ACHIEVING ECOLOGICAL INTEGRITY ON THE OAK RIDGES MORAINE: TOWARDS ECOLOGICALLY RELEVANT WATER MANAGEMENT

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ABSTRACT
One of the objectives of the Oak Ridges Moraine Conservation Plan is to protect the ecological integrity of the Plan Area. Hydrological integrity, a condition of ecosystems in which hydrological features and functions are unimpaired by stresses from human activity, is recognized as a fundamental component of ecological integrity. The Plan takes a multi-faceted approach to protect hydrological features and functions: prevention, mitigation, and adaptive environmental management. Watershed plans that include water budgets set the stage for an adaptive watershed management process that includes: target setting; development and implementation of a land and water use and management strategy; and environmental monitoring. Targets provide purpose for the predictive modelling necessary to develop management strategies; form the basis for a monitoring program to assess the achievement of goals; and act as red flags that direct management or trigger action.

RÉSUMÉ
L'un des objectifs du Plan de conservation de la moraine d'Oak Ridges consiste à protéger l'intégrité écologique de la zone visée par le plan. L'intégrité hydrologique, condition où les caractéristiques et les fonctions hydrologiques des écosystèmes ne sont pas affectées par les pressions découlant des activités humaines, est considérée comme une composante essentielle de l'intégrité écologique. Le Plan prévoit une démarche variée pour protéger les caractéristiques et les fonctions hydrologiques : prévention, atténuation des impacts et gestion adaptative de l'environnement. Les plans hydrographiques dotés de bilans hydriques ouvrent la voie à une gestion adaptative de l'environnement comprenant : la détermination des objectifs; l'élaboration et la mise en œuvre d'une stratégie d'utilisation et de gestion des terres et des eaux; et la surveillance environnementale. Les objectifs permettent d'établir la modélisation prédictive nécessaire pour élaborer des stratégies de gestion; jeter les fondements d'un programme de surveillance servant à évaluer si les objectifs sont atteints; et agir comme signal d'alarme pour orienter la gestion ou déclencher l'action.

1. INTRODUCTION

The Oak Ridges Moraine is one of Ontario's most significant landforms, stretching 160 km from the Trent River in the east to the Niagara Escarpment in the west. The drainage divide separating watersheds that drain north to Georgian Bay, Lake Simcoe, and the Trent River system from those that drain south into western Lake Ontario is located on the Moraine. Among the Moraine's valued attributes are clean and abundant water resources and diverse plant and animal habitat. The Moraine's ecological functions are recognized to be critical to the health and well-being of the region's residents and ecosystems. There is concern about protecting the Moraine in the face of increasing pressures for new residential, commercial, industrial, and recreational uses.

The Oak Ridges Moraine Conservation Act, which received Royal Assent on December 14, 2001, provides the authority for the ecologically-based Oak Ridges Moraine Conservation Plan (ORMCP). The purpose of the ORMCP is to provide land use and resource management direction to protect the ecological and hydrological features and functions of the 190,000 hectare Moraine.

1.1 Evolution of Oak Ridges Moraine Conservation Plan

The ORMCP was conceived of as a land use plan. Early in its development, emphasis was placed on the protection of features. Natural Core Areas, which make up 38% of the Plan Area, were identified as those areas having the greatest concentrations of natural heritage features. Natural Core Areas ultimately received the greatest degree of protection: only existing uses and very restricted new resource management, agricultural, low intensity recreational, home businesses, transportation and utility uses are allowed. Other land use designations include Natural Linkage Areas, Countryside Areas and Settlement Areas.

While the restriction of land uses aimed at protecting features such as wetlands and woodlands was an admirable first step, not everyone was willing to accept this as an "ecosystem approach." The boundaries of the Natural Core, Natural Linkage, Countryside, and Settlement Areas were not ecologically relevant. It was necessary to ensure that the ecological functions upon which the features depended would also be maintained.

