews.

Project: UTRCA - The Vetrepharm Inc. Soil and Water Conservation Farm Plan

1. Problems/Issues: 1a) the critical issues, 1b) the management goals, 1c) the incentives for proceeding.

1a) The critical issues were soil erosion, soil and water conservation.

1b) The management goals were controlling wind and water soil erosion, and improving water infiltration.

1c) The incorporated company, the landowners, wished to convey an image of being a responsible member of the agricultural community

2. The scope: 2a) the spatial area of concern, 2b) the abiotic, biotic, and cultural concerns, 2c) ecological/human interrelationships, 2d) ecosystem or ecosystem attributes affected.

2a) The spatial area of concern was the tillable area of the landowner's farm. The area was approximately two thirds of the 177acre farm.

2b) The concerns: abiotic: soil and water,

biotic: crop yields on degraded soils, and

cultural: conveyance of a favourable image.

2c) The human/ecological relationships were tied to unsatisfactory tillage on lands with severe slopes and crop rotation.

2d) The ecosystem attributes affected were soil and water, and indirectly biological production.

3. The investigative process: 3a) types of surveys or (and) studies conducted, 3b) professional and stakeholder input, 3c) reported results of investigations.

3a) The investigation process was conducted in accordance with the Joint Agricultural Soil and Water Conservation Program (JASWCP) by UTRCA.

3b) UTRCA prepared a farm plan based on the investigation's findings.

3c) It was agreed that the landowner would implement the plan in a manner that would blend into the farm's overall operation.

4. The action plan: 4a) recommendations made. 4b) what and how recommendations acted upon.

4a) The recommendations include a combination of terrace construction. contour strip cropping, water runoff control, and windbreak planting.

4b) Implementation of the plan is extended over a three-year period.

5. Follow-up monitoring: 5a) type and interval of monitoring, 5b) reported monitoring results.

5a) Monitoring is the landowner's responsibility.

5b) Same as 5a.

Project: UTRCA - Kintore Creek Paired Watershed

1. Problems/Issues: 1a) the critical issues, 1b) the management goals, 1c) the incentives for proceeding.

1a) The problem was high delivery to Kintore Creek of sediment containing soil, agricultural chemicals, and animal wastes.

1b) The management goals were to develop low and no tillage, and other practices for controlling soil erosion and sediment transport to the creek.

1c) The incentives for proceeding were watershed environmental enhancement. re-establishing a fishery, and developing better farming methods. Environment Canada was interested in the project for the purpose of accumulating data for calibrating its erosion delivery maps. OME was interested in doing water quality monitoring.

2. The scope: 2a) the spatial area of concern, 2b) the abiotic, biotic, and cultural concerns, 2c) ecological/human interrelationships, 2d) ecosystem or ecosystem attributes affected.

2a) The spatial area included a 1500 acre focus area on which to carry experiments and a similar area used as a control area.

2b) The concerns: abiotic: soil erosion and water quality,
biotic: loss of the fishery and lowered crop yields, and
cultural: lower crop returns relative to cultural inputs.

2c) The ecological/ human relation in the creek sub-watershed is intensive agricultural land use.

2d) The creek's aquatic-life habitat was severely degraded and there was excessive loss of valuable soil due to erosion.

3. The investigative process: 3a) types of surveys or (and) studies conducted, 3b) professional and stakeholder input, 3c) reported results of investigations.

3a) The investigation was carried out in the form of a combined monitoring, research, and experimentation process. It was directed by UTRCA and conducted jointly with the landowners

3b) The landowners and UTRCA jointly decided upon the actions to be taken. The landowners carried out the physical experiments.

3c) Expensive low and no-till machinery required extensive field modification. Soil and weather conditions limit its use. It is not adaptable to some types of crops. About 20% is the limit of heavy crop residue that can be mulched back into the soil.

4. The action plan: 4a) recommendations, 4b) what and how recommendations acted upon.

4a) To be beneficial, low and no till methods require favourable soil and weather conditions, and must be limited for use with crops to which they can be adapted. It was recommended that landowners in the control area be accepted into the low and low till project in the seventh year of the project because their interest in participating equaled that of those in the focus area.

4b) Landowners in the control area were accepted into the program in the seventh year of the project. A limited amount of tree planting was carried out primarily for windbreak and stream shading.

5. Follow-up monitoring: 5a)type and interval of monitoring, 5b) reported monitoring results.

5a) Biweekly and storm event water monitoring was carried throughout the project. In 1990 an agricultural chemical survey and a groundwater survey were added. A liquid manure application experiment was monitored.

