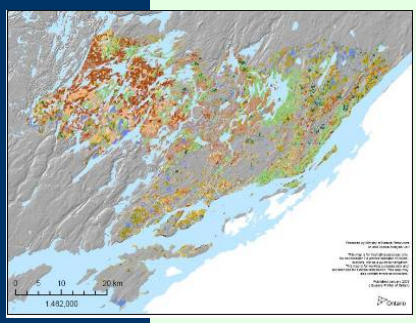
SUSTAINING WHAT WE VALUE

A Natural Heritage System for the Frontenac, Lanark, Leeds & Grenville Area of Eastern Ontario



Part 1: Project Report 2011

Report of the "Sustaining What We Value" Scenario Planning Team
August 2011. Part 1: Project Report.

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sustaining what we VALUE

March 2011

Letter of Endorsement
"Sustaining What We Value" – A Natural Heritage System (NHS)

"Sustaining What We Value" is a collaborative, multi-partner project within the study area that includes Leeds and Grenville County and portions of Lanark and Frontenac Counties. Through active community engagement, the project has resulted in significant and useful products that reflect priorities to sustain the natural environment, the foundation of our region's social, cultural and economic values. We, the Scenario Planning Team (SPT), identified a Natural Heritage System with the assistance of Marxan, a decision-support tool that minimizes the extent of land needed to achieve natural heritage goals. The process used to identify the preferred NHS is founded on the following principles:

1. The perspective is **ecological and at a landscape scale**.

2. The NHS products are informed by **the best available science** and uses the most current information and data**.**

3. The process is one of **inclusion and collaboration between a diverse group** of community members and partners.

4. The resulting products are available to be used as **tools to prioritize and coordinate conservation efforts** throughout the project area.

5. The products are available as technical information to **support municipalities' land use planning efforts**.

6. The process promotes the **link between healthy ecosystems and healthy human communities**.

We are confident that the mapped Natural Heritage System will provide a sound and strategic focus for conservation groups and community organizations to help guide the selection of appropriate sites for their stewardship activities, land securement programs and conservation efforts.

It is our sincere recommendation that these NHS products be used as technical guidance to inform municipalities as they undertake land use planning. Ideally we encourage local municipalities to adopt their portion of the Natural Heritage System into their official plans to meet the needs and priorities of the individual municipality and to ensure the long-term health of the entire region.

We also encourage government agencies to use the products to inform strategic resource management decision-making and to support the protection of our valued natural heritage.

As residents of Eastern Ontario we are fortunate that we still have an intact and diverse Natural Heritage System to protect – an enviable and rare opportunity in southern Ontario. It is not only an opportunity but also our responsibility to maintain the ecological integrity of our landscape. The ultimate test of the success of this project will be its ability to contribute to the continued maintenance of our natural wealth.

Sincerely,

The “Sustaining What We Value” Scenario Planning Team

Emily Conger	Algonquin to Adirondacks Conservation Association
Dan Ethier	Ministry of Municipal Affairs and Housing
Karen Fraser	United Counties of Leeds and Grenville
Joe Gallivan	County of Frontenac
Bob Gollinger	Grenville Land Stewardship Council
Linda Hill	Landowner
Cyril Holmes	Ontario Federation of Anglers and Hunters
Barb Kalivas	Township of Elizabethtown-Kitley
Carrie Kasurak	Lanark, Leeds and Grenville Health Unit
Jeff Leggo	St. Lawrence Islands National Park
Pierre Mercier	Leeds and the Thousand Islands Municipal Heritage Committee
Margot Miller	Area Artist
Erin Neave	Eastern Ontario Model Forest
Mara Shaw	Cataraqui Region Conservation Authority
Shaun Thompson	Ministry of Natural Resources
Dave Walker	Canadian Land Trust Alliance
Laurie Wight	Farmer/ Landowner

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List of Abbreviations

ANSI	Area of Natural and Scientific Interest	NAESI	National Agri-Environmental Standards Initiative
ARN	Assessment Role Number	NGO	Non Governmental Organization
CA	Conservation Authority	NHIC	Natural Heritage Information Centre
CLI	Canada Land Inventory	NHRM	Natural Heritage Reference Manual
CRCA	Cataraqui Region Conservation Authority	NHS	Natural Heritage System
DEM	Digital Elevation Model	OBM	Ontario Base Map
DRAPE	Digital Raster Acquisition Project - East	OGDE	Ontario Geospatial Data Exchange
ELC	Ecological Land Classification	OP	Official Plan
EOMF	Eastern Ontario Model Forest	PPS	Provincial Policy Statement
FABR	Frontenac Arch Biosphere Reserve	PSW	Provincially Significant Wetland
FRI	Forest Resource Inventory	PVM	Predicted Vegetation Modelling
GIS	Geographic Information System	RVCA	Rideau Valley Conservation Authority
LIO	Land Information Ontario	SLC	Soil Landscapes of Canada
MARXAN	Conservation planning software (see section 3.7.1 or Appendix D, glossary)	SOLRIS	Southern Ontario Land Resource Inventory System
MMAH	Ministry of Municipal Affairs and Housing	SPT	Scenario Planning Team
MNR	Ministry of Natural Resources	SAR	Species at Risk

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1.0 Vision & Goals

The “Sustaining What We Value” Project is a multi-partner initiative funded by GeoConnections, a national program administered by Natural Resources Canada. The project engaged community members, practitioners, and other stakeholders in the communities of South Frontenac, Lanark, and Leeds and Grenville Counties to ensure the protection of the cultural, social, ecological and economic attributes of the area. As a first step, this project (Phase 1) focussed on identifying the most important ecological values that form the foundation of a healthy economy and community. The project developed a Natural Heritage System (NHS) using the best available science and information and input from a stakeholder engagement process. The NHS is available as a tool to inform stewardship activities, land-use planning, and other conservation activities.

The purpose of this report is to describe how the natural heritage system was developed. The process was guided by a group of stakeholders from the community, the Scenario Planning Team. They agreed upon the following vision and goals for the project.

Vision Statement

A sustainable quality of life for the communities within and adjacent to the study area is supported by a balance of environmental, economic, cultural, and social land uses. This includes a system of connected natural areas capable of conserving indigenous biodiversity, ecological functions and species habitats.

Goal

To identify, through engagement and agreement of local communities, a healthy Natural Heritage System (NHS) for the study area that will:

- Provide a focus for strategic land restoration to improve land sustainability, land securement, stewardship, and the conservation of biodiversity.
- Inform and support sustainable land use planning and resource management decision-making.
- Support sustainable economic opportunities.
- Support social well-being.
- Maintain cultural heritage.

2.0 Background and Context

Southern Ontario is a complex landscape, both in social and ecological terms. More than 90 per cent of the lands are privately owned and large areas are subject to intense development pressures. Approximately 80 per cent of all woodlands and 72 per cent of all wetlands have been lost since European settlement began. The Environmental Commissioner of Ontario in his Special Report on Species at Risk (2009) stated that habitat loss, including alteration and fragmentation, is the main threat to approximately 67% of Ontario’s Species at Risk. In addition to these challenges, multiple agencies, including provincial ministries, Conservation Authorities, non-governmental organizations (NGOs) and municipalities are involved in land use planning and natural heritage conservation on the same landscape, often at different scales. There is great untapped potential for all of the key players to develop a common vision and processes to support each others’ natural heritage conservation efforts.

Eastern Ontario is extremely fortunate to have some of the highest percentages of remaining natural areas in southern Ontario. In recognition of the region's rich biodiversity and conservation efforts, the Frontenac Arch is world renowned as a UNESCO World Biosphere Reserve. The region is also home to St. Lawrence Islands National Park and the Thousand Islands, and many other natural areas including Frontenac and Charleston Lake Provincial Parks. The Region's natural assets contribute to the local economy and quality of life of residents. This project brought together numerous local partners to work together to identify which natural areas are critical to sustain the health of this unique region.

2.1 Steering Committee

In Eastern Ontario, the conservation community has a long history of cooperation and collaboration. Recognizing the benefits of working together, a group of organizations formed a Steering Committee and submitted a successful funding application to GeoConnections. The Steering Committee was responsible for the overall direction of the project (for more information, see Appendix B) and was made up of the following organizations:

- Eastern Ontario Model Forest
- Environment Canada
- Frontenac Arch Biosphere Reserve
- Ministry of Natural Resources
- Ontario Nature
- St. Lawrence Islands National Park
- United Counties of Leeds and Grenville

Early on, the Steering Committee recognized that natural systems are a key component of sustainability and the foundation for healthy communities. The initial project activities involved an extensive inventory and evaluation of existing tools, data and targets available for natural systems mapping and modelling. The Steering Committee also interviewed a number of municipal planners to ask what tools and information they need to help support decision-making. Based on this background research and their knowledge and experience, the Steering Committee decided to pursue the development of a "natural heritage system" as a key component of the project.

2.2 What Are Natural Heritage Systems?

Natural Heritage Systems (NHS) are networks made of natural features and areas such as wetlands, forests, river corridors, lakes and meadows. They can also include areas that have the potential to be restored. These natural areas provide "ecosystem services" that support life and the health of people, plants and wildlife. Some of the services provided by our natural systems include:

- Clean air and clean water
- Pollination and food production
- Habitat for fish and wildlife species

- Resiliency to environmental stressors - climate change, invasive species, flooding, soil erosion
- Production of medicines, biofuels and other products
- Recreation/ tourism opportunities

The Steering Committee's goals for using a natural heritage systems approach included: identify a desired future landscape, integrate data from a range of sources, and highlight the benefits that natural ecosystems provide.

2.3 An Integrated Systems Approach

Over the past two decades, there has been growing recognition that a systems approach to conservation planning is required to adequately address current ecological pressures. The need for a "landscape system" approach resulted in the establishment of the Natural Heritage System (NHS) concept through the Provincial Policy Statement (PPS) in 1997 and 2005, and the Natural Heritage Reference Manuals in 1999 and 2010. Building on previous work, the Ministry of Natural Resources (MNR) has developed a method for NHS design and planning at a regional landscape scale that incorporates the best science, technology and information, while focusing on stakeholder engagement as a vital component of the process (MNR 2006, 2008, 2010). The NHS design and planning method differs from earlier approaches in that it:

- Engages diverse stakeholders as decision-makers throughout the process (Lenihan 2009)
- Uses a science-based approach to inform stakeholder's decisions on targets for what to include in an NHS
- Is based on regional, ecological boundaries
- Uses an objective decision support tool (i.e., Marxan)
- Provides a set of digital map layers that can be used to support strategic decision-making by many different organizations

The Steering Committee engaged local stakeholders to identify an NHS using this methodology. The mapping and design results provide information that can be used by all stakeholder organizations to ensure synergy among their various planning, land management and stewardship activities.

It is important to note some key definitions for the purpose of this report:

Natural Heritage Systems (NHS) Design *– A collaborative engagement process to identify, evaluate and spatially map significant natural heritage species, spaces and functions resulting in a viable Natural Heritage System.*

Natural Heritage Systems (NHS) Planning *– Activities that inform and guide the long-term, strategic management and stewardship of landscapes; and that form the basis of diverse planning decisions to conserve our natural heritage in a sustainable manner and to contribute to the quality of life.*

The definition of the term "planning" in this report is broad and inclusive and is not meant to apply only to "municipal planning".

It is also important to note that the NHS designed through the engagement approach and presented in this report will be a very useful tool to support effective resource management and a wide range of conservation program objectives. However, until a municipality explicitly designates an NHS and develops land use direction and policy regarding permitted activities in its official plan, the NHS does not have any "official" status for municipal planning purposes.

2.4 Study Area

The project study area includes ecodistricts 6E-10 and 6E-11, as well as the remainder of the United Counties of Leeds and Grenville (Fig. 1). The Steering Committee selected this study area in order to achieve full coverage of the United Counties of Leeds and Grenville, a key municipal partner. This approach combined an ecologically based boundary with the need to recognize the practical scale on which land use decisions are made. The study area also includes all or portions of 23 lower and single tier municipalities found in the United Counties of Leeds and Grenville, the County of Lanark, the County of Frontenac, and the City of Ottawa.

