Rare Species Mapping to Improve Environmental Management Throughout New Brunswick

Final Report to

New Brunswick Environmental Trust Fund

Project # 130072

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1.0 Executive Summary

Prior to this project, the New Brunswick Department of Environment and Local Government (DELG) screened for biodiversity significance using a 1995 Environmentally Significant Areas database that was very out of date and lacked 97.3% of the 44,000+ rare species locations then in the Atlantic Canada Conservation Data Centre (AC CDC) rare species database.

The New Brunswick Environmental Trust Fund (ETF), awarded funds to the AC CDC in May 2013 to complete a project entitled "Rare Species Mapping to Improve Environmental Management Throughout New Brunswick", designed: a) to improve the AC CDC rare species occurrence database; and b) to develop GIS tools using that database for DELG and Department of Natural Resources (DNR) in order to improve environmental management for rare species.

AC CDC work on this project from May 2013 to March 2014 has met these goals. The specific achievements of the project are as follows:

1) Provision (under a one year data use agreement for fiscal year 2014-15) to DELG of the October 2013 AC CDC GIS database of rare species occurrences for DELG use in developing a long-term wetlands policy, and for use in Environmental Impact Assessments (EIAs), Wetland and Watercourse Alteration (WAWA) permitting and municipal and regional land use planning. Updated data incorporating extensive new records and data improvements from this project will be provided to DELG March 31, 2014.

2) Increasing the amount and quality of data in the AC CDC database through refinement of approximately 6,000 existing species' occurrence records, and the addition of 232,437 New Brunswick species' occurrence records (16,774 of rare species).

3) Development of a series of GIS biodiversity tools for the use of DELG and DNR staff relative to EIAs, WAWA permitting and municipal and regional land use planning. The *Prefilter* and *RRP Parser* tools filter and weight AC CDC species occurrence records based on **R**arity & legal protection, **R**ecency and location **P**recision to identify those most relevant to evaluation of biodiversity hotspots. The *Parcel Evaluator* tool uses the above rare species data to identify land parcels (e.g., wetlands, PIDs, protected areas) in which there is a very high likelihood of rare or protected species occurrence, and it ranks these parcels by total RRP score.

The extensive AC CDC database updates and improvements completed under this project will serve conservation on an ongoing basis as they contribute to AC CDC responses to hundreds of data requests per year from environmental consultants, government biologists and land managers, natural resource companies, environmental NGOs, academics and others. The project's provision of AC CDC data to DELG increases the amount of rare species occurrence data available to DELG staff by more than 30 times, and the GIS biodiversity tools using this data will greatly enhance DELG and DNR staff ability to make recommendations that reduce or eliminate development-related impacts on rare species.

AC CDC hopes to see continued ETF support in coming years to allow the continued use of AC CDC data by DELG, and to further optimize GIS tool processes and output products.

2.0 AC CDC Biodiversity Database Enhancements and Additions

Addition of Records to the Database

This ETF project supported a massive addition of data to the AC CDC database, with the number of species occurrence records (a species documented in a specific geolocation) increasing by 232,437 during fiscal year 2013-2014. Of those new records, 16,774 were of provincially rare species, including 9,072 records were of federally or provincially listed Species at Risk. The largest portion of the new records came from Bird Studies Canada's 2006-2010 data from the second Maritimes Breeding Bird Atlas (194,703 records, 14,724 of which were rare). Most of the remaining new records came from AC CDC fieldwork and the AC CDC-led Maritimes Butterfly Atlas (37,238 records, 1,999 of which were rare).

3.0 Rare Biodiverstiy Geospatial Products

A suite of ArcGIS geospatial tools were developed to assist DELG and NB DNR in evaluating the significance of areas of interest to rare and protected species in New Brunswick:

The following sections outline the specific activities undertaken and the products generated as a result of the ETF funding.

