Priority Sites for Conservation Action in Ontario: Applying the Provincial Natural Heritage Database

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Abstract

Over the past three decades, many efforts have identified sites of ecological importance in Ontario, employing a variety of criteria, methods and data sets, and applying them at different scales. These efforts have been spearheaded by international, federal, provincial, regional and local agencies, and non-government organisations, and have resulted in a panoply of designations, ranging from world biosphere reserves to municipal environmentally significant areas. With the development of a provincial natural areas database at Ontario's Natural Heritage Information Centre (NHIC), the great majority of these identified areas of ecological significance are now electronically documented and georeferenced. Locations of rare species and vegetation communities are also documented in the NHIC element occurrences (EO) database, using standard methodology and database structure developed by The Nature Conservancy and used by conservation data centres throughout the western hemisphere. As a first attempt at an integrated, province-wide application of the NHIC natural areas and EO databases, a methodology is being developed and tested which uses Geographic Information Systems technology to identify areas containing concentrations of high-quality occurrences of imperilled elements. Areas are prioritised for conservation action on the basis of the level of significance of elements present (global vs. provincial) and by quality of occurrence using standard criteria that rank occurrences based on predicted long-term viability. Priority sites lists will be developed for the province and for each of its ecological regions, to help focus conservation efforts at multiple scales. Because NHIC database enhancement is an ongoing process, more refined priority sites lists may be produced in the future, with annual updates planned.

Introduction

The Conservation Data Network

NHIC is a member of the Association for Biodiversity Information (ABI International), which includes conservation data centres and natural heritage programs in eight Canadian provinces, all fifty U.S. states, and a number of Caribbean, Central American and South American countries (NHIC 1994). According to ABI, these programs "co-operate to define common data standards, contribute to joint development of computer systems, exchange experience in building self-sustaining institutions, and combine data into multi-jurisdictional information products" (ABI 1999).

The Provincial Natural Areas Database

Over the past three decades, many efforts have identified sites of ecological importance in Ontario, employing a variety of criteria, methods and data sets and applying them at different scales. These efforts have been spearheaded by international, federal, provincial, regional and local agencies, and non-government organisations, and have resulted in a panoply of designations, including UNESCO World Biosphere Reserves (Long Point and the Niagara Escarpment), almost six hundred International Biological Program sites, several Important Bird Areas, hundreds of Life Science Areas of Natural and Scientific Interest (ANSIs), numerous areas of Endangered Species Habitat, and most municipalities have designated "environmentally significant areas" (or their equivalent) in their official plans. In addition to these designations, which are generally made on the basis of ecological or biological significance with land tenure either not being a factor or being only one of several considerations, many types of areas have been set aside or acquired by public and private organisations for the purpose of protecting or preserving natural features. Such "managed areas" include national parks, national wildlife areas, provincial parks, conservation authority areas and municipal parks.

This array of sites and designations has to date made the selection and prioritisation of sites for investment of scarce conservation funds a difficult challenge. Having the geographic locations and associated tabular information for these sites stored in one central database is an important and versatile tool for meeting this challenge.

With the development of a provincial natural areas database at NHIC, the great majority of these areas of ecological significance (e.g., parks, ANSIs and evaluated wetlands) are now electronically documented and georeferenced. Between 1995 and 1999, tabular information on almost seven thousand sites has been entered into the NHIC Natural Areas Database (NADb). Concurrently with the NHIC data loading, the boundaries of provincial Areas of Natural and Scientific Interest, provincially significant wetlands and provincial parks have been digitised into the Ontario Ministry of Natural Resources' Natural Resources and Values Information System (NRVIS), which stores digital data for application in a Geographic Information Systems (GIS) environment (OMNR 1997).

The Provincial Element Occurrence Database

One of the primary functions of the NHIC, and of other conservation data centres, is to maintain information on "elements of biodiversity", or simply "elements". "Elements" is the term used to denote all plant and animal species, as well as all natural community types, that contribute to the planet's biodiversity. Geographical locations and biological information pertaining to over 1,700 species and natural communities considered to be at risk in Ontario are tracked by NHIC. This information is documented in the NHIC element occurrences (EO) database, using the standard methodology and database structure developed by The Nature Conservancy.