Ecodistricts are spatial units within the Ecological Land Classification system (ELC), which is a standardized method of describing, classifying, and monitoring ecosystems (Hills 1959). Ecodistricts reflect broad variations of environmental conditions such as surficial geology and regional climate, which in turn drive broad patterns of vegetation and ecosystem type. Ecodistrict 6E-10 consists of a southern extension of the Canadian Shield known as the Frontenac Axis. The ecodistrict is characterized by a rugged landscape with frequent bedrock exposures, rock barrens, cliffs and escarpments. Ecodistrict 6E-11 consists of the Smiths Falls Limestone Plain and is characterized by shallow soil over limestone and numerous wetlands (Chapman and Putnam 1984).

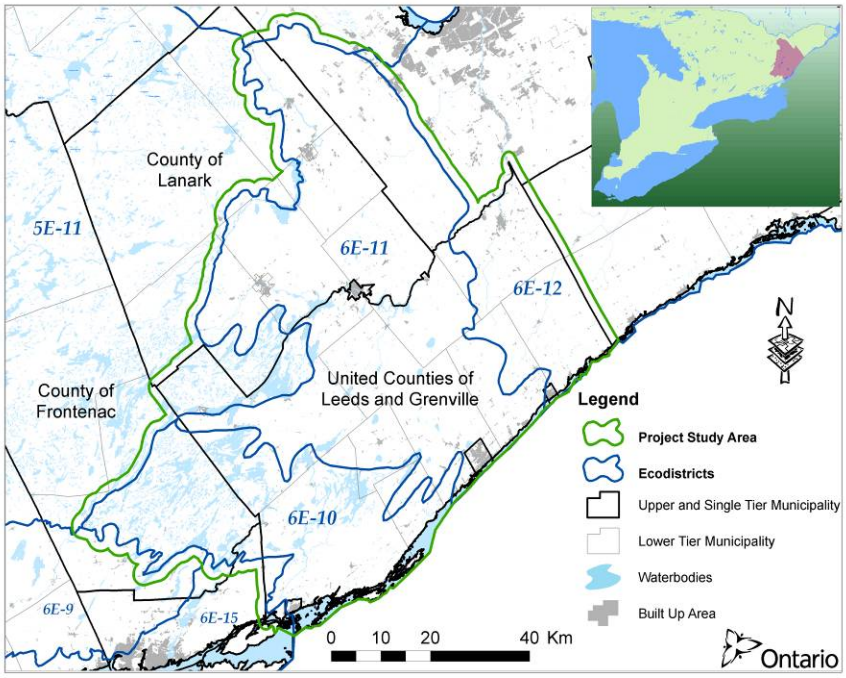


Figure 1. Sustaining What We Value project study area

Using an ecological unit for natural heritage planning ensures a scientifically sound comparison of the landscape features and values within that ecological unit. The use of ecodistricts is also supported by other landscape-level initiatives such as Ontario's Biodiversity Strategy.

3.0 The Natural Heritage System Design Process

Once the background reports were completed and the study area was identified, the Steering Committee embarked on the next major phase of the project: designing the natural heritage system (NHS). The Steering Committee was committed to engaging the public to guide this process. Two approaches were used to engage the public:

1. Inviting the general public to contribute through various venues
2. Convening a Scenario Planning Team, a stakeholder group representing the diverse interests in the study area, to make decisions on the NHS design

The Steering Committee used the general public outreach to collect input on how to identify and invite Scenario Planning Team members.

3.1 Public Outreach

In addition to engaging a diverse group of stakeholders, this project also sought to explore innovative ways of engaging the broader public of the study area. In partnership with the Centre for Community Mapping (COMAP), the Steering Committee developed an online community values mapping tool. The tool was an interactive map that allowed community members to log on and drag and drop markers onto places on the landscape that they value. A set of ten value types, based on a similar initiative done by the Canadian Forest Service in Alberta (Beverly et al. 2008), was used. To invite participation, three different methods were used:

- A mail-out to over 1,300 randomly selected households in the study area with a letter and unique access code
- Invitations sent out informally through existing email networks
- A hands-on workshop in local high schools to reach out to youth

> *"I have marked Charleston Lake and Charleston Lake Park as a wilderness, scenic, recreational, educational, and biodiverse region. The area is a jewel of Eastern Ontario."*
>
> - Community Values Mapping Participant

The initiative resulted in over 50 community members and an equal number of students mapping over 800 value locations (Fig 2). Two local newspapers also ran stories about the high school mapping workshops (see Appendix C). Although the participation rate was lower than the Steering Committee had hoped for, the initiative identified a large range of values in all ten categories. Many users also entered comments with their value locations (See Appendix C). The top value categories that were mapped were scenic and recreational, followed by a tie between historical/cultural and biodiversity.

This mapping initiative also resulted in several lessons-learned that will be helpful for planning future projects, such as:

1. The mapping tool effectively translated community values into a spatial mapping product and gathered diverse input with limited expense.
2. The online map may have been challenging for some users, despite efforts to simplify the design.
3. A lack of high-speed internet in a large portion of the study area likely limited the number of respondents.
4. W single mail-out to invite participation may not be very effective. Other initiatives (Beverly et al. 2008) have achieved more success by using repeated reminder mailings, something that was not possible with the limited budget of this project.

Future projects would benefit greatly from continued development and testing of community values mapping approaches as a tool to engage the broader public.

In addition to the community values mapping initiative, the project also promoted public involvement through a project website, www.sustainingwhatwevalue.ca, and two public workshops in Athens. The first workshop was held at the start of the project in June 2009, and the second was held in May 2010. The first workshop provided significant guidance for the project activities. Over 100 organizations from all levels of government, local organizations,

agriculture, development and other interests were invited to attend. Workshop attendees identified a list of people who should be engaged in the Scenario Planning Team, and self-identified their interest in participating. Attendees also provided input on the facilitation of the Scenario Planning Team, and produced a draft vision statement for the project. The second workshop focused on reporting back to the community on the project's progress.

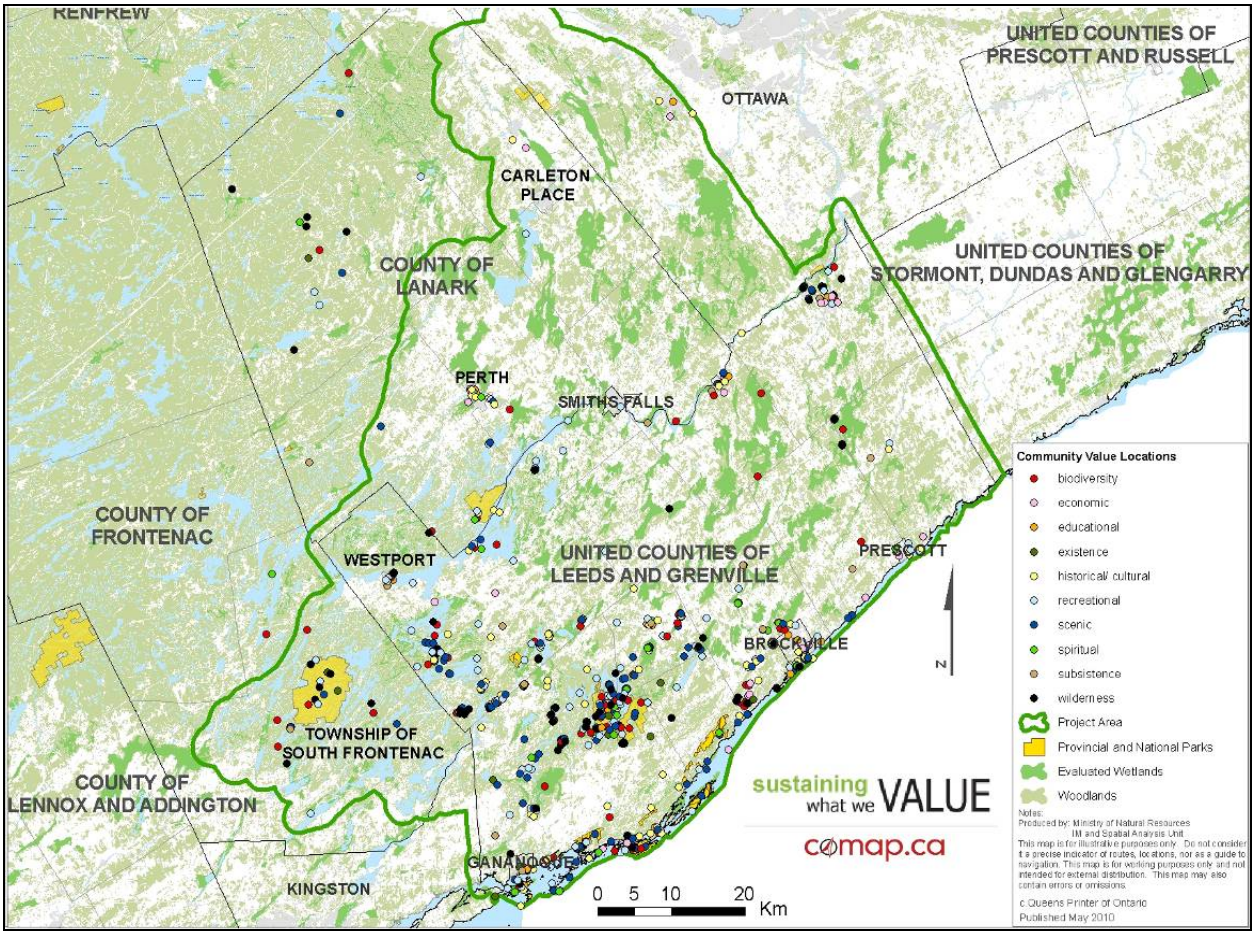


Figure 2. Map of community value locations from the community values mapping initiative

3.2 The Scenario Planning Team

The Scenario Planning Team was convened by the Steering Committee to identify a natural heritage system (NHS) using a collaborative process (see Figure 3). The resulting natural heritage system design reflects the Scenario Planning Team's vision of the areas needed to sustain the natural environment within the study area.

Members

The Scenario Planning Team was made up of a diverse group of local stakeholders from the study area, including:

- Algonquin to Adirondacks Conservation Association
- Area Artist/ Landowner

- Canadian Land Trust Alliance
- Cataraqui Region Conservation Authority
- County of Frontenac/ Upper Tier
- Cultural Heritage (Leeds and the Thousand Islands Municipal Heritage Committee)
- Eastern Ontario Model Forest
- Farmer/Landowner
- Grenville Land Stewardship Council
- Lanark, Leeds and Grenville Health Unit
- Landowner
- Ministry of Municipal Affairs and Housing
- Ministry of Natural Resources
- Ontario Federation of Anglers & Hunters
- St. Lawrence Islands National Park
- Township of Elizabethtown-Kitley/ Lower Tier
- United Counties of Leeds and Grenville/ Upper tier

The Scenario Planning Team was formed by an open invitation to community members and organizations to attend a public workshop held in Athens in June 2009. Workshop attendees provided feedback on who should be represented on the committee and some volunteered to participate. The Steering Committee also made all possible efforts to invite the identified interests to participate. Despite these efforts, the Scenario Planning Team felt that there were three notable gaps in representation: the development industry, the aggregate industry, and First Nations. These three organizations generally had limited organizational capacity to participate. In addition, the Grenville Federation of Agriculture was only able to participate in some of the meetings, but was kept informed throughout the process. Based on the feedback from the first Athens workshop, a neutral facilitator was hired by the Steering Committee to lead the Scenario Planning Team meetings.

Role of the Scenario Planning Team

Using the best available information and local and regional technical support and expertise, the Scenario Planning Team was guided through the process of NHS design. The Team discussed options and made decisions through consensus for a range of ecological, social and economic values on the landscape. For the full Terms of Reference for the Scenario Planning Team, see Appendix B.