- The *Prefilter tool* filters the AC CDC biodiversity database to contain records most relevant for the evaluation of rare biodiversity hotspots

- The *RRP parser tool* parses, categorizes and weights database attributes (i.e., **r**arity/level of protection, **r**ecency, and **p**recision) so they can be used in hotspot evaluations

- The *Parcel Biodiversity Evaluator* uses the RRP dataset to identify rare and/or protected species in parcels of interest (e.g., wetlands, PIDs, protected areas), and rank these parcels by RRP score

- The *Biodiversity Hotspot tool* uses various RRP ranking scenarios to generate continuous Hotspot models for New Brunswick which can be overlaid on parcels of interest

- The *Wetland Indicator Species Extractor tool* generates a parsed dataset comprising high-precision wetland indicator plant species records that can be used in the testing of wetland models, or as an input to the *Parcel Biodiversity Evaluator* and *Biodiversity Hotspot* tools

These tools were designed on the principle that:
  a) the conservation and management significance of each record is a function of the degree of rarity and level of protection associated with the species;

b) the conservation and management significance of each record is a function of the level of confidence that this species could be found at this location which is, in part, a function of the recency and locational precision of the record; and

c) the biodiversity significance of a given area, region or parcel of land, correlates with the distribution and density of records of high conservation value.

In all the above tools, tool parameter values can be set by the tool operators so that custom scenarios can be run. Tools have been designed to allow flexibility in the input datasets used:

- Any polygon dataset with features located in New Brunswick can be evaluated
- Initial prefiltering and parsing tools are designed on the AC CDC database 'All species' dataset schema so tools can quickly and easily accommodate updates of the AC CDC database

Software Requirements:
- Models have been developed and tested using *ArcGIS 10.2.1*
- The Rare Biodiversity Hotspot Evaluator requires raster tools that are part of the *Spatial Analyst* extension

3.1. ETF Prefilter

This tool filters data from the AC CDC "All species" database so that the most relevant subset of data can be used in the ETF geospatial tools. Filtering occurs on:

- Element Rarity (e.g., Subnational Rarity Ranks)
- Level of Federal and Provincial protection (e.g., SARA, COSEWIC and species listed by the New Brunswick Species at Risk Act)
- Record location precision (i.e., the estimated horizontal error in the location of a record)

Box 1. An example of a prefilter query to isolate relevant records for ETF tools:

((NPROT IN ('E', 'E,E,SC', 'SC', 'T')) OR (Nprotsar IN ('E','SC','T')) OR (SPROT IN ('Endangered', 'Reg.Endangered')) OR (SRANK LIKE 'S1%' OR SRANK LIKE 'S2%' OR SRANK LIKE 'S3%' OR SRANK LIKE 'SH%' OR SRANK LIKE 'SX%') OR (Sgsrank IN ('1 At Risk' , '2 May Be At Risk' , '2 May Be At Risk' , '3 Sensitive', '3 Senlitive', '0.1 Extirpated'))) AND (PREC >0 AND PREC <=5) AND (Subnat = 'NB')

3.2. ETF RRP Parser

The RRP Parser tool uses a series of ArcGIS geoprocesses to parse attributes from the AC CDC database, categorize them, and assign weights based on the level of importance of each variable as perceived by the user. These categorized and weighted values can then be used for ranking parcels as to their likely significance to rare and protected species.

- **Taxon Parsing**:
  - Higher Taxonomic group codes are extracted from Natures Serve alphanumeric taxonomic identifiers (i.e., ELCODE values)
    - i.e., 'A*' for vertebrates, 'I*' for invertebrates, 'V*' for vascular plants, and 'N*' for nonvascular plants

- **Recency Parsing:**
  - o year values are extracted from database date values (e.g., '2010 05 03', '198X XX XX', '19XX XX XX')
  - o record dates in the database vary in precision and recency precision is assigned as follows:
    - ▪ "year" – record data is precise to year (e.g., '2014')
    - ▪ "decade" - record data is precise to decade (e.g., '197X')
    - ▪ "century" - record data is precise to century (e.g,. 19XX)
  - o <u>Recency categories</u> are assigned using a combination of "year" value and recency precision ("yearPrec"; Table 1).
  - o <u>Recency weights</u> can be assigned by the user depending on perceived importance of each recency category (Table 1).