Part III of the Plan, "Protecting Ecological and Hydrological Integrity," was developed with the purpose of integrating "environmental and land use planning in order to maintain, and where possible improve or restore, the ecological integrity of the Plan Area." Conceptually, the Part III policies may be considered another layer or sieve on top of the land use designations. Policies in this Part support connectivity (to allow the movement of plants and animals), landform conservation, and hydrological integrity

– aligning the ORMCP more closely with an ecosystem approach that recognizes that "everything is connected to everything else."

Ecological Integrity

Ecological integrity, which includes hydrological integrity, means the condition of ecosystems in which,

(a) the structure, composition and function of the ecosystems are unimpaired by stresses from human activity,
(b) natural ecological processes are intact and self-sustaining, and
(c) the ecosystems evolve naturally.

1.2 Hydrological Integrity

The need for policies in the ORMCP to address specific water issues (e.g. stormwater management, water extraction) was recognized. But a more comprehensive approach to water management; one that acknowledged the importance of water and its hydrological cycle to an ecosystem approach, was needed.

An ecosystem approach recognizes that "everything is connected to everything else," and one of the most important connectors, integrating physical, chemical, and biological processes, is the hydrological cycle. It links hydrological features – streams, wetlands, kettle lakes, and groundwater – to each other and to human activities and constructed features. It provides pathways for the transport of food and nutrients, but also for the movement of contaminants.

Ecological integrity is not possible without hydrological integrity. In the ORMCP, hydrological integrity means the condition of ecosystems in which hydrological features and hydrological functions are unimpaired by stresses from human activity. The ORMCP identifies the following hydrological features:

(a) permanent and intermittent streams,
(b) wetlands,
(c) kettle lakes and their surface catchments,
(d) seepage areas and springs, and
(e) aquifers and recharge areas.

These features rely upon and provide hydrological functions, defined in the Plan as the functions of the hydrological cycle.

1.3 "Water Policies"

With the goal to "maintain, and where possible improve or restore, the ecological integrity of the Plan Area," a multi-faceted approach to hydrological integrity was taken. The "water policies" involve prevention (e.g. protection of hydrologically sensitive features, impervious and natural areas, groundwater source protection); mitigation (e.g. stormwater management, sewage and water system plans); and adaptive environmental management.

Hydrologically Sensitive Features

The approach of protecting features by means of land use restrictions is continued in Section 26 of the ORMCP. Most development and site alteration is prohibited within hydrologically sensitive features and their minimum vegetation protection zone (Section 26 (2)).

Within 120 m of a feature, but beyond the feature and the minimum vegetation protection zone, an application for development or site alteration must be accompanied by a hydrological evaluation (Section 26 (3 and 4)). The hydrological evaluation must demonstrate that the development or site alteration will have no adverse effects on the hydrologically sensitive feature or on the related functions (Section 26 (4) a)) and determine whether the minimum vegetation protection zone is sufficient (26 (4) c) and (5)).

Hydrologically Sensitive Feature	**Minimum Vegetation Protection Zone**
Wetlands	30 m from any part of feature
Kettle lakes	Larger of 30 m from any part of feature or surface catchment
Permanent and intermittent streams	30 m from meander belt
Seepage areas and springs	30 m from any part of feature

Impervious and Natural Areas

The ORMCP specifies that except with respect to land in Settlement Areas, development and site alteration are prohibited if they would cause the total percentage of the subwatershed area that has impervious surfaces to exceed 10 % (Section 27 (1)). The desirability of ensuring that at least 30% of the area of the subwatershed has self-sustaining vegetation must be taken into account when considering applications for development or site alteration outside of Settlement Areas (Section 27 (2)). Sections 27 (3) and 45 (3 and 4) also address the need to reduce areas with impervious surfaces and increase areas with natural vegetation.

Groundwater Source Protection

The ORMCP requires municipalities to incorporate into their official plans policies that establish wellhead protection areas around all existing and new wells for municipal water services (Section 42 (1) a)) and prohibit or restrict uses within these areas (42 (1) b)). Section 28 identifies specific uses which are prohibited in wellhead protection areas or require restrictions in Official Plan policies. The ORMCP also delineates Areas of High Aquifer Vulnerability and specifies uses that are prohibited in these areas (Section 29).