3.3 Use of a Decision-Support Tool

In a landscape rich in natural features, such as the “Sustaining What We Value” project area, there are many different options for NHS design. A decision-support tool is very useful to quickly and objectively produce a number of different options for comparison. This project used a conservation planning and decision support software called Marxan to produce several different NHS scenarios. The scenarios show important natural areas that best meet the objectives and targets established for the system by the Scenario Planning Team. Marxan was designed at the Ecology Centre at the University of Queensland, Australia and has been applied around the world to provide decision support for conservation reserve planning. Marxan has been scientifically proven and is rigorous, transparent, and repeatable (Ardron *et al.* 2010). The Marxan methodology for NHS design in southern Ontario was pilot-tested by MNR in 2006 and was found to be an effective means of identifying priority natural areas (MNR 2006, 2008).

3.4 NHS Design Process Overview and Timeline

The steps in the NHS design process are illustrated in Figure 3. The process alternates data preparation and analysis activities with target-setting and decision-making by the Scenario Planning Team. The timeline for this project is included for each step in the process. Step 1 involved the Steering Committee preparing the funding application for GeoConnections, defining the project study area, and convening the Scenario Planning Team (Sections 3.1-3.3 above). The process of building partnerships takes time; however the benefits (described in step 9) of knowledge sharing and trust that result are worth the investment. Steps 2 – 8 are described in more detail in the next sections of this report.

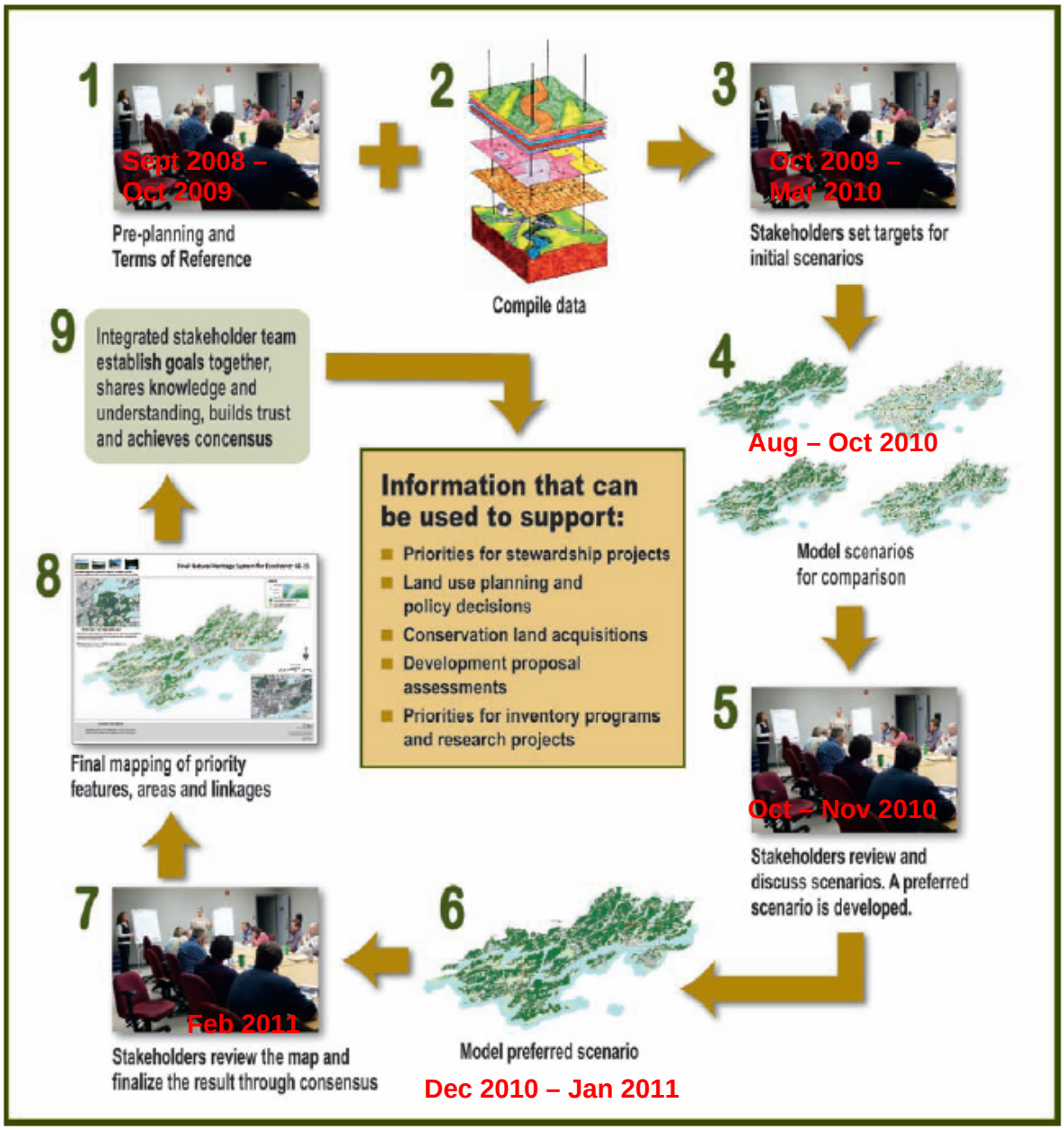


Figure 3. Overview of the NHS design process and timeline for the "Sustaining What We Value" project (Adapted from: A Guide to Designing and Planning Natural Heritage Systems in Southern Ontario, MNR 2011).

3.5 Step 2 – Compile Data

The primary data sources compiled for this NHS project are listed in Table 1. Datasets were obtained from MNR corporate databases such as the Land Information Ontario (LIO) Warehouse and Natural Heritage Information Centre, from other government and non-governmental organizations, or were derived from other datasets (e.g. forest interiors derived from forest cover mapping). These data layers were used to support the Scenario Planning Team discussions with mapping of current conditions and to run the NHS analysis (see Section 3.7).

Table 1. Data layers used to support the NHS project (datasets are available through LIO unless otherwise noted; for more detail, see target table in Appendix A).

Data Category	Dataset	
Primary/Base Data	Predictive Vegetation Modelling ELC Vegetation Types for ecodistrict 6E-10	
	Forest Resource Inventory ELC Vegetation Types for ecodistricts 6E-11, 12 (from EOMF)	
	Southern Ontario Land Resource Information System (SOLRIS)	
	SOLRIS Phase 1 Wooded Areas Updated to 2008 DRAPE Imagery	
	Great Lakes Coastal Wetlands (from Great Lakes Commission)	
	Ontario Ecodistricts	
	Soil Landscapes of Canada (from Agriculture and Agri-Foods Canada)	
	Tertiary and Quaternary Watersheds	
	WRIP Delineated Catchments (Arc Hydro Quaternary Watershed Sessions)	
	Ontario Road Network	
	Canada Land Inventory Agricultural Capability Classes (from Agriculture and Agri-Foods Canada)	
	MPAC Assessment Parcel	
Socio-political Considerations	National Parks	Nature Conservancy of Canada Properties (1)
	National Wildlife Areas	Ontario Heritage Trust Properties (1)
	Provincial Parks	St. Lawrence Parks Commission Properties (1)
	Wildlife Management Areas	Frontenac Arch Biosphere Reserve (1)
	Wilderness Areas	Important Bird Areas (from Canadian Wildlife Service)
	Crown Lands (MNR Land Tenure 3 dataset)	Migratory Bird Sanctuaries (from Canadian Wildlife Service)
	Evaluated Wetlands (Wetland Unit)	Rideau Waterway Heritage River System (derived from former LIO Water Line Segment)
	Areas of Natural Science Interest (ANSI)	National Historic Canals (from Parks Canada)
	Conservation Authority Floodplain Mapping (1)	National Historic Parks and Sites (from Parks Canada)
	Conservation Authority Properties (1)	University Biological Research Properties (from COA)
	Ontario Nature Reserves (1)	First Nations Reserves
	Ducks Unlimited Properties (1)	SOLRIS Hedgerows
	Community Forests (Agreement Forests)	SOLRIS Built-Up Area Impervious
	Land Trust Properties (1)	SOLRIS Waterbodies
Costs	Licensed Aggregate Pits/Quarries (Aggregate Site Authorized)	
	Prime Agricultural Lands (SOLRIS Agricultural Areas + CLI Class 1-3)	
	Prime Agricultural Areas (SOLRIS Agricultural Areas + CLI Class 4-7)	
	Major Roads and Concessions (from ON Road Network)	

Data Category	Dataset	
Overlays	Species at Risk Element Occurrences (from Natural Heritage Information Centre)	
	Community Values (from project web-mapping, see Section 3.1)	
	Cultural Heritage Sites [(2)]	
	Ecosystem Services (from Troy and Bagstad 2009)	
Derived Datasets for Targets [(3)]	Biodiversity Representation	Biodiversity Types
	Ecological Functions	Forest Cover
		Wetland Cover
		Interior Forest Areas at 100, 200 m
		Forest Patches
		Wetland Patches
		Wetland Functional Zones
		Riparian Functional Zones, 30 m
		Natural Cover 2 km from Roads
	Watershed Functions	Headwater Areas
		Riparian Functional Zones, 100 m
	Agricultural/ Economic	Maple Syrup Producing Stands

Notes
[(1)] Spatial data received from each respective organization
[(2)] Incomplete spatial data (heritage sites, cemeteries, cheese factories) received from United Counties of Leeds and Grenville, the Frontenac Arch Biosphere Reserve, and the Leeds and the Thousand Islands Municipal Heritage Committee
[(3)] Datasets derived through GIS analysis of base datasets

The Scenario Planning Team considered the availability, quality, and extent of different datasets when discussing the NHS design inputs (targets and socio-political considerations – see next two sections of this report)..Where datasets were incomplete or did not exist, the Scenario Planning Team identified and recorded these as data gaps (see Section 5). To be used as an input layer for NHS design, datasets must be consistent and complete across the entire study area. Incomplete datasets will bias the resulting NHS to select the areas where more data is available. Since there were two different ELC vegetation type datasets to achieve full coverage of the project area, additional processing (crosswalking) was undertaken to match the equivalent vegetation types in each layer together. Some data layers that were identified as incomplete were considered by the Scenario Planning Team as overlays that could be used to validate and refine the final NHS during implementation. This would ensure that the NHS adequately captures the values reflected in the datasets that could not have targets applied. The identified overlays included species at risk occurrences, cultural heritage sites, and community and ecosystem services (see Section 4).

3.6 Step 3 – Scenario Planning Team Inputs

The Scenario Planning Team met for eight full-day sessions between October 2009 and March 2010 to identify goals and objectives and inputs for the NHS design. Each session was facilitated by a neutral facilitator. The two main categories of NHS design inputs that the Scenario Planning Team discussed were:

- socio-political considerations, and
- ecological targets.

The decisions the Scenario Planning Team made for each input determine “how much” of each type of feature or area should be included in the NHS design.

3.6.1 Socio-Political Considerations

Socio-political considerations are attributes of areas that can help account for existing land use and management decisions. The Scenario Planning Team determined how areas such as urban green space and prime agricultural land should be treated when the software was considering them for inclusion in an NHS. Incorporating socio-political considerations where possible allowed the Scenario Planning Team to try and recognize and respect the diverse land uses found in our communities

The “Sustaining What We Value” project area includes a unique mix of communities, agricultural areas, employment areas, and protected areas such as Frontenac and Charleston Lake Provincial Parks. These diverse features can be considered as constraints or opportunities when designing an NHS. The Scenario Planning Team carefully considered the management objectives for many different socio-political considerations in order to assign an appropriate status.

Socio-political considerations are accommodated in the NHS design by assigning each one a status. The status tells Marxan how a particular area of land should be treated. To be included in the design process, each socio-political consideration must be mapped. The items that were discussed and their assigned status can be found in Table 2.