An EO is not simply an observation or report of a species at a site. An EO generally includes several observations of a species over a period of years or even decades, and may involve several different geographic locations. If all of the spatially and temporally disparate records occur within a continuous area of habitat for the species, unbroken by natural or artificial barriers, then the combined records form one EO. Thus, an EO may be considered a local "population" of a species.

Element Ranking

Another integral function of conservation data centres is to assess the sub-national (i.e., provincial) conservation status of each element. The sub-national status rank (S-rank) is based primarily on the number of occurrences of an element in the province (see Table 1). The S-rank may be adjusted based on the predicted viability of those occurrences. For example, a species having 19 high-quality occurrences, with high predicted viability, could conceivably be ranked S3 even though the numerical threshold for S3 is 21 occurrences, whereas a species having 28 occurrences that is declining rapidly in the province (due, for example, to illegal commercial harvesting or rapid habitat degradation) may be ranked S2.

Similarly, The Nature Conservancy assigns a global rank (G-rank) for each element in order to provide a standardised conservation rank for a species or vegetation community across its entire range. This enables state, provincial and national jurisdictions to assign conservation priority on the basis of an element's worldwide status, not just its status within the jurisdiction. G-ranks are assigned on the basis of S-ranks provided by all of the conservation data centres in the heritage network, and are updated annually. The numerical criteria for G-ranks are provided in Table 1.

Element Occurrence Ranking

Ideally, information on the population size, habitat quality, threats and landscape context are available for inclusion in the EO database. Based on such information, each EO is ranked according to the predicted long-term viability of the species or community at the location. This ranking system is based on standard criteria developed by The Nature Conservancy for use by natural heritage programs and conservation data centres throughout the western hemisphere (TNC 1997).

Element occurrences are ranked using the letter codes indicated in Table 1. The viability of the occurrence is based on expert opinion and the most current biological knowledge on the species or community. In many cases, the biology of the species is not well enough known to predict viability with a great deal of certainty. Nevertheless, large population size and extensive tracts of continuous habitat with no known immediate or long-term environmental threats would suggest an "A" quality occurrence (high predicted viability), whereas a population of a few individuals in highly-fragmented, disturbed habitat with known environmental threats would score "D" (probably not viable). "B" and "C" quality occurrences fall within these two extremes. Such a ranking system, though certainly not perfect, is easily understood and can be adjusted as new data or better information become available on the occurrence or the biology of the element in question.

This EO ranking system makes it possible to identify and map the most viable occurrences, and to identify concentrations or clusters of high quality occurrences on the landscape. Documented natural areas containing concentrations of high-quality occurrences of imperilled elements may be selected as the top candidates for conservation action. Using Geographic Information Systems technology, areas can be prioritised for conservation action in terms of the level of significance of elements present (global vs. provincial) and by quality of occurrence using standard criteria that rank occurrences based on predicted long-term viability.

Methods

Three successive methodologies were developed as part of this paper. A final methodology will be chosen to be used as part of a one-year collaborative project between the NHIC and The Nature Conservancy of Canada (NCC) to identify priority sites for conservation activities. Preliminary results would indicate that Method 3, with possible further refinement, will best highlight significant concentrations of EOs on the landscape for the purposes of this project. A brief description is given for each method, including the disadvantages and advantages of each.

In each methodology, relative 'significance values' are assigned to each EO and its associated observations, as an EO can be comprised of several observations with their own unique locations (see points "pts" columns in Table 1). From these values, a significance 'surface' for Ontario is generated to highlight areas of significant EOs. Although the values assigned to each EO and its observations remain constant, each method uses these values in a different manner.

Method 1

1. Calculate a 'significance value' for all EO records by multiplying values assigned to each EO based on its EORANK, GRANK, and SRANK (Table 1).
2. Take all Element Occurrence (EO) records and the associated observations with accuracy of 3 (1000m) or better and buffer them all by 1000m, creating EO concentration polygons containing one or more EOs.
3. Total the 'significance values' of EO records contained within each polygon.
4. Divide the polygon value by its area.
5. Map the data to show the highest value polygons as 'significant' concentrations.