5b) By the seventh year a 20% reduction in phosphorus and sediment delivery to the creek was reached. Invertebrate monitoring indicated improvement in the creek's water quality. Agricultural chemical monitoring results were inconclusive. Ground water monitoring results were not included in the project report. Liquid manure application monitoring indicated more satisfactory results when applied with a no till prototype injector system but that considerably more experimentation is required before definitive conclusions may be drawn.

Project: MVCA - Pilot Woodland - Upland Forest Restoration Project

1. Problems/Issues: 1a) the critical issues, 1b) the management goals, 1c) the incentives for proceeding.

1a) At issue was the development of a program that addresses the loss of 80% of the Maitland watershed's natural wetlands to agricultural land uses.

1b) The management goals were to change the management goals of individual farmers by returning unsuitable lands in agricultural use to natural vegetation cover and habitat.

1c) The incentive was to regain natural biodiversity by discontinuing tillage on unproductive soils.

2. The scope: 2a) the spatial area of concern, 2b) the abiotic, biotic, and cultural concerns, 2c) ecological/human interrelationships, 2d) ecosystem or ecosystem attributes affected.

2a) The spatial area of concern included patches of land that were under unsuitable agricultural use.

2b) The concerns: abiotic: the loss of water storage, filtration, and infiltration provided by former natural wetlands and soil erosion on farmed land that is unsuitable for tillage,

biotic: the loss of natural wetland and upland vegetation and habitat, and

cultural: difficult and inefficient farming practices that yield unproductive results.

2c) The ecological/human relationship revolves around unsuitable land use.

2d) The attributes affected are the loss of wetlands and natural lowland and upland vegetation and habitat.

3. The investigative process: 3a) types of surveys or (and) studies conducted, 3b) professional and stakeholder input, 3c) reported results of investigations.

3a) The investigative process was in accordance with the MVCA's "Resource Land Restoration Mapping Program" (RLRMP).

3b) MVCA and the landowners were involved in the process.

3c) The focus area was an ideal fit for a RLRMP project.

4. The action plan: 4a) recommendations made, 4b) what and how recommendations acted upon.

4a) A RLRMP project was recommended.

4b) An on site RLRMP project was carried out.

5. Follow-up monitoring: 5a) type and interval of monitoring, 5b) reported monitoring results.

5a) An annual monitoring program, on a five-year basis, was initiated.

5b) Monitoring reports included: rapid early colonization by pioneer species, rapid development in wet communities, rapid white cedar and white growth, and 22% of 88 trees marked for monitoring had died by the year four monitoring date.

Comparisons and Discussion – Farm Project Group

Family farms are the norm in the study areas. Each farm operation experiences seasonal, annual, and livestock cyclical changes unique to its operation. Weather and market price fluctuations are likely to have a greater impact on a specialized farm operation than on a mixed farming operation. Modern agricultural operations are complex in and of themselves and that degree of complexity is likely to vary in relation to how compatible a particular operation is with the natural ecosystem into which it is interjected. A farm operation is foreign to its surrounding natural ecosystem. The more closely crop and animal species of the operation resemble the flora and fauna in the natural ecosystem, the greater the likelihood of adaptation. However domestic species that are adaptable may also readily become aggressive exotic invaders into the natural ecosystem. A prime example in the study areas, even to the casual observer, is Japanese Mustard. Economic pressures may cause an individual farmer to extract maximum yields from his/her land in conflict with best management practices, or may be incentive for converting unsuitable lands to agricultural use.

The agroecological-wildlife enhancement farm project was one of nine original pilot farm projects undertaken for developing a program for farm management on the basis of farm as ecosystem. An outstanding feature of the program is that it uses the farmer's knowledge about his/her farm and its operations along with the aid of a seven-step planning guide to develop and map a farm management action plan and carry it out. Approaching farm planning in the context of farm as ecosystem places it among the most advanced approaches to farm management in existence. The farm as ecosystem approach makes the program widely adaptable to nearly all types of farm operations. If it becomes widely adapted it could result in a big step toward enhancement and protection of ecological health in intensively farmed watersheds.

The Vetrepharm Inc. farm project was a demonstration of reengineering of a severely sloped landscape for combating erosion under normal tillage practices. It demonstrated that most landscapes could be reengineered to suit agricultural land uses. It also demonstrated that conservation authorities are prepared to respond to requests that require advanced technical skill. The scope of such an extensive landscape reengineering undertaking is likely beyond the carrying capacity of the average family farm. Reforestation or permanent pasture in some areas might have been a logical alternative.