Table 1. Default recency categories and user-defined weights used in the RRP Parser tool

RECENCY category	Category Description	Pseudocode	User-defined Weight (where 1 = Max weight)
rec10	if (yearPrec in "year" and int(year[0:4]) >= 2000) or (yearPrec in "decade" and int(year[0:3]) >=200): return "rec10"	If the observation occurred in, or after, 2000	1
rec20	if (yearPrec in "year" and int(year[0:4]) >= 1990) or (yearPrec in "decade" and int(year[0:3]) >=199): return "rec20"	If the observation occurred in, or after, 1990	1
rec 30	if (yearPrec in "year" and int(year[0:4]) >= 1980) or (yearPrec in "decade" and int(year[0:3]) >=198): return "rec30"	If the observation occurred in, or after, 1980	0.7
rec 40	if (yearPrec in "year" and int(year[0:4]) >= 1970) or (yearPrec in "decade" and int(year[0:3]) >=197): return "rec40"	If the observation occurred in, or after, 1970	0.7
rec 50	if (yearPrec in "year" and int(year[0:4]) >= 1960) or (yearPrec in "decade" and int(year[0:3]) >=196): return "rec50"	If the observation occurred in, or after, 1960	0.3

- **Species Significance Parsing - rarity and level of protection**:
  - o <u>Species rare/protected categories</u> are set by the user based on rarity ranks and level of Federal and provincial protection (Table 2).
  - o <u>Species rare/protected weights</u> can be assigned by the user depending on perceived importance of various ranks (Table 2.)
  - o Binary fields are also generated to indicate whether a species is considered 'rare' or protected:
    - ▪ 'ISRARE':SRANK[0:2] in ("S1","S2","S3","SH","SX")
    - ▪ 'ISPROT': COSEWIC in ("E","E,E,SC","T","SC") or SARA in ("E","T","SC") or SPROT in ("Endangered","Reg.Endangered")

Table 2. Default rarity/protection categories and user-defined weights used in the RRP Parser tool

RARE/PROT Category	Category Description	User-defined Weight (where 1 = Max weight)
1	SARA in (Endangered, Threatened) OR SPROT in (Endangered, Regionally Endangered)	1
2	COSEWIC in (Endangered, Threatened, Special Concern)	0.9
3	SGSRank in (At Risk)	0.8
4	SGSRank in (May Be At Risk, Extirpated)	0.7
5	SGSRank in (Sensitive)	0.6
6	SRANK =< S3S4 AND SGSRank in (Secure)	0.5

- **Record Precision:**
  - Location uncertainty values are the estimated horizontal error in record location; these are continuous distance values ranging from 0 to several-thousand meters
  - The Prefilter tool (above) can be used to exclude records with excessively-high locational uncertainty values (i.e., low precision)
  - However, for records that are not filtered out by the prefilter, users can assign weights to values using distance bins (Table 3).

Table 3. Default precision categories and user-defined weights used in the RRP Parser tool

PRECISION Category	Category Description	User-defined Weight (where 1 = Max weight)
1	0 < Location uncertainty =< 150m	1
2	150m < Location uncertainty =< 300m	0.8
3	300m < Location uncertainty	0.6

- **RRP Scores:**
  - After attributes are parsed, categorized and weighted, RRP Scores for each record can be calculated using the following algorithm:

  Record RRP Score = $\text{Weight}_{rarity} * \text{Coefficient}_{rarity} + \text{Weight}_{recency} * \text{Coefficient}_{recency} + \text{Weight}_{precision} * \text{Coefficient}_{precision}$

Where:
- weights are assigned as previously described
- coefficents can be adjusted to differentially for Rarity, Receny and Precision in the RRP calculation
- by default coefficients are set to '0.333' so that each attribute is equally weighted and the maximum RRP Score is 1.0