Status Types:

- Conserved – these areas must always be included within the NHS
- Preferred – if two or more areas contribute equally towards targets, these areas are preferred over others that are available
- Excluded – these areas are never included in the NHS
- Available – all other areas that do not fall into the above status categories
- Available with Cost – these areas are available for inclusion, but the area included in the NHS will be minimized. A cost multiplier was applied to the area (in hectares) of a particular land use that the Working Group felt should be minimized in the system. This parameter encourages Marxan to search all other possible options to achieve the targets at a lesser cost (see section 3.7.1 for more information on how Marxan works).

It was not always possible to set a status because of a lack of information or mapped data. In these cases, the Scenario Planning Team identified them as data gaps for consideration in future NHS design and planning exercises (Section 5).

Table 2. Summary of the status assigned to socio-political considerations by the Scenario Planning Team (for detailed table with rationale, see Appendix A).

ALWAYS INCLUDED	MAY BE INCLUDED	NOT INCLUDED
Conserved	**Preferred**	**Excluded**
• Provincially Significant Wetlands • Community Forests (formerly Agreement Forests) • Conservation Authority Conservation Areas and Properties • Ducks Unlimited Owned Properties • Land Trust Properties • Ontario Heritage Trust Properties managed for natural heritage values • Nature Reserves managed by Ontario Nature or its affiliates • Nature Conservancy of Canada Properties • Conservation Easements • St. Lawrence Parks Commission areas • National Parks • National Wildlife Areas • Wildlife Management Areas (also called Provincial Wildlife Areas) • National Historic Parks and Sites with natural heritage protection objectives • Provincial Parks • MNR-managed crown lands • University Biological Research Properties • Open Water (including Inland Lakes, Rivers)	• Areas of Natural and Scientific Interest • Wetlands >0.5 ha in CRCA jurisdiction • Other Crown Lands (not managed by MNR) • Rideau Waterway Canadian Heritage River System • Migratory Bird Sanctuaries • Important Bird Areas • Frontenac Arch World Biosphere Reserve	• Existing and Approved Urban Areas that are 100% impervious / built-up • Fencerows/ hedgerows
	Available (default)	**NOT FOUND IN STUDY AREA**
	• Municipally Owned Public Lands including Parks and Open Spaces • Conservation Authority Floodplain Regulated Areas • National Historic Parks and Sites without natural heritage protection objectives • Existing or Approved Renewable Energy Developments • Agricultural Lands rated CLI 4 to 7 • Existing Aggregate Pits • Prime Sand and Gravel Deposits • First Nations Reserves (1) • Natural Heritage Areas, Features and Systems Designated within Municipal Official Plans (2) • National Historic Canals (adjacent properties with natural heritage objectives) (2) • Invasive Non-Native Plant Species (2) • Prime Bedrock Deposits (unconstrained) (2) • Conservation Land Tax Incentive Program properties (3) • Managed Forest Tax Incentive Program properties (3) • Forest Stewardship Council Certified Lands (3)	• Crown Game Preserves • Fish Sanctuaries • Specialty Crop Areas (as designated by the province)
	Available with Cost Applied	
	• Prime Agricultural Lands rated CLI 1 to 3 • Existing Aggregate Quarries • Roads	

Notes
(1) Representative not available; inclusion in the NHS to be influenced by targets only
(2) Insufficient data to spatially map these features, so the default is available. See Table 7 for more details.
(3) Scenario Planning Team felt that participation in tax incentive programs should not influence inclusion in NHS; due to privacy considerations, no data showing the locations of these properties was obtained for this project

3.6.2 Ecological Features and Targets

Targets quantify the amount of or portion of an ecological feature (e.g. a forest type or species habitat) to be captured by an NHS. Explicit, numerical targets were set based on the best available science and suggested thresholds. Where there was no documented literature available to suggest a target for an ecological feature, the target was based on expert opinion, local knowledge and/or stakeholder consensus.

The "Sustaining What We Value" project area is fortunate to have 59% of the land area in natural cover (27% wetland and 32% upland forest) – one of the highest percentages in southern Ontario. The Scenario Planning Team sought to ensure that science-based targets were set in place. These targets identify the existing natural areas that they felt were essential to sustain the biodiversity and ecological health of this region.

Prior to each Scenario Planning Team meeting, technical advisors from the Steering Committee prepared background information on suggested thresholds and targets in consultation with resource experts. The current condition for each feature in the study area was evaluated and mapped using data prepared in ArcGIS. Resource experts (e.g. hydrologist, ecologist, biologist) were present at meetings to support discussions if possible. The best available knowledge was used to create targets for a 'baseline' NHS scenario. Where consensus on a target could not be reached, alternative 'what if' targets were identified for investigation through learning scenarios. The feature categories are described below in Table 3. The agreed-to ecological features and their associated targets agreed-to by the Scenario Planning Team are listed in Table 4.

Table 3. Ecological feature categories discussed by the Scenario Planning Team (adapted from Great Lakes Conservation Blueprint for Terrestrial Biodiversity, Henson and Brodribb 2004).

	**Biodiversity Representation** **Definition:** Features that represent unique vegetation communities, the foundation of ecosystems that contribute to the biodiversity of Ontario. The consideration of these conservation features can help ensure that native forests, wetlands, grasslands and other vegetation communities are represented in an NHS.
	**Ecological Functions** **Definition:** Features that contribute to ecosystem functions such as the movement of species. Stakeholders set targets for the number, size and proximity of habitat patches required to sustain healthy plant, animal and fish populations. Landscape scale features, such as patch size and forest interior, can help ensure that habitats are included for a broad range of species.
	**Species-specific Habitat** **Definition:** Features and targets in this category address individual species and their habitat needs. If available, this finer level of detail can help ensure that desired species specific habitat requirements are represented in the NHS.
	**Watershed Functions** **Definition:** Features that regulate the quality and quantity of water to maintain healthy watersheds. Stakeholders set targets within watershed boundaries to help protect streams, rivers and lakes from erosion and contaminants, maintain groundwater levels and minimize flooding.

Table 4. Summary of ecological features and targets for the Baseline NHS scenario agreed-to by the Scenario Planning Team (Note: numbering is not sequential. For detailed target table, see Appendix A).

FEATURE CATEGORY	Feature ID, ECOLOGICAL FEATURES and EXPLICIT TARGETS	NOTES
Biodiversity Representation	1. Wooded Area Types: 5% of total woodland cover to be represented by each forest type within the system *2a. Old Growth Forests*: 5% of total woodland cover to be represented by old growth* *3. Rare Ecosystems*: 100% of S1, S2, S3 communities identified by the NHIC* 4. Wetland Types: 5% of total wetland cover to be represented by each type within the system	Targets as are applied within each Soil Landscape sub-unit within each Ecodistrict. Woodland and wetland types are from FRI ELC in ecodistrict 6E-11/12 and PVM ELC in ecodistrict 6E-10.
Ecological Functions	2. *Forest Age Classes** 5. Other Habitat Types/ Unique Features: 100% of coastal wetlands (*grasslands/ rock barrens*)* 6. Forest Cover: 30% of total land area 7. Wetland Cover: 30% of total land area 8. Forest Patch Size: 100% of patches ≥ 75 ha in size 9. Proximity of Forest Patches: No target – implement through Marxan calibration 10. Forest Interior: a. 10% of total forest cover at 100 m from forest edge b. 5% of total forest cover at 200 m from forest edge 11. Wetland Patch Size: a. Ecodistrict 6E-10: i. 100% of wetlands ≥100 ha ii. 100% of marshes, fens, bogs 50-100 ha iii. 50% of swamps 50-100 ha b. Ecodistrict 6E-11,12, 5E-12: iv. 100% of marshes, fens, bogs ≥100 ha v. 50% of swamps ≥100 ha 12. Wetland Adjacent Upland Natural Cover: a. 100% of wetlands with 75-100% cover within 120 m b. 50% of wetlands with 50-75% cover within 120 m 13. Proximity of Wetland Patches: No target – implement through Marxan calibration 14. Riparian Vegetation (within 30 m of streams, rivers, inland lakes): 100% of reaches with 75-100% natural cover 15. Riparian Vegetation (within 300 m of streams, rivers, inland lakes): no target 16. Remoteness/Distance from Roads: 100% of natural cover found ≥ 2 km from any road	Targets are applied within each Soil Landscape sub-unit within each Ecodistrict (see Figure 3). Targets adapted primarily from Environment Canada's guidelines found in 'How Much Habitat Is Enough', 2nd Edition (2004). See Appendix A for full reference list for each target.
Species-specific Habitat	17. *Habitat for Species at Risk** 18. *Habitat to Support Species with a Range of Resource Needs**	No validated mapping of individual species habitat is available to support targets.
Watershed Functions	23. Forest Cover: 30% of the land area by quaternary watershed 24. Wetland Cover: 10% of total land area by tertiary watershed and 6% by quaternary watershed 25. Largest Natural Patch: Omitted (no target) 26. Natural Cover in Headwater Catchments: 50% of the land area be included, of which: a. 30% consist of wetlands b. 20% consist of upland forest 27. Riparian Functional Zones (streams, rivers, inland lakes): 100% of reaches with 75-100% natural cover within 100 m	Targets are applied within tertiary and quaternary watersheds, or headwater catchments (see Fig 4 & 5). Targets adapted primarily from Environment Canada's guidelines found in 'How Much Habitat Is Enough', 2nd Edition (2004). See Appendix A for full reference list for each target.
Other (Agricultural/ Economic)	19. Maple Syrup Production: 50% of sugar-maple dominated stands	Target based on expert opinion and local knowledge.

** Data GAP: Criterion agreed to in principle but targets could not be implemented because adequate study area wide data / mapping is currently unavailable (see section 5 on data gaps).*

A primary reference used to inform the targets listed in Table 4 was the science-based guidelines from the document “How Much Habitat is Enough”, which was developed by Environment Canada (2004) for the Great Lakes Areas of Concern. These guidelines are widely cited and have been used by conservation authorities as well as some municipalities to guide natural heritage planning. However, there were a few targets for which these guidelines do not provide specific direction. These targets drew on and integrated other recent sources, as well as local expert opinion, as described below. A full reference list for each target can be found in Appendix A. Each target is applied within ecologically relevant assessment units (Fig 4 and 5).

Biodiversity Representation

Wooded Area and Wetland Types (ID numbers 1&4): Biodiversity representation is discussed in the Environment Canada (2004) guidelines, but no specific guidance for numerical targets is provided, because this is assumed to require an approach suited to the local area. The Natural Heritage Reference Manual (MNR 2010) suggests: “*Woodlands should be considered significant if... the site is represented by less than 5% overall in woodland area and meets minimum area thresholds*”. Based on this guidance, the Scenario Planning Team decided to address terrestrial biodiversity by targeting 5% of each forest or wetland type within each soil-landscape sub-unit within each Ecodistrict (Figure 4).

Ecological Functions

Remoteness/ Distance from Roads (16): The Great Lakes Conservation Blueprint, Technical Methodology (Henson and Brodribb 2004) used distance from roads as a factor to assess the condition of a natural area. Natural areas with fewer roads are less fragmented and may be less impacted by development. All ecological functions targets were also assessed within each soil-landscape sub-unit within each Ecodistrict (Figure 4).

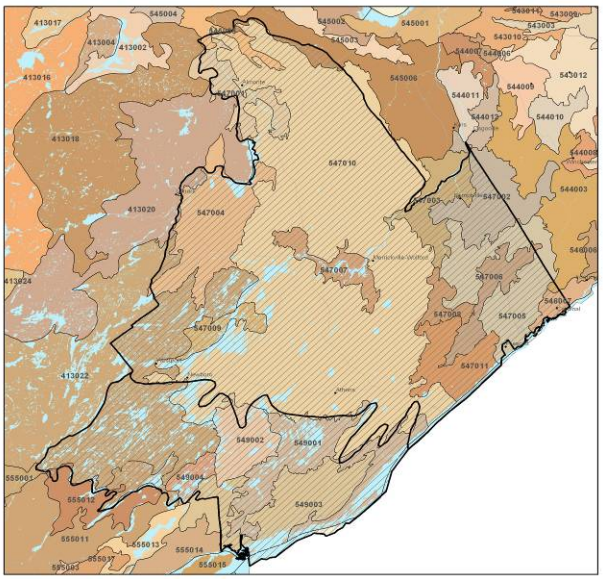


Figure 4. Ecodistrict soil landscape units used to assess biodiversity and ecological function targets. Targets are applied in each discreet unit to ensure distribution.