The Kintore Creek Paired Watershed project was a ten-year, in-the-field, focus area/control area experimentation and demonstration project. Its purpose was to develop and demonstrate low-till and no-till cropping methods for controlling erosion and stream sedimentation. A liquid manure seepage to surface and groundwater monitoring program was included. Its results were inconclusive. The experiment established advantages and disadvantages associated with various types of machinery, limits to the adaptability of no-till and low-till methods as related to types of crops, types of soils, and weather conditions. Ongoing monitoring indicated that by the seventh year there was a 20% decrease in sediment and phosphorous loading in the creek. Perhaps the greatest indication of the project's success is that in the seventh year many of the participants in the control area asked to and became included in the focus group.

The pilot woodland swamp-upland forest restoration project was undertaken, as a MVCA Resource Land Restoration Mapping Project whose prime purpose is to rehabilitate to a natural state lands that had been put to unsuitable agricultural uses. Counteracting the loss of 80% of the watershed's wetlands, most of it on private lands, is the major objective of the program. Each rehabilitation project is designed to address the specific conditions, as they exist on the individual project site. Landscape modification is most likely involved when reestablishing a wetland. Either natural vegetation regeneration or nursery stock may be used depending on the availability of nearby invading desirable natural species. The scope of such a project is likely to require cooperation between the landowner and the conservation authority as well as financial assistance. Such projects will have to demonstrate how the values of land rehabilitation will benefit the landowner in order to be adopted on a broad scale.

The four farm projects were initiated in response to a request from the farmer(s) to the respective conservation authority. The reasons behind the requests were varied and often addressed more than one of aesthetic values, operating efficiency, crop yields, soil and water conservation, land rehabilitation, and economic returns. The conservation authorities place much trust in the demonstration value of projects for having the projects' ideas copied by other landowners

The four farm-oriented projects are typical examples of the conservation authorities' remaining strong connections to that part of their core mandate that emphasizes stream flow management, soil and water conservation and water quality. The individual farm projects are a practical approach by the conservation authorities in the study areas with their high rate of private land-ownership. Authority records show that along with some tree planting projects, individual farm projects are almost entirely carried out on privately owned lands. The conservation authorities' role is primarily to provide technical advice and support, and aid in procuring financial assistance. Full cooperation between the landowner and the authority is essential. The conservation authorities appear to rely on developing an individual farm plan in cooperation with the farmer that best addresses the situation, the particular farm's operations, the economic realities, and applying the art of persuasion and a promise of continued technical advice to the farmer for following through.

Analysis – Watershed Project Group

Project: GRCA - A Watershed Forest Plan for the Grand River

1. Problems/Issues: 1a) the critical issues, 1b) the management goals, 1c) the incentives for proceeding.

1a) The remaining natural forest exists in highly fragmented isolated patches, many of which are too small to contain interior habitat.

1b) The goal was to develop of a basin-wide forest plan that would eventually become adapted into the municipal and provincial planning policies.

1c) A strong incentive was to seize the opportunity to develop sustainable forest management by expanding the remaining forest, in particular the Carolinian forest.

2. The scope: 2a) the spatial area of concern, 2b) the abiotic, biotic, and cultural concerns, 2c) ecological/human interrelationships, 2d) ecosystem or ecosystem attributes affected.

2a) The scope was the development of a forest plan for the entire river basin.

2b) Concerns: abiotic: soil and water conservation, and water quality, biotic: ecosystem resilience, biodiversity, and flora and fauna habitat, and cultural: sustained biological production beneficial to humans, aesthetics, and recreational opportunities.

2c) Humans depend on the ecology's biological products for their livelihood. Extreme fragmentation of the ecosystem may diminish ecological productivity of the crops for which it was fragmented in the first place. .

2d) In several of the watershed's areas the forest cover is below 30%. Below that level ecosystem sustainability is doubtful (GRCA, 2001). There is a high number of species on the species at risk list.

3. The investigative process: 3a) types of surveys or (and) studies conducted, 3b) professional and stakeholder input, 3c) reported results of investigations.

3a) Scientific and historic forest literature appropriate to the Grand River geographical area was reviewed.

3b) GRCA's entire forestry staff was involved.

3c) Examples of faulty existing forestry management practices and long-term reforestation programs were found to be inconsistent with common reforestation practices. Two sub-watersheds have a strong Carolinian vegetation representation.

4. The action plan: 4a) recommendations made, 4b) what and how recommendations acted upon.

4a) Development of a forest plan is in its final stages.

4b) Onus for implementation lies with adoption of the plan's policies into municipal and provincial planning policies.

5. The follow-up monitoring: 5a) type and interval of monitoring, 5b) reported monitoring results.

5a) GRCA monitors the forest on an ongoing basis.

5b) An up-to-date forest database. The influence of plan monitoring must await implementation of the plan.