Stormwater Management

The ORMCP requires applications for major development to be accompanied by a stormwater management plan (Section 45 (1)). The objectives of the stormwater management plan are to: prevent any increase in flood risk; prevent increases in stream channel erosion; protect water quality; maintain groundwater quantity; and ultimately to protect aquatic habitat and the associated species (Section 46 (1)). These objectives are to be met using a treatment train approach that incorporates lot-level, conveyance, and end-of-pipe controls (Section 46 (2)). Applications for development or site alteration must demonstrate that planning, design and construction practices that protect water resources will be used (Section 45 (2)). The ORMCP prohibits new rapid infiltration basins and columns (Section 47).

Sewage and Water System Plan

The ORMCP requires an application for major development to be accompanied by a sewage and water system plan that demonstrates, among other things, that the ecological integrity of hydrological features and key natural heritage features will be maintained and that the project will comply with the applicable watershed plan and water budget and conservation plan (Section 43).

Watershed Plan

All of the component water policies may in fact be coupled with the requirements of the watershed plan. The ORMCP requirement for upper-tier and single-tier municipalities to prepare watershed plans may be considered a core water policy (Section 24). It recognizes the relevance of the hydrological cycle within watersheds to ecological integrity. It provides a holistic framework without which feature – focused and issue – based policies would be inadequate.

The watershed plan requirements set the stage for an adaptive watershed management process that includes: target setting; development of a land and water use and management strategy; implementation of the management strategy; and environmental monitoring.

2. ADAPTIVE WATERSHED MANAGEMENT

The ORMCP requires the identification of "targets to meet the water needs of the affected ecosystems," (Section 25 (2) c) i)). Use of the term "targets" is a recognition that the knowledge necessary to explicitly define ecological requirements is incomplete. Given that our knowledge of ecosystem requirements is likely to remain incomplete for the foreseeable future, adaptive watershed management is critical, particularly in the face of continuing pressures for development.

Targets may be provided for various water resources including stream ecosystems; kettle lake ecosystems; wetland ecosystems; and aquifers. The targets are intended to provide purpose for predictive modelling and the development of land and water management strategies; direct management (maintenance, improvement, or restoration); and form the basis of the monitoring program to audit the achievement of goals and evaluate and, if necessary, revise the targets.

Watershed goals and objectives set the stage for the development of specific indicators, measures, and targets. These terms are defined in the Box (adapted from SOLEC, 1998) with an analogy to human health assessment (Maddock, 1999).

<u>Indicator</u> - A measurable attribute or combination of attributes that provide reliable, outcome-oriented, managerially and scientifically useful, evidence of ecosystem health or trends in ecosystem health. A doctor wishing to assess the health of a patient may check several **indicators**, such as pulse, breathing, temperature, the patient's reactions and the blood content.

<u>Measure</u> - A single measurable parameter or statistic which provides information regarding the status and trends associated with an attribute. The doctor will use a specific **measure** of each indicator, such as the pulse rate per minute, or the oxygen levels, sugar levels and red blood cell count of a blood sample.

<u>Target</u> - Specific, quantitative, spatially and temporally bounded, benchmarks for indicators that determine achievement of objectives. The doctor will compare the measurements against the expected normal or healthy values – the **targets.**

MacKay (2001) suggests that four categories of measures are necessary to protect the health and function of aquatic ecosystems: water quantity (quantity, pattern, timing, water level); water quality (including physical, chemical, and biological characteristics of water); habitat (characteristics and condition of the instream and riparian habitat); and biota (composition, distribution, abundance, and condition of aquatic biota). A fifth category, integrative measures, may also be considered. These integrative measures correspond less directly to ecosystem requirements, but may be appropriate performance measures (integrative or surrogate indicators) for the higher level goals. Cairns (1995) suggests that until more robust methods are developed, a fair judgement of ecological integrity can be made by examining the practices of a human society within the ecosystem (e.g. "What percentage of the entire catchment basin consists of impervious surfaces?").