Note that while Method 1 uses EOs and observations to create the buffers, it only uses EOs to calculate the polygon values.

Disadvantages:

- This method only uses records of accuracy 100m and 1,000m. Records of 10,000m accuracy are not incorporated in a meaningful manner.
- This analysis is biased towards records with fewer observations; an EO concentration polygon with many observations would have a larger area than

Provincial Ranks			Global Ranks			Quality Ranks		
	Occurances Provincially	Pts		Occurrences Globally	Pts			Pts
S1	1 to 5	50	**G1**	1 to 5	1000	**A**	excellent	20
S2	6 to 20	20	**G2**	6 to 20	500	**B**	good	10
S3	21 to 100	10	**G3**	21 to 100	100	**C**	fair	5
S4	101 to 1000	2	**G4**	101 to 1000	5	**D**	poor	1
S5	> 1000	1	**G5**	> 1000	1	**E**	extant	2
SH	historic	1				**F**	failed to find	1
SX	extirpated	1				H	historic	1
						X	extant	1

Table 1. Relative Significance Values Assigned to Element Occurrences and Observations

one with none, but it would be devalued by having its value spread out over a larger area.

Method 2

1. Calculate a 'significance value' for all EO and observation records by multiplying values assigned to each EO based on its EORANK, GRANK, and SRANK (see Table 1).
2. Select the most recent, highest accuracy record of up to 10,000m (10 km) accuracy for each unique combination of species and coordinate location.
3. Calculate a 'location value' for each coordinate location by adding up all 'significance values' at that location.
4. Generate a three-dimensional surface of the records using the coordinate locations as the X- and Y-values, and each 'location value' as the Z-value. Interpolate the Z-values for all areas between the points.
5. Set a minimum threshold value for the significance of a location, and highlight areas with 'location values' above the minimum as 'significant' concentrations.

Advantages over Method 1

- Method 2 incorporates 10,000m EOs and observations.
- Method 2 creates a continuous surface, and areas of significance are identified by finding the 'peaks' of that surface. This eliminates the bias caused when more points are used to define EO concentration polygons than are used to calculate the 'significance value' of these polygons as in Method 1.

Disadvantages

- Where data are widely dispersed, a misleading level of importance is applied to intermediate areas. Using this methodology, all empty space between two highly-significant records tends to be considered important as well. For example, Pelee Island and Point Pelee contain many high-valued locations with no intervening records in the water between them. However the intervening water is identified as significant by this method, even though it doesn't contain EOs. Similarly, an adjacent low-valued record could rapidly diminish the value of a nearby high-valued record.
- This methodology does not take into account the accuracy of the locations, or the proximity of other high-valued records.

Method 3

The first two steps of this method are the same as Method 2.

1. Calculate a 'significance value' for all EO and observation records by multiplying values assigned to each EO based on its EORANK, GRANK, and SRANK (Table 1).
2. Select the most recent, highest accuracy record of up to 10,000m (10 km) accuracy for each unique combination of species and coordinate location.
3. Buffer all of the records individually by the distance represented by their accuracies.
4. Assign each buffer a 'value per unit area' by taking the original record's 'significance value' and dividing that by the area of the buffer polygon.
5. For every 50 by 50 metre area, calculate the value of the cell by adding up

the 'values per unit area' of all the buffers that overlap that cell. This produces a coverage showing the value for all 50 by 50 metre cells in Ontario.

6. Finally, to generate areas of interest, use a smoothing algorithm such as ARC/INFO's GRID FOCALMEAN function to average out the value of every 50 by 50 metre cell to be equal to the average of all other cells within a kilometre of it. This prevents deep 'valleys' from appearing in the data between records that are within a kilometre of each other. Set a minimum threshold value for the significance of a location, and highlight areas with 'location values' above the minimum as 'significant' concentrations. This method highlights areas containing records of significance that lie within a kilometre of each other as with Method 1 above.