Project: GRCA – Watershed Plan for the Upper Grand River Watershed

1. Problems/Issues: 1a) the critical issues, 1b) the management goals, 1c) the incentives for proceeding.

1a) At issue was to development of an integrated watershed plan for the prime headwaters area of the Grand River basin.

1b) The management goals were to provide guidance to local, regional, and provincial governments in developing secondary and official plans for future environmentally friendly development.

1c) The incentive was satisfying local planning needs and develop a plan that could form a basic plan that could, over time, be expanded into a Grand River basin-wide plan.

2. The scope: 2a) the spatial area of concern, 2b) the abiotic, biotic, and cultural concerns, 2c) ecological/human interrelationships, 2d) ecosystem or ecosystem attributes affected.

2a) The scope of the undertaking involved a 655 sq. km headwaters area of the Grand River watershed.

2b) Concerns: abiotic: farm drainage, peat extraction, commercial water taking, and water quality,

biotic: fisheries, remaining natural heritage, and general environmental state, and

cultural: the public's role, ecotourism, and access to information.

2c) The rural culture closely ties humans to agriculture and natural resources for their livelihood.

2d) The ecosystem's attributes are common to those of a river headwaters region. A large amount of the natural vegetation has been removed. There are many old fields as a result of abandoned farm operations.

3. The investigative process: 3a) types of surveys or (and) studies conducted, 3b) professional and stakeholder input, 3c) reported results of investigations.

3a) Eleven areas of concern were investigated: farm drainage, peat extraction, commercial water taking, fisheries, remaining natural areas, water quality management, ecotourism, environmental health, the public's role, and access to information.

3b) GRCA staff, a local steering committee representing six municipalities, and the general public had input into the plan.

3c) A watershed plan was developed for the area.

4. The action plan: 4a) recommendations made, 4b) what and how recommendations acted upon.

4a) It is recommended that the plan's policies be adopted into the local municipalities' secondary and official plans. GRCA developed a set of guidelines for peat extraction. It is recommended that the province adopt the peat extraction guidelines as provincial policy. No policies exist at the present time.

4b) Municipal adoption is required for implementation.

5. Follow-up monitoring: 5a) type and interval of monitoring, 5b) reported monitoring results.

5a) The formulation of the plan was guided by existing monitoring data.

5b) Premature.

Project: MVCA - Maitland Watershed Partnerships

1. Problems/Issues: 1a) the critical issues, 1b) the management goals, 1c) the incentives for proceeding.

1a) The leading issues were the absence of a basin wide plan for investigating ecological issues and the absence of a basin wide partnerships program, under the direction of MVCA, for the purpose of carrying out ecosystem enhancement. There was also a lack of up to date data about the state of the watershed's ecosystem.

1b) The management goal was to assemble several existing groups into a single organization, under the direction of MVCA, that in the short run would become educated in ecological issues management, would investigate the state of the ecosystem, and carry out demonstration projects to be used as public educational tools. It is hoped that in the long run it would develop into a basin wide program.

1c) The incentive for proceeding was the expressed willingness of twenty-seven organizations to pool their resources to become a cohesive action group.

2. The scope: 2a) the spatial area of concern, 2b) the abiotic, biotic, and cultural concerns, 2c) ecological/human interrelationships, 2d) ecosystem or ecosystem attributes affected.

2a) The entire river basin is the area of concern in the long-term.

2b) The concerns: abiotic: the lack of data concerning the state of soil health and quality of water,

biotic: ecosystem and habitat fragmentation, and cultural: some of the agricultural tillage practices, inadequate animal and human waste management, a shortage of monetary and trained human resource persons for proceeding with the program.

2c) The environmental/human relationship revolves agricultural and urban land uses in the absence of an up to date data and knowledge base upon which to make action plans.

2d) Soil health, ecosystem fragmentation, and groundwater and surface water quality are the main ecosystem attributes affected.

3. The investigative process: 3a) types of surveys or (and) studies conducted, 3b) professional and stakeholder input, 3c) reported results of investigations.

3a) Project participants were divided into three teams and each team investigates one of three ecological priority areas; agroecological, terrestrial, and water

3b) Same as 3a.

3c) Team education and establishment of demonstration projects were the result of the investigations.

4. The action plan: 4a) recommendations made, 4b) what and how recommendations acted upon.

4a) Continuation of education and of demonstration projects was recommended.

4b) The teams are following through on the recommendations.

5. Follow-up monitoring: 5a) type and interval of monitoring, 5b) reported monitoring results.

5a) Demonstration projects are continuously monitored.

5b) Premature.

Comparisons and Discussion - Watershed Project Group

The three watershed projects may be viewed as representing a step in the maturation process of the conservation authorities' mode of operations. While remaining true to their core mandate of soil and water conservation, stream flow management, and water quality, it represents an expansion beyond the sub-watershed adaptive ecosystem management approach, toward adaptive ecosystem management at the river basin level.