There are linkages between the measures in various categories and part of the target setting process will involve moving to a shorter list of measures with reduced redundancy. Criteria which may be used for the selection of measures have been developed (e.g. Noss (1990) and Environment Canada (2001)). It is the suite of measures, not each individual measure, which should meet the criteria.

Perhaps the most important of the criteria used to select an indicator is ecological relevance. For example, the monthly mean of the daily groundwater table position provides a general measure of habitat availability or suitability for wetlands and kettle lakes. Key phases of organisms' life cycles may be intimately linked to the timing of annual extremes such that human-induced changes in timing may cause reproductive failure, stress, or mortality. The occurrence of particular water conditions can determine whether certain life-cycle requirements are met or can influence the degree of stress or mortality associated with extreme conditions such as soil saturation or droughts. The rate of change may influence the ability of plant roots to maintain contact with groundwater. The abruptness and number of changes may influence the degree of stress experienced by organisms. These examples illustrate the ecological significance of intra-annual variability and highlight the importance of considering ecological relevance when selecting approaches for predictive modeling.

Targets will be spatially and temporally variable to account for seasonal and annual variability and location within the watershed. Targets indicative of good health are required rather than thresholds to ill health. Short- and long-term targets (i.e. interim and final targets), may be desirable in situations where improvement or restoration is required. Targets must be set on the basis of the best scientific information available and expert judgement. They are needed to guide management but they are not immutable.

An environmental monitoring plan is required (Section 24 (3) d)) to refine the models developed for watershed characterization and impact prediction; assess the validity of targets and detect changes requiring target adjustments; to trigger additional management or monitoring activities; and evaluate the success of management strategies vis-à-vis the targets. Although perhaps a statement of the obvious: monitoring and evaluation are absolutely essential to the success of an adaptive environmental management approach.

The design of the environmental monitoring plan will be largely completed during the target setting process, which must address not only what is to be monitored but also where, how frequently, and using what protocol.

3. CHALLENGES

Paradoxically, the ORMCP represents an attempt to apply an ecosystem approach to an area defined by administrative boundaries. However, maintaining the ecological integrity of the Moraine is important not only to the plants, animals, and humans inhabiting the Moraine but also to the ecological functions sustaining ecosystems off the Moraine. While the ORMCP only applies to the Plan Area, to maintain the Moraine's ecological functions, some activities will require a broader scope, taking in areas extending beyond the political ORM entity.

Target setting should address ecological integrity at multiple levels of organization (i.e. populations, communities, ecosystems, landscapes), over a range of spatial and temporal scales, using a variety of measures. It is desirable to move beyond assessment of the requirements of a single species or a few indicator species, as this approach may neglect the needs of other species and ecosystem processes and functions in general. Scales (extent and resolution) must allow the responses of watersheds to various influences to be assessed; allow ecological processes at interfaces within the hydrological cycle to be taken into account; and meet management requirements.

The linkages between water quantity and quality and biotic components remain poorly understood. There is a need for research in the field of applied "hydro-ecology" defined by Dunbar and Acreman (2001) as "the linkage of knowledge from hydrological, hydraulic, geomorphological and biological/ecological sciences to predict the response of freshwater biota and ecosystems to variation of abiotic factors over a range of spatial and temporal scales." For the present, targets for water quantity and quality set based on the best available information will serve as constraints for predictive modeling and the selection of management strategies. Monitoring of the water quality and quantity measures will allow models to be refined and the effectiveness of the management strategies to be evaluated. At present, biotic targets may not be of direct utility for predicting the outcome of management activities because we do not yet fully understand how biotic measures will respond to various effects. However, biotic measures provide more direct assessment of ecological integrity and their use will assist in the development, over time, of water quality and quantity targets that are more ecologically relevant.

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