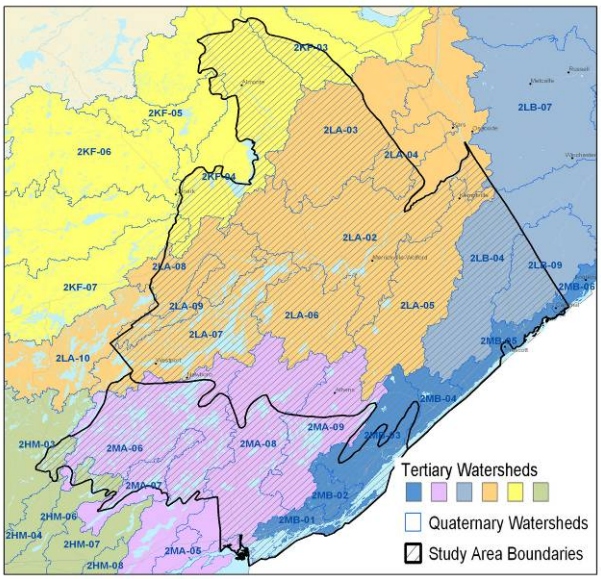


Figure 5. Watershed units used to assess watershed function targets. Targets are applied in each discreet unit to ensure distribution.

Species-specific Habitat

The Environment Canada (2004) guidelines generally consist of landscape-scale guidelines that assume that the habitat needs of a broad range of species will be captured. Setting targets for

rare or sensitive species also ensures that their individual habitat needs are included. In the "Sustaining What We Value" project study area, sufficient data was not available to enable setting explicit targets for this category. See section 5 on data gaps.

Watershed Functions

Headwater Catchments (26): Headwaters are critical areas for maintaining both water quality and quantity. Both the current science and provincial policies recognize the interconnectedness of surface and groundwater protection with natural heritage protection. The Provincial Policy Statement (MMAH 2005) directs that linkages between natural heritage features and water features be recognized. The Natural Heritage Reference Manual (MNR 2010) includes headwater areas and significant groundwater recharge areas in the attributes of natural core areas, and recommends they be protected through NHS. However, no recommendations or specific guidelines on how much to include are provided. For this project, the Scenario Planning Team, in consultation with local experts, set a target of 50% of the land area (30% wetland and 20% upland forest cover) for natural cover in headwater catchments.

> *"It is recommended that measures be taken to protect water features, wetlands and other areas of hydrological importance (e.g., headwaters, recharge areas, discharge areas) within Natural Heritage Systems."*
>
> *Natural Heritage Reference Manual (MNR 2010)*

Riparian Functional Zones (27): Several sources [Environment Canada 2004; Natural Heritage Reference Manual (MNR 2010); ELI 2003; U.S. EPA (Mayer et al. 2005); Lake Simcoe Protection Plan (MOE 2009)] suggest varying widths of vegetation buffer zones on streams and rivers, ranging from 30 to 100 meter widths. For this project, the Scenario Planning Team set a target to include existing natural vegetation within 100 m of riparian areas.

> *"... natural shoreline areas perform multiple functions, including control of run-off and associated nutrients and other pollutants, stabilizing shorelines from erosion, conserving habitats for a disproportionately high number of aquatic and terrestrial species, regulating temperature and microclimate, screening noise and wind, preserving the aesthetic appeal of the landscape and providing recreational opportunities."*
>
> *Lake Simcoe Protection Plan (MOE 2009)*

Other – Agricultural/ Economic

Natural features such as woodlands often provide numerous economic benefits to local communities. The Natural Heritage Reference Manual (MNR 2010) recognizes this by including optional criteria for economic and social values that can contribute to woodland significance. The Scenario Planning Team felt that maple syrup production was an important local sustainable forest industry that is compatible with an NHS. As a result, a Baseline target was set to include 50% of existing sugar maple dominated forests in the NHS.

3.6.3 Natural Heritage System Scenarios

Given the diverse interests of the Working Group members and their knowledge of the local landscape, they did not always agree on a single target level or socio political consideration status. At other times the group expressed curiosity about the impact of different target levels on the results of the analysis. These “what if” questions were grouped by theme into the 14 learning scenarios (including the Baseline) described in Table 5 below. The learning scenarios helped the Scenario Planning Team understand the impacts of their decisions on the NHS for this landscape.

Table 5. Learning scenarios designed to explore alterative scenarios to the Baseline.

Scenario Number	Learning Scenario Name	Description
1	Baseline	This scenario reflects the best available science and knowledge and current socio-political considerations across the study area based on the deliberations and input of the Scenario Planning Team. The baseline targets are described in Table 4 and the socio-political statuses assigned in Table 2. All other scenarios are compared against the Baseline. Note: This scenario was revised to remove conserved status from waterbodies (lakes and rivers), since this resulted in an additional 15% of the natural inventory to be included into the system which has no basis in policy.
2	The Best Half of the Features that Exist on the Landscape	Same as Baseline except all targets are set to half (50%) of what is currently present across the study area for every feature. This scenario reveals where across the landscape is the most important half of all existing features subject to the socio-political statuses and costs identified by the Scenario Planning Team (Table 2).
3	The 'Best of the Best'	Same as Scenario 2 above except all socio-political statuses are considered ‘Available’, all costs are set to zero and the Boundary Length Modifier is set to zero (calibration tool that forces Marxan to ‘clump’ natural areas together). This scenario reveals the ‘richest’ ecological areas in the landscape because there are no constraints forcing Marxan to clump natural areas together or consider socio-political considerations.
4	Baseline Determined by Ecodistricts	Same as the Baseline except only Ecodistricts were used to assess Biodiversity Representation and Ecological Function targets rather than Ecodistrict and Soil Landscape Combinations. This scenario explores whether distributing targets only at the ecodistrict scale results in a significant decrease in the amount of area needed to meet the targets.
5	No 'Conserved' Status for Water	Recommended by science experts review. No longer a separate scenario – was included as a revision to scenario 1, Baseline.
6	Baseline Targets Adjusted Down	Same as the Baseline Scenario except the targets for some specific features were reduced based on the scientific literature as follows: 1. Biodiversity Representation Targets for both Wooded and Wetland Types reduced from minimum 5% representation to 3%. 2. Wetland Cover Targets reduced from minimum 30% to 10% by Ecodistrict Soil Landscape Units and by Headwater Catchments 3. Patch Size Targets reduced to a minimum of at least one 200 ha Forest and one 100 ha Wetland patch per unit 4. Target for 100% Wetland and Riparian Buffers with >=75% natural cover reduced to 50% 5. Forest Cover Targets in Headwater Catchments reduced from 20% to 7% Note: This scenario was added because sensitivity analysis revealed that these 5 targets had the greatest influence on the Baseline result.

Scenario Number	Learning Scenario Name	Description
7	What If All Conservation Lands Were Fully Protected?	Same as Baseline except all Conservation Lands are set to Conserved. Not run. Given that almost all available natural lands ended up being required to meet the targets, this scenario would have very little impact on the results
8	Agricultural Expansion	Same as Best Half Scenario 2 except costs set on all Prime Agricultural Soils (CLI 1-3) including soils currently under Natural Cover. Not run. Given that almost all available natural lands ended up being required to meet the targets, this scenario would have very little impact on the results
9	Quarry Expansion	Same as Best Half Scenario 2 except costs set on all unconstrained bedrock areas. Not run due to unavailability of mapping of unconstrained bedrock areas.
10	Targets for Forest and Wetland Cover Only	This scenario applies the same target reductions as scenario 6 and in addition, all targets have been turned off except for the following: 1. Forest & Wetland Cover Targets by Ecodistrict Soil Landscape Units 2. Forest & Wetland Cover Targets by Watersheds 3. Forest & Wetland Cover Targets by Headwater Catchments
11	Natural Cover in NHS Capped at 50%	Under the Baseline Scenario, lands assigned as conserved status (i.e. areas already fully protected through existing policies and legislation) account for 40% of the existing natural cover. Under this scenario, an additional 10% was added consisting of areas with the highest abundance of targeted features.
12	Natural Cover in NHS Capped at 60%	Same as Scenario 11 except an additional 20% of the natural inventory was added.
13	Natural Cover in NHS Capped at 70%	Same as Scenario 11 except an additional 30% of the natural inventory was added.
14	Natural Cover in NHS Capped at 80%	Same as Scenario 11 except an additional 40% of the natural inventory was added.

3.7 Step 4 – Natural Heritage Systems Analysis and Scenario Mapping

When all the ecological targets, socio-political considerations, and learning scenarios were agreed-to by the Scenario Planning Team, the lead analyst with the Ministry of Natural Resources used these inputs to complete the NHS analysis and scenario mapping process (step 4 in Figure 3). This step involves prepping the input data for each scenario and using Marxan, a decision support tool, to identify efficient configurations of sites that best meet the targets and socio-political considerations for each learning scenario. The analysis phase took 3-4 months during spring and summer 2010. The results for each of the scenarios were mapped and brought back to the Scenario Planning Team for review in the fall of 2010.

3.7.1 NHS Analysis Using Marxan

For the NHS analysis, each input data layer (Table 1) corresponding to an identified ecological target or socio-political consideration was prepped and loaded into the Marxan software (for technical details, see Ardron *et al.* 2010, or see metadata in the final data package). This process was repeated for each of the NHS Scenarios identified in Table 5. As described in

Section 3.3, Marxan provides decision-support by using the algorithm *simulated annealing* to identify near-optimal spatial arrangements of areas for inclusion in an NHS subject to the targets and constraints requested by the Scenario Planning Team. The Marxan methodology divides the landscape up into regularly shaped "land units" that facilitate rapid computation. A five hectare hexagon shaped land unit has been shown to be an optimal resolution for the southern Ontario landscape (MNR 2008). The "Sustaining What We Value" project area has 140,454 land units, meaning there are millions of design options that the software considers. Each land unit simply acts as a container for the spatial data within it; no level of detail or accuracy is lost.

The Marxan algorithm uses three key parameters to figure out the most efficient combination of areas to include, which are described below and illustrated in Figure 6.

- Land Unit Cost – default cost equals the area of the land unit in hectares.
- Land Unit Boundary Cost – equals the amount of edge X Boundary Length Modifier (BLM) which is a user defined constant (increasing the BLM value increases the cost of a more fragmented design).
- Cost of Not Meeting Targets – Not achieving a target carries a penalty cost.