GRCA's watershed forest plan brings the watershed's forestry management together into a single plan with an ecosystem approach. On a basin-wide basis only 18% of the area is under forest cover. In the upper middle Grand and lower middle Grand areas, and in the Nith sub-basins intensive agricultural area coverage ranges between 10 and 15%. In the Speed River and McKenzie Creek Sub-watersheds the coverage ranges between 20 and 25% with a strong representation of Carolinian species. Gilbert and Anderson (1998) and GRCA et al (2001) stated that 20% forest coverage with up to 30% of natural coverage is required to maintain natural ecosystem integrity among the 70% of otherwise controlled ecosystem. The watershed forestry plan is designed to address the situation by providing detailed information about the existing state of the watershed's forest, about best forest management practices, and about silviculture in general. Faced with the realities of financial constraints and the large degree of land-ownership, reforestation rests with finding opportunities in cooperation with private landowners and lands that come under conservation authority influence. Of the latter conservation authorities have the power to exert influence in the vast riparian networks that exist in all river watersheds.

The watershed plan for the Upper Grand was developed as a comprehensive watershed management plan for the headwaters region. It addresses the eleven issues that were considered to be key to the environmental management of the region. It may be argued that the plan is slanted in favour of the cultural component of the ecosystem. However, it likely represents the best achievement in the development of an ecosystem approach to a management plan in an environment where the abiotic and biotic components of the ecosystem are evaluated and managed by the cultural component.

The Maitland watershed partnerships program, in its present state, represents a first step toward the development of a watershed plan. The lack of existing up-to-date data on the watershed's ecological health made it necessary to accumulate base-line data. The program is proceeding under the direction of MVCA with numerous committed resource groups formed into three service teams. The teams are an agroecological team, a terrestrial service team, and a water service team. After about a year of active fieldwork they have established demonstration projects and are accumulating data pertinent to their teams' objectives. The terrestrial team has completed a watershed survey of the natural terrestrial vegetation.

The three watershed projects display characteristics that appear to be common to the way conservation authorities have operated and evolved over the time of their existence. The watershed forest plan has the prime purpose of managing the watershed's forests but is designed to fit into a future comprehensive watershed management plan. The watershed plan for the upper Grand has the prime purpose of managing the headwater's ecosystem but was designed to become an integral part of a future watershed management plan. The Maitland watershed partnerships program has the prime purpose of assembling information and developing strategies for enhancing the watershed's ecological health with the likelihood that a future watershed plan will be developed out of the present undertaking. The GRCA's watershed fishery plan (although not included in the projects in this study) is another example. The Eramosa River-Blue Springs project, included in the sub-watershed projects, is an additional example. It is, no doubt, beyond the financial and human resources available to an individual conservation authority to develop a comprehensive watershed management plan from start to finish in a single undertaking within a limited allotted time. This piecemeal progressive approach to developing a watershed plan may be interpreted as the conservation authorities' adaptation to real conditions.

Chapter 6: Summary, Conclusions, and Recommendations

Thesis Summary

Upon beginning this thesis some clarity was sought regarding the conservation authorities' operations, their mandate and their powers. It was also necessary to determine that the conservation authorities' restoration projects were recorded on file at the authorities' head offices and available for public viewing. Chapters 1, 2, and 3 trace the research process along with supporting references. A brief outline is summarized in the following paragraphs.

Two decisions were made for practical reasons and to satisfy the credibility issue. Three conservation authorities, the GRCA, MVCA, and UTRCA would become the designated authorities and therewith their respective river basins would be the study areas. A contact person at each of the three authorities aided in making the files available but did not restrict access to any file or try to influence the selection of projects to be investigated. Four projects from each authority, representing farm, sub-watershed, and watershed projects were selected. Selecting projects from all three general groups of projects was considered important because it traces the three major steps in the evolution of the conservation authorities' approach to conservation from their core mandate of soil and water conservation, stream flow management, and water quality through the inception of the ecosystem approach and onward toward development of comprehensive watershed management plans. They have not abandoned their core mandate. They have, instead, incorporated the core mandate into their broadening, and slow, but steady, advancement from farm projects, through the sub-watershed projects and toward ecosystem management plans for the river basin.

During the evolution of their operations conservation authorities have not moved off the foundation put in place by the six founding principles and ten allotted powers. They have been able to remain true to the responsibilities of their core mandate of soil and water conservation, stream-flow control, and water quality, while at the same time becoming able to address all other attributes that make up an ecosystem. They have adjusted their approach to take advantage of gains made in ecological knowledge and the emergence of the notions of sustainability and managing the environment through an ecosystem approach. They have also had to adapt to changes in government policies, changes in the Planning Act, changes in public attitudes, and changes in financial and human resources available to them.