Advantages

- Areas of significant record concentrations are highlighted.
- Incorporates records of accuracy 10 km or better in a meaningful manner, while favouring higher accuracy records by concentrating the 'significance value'.
- Acknowledges intervening space between records closer than a kilometre apart, while enabling insignificant areas far from any EOs to remain insignificant (or unknown).

Disadvantages

- As with Method 2, it is impossible to determine from the resultant layer alone if 'insignificant' areas are due to insignificant record concentrations or simply lack of available data. EO and observation points must be displayed to reveal this.
- To run this methodology at 50m resolution for all of Ontario requires a lot of time using current technology. For example with ARC/INFO on PIII with 512Meg RAM it would take about two weeks.

Discussion

Priority sites lists may now be developed using Method 3 for the province and for each of its ecological regions, to help focus conservation efforts at multiple scales. The first priority sites lists are planned to be released for use by NCC in March 2000, with preliminary lists available in advance of that date. A sample result for the Niagara Peninsula area using Method 3 is shown in Figure 1.

Digital polygons for documented natural areas can be overlaid on the highlighted 'significant' concentrations and priority sites for conservation can be identified. Alternatively, lots and concessions, or even land tenure mapping where available, may be overlaid in order to identify landowners of critical conservation lands.

It should be recognised that data gathering has been far more intensive in southern Ontario than in the north, and that new rare species and communities continue to be discovered in the north, most notably in the southern part of northwestern Ontario, where boreal, prairie and mixed forest regions intermingle. Because NHIC database enhancement is an ongoing process, more refined priority sites lists may be produced as new and better information becomes available, and as analytical methods are refined. Annual updates are planned.

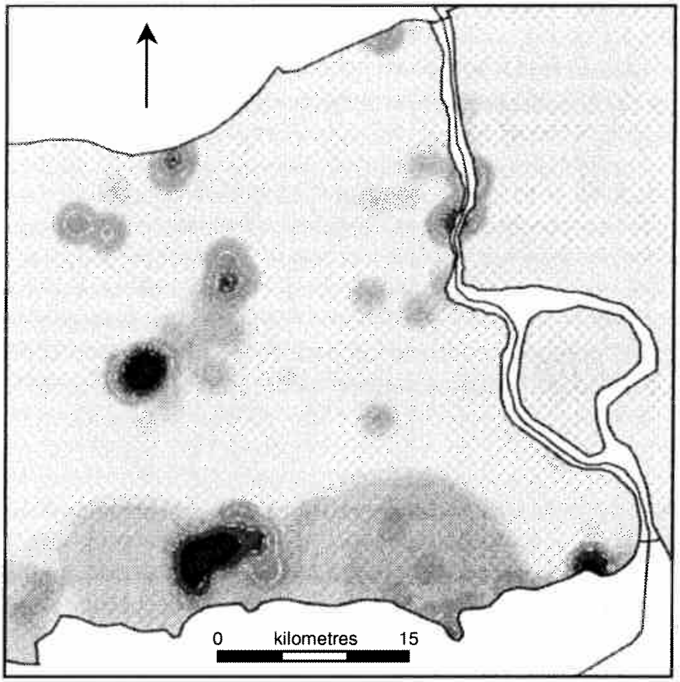

Figure 1. Sample result for Niagara Peninsula area showing significant concentrations (darker shading) using Method 3.

References

ABI (Association for Biodiversity Information). 1999. *Association for Biodiversity Information: The international network of natural heritage programs and conservation data centres.* ABI World Wide Web Home Page, http://www.abi.org/

NHIC (Natural Heritage Information Centre). 1994. About the Centre. *Ontario Natural Heritage Information Centre Newsletter.* 1(1): 1-2.

OMNR (Ontario Ministry of Natural Resources). 1997. *NRVIS Project: 1997/98 Work Planning Guidelines.* Peterborough, Ontario: Ontario Ministry of Natural Resources.

TNC (The Nature Conservancy). 1997. *Draft Element Occurrence Data Standard, Part 1.* For review by The Heritage Network, The Nature Conservancy Science and Stewardship Staff, and Cooperators. Arlington, Virginia: The Nature Conservancy.