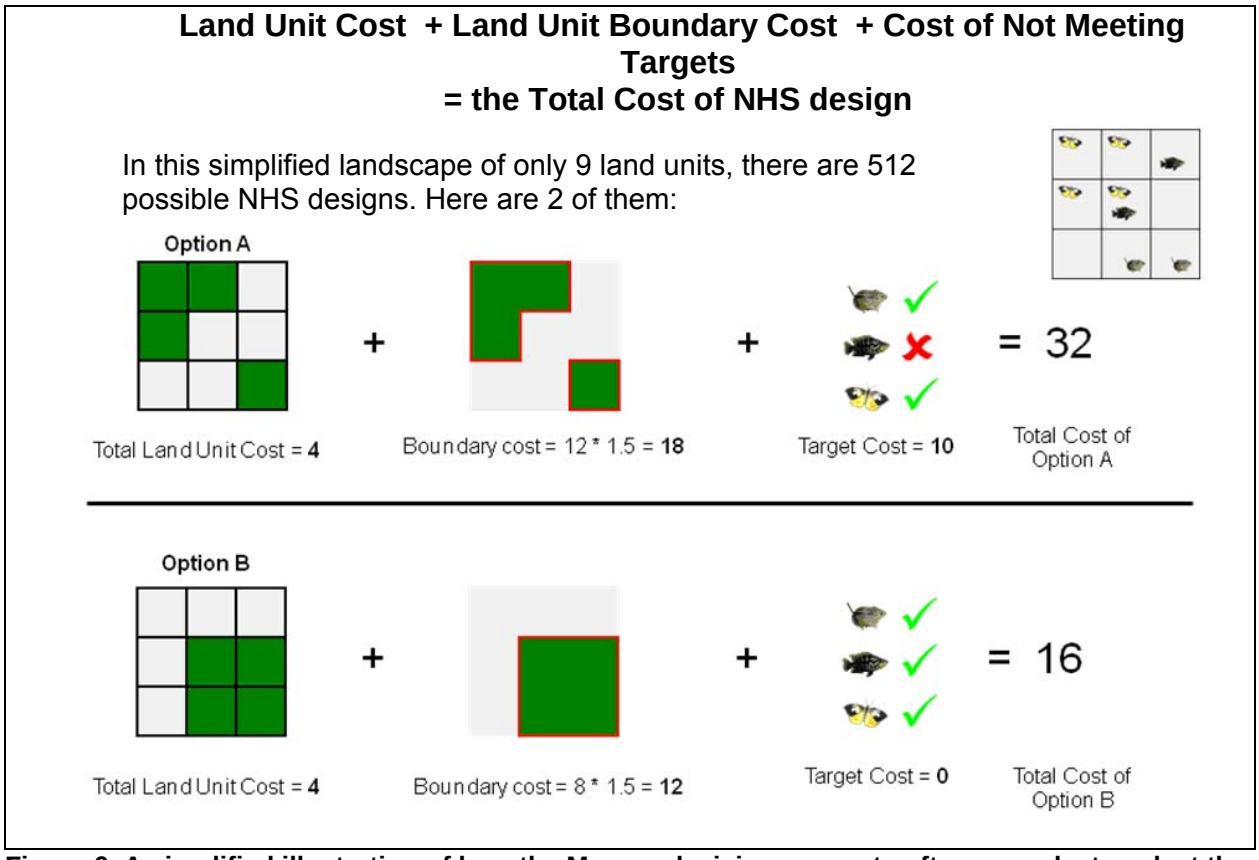


Figure 6. A simplified illustration of how the Marxan decision support software works to select the most "cost effective" option for a theoretical NHS (School of Anthropology and Conservation - University of Kent).

The socio-political inputs from the Scenario Planning Team provide Marxan with additional information about each land unit, as described in Section 3.6.1 (e.g. land units with 'excluded' status will be ignored by the software, and additional costs for certain land types can be added to the land unit cost). For each scenario identified in Table 5, Marxan selected and assessed 100 million different combinations of land units (iterations), and this process was repeated 100 times (runs) to identify the 'least-cost' solution. These parameters were identified through calibration of the software to ensure the number of iterations and runs were sufficient to explore the range of options in this landscape. The average computer processing time for each scenario was 7-10 hours.

Marxan seeks to achieve all the targets while minimizing the land unit cost and clumping land units together to minimize the amount of 'edge'. Since the land unit cost is set to the amount of land area, the resulting 'least-cost' solution is the NHS design that best meets the targets in the least amount of area.

Prior to bringing the scenario results to the Scenario Planning Team, a meeting was held with MNR science experts to provide feedback on how to best display the scenario maps and to help identify any unusual results or gaps. This meeting resulted in a recommendation to the Scenario Planning Team to remove the 'conserved' status from open water in the Baseline scenario (see Appendix A for details). This revision was run prior to the Scenario Planning Team meeting so it was available for comparison and decision support. In addition, during the NHS analysis process, several scenarios in Table 5 were effectively eliminated either because data could not be obtained or because the conditions they tested did not prove to produce alternative scenario results for the group to compare (see Table 5 for details).

3.8 Step 5 – Evaluating the Natural Heritage System Scenarios

Three full-day meetings of the Scenario Planning Team were held in fall 2010 and early winter 2011 to review the learning scenarios and seek agreement on a preferred scenario (steps 5-7 in Fig 3). The scenarios were mapped on large posters and detailed information packages were provided containing statistics on target achievement and overall percent feature inclusion by each scenario. Team members reviewed each map and the statistics to help them individually and as a group assess how well each met their stated vision and goals for a preferred NHS.

3.8.1 The Baseline Scenario

The Baseline scenario formed the point of reference for all comparisons. The Baseline scenario reflects the available documented science for targets and suggested ecological thresholds (Table 4), as well as current policies on land use or socio-political status (Table 2). The Scenario Planning Team agreed with the science experts' recommendation to remove conserved status from open water, so all subsequent comparisons were made to this revised Baseline (Scenario 1). The Baseline scenario map of selected areas is shown below in Figure 7.

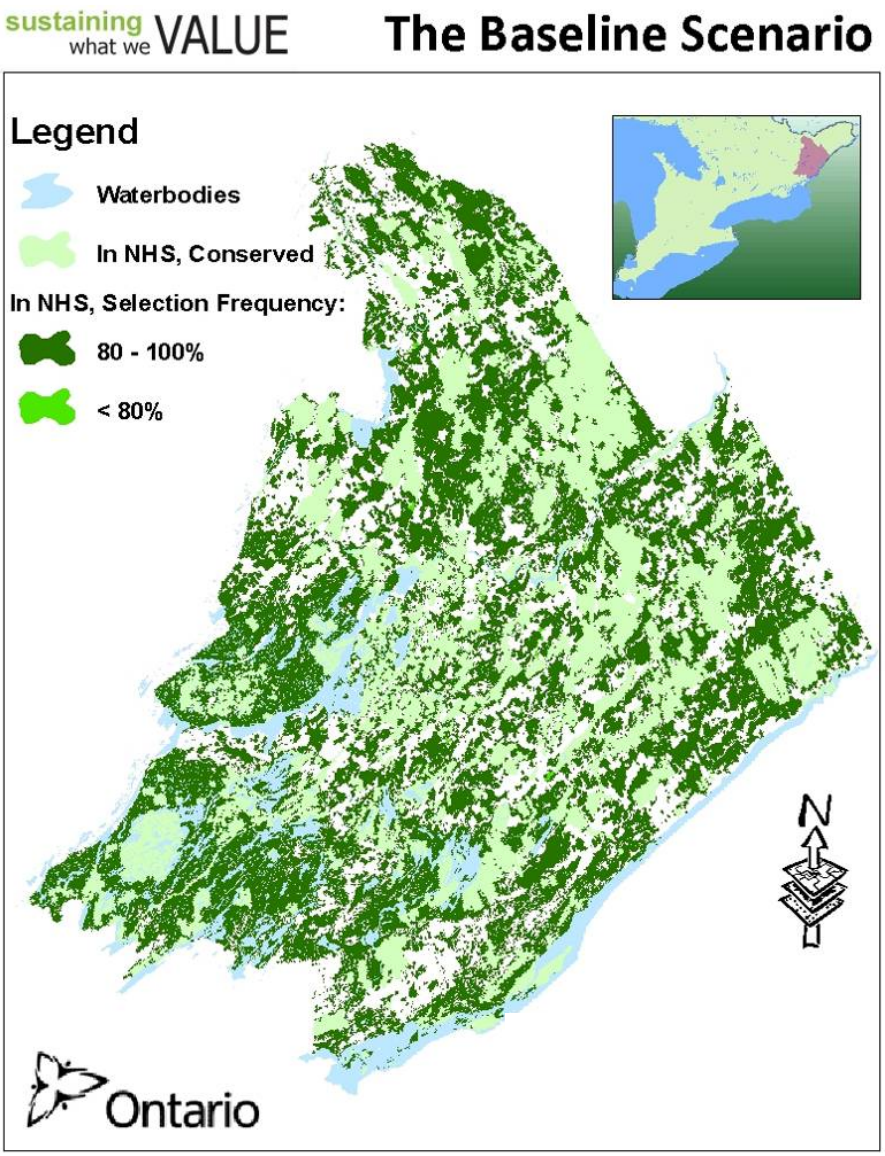


Figure 7. The Baseline scenario result from the NHS analysis using Marxan. This scenario incorporates the socio-political status types described in Table 2 and ecological targets described in Table 3 that were selected by the Scenario Planning Team.

The Baseline scenario resulted in 58% of the total land in the study area being included in the NHS. This represents 99% of the existing natural areas (i.e. wetlands and woodlands). This outcome primarily resulted from the Scenario Planning Team's decisions to:

(1) always include (conserve) certain lands such as PSWs in the NHS (see Table 2), and
(2) to set targets for ecological and watershed functions as a percent of the total land base, as suggested by Environment Canada's guidelines found in 'How Much Habitat is Enough'. The latter decision meant that where sub watersheds or soil landscape units were below these targets levels, 100% of the ecological feature would be always be added to the solution.

The light green on the above map represents all the areas given 'conserved' status by the Scenario Planning Team (see Table 2 for complete list). These areas were included automatically in the NHS. The darker green represents the additional natural areas that were required to meet all the ecological targets (see Table 4).

In addition to the Baseline scenario, the lead analyst ran 35 different variations of the Baseline to better understand why 99% of the existing natural cover was required to meet the targets. This sensitivity analysis involved successively turning off one target at a time and then different groups of targets. The analysis revealed that no one target is driving the result; rather it is a group of five targets. These targets are:

1. Biodiversity Representation
2. Wetland & Forest Cover By Ecodistrict Soil Landscape combinations
3. Wetland & Forest Cover By Watersheds
4. Wetland & Forest Cover By Headwater Catchment
5. Forest Patch Size

As a result of this analysis, the Scenario Planning Team requested Scenario 6, Baseline Targets Adjusted Down, be added. The lead analyst worked with the ecologists on the Team to identify lower targets for these five features that were still supported by the scientific literature.

The Scenario Planning Team considered the Baseline Scenario to be an important science-based product that demonstrates the extent of the landscape required to fulfil the suggested ecological thresholds described in the reference documents. They considered the Baseline Scenario to be an ideal to work toward over the long-term. The Scenario Planning Team also recognized that for short-term implementation, trade-offs for social, economic and implementation considerations need to be considered. The Baseline scenario was the point of reference for comparing all other scenarios.

3.8.2 Assessing Trade-Offs Between Learning Scenarios

In total, there were ten scenarios (excluding the Baseline) listed in Table 5 that were carefully considered by the Scenario Planning Team to identify an alternative preferred scenario for implementation. The target-achievement of each learning scenario was evaluated based on how it compared to the results of the Baseline scenario. The Scenario Planning Team felt that using this comparison would allow them to consider striking a balance between the literature-based targets of the Baseline and what they thought would be feasible to implement on the ground. Their discussion and assessment of tradeoffs included consideration of the following criteria that were identified from the Terms of Reference:

- ✓ Does it meet your vision of what an NHS should be for this landscape?
- ✓ Is the NHS based on the best available science?
- ✓ Has it adequately addressed the ecological values; i.e. “the NHS for the study area will consist of a network of core areas, regional connections and local linkages“?
- ✓ Does it adequately consider social, economic and cultural values?
- ✓ Is it a product that will be beneficial, practical and useful for:
  - o Land use planning and policy decisions
  - o Establishing priorities for stewardship and restoration
  - o Establishing priorities for land acquisition
  - o Establishing priorities for inventory programs and research

The Scenario Planning Team agreed that the Baseline scenario was the ideal scenario and something to work toward in the long-term. However, for short-term implementation, the alternative preferred scenario should make some compromises. Reviewing the learning scenarios helped the Scenario Planning Team see the effect of varying the overall ‘size’ of the NHS on the landscape. The Team agreed that around 80% achievement of the Baseline targets would be acceptable for the preferred NHS.

- ✓ Does it have a high probability of being accepted and used?