While operating within their mandate, individual conservation authorities still display a large degree of individual autonomy. Without that autonomy it would be difficult to address issues that are specific to their particular watershed. Regardless of individual authority autonomy neighbouring conservation authorities collaborate on similar issues, e.g. GRCA and MVCA on forestry issues, and UTRCA on agricultural issues with Kettle Creek and Catfish Creek authorities.

The Conservation authorities maintain a strong commitment to particular committee reports that are specific to their watershed, e.g. GRCA to the GRIC (1982) report, MVCA to the Policies and Procedures Manual (1992), and UTRCA to the TRIC (1982) report. GRCA's commitment to GRIC consumes a sizeable portion of its operating resources for stream-flow management, water supply, and water quality. MVCA's Policies and Procedures Manual reflects the prominence of agriculture in the river basin but is flexible enough to allow for a balanced approach to watershed wide issues. UTRCA maintains a strong commitment to the TRIC report (see chapter 3). While it recommended management on a "watershed as ecosystem" basis, UTRCA's prime role was to deal with rural land management. Their commitment to the rural land management cause is evident in the numerous individual farm plans on record, and in the emphasis placed on soil and water conservation in their sub-watershed projects.

In accordance with provincial policies the conservation authorities adhere to the OMEE and OMNR (1993) definitions of ecosystem and ecosystem management that were issued in connection with sub-watershed management. Thereby the conservation authorities have been able to gain knowledge and experience through sub-watershed ecosystem management that may be applied to watershed management plans. GRCA has made progress in that direction through the development of the watershed forest management plan, the watershed plan for the Upper Grand, and the Eramosa River-Blue Springs plan. GRCA also has a watershed fishery plan. The progress made to-date on the MVCA's Maitland Watershed Partnerships project represents a major first step in that direction.

The observations in the above summary are both supported and limited by the quality, pertinence, and interpretation of the information contained in the published reports of the twelve projects selected for the sample. Though twelve from among the numerous project records on file is a small sample, the sample selection process was designed to produce a sample that represents a general cross-section of the three conservation authorities' restoration efforts. How well the sample represents a broad cross-section of the restoration efforts by the conservation authorities across southern Ontario is hard to determine but one may speculate that similarities likely do exist.

Some after-the-fact reflections are in order at this stage of the thesis exercise. The early decision to conduct the thesis in six stages provided flexibility for dealing with the overall exercise in readily manageable segments. Selecting the Chapter 2 literature for its likely relevance to river basin issues resulted in the assembly of a body of literature that was adequately related to the issues in the study areas. Chapter 3 provided sufficient grounding for understanding the biophysical nature of the study areas' ecosystems and for understanding the conservation authorities' mandate and its operational scope, as well as, its limitations. The Chapter 4 six-step case study investigation format was an adequate tool for capturing the required pertinent data from within the extensive restoration project files. After-the-fact reflection on Chapter 5's five-component conceptual analysis framework suggests possible improvements. It is acknowledged that the addition of a temporal component to the conceptual framework would have added a significant analytic element. Time, as a critical factor, has direct relevance to farm planning because farm operations are cyclical. However, the development of sub-watershed and basin-wide management plans relies very heavily on voluntary help, which by nature is sporadic, and since the conservation authorities adhere to their mandate's bottom-up approach, it makes it difficult or impossible to conduct the consultation process within a rigid time-frame. Therefore, the goal of eventually achieving a plan, at some undetermined time, receives greater priority than achieving a plan within a given time. Falling short of meeting a time deadline denotes failure, causes volunteer disillusionment, and volunteer disengagement.

Notwithstanding the inherent limitations, there is opportunity to draw some conclusions and offer some recommendations based on the case studies and their analysis. It also does not appear that prudence would be violated by drawing additional conclusions and offering additional recommendations based on general observations and insights gained apart from those gained from the twelve selected projects within the case study sample.

Conclusions and Recommendations

Since this thesis exercise began by seeking clarity regarding the conservation authorities' mandate and powers, it demands responsibility for drawing conclusions and making recommendations that are compatible with and achievable within that mandate and those powers.

Making comparisons between the three conservation authorities' restoration efforts is baffled by having three organizations operating under a similar mandate, but one that is tempered by the dictates of a measure of individual autonomy, and while carrying out restoration efforts on projects that are diverse within and between basins. For example, the result of efforts applied to rehabilitating Canagagigue Creek have a different value from the efforts applied to conserving a lower Maitland valley ecosystem or an Eramosa- Blue Springs ecosystem. Comparisons between them do not yield interval or ratio values.