The Scenario Planning Team's assessment of the ten learning scenarios (excluding the Baseline, which was the reference for comparison) against these criteria is shown in Table 6.

Table 6. The Scenario Planning Team's assessment of the learning scenarios based on criteria from the Terms of Reference. Scenarios are listed with those eliminated earliest first.

Scenario	Does it meet your vision for an NHS?	Is it based on the best available science?	Has it adequately addressed the ecological values?	Does it adequately consider social, economic and cultural values?	Will it be beneficial, practical and useful for implementation?
Scenario 3: Best of the Best	No – This scenario demonstrates the effect of removing all constraints on the Marxan software. The result is a "salt and peppering" of the most ecologically rich areas across the landscape.	No. The targets are, but connectivity is not considered.	No, the result is highly fragmented.	No, socio-political considerations were not included.	No – a highly fragmented system would be difficult to manage
Scenario 4: Baseline Determined by Ecodistricts	Yes	Yes	No - this scenario revealed that using a larger assessment area (ecodistricts only instead of soil landscapes within ecodistricts) resulted in a small 11% reduction in the number of land units that were selected. This is because Marxan does not have to distribute the targets as much. With input from local ecologists, the SPT decided not to use this approach and to keep soil landscapes as the assessment area for the targets. More distribution ensures that ecologically rich areas in an ecodistrict cannot compensate for less rich areas.	No – similar result as the Baseline scenario (58% of land area included, or 99% of existing natural cover).	No – may not be practical.
Scenario 2: Best Half of What's Left	No – does not meet vision of a connected system.	No, the literature-based targets were not used as inputs.	No. This scenario met 68-72% of the Baseline ecological targets. The Scenario Planning Team decided that this did not perform well enough.	Yes – included 38% of the land area (65% of existing natural cover).	No. The Scenario Planning Team felt that this scenario may be easily questioned due to the 'across-the-board' 50% targets.

Scenario	Does it meet your vision for an NHS?	Is it based on the best available science?	Has it adequately addressed the ecological values?	Does it adequately consider social, economic and cultural values?	Will it be beneficial, practical and useful for implementation?
Scenarios 11-14: Natural Cover Capped at 50%, 60%, 70%, 80%	No.	No, the literature-based targets were not used as inputs.	No. The highest target achievement in these scenarios was 63% of the biodiversity targets and 83% of ecological functions. Scenarios 6 and 10 matched or exceeded these target achievements in less land area because they used the full optimization power of Marxan.	Yes – included a maximum of 51% of the land area.	No. These scenarios did not utilize the full optimization potential of Marxan to select the areas. In order to allow capping of the amount of natural cover, the areas included in the system had to be pre-selected based on their abundance of targeted features.
Scenario 6: Baseline Targets Adjusted Down	Yes	Yes, all targets are based on literature references.	Yes. This scenario met 81-92% of all Baseline targets. **Refined system met 91-99% of Baseline targets.**	Yes – included 52% of the land area (88% of existing natural cover) **Refined system included 55% of land area.**	Yes
Scenario 10: Targets for Forest and Wetland Cover Only	Yes	Yes. This scenario reveals that the science-based forest and wetland cover targets alone are sufficient to meet most of the other targets.	Yes, except for biodiversity representation. This scenario met 74-82% of the Baseline targets, except biodiversity representation which had an average achievement of 64%. **Refined system met 83-91% of Baseline targets.**	Yes – included 44% of land area (75% of existing natural cover). **Refined system included 50% of land area.**	Yes. This scenario has the added benefit of simplifying the target inputs down to the 3 key drivers of the system. This can help with communicating to the public.

3.8.3 Steps 6, 7 – Refining the Learning Scenario Maps to Select a Preferred Scenario

The Scenario Planning Team identified Scenarios 6 and 10 as potentials for a preferred NHS scenario that is an alternative to the Baseline. To further assist them with seeing the differences between these two scenarios, they were each mapped back to the original natural features. This process involves taking the selected hexagons and resolving them back to the original feature mapping. The percent inclusion and target achievement for the refined mapping were recalculated and are shown in bold in Table 6. The refined maps ended up having higher target achievement in all categories. In particular, the achievement of biodiversity targets in Scenario 10 increased from 64% in the draft system to 83% in the final system. Based on comparing these results, the Scenario Planning Team selected Scenario 10: Targets for Forest and Wetland Cover as their alternative preferred NHS scenario. The rationale for this decision was:

1. The Forest and Wetland Targets Only Scenario reflects the Scenario Planning Team's efforts to design an NHS that meets most (83-91%) of the minimum thresholds as described in the available literature.
2. The Forest and Wetland Targets Only Scenario simplifies the number of targets included and may be easier to explain to others.
3. The Scenario Planning Team felt that the scenario options that set all targets to 50% or more of what currently exists would be difficult for them to defend from a documented science perspective.
4. The Scenario Planning Team felt that the Baseline NHS and alternative preferred NHS both form an information package meant to inform users about the landscape and the features it contains. It is also intended to inform many different uses and is not meant to be implemented by one organization alone (see Section 6.0).

A key conclusion from all eleven scenarios is that even at 58% natural cover in this landscape, some of the soil landscape or watershed units are still at or below the suggested thresholds (e.g. 30% of the land area in forest cover) found in the available scientific literature. The Scenario Planning Team supports using the results of the Baseline Scenario or the alternative Preferred Scenario to better understand the landscape and to work toward landscape sustainability over the long-term.

4.0 The Preferred Natural Heritage System (Step 8)

The preferred NHS (Figure 8) was chosen by the Scenario Planning Team as an alternative to the Baseline that they felt provides an acceptable balance between environmental, economic and social objectives. In addition, it provides a number of vital ecosystem services to the communities within the study area (Troy and Bagstad 2009). Some key information about the NHS is described in Box 1 below.

Box 1: Preferred Natural Heritage System Vital Statistics

Land cover Type	Percent Of Total Type Included in NHS	Percent Included, expressed as a percent of land area
Natural Cover	86%	50%
Wetlands	94%	25%
Upland Treed	79%	25%
Forested (including upland forest and swamps)	85%	35%

Target Achievement Relative to Baseline (based on area weighted averages by Assessment Unit)	
Biodiversity Representation	83%
Ecological Functions	91%
Watershed Functions	91%
Maple Syrup Producing Stands	100%

Quick Facts:

- The NHS provides many vital ecosystem services to our communities. These services include:
  - clean air and water
  - flood and erosion prevention
  - pollination and pest control
  - recreation/ tourism opportunities

  For more information on ecosystem services in southern Ontario please see Troy and Bagstad 2009 (http://www.mnr.gov.on.ca/en/Business/LUEPS/2ColumnSubPage/279467.html).

- As part of this project, the community identified scenic vistas, recreation and biodiversity as top community values in this area (Section 3.1). The final data package contains the mapped community value locations which can be overlain on the NHS for comparison or analysis.

- The area around Frontenac Park is the largest remaining contiguous habitat patch remaining in all of the Mixedwood Plains Ecozone except for Manitoulin Island. This area is rich in biodiversity, and is one of the many features that make this part of southern Ontario unique.

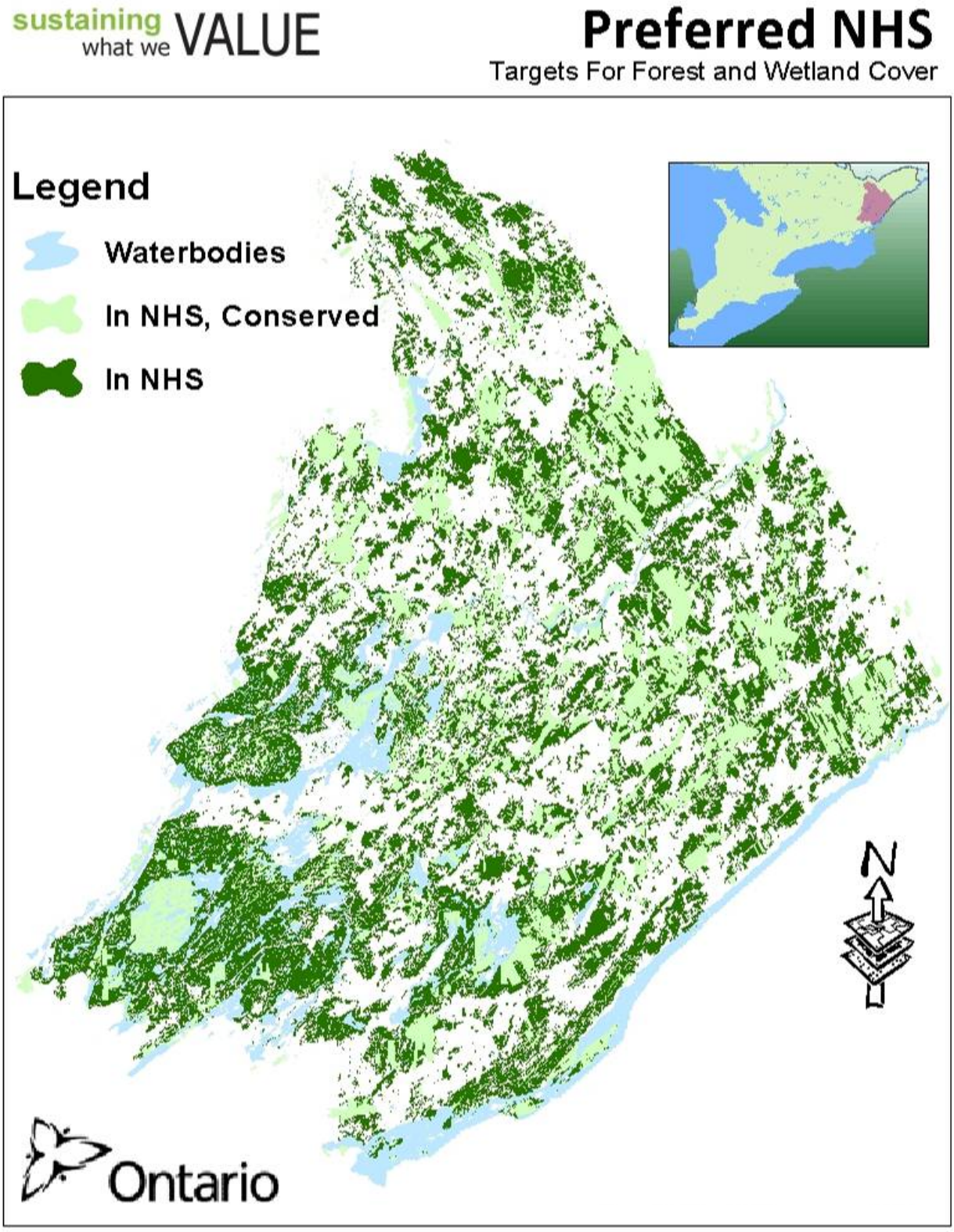


Figure 8. The preferred NHS selected by the Scenario Planning Team.

5.0 Identified Data Gaps and Future Updates

The NHS identified from this process used the best available data. However, there are always areas where the existing data can be improved. Throughout the NHS design process, the Scenario Planning Team identified a number of data gaps. The data gaps include information that is not yet available, or data that was inadequate to inform the NHS design. The data gaps identified by the Scenario Planning Team are documented in Table 7.

All plans, even long range strategic plans, require periodic review to ensure that they remain a relevant tool for those using it to inform their operational decision making. At this time, it is recommended that the NHS products be assessed periodically by the agencies using it to assess whether it continues to meet their needs. The Scenario Planning Team recommends that these data gaps be used to set priorities for improving data in a future cycle of NHS design and planning.

Table 7. Data gaps identified by the Scenario Planning Team.

Data Gap	Description
Biodiversity Representation	
Old Growth Forests	• Insufficient data to define and map older growth forest across study area; too many assumptions to accurately predict old growth using the EOMF FRI inventory
Rare Ecosystems	• Could not match S1, S2, S3-ranked communities from NHIC with available vegetation type classes
Ecological Functions	
Forest Age Classes	• Insufficient data to adequately identify forest age
Unique Features	• Mapping of rock barrens and grasslands not available for entire study area • NHIC mapping of rare communities not available for study area
Species-specific Habitat	
Species at Risk	• Species at risk (SAR) occurrence data were not used to set explicit targets because these data are generally biased to public lands and roadside areas. These data could be overlain on top of the NHS for subsequent refinement and validation purposes.
Habitat to Support Species with a Range of Resource Needs	• In the 6E-10&11 study area, there are several habitat models available that identify possible habitat for a number of species. However, none of these models have been validated by empirical data so local experts recommended that these maps not be used to set explicit targets.
Other: Economic/ Cultural	
Maple Syrup Production	• Mapping of existing stands in maple syrup production was not available
Cultural heritage	• Consistent, spatial mapping of cultural heritage sites across the entire study area lacking (most mapped sites were in Leeds and Grenville)
Socio-political considerations	
Natural Heritage Areas, Features and Systems Designated within Municipal Official Plans	• Consistent and compatible data could not be received from all municipalities
Municipally Owned Public Lands including Parks and Open Spaces	• Data on all municipally owned lands and their management objectives was not available
Conservation Easements	• Could not obtain data
Federally owned lands adjacent to National Historic Canals	• Data not available from Parks Canada (not assembled)

Prime Bedrock and Sand & Gravel Deposits (unconstrained)	• Final mapping of constraints to aggregate resources not yet available from the Ministry of Northern Development, Mines and Forestry
Existing and Approved Urban Areas	• Data not available from municipalities for areas planned for future development (but not needed due to 'available' status)
Existing and Approved Renewable Energy Developments	• Data not available for entire study area (but not needed due to 'available' status)
Invasive Species	• No mapping of invasive species hotspots available

6.0 Example Uses of the Natural Heritage System Information

Use of the NHS information produced in this project is voluntary. However, there are many benefits of using the information generated from this process. The product is:

- scientifically defensible, based on the documented literature and analytical tools used
- is based on the best available data, and
- it was agreed to by a diverse group of local stakeholders.

The Scenario Planning Team hopes that the NHS will be used to help inform and coordinate all of these activities. One organization alone cannot sustain our natural heritage. Through collaboration and use of the NHS to support good decision-making, all organizations can work more efficiently toward this goal.

The final product of this project is more than just a map. It is a digital information package in GIS format containing more than 30 input layers, scientific targets, and identified priority areas with their significance to the landscape as a whole. This package of compiled information and data layers can inform:

- Identification of potential core areas, corridors and linkages (section 6.1)
- Priorities for Stewardship Projects (section 6.2)
- Conservation Land Acquisitions (section 6.3)
- Development Proposal Assessments (including cumulative effects) (section 6.4)
- Land Use Planning and Policy Decisions (section 6.5)
- Economic Development (section 6.6)
- Priorities for Inventory Programs and Research Projects (section 6.6)

There are a number of different map products that can be generated from the information package to support different uses. The above-mentioned example uses of the products are described below.

6.1 Identifying NHS Core Areas and Corridors

The map of the Preferred NHS in Figure 8 shows the existing natural areas required to meet the ecological targets set by the Scenario Planning Team in this landscape. Strictly speaking these results may not be a complete natural heritage system. Some natural features identified may require restoration to better link them together. Identifying connections and restoration areas is a complex question that could become an entire subsequent project of its own. This project only took an initial look at what might be required to complete this type of analysis and some sample products are included in the final data package.

The Natural Heritage Reference Manual (MNR 2010) identifies core areas, corridors and linkages as fundamental components of an NHS. Core areas are considered the building blocks of an NHS. They can consist of one feature or a collection of features that can include a mix of ecosystem types (e.g., grasslands, alvars, woodlands, wetlands). Core areas should be capable

of providing and sustaining ecological functions (MNR 2010). Corridors and linkages are linear areas intended to provide connectivity (at the regional or local level, respectively) and enable plants and animals to move between core areas (MNR 2010).

To demonstrate how the results of the project could be interpreted to describe the system in the terms used in the Natural Heritage Reference Manual, the selected natural areas of the preferred scenario were differentiated into *potential* core areas, corridors and linkages (results included in final data package). The lead analyst completed this analysis using guidance from the Natural Heritage Reference Manual (MNR 2010) and input from experts that were convened by members of the Working Group in fall 2011. The criteria used to complete the analysis can be found in the metadata accompanying the final data package. The identification of core areas, corridors and linkages included gaps between areas of existing natural cover if they met the applied criteria.

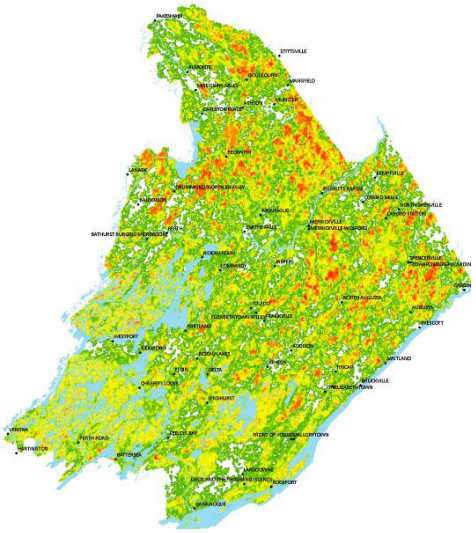
The team of local ecologists and other experts reviewed the results and agreed that this approach helps identify *potential* cores and *potential* corridors/linkages but that additional field work and ground truthing would be required to determine whether the identified cores and corridors are functional. The identification of corridors/linkages is particularly challenging and experts don't always agree on what specifically defines a linkage or a corridor. Different species have varying abilities to move between natural areas and there are many other factors that affect movement (e.g. habitat quality, human use of an area, etc.). In addition, it is impossible to know whether animals use a corridor or linkage without field work. For these reasons, the identified *potential* corridors and linkages included in the data package for this project should be treated with caution. They represent one possible analysis that could be used to separate natural areas into core areas and linkages; they do not represent any field verification or any existing policy. Future field work or scientific studies could greatly help improve our understanding of what creates a good corridor or linkage and help verify areas of the landscape that currently provide a linkage function for wildlife.

6.2 Using the NHS to assess priorities for stewardship projects.

The mapping of *potential* cores and corridors can help inform restoration activities. The green areas on the example map (below) are areas of existing natural cover. The yellow represents efficient locations that could enhance the function of existing natural areas (e.g. facilitate movement in a corridor or enhance forest interior). This type of information can be used to inform strategic restoration activities (e.g. tree planting). The mapped NHS may also provide a framework for engaging local landowners within these areas. It is important to note that identifying restoration areas is highly site-specific, requiring ground truthing, site assessment and working with landowners, which was beyond the scope of this project. However, the NHS information package can provide useful information to form a starting point for on-the-ground work.

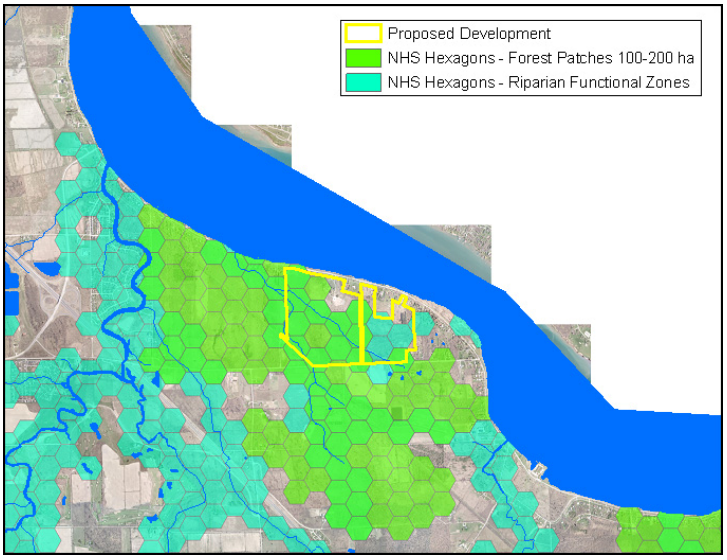
6.3 Using the NHS to identify priority areas for conservation land acquisition.

The map to the right shows the cumulative abundance of targeted features on the landscape (hot spots for ecological value). The red areas are the richest in terms of their contribution to the targets. This information can be used to help identify priority areas for land acquisition. In addition, the underlying data provides information on whether a particular parcel falls within a *potential* core area or corridor, and exactly how much it contributes to the targets. This information is also useful to create an appropriate management plan for a property once purchased.



6.4 Using the NHS to assess impacts of development.

The NHS analysis outputs are useful to assess the impact of a proposed development because a large amount of information is rolled up in each 5 hectare container. The map to the left shows the top two targeted features that would be impacted by this hypothetical development. The brighter green hexagons were selected to meet both the forest patch and riparian functional zone targets. Using the NHS information package, an impact table can be generated to add up the total hectares impacted for each target. In many cases, the total impact is substantially more than the size of the development. This is because one feature (e.g. a forest patch) can contribute to several targets. In this example, the total development area is 91 hectares, but the total impact across all targets is 195 hectares. This impact assessment calculation can inform decision-makers about the feature values that would need to be replaced elsewhere if this development went forward.



6.5 Land Use Planning and Policy Decisions

In addition to the examples shown above, the NHS package can be used to inform upper and lower tier municipal official plans and policies if desired. The products can be used as technical guidance to inform municipal land use planning during the normal processes under the *Planning Act*. It is not expected that the entire product will be adopted by a municipality wholesale. A municipality may choose to adopt elements of the NHS within its official plan through a land use

designation, a map schedule, an overlay type of designation, or an impact assessment tool. A major benefit of using the information products from this process is that the ecological contribution of every natural area can be explained and fully quantified. The contributions of a set of features to the overall landscape are equally valid if a municipality only implements a portion of the preferred NHS. In addition, the NHS information may be useful to inform municipal by-laws (e.g. vegetation removal, tree preservation, etc.).

6.6 Other Uses

In addition to the uses described above, the Scenario Planning Team felt that the NHS could be used as a tool for economic development. The NHS information could be used to promote areas for recreation and tourism, or be used to appropriately direct economic development activities. This area of eastern Ontario is rich in natural wealth that can support many sustainable economic development opportunities. The NHS information could be used to help attract tourism and recreation operators to experience and help protect what the region has to offer. Finally, the data gaps identified during this project can help inform priorities for inventory programs and research projects. The Working Group identified a number of data gaps throughout the project (see Section 5.0).

7.0 Conclusion

The “Sustaining What We Value” project engaged a diverse group of stakeholders, the Scenario Planning Team, to identify a natural heritage system for the Lanark, Frontenac, and Leeds and Grenville area of eastern Ontario. The group considered the available documented science and data, and worked with resource analysts and experts to complete an analysis of the existing natural areas and their importance to the region as a whole. The Scenario Planning Team considers the Baseline scenario to be an important science-based product that represents an ideal to work toward over the long-term. For the shorter-term, the Scenario Planning Team identified an alternative preferred NHS scenario that meets at least 80% of the baseline targets while still including flexibility for social and economic values (see section 4.0). The Scenario Planning Team supports using the results of this project to better understand the landscape, its ecological values, and to work toward sustainability over the long-term.

As described in section 6, the NHS information package can support a variety of strategic implementation initiatives. Each organization involved in natural heritage protection has a unique role to play. For more information on the NHS products, please download the final data package including comprehensive metadata from Land Information Ontario (under package products) or contact:

Planning and Information Management Supervisor
Kemptville District Office of the Ministry of Natural Resources
10 Campus Drive, Postal Bag 2002, Concession Road
Kemptville, ON, K0G 1J0
(613) 258-8204.

The Scenario Planning Team hopes that the NHS information will be used to help inform and coordinate many different activities on the landscape. One organization alone cannot sustain our natural heritage. Through collaboration and use of the NHS to support good decision-making, all organizations can work more efficiently toward this goal.

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