The three general groups of farm, sub-watershed, and watershed projects that make up the case studies sample trace the conservation authorities' operational evolution from their core mandate through the inception of the ecosystem approach in connection with the sub-water projects and onward toward the development of watershed management plans. The changes in their approaches appear to have lagged behind the discovery of advanced knowledge and the changing attitudes toward newly developed strategies, e.g. the ecosystem approach came into general use in the late 1970s whereas the OMEE and OMNR definitions of ecosystem and ecosystem management bear a 1993 date. Part of the reason for the lag in time may be due to the conservation authorities' bottom-up approach supported by the local initiatives, the provincial-municipal partnership, and the cooperation and coordination founding principals, which do not place the authorities in an aggressive leadership role.

The prominence of farm projects on record along with the absence of references to urban ecological degradation make it appear that urban ecological degradation issues received little attention before the ecosystem approach came into use. The Laurel Creek Conservation Area and Nature Centre located in the Grand River basin within the expanding north-western section of the City of Waterloo is benefiting from present, if belated, inclusion of urban projects. It is an urban site presently coming under a comprehensive ecosystem management approach through a review process leading to development of an up-to-date Master Plan: The recent farm projects on record, with the notable exception of MVCA's agroecological–wildlife enhancement project, and to a lesser extent its pilot woodland swamp-upland forest project, were all focused on issues like soil and water conservation, crop yields and economic returns. They did not focus on the farm as ecosystem or as part of the greater ecosystem. The agroecological farm management system with its farm as ecosystem approach perhaps places it in the most advanced farm management category. While the other farm projects addressed specific issues, they aimed at attaining goals and it may be claimed that they succeeded. A high degree of private land-ownership and a low area of natural forest cover are common in the intensive agricultural regions of the study areas, particularly in the Upper Thames River watershed. The farm economy depends on extracting high yields from all available land, and in intense agricultural regions planting windbreaks represents the greatest opportunity for reforestation. Farm projects have been and remain a practical approach in areas of high agricultural intensity. They are amenable to full cooperation between the farmer and the conservation authority, which bodes well for success. The issue of private land-ownership arose in all twelve case studies and appeared to have been taken into account when developing restoration strategies.

The projects in the sub-watershed group represent the conservation authorities' full immersion into environmental management by way of the ecosystem approach, which takes into consideration all the abiotic, biotic, and cultural attributes of an ecosystem. The manipulation of one or more of the abiotic, biotic and cultural entities of the ecosystem was the type of restoration strategy used with respect to all of the sub-watershed case studies. Full inclusion of the cultural component not only as a presence in the ecosystem but as an integral part of the ecosystem ushered in a demand, by the cultural component at large, for having its collective voice heard. This became evident in two ways. The general public sought opportunities for enjoying the ecosystem's recreational opportunities, aesthetic values, and other benefits. Other stakeholders began to demand having input into how the ecosystem was being managed and in return many became committed to participate in the ecosystem's management by volunteering. The surge in public participation had an unsettling effect on landowners. They anticipated that their landowner rights could be infringed upon in favour of the public's interests. The conservation authorities endeavor to strike a balance between the conflicting interests. The Lower Maitland and the Eramosa River-Blue Springs projects are two good examples of how the two factions can work together for the benefit of both the landowners and other stakeholders as well as for the benefit of the ecosystem.

The Watershed project reports, in their present state, may be viewed as progress reports on the development of comprehensive watershed plan development. They are also examples of advanced approaches to and strategies for managing the ecosystem on the river-basin level. Present-day knowledge regarding environmental management and present-day public attitudes appear to indicate that development of a single comprehensive management plan is a desirable goal. There are however some impediments to be overcome. What it would take to mesh together and coordinate GRCA's existing watershed forest plan, its Upper Grand watershed plan, its Eramosa River-Blue Springs plan, the watershed fishery plan, and the many still missing initiatives would in all likelihood overwhelm its resources in the short or medium term future. Given that approaches to environmental management change with changes in governmental policies and changes in public attitudes, as well as due to the development of new ecosystem management strategies, it is conceivable that the goal for single watershed management plans will be superseded by some new approach.

It is premature to comment on follow-up monitoring as it relates to the watershed group of the case studies. The five component conceptual analytic framework that was applied to the case studies revealed a general weakness in follow-up monitoring. With regard to the farm group, the responsibility for follow-up monitoring was generally deferred to the farmer. This may be a practical solution because the farmer has first hand knowledge about his/her farm and its operation. The farmer also has a prime economic interest. Mitchell (1997) clearly stated the necessity for follow-up monitoring. The conservation authorities would most likely gain greater assurance of final project success by making follow-up monitoring a basic requirement for initiating all restoration projects.

It is cause for concern, as was indicated in the GRCA watershed forest plan literature, that the conservation authorities are the only remaining government sponsored agency in Ontario that engages in tree planting. Even so, financial constraints and elimination of provincial tree nurseries have greatly reduced their tree planting operations during the past decade.

Gilbert and Anderson (1998) and GRCA et al. (2001) in connection with the watershed forest plan, both made reference to 20% forest cover and up to 30% natural cover required for sustaining the integrity of a natural self-organizing ecosystem existing within an otherwise altered ecosystem. Other than the above references I have not found literature regarding this 30%:70% self-organizing natural/culturally controlled ecosystem coexistence. Extensive long-term research into the 30%:70% solution or a variety of natural/controlled ecosystem ratio models may produce valuable guidelines for environmental management in areas like the study areas where natural ecosystem fragmentation is severe.

Shrubsole (1996, refer to chapter 2) outlined a series of examples regarding divisions of responsibility among various agencies with regard to various ecosystem management responsibilities. The responsibilities in relation to water issues, in particular, are divided among numerous agencies. This bureaucratic entanglement was brought to a head with the Walkerton tragedy in 2000. Newly emerging conservation authority literature indicates that they are responding by attempting to reawaken general support for water protection strategies that have fallen by the wayside due to loss of wetlands and the impacts of improper handling and disposal of agricultural, domestic, commercial, and industrial wastes. One example of their efforts is a position paper on wetlands management policy put forth for discussion by GRCA with the hope that discussions will result in a wetlands regulation under the Conservation Authorities Act. A key element proposed by the position paper is that all wetlands be declared significant without significance being tied to a set of arbitrary classification criteria (MacMillan, 2001). At the very least, the bureaucratic entanglement related to present water management issues requires a thorough review. The conservation authorities, whose core mandate is rooted in water management, have fifty-five years of experience, and are familiar with the bio-geophysical attributes of their respective watersheds, should be in a position to take on an expanded role. Beside the wetlands issue, conservation authorities appear to have the expertise for playing a leading role in improving the management of agricultural and cultural wastes.

In an advanced socioeconomic system, like the one in the study areas, and where there are conflicting land use pressures, there may be an advantage in adopting a plan similar to the Niagara Escarpment Plan (refer to chapter 2).

The level of combined landowner and stakeholder participation in the sub-watershed and basin-wide projects strongly indicates general public awareness of the values of the environment and an interest in participating in its management. In this era of financial constraints such interest bodes well for advancing public stewardship to fill the gap left by withdrawal of government resources. Stewardship, in various forms, is being given an important environmental management role during this era of financial constraints. Farm operators have been land stewards for a long time. It may be argued that their land stewardship efforts have been narrowly applied for the purpose of improving crop yield. In our environmentally aware population it may be assumed that we all bear stewardship responsibilities. Conservation authorities in cooperation with a willing public have been able to apply participatory stewardship on a broad scale. The community stewardship organization set up to administer the Eramosa River-Blue Springs sub-watershed plan is a good example. The Eramosa-Blue Springs case study is also a good example of how environmental issues that capture the attention of the public and make them want to participate on a long-term basis, are key to the successful application of a community stewardship organization. The sub-watershed and watershed projects in the case studies all appeared to be initiated as a result of the presence of some compelling issues that aroused the public's attention and their willingness to participate.

The 1995 Private Land Resource Stewardship Program operated through Stewardship Councils added a new dimension to stewardship in Ontario (Faught, 1999). Of the twelve sample case studies, the Lower Maitland River project is the only one in which the records indicate a physical on-the-ground partnership between a stewardship council and the project's other participants. This general absence of stewardship councils' physical participation in the case studies may or may not indicate that the councils could improve their on-the-ground achievements through closer partnerships with the conservation authorities. Or perhaps, the conservation authorities' demonstrated successes in involving public stewardship in their restoration projects along with the dissemination of stewardship literature through their education-oriented nature centres indicates that stewardship programs may naturally fall into the conservation authorities' domain. The conservation authorities' present stewardship education reaches out mostly to primary and secondary students through the nature centres and to adults through printed handouts. Finding the resources to expand the present programs to include a broadly based public stewardship awareness program may return long-term stewardship dividends.

Although acknowledging the limitations of this thesis it is also claimed that it portrays a general outline of the conservation authorities' river basin ecosystem restoration efforts. It offers some insight into their operations, how they adapt to changes in conventional approaches to environmental management, and the scope of their operations that extends beyond ecosystem restoration efforts. The breadth of that scope provides many avenues for research possibilities.

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