Box 2. An example RRP Calculation for a Least Bittern Record using the default categories and weightings above:

Rarity/protection: SARA = 'Threatened' → rarity category = 1 → rarity weight = **1**
Observation year: 1963 → recency category = 'rec50'→ recency weight = **0.3**
Precision: 350 m → precision category = 2 → precision weight = **0.8**

Record RRP Score = Weight$_{rarity}$*Coefficient$_{rarity}$ + Weight$_{recency}$*Coefficient$_{recency}$ + Weight$_{precision}$*Coefficient$_{precision}$

Scenario 1: Record RRP Score = **1***0.333 + **0.3** *0.333 + **0.8***0.333 = **0.7**

Note: If the tool operator wished to assign higher value to rarity than recency or precision, the coefficients could be adjusted accordingly:

Scenario 2: Record RRP Score = **1***0.70 + **0.3** *0.15 + **0.8***0.15 = **0.87**
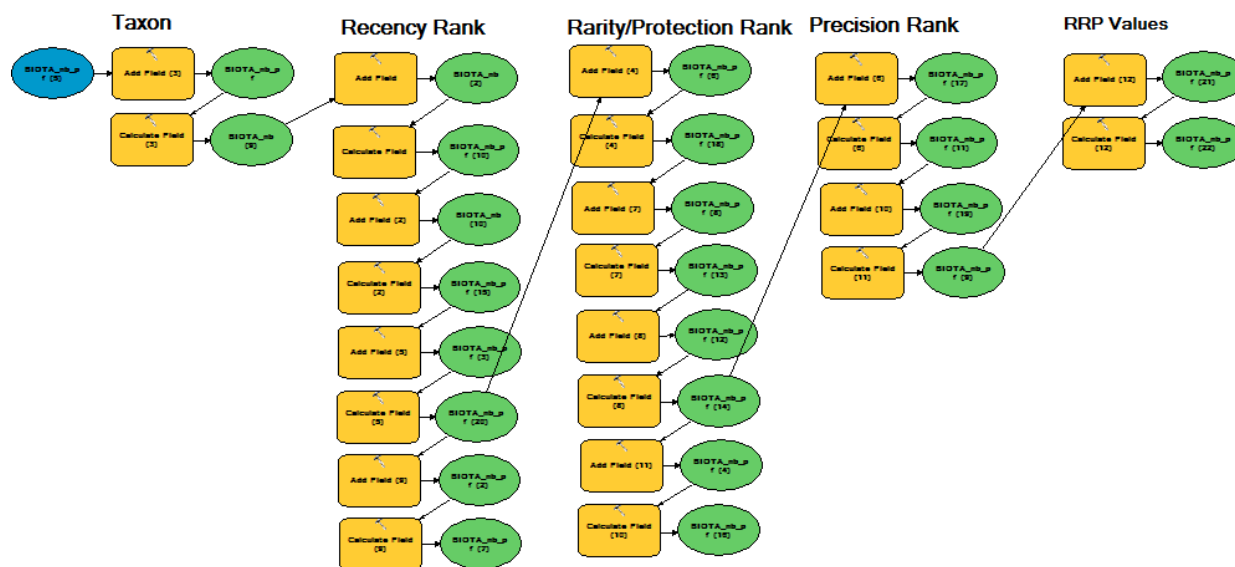

Figure 1. ArcGIS Model Builder model of the RRP ("Rare, Recent, Precise") Parser tool for parsing and weighting AC CDC record attributes for use in Biodiversity Hotspot evaluations.

3.3. ETF Rare Biodiversity Parcel Evaluator

The ***ETF Parcel Biodiversity Evaluator*** is a tool developed from a Python script that allows users to carry out a number of queries that assess the relationship between the RRP layer (produced by the RRP Parser tool) and any polygon layer of interest (e.g., PIDs, wetlands, protected areas, counties, watersheds). The user interface is illustrated in Figure 2. Examples of mapped query results are given in Figures 3 and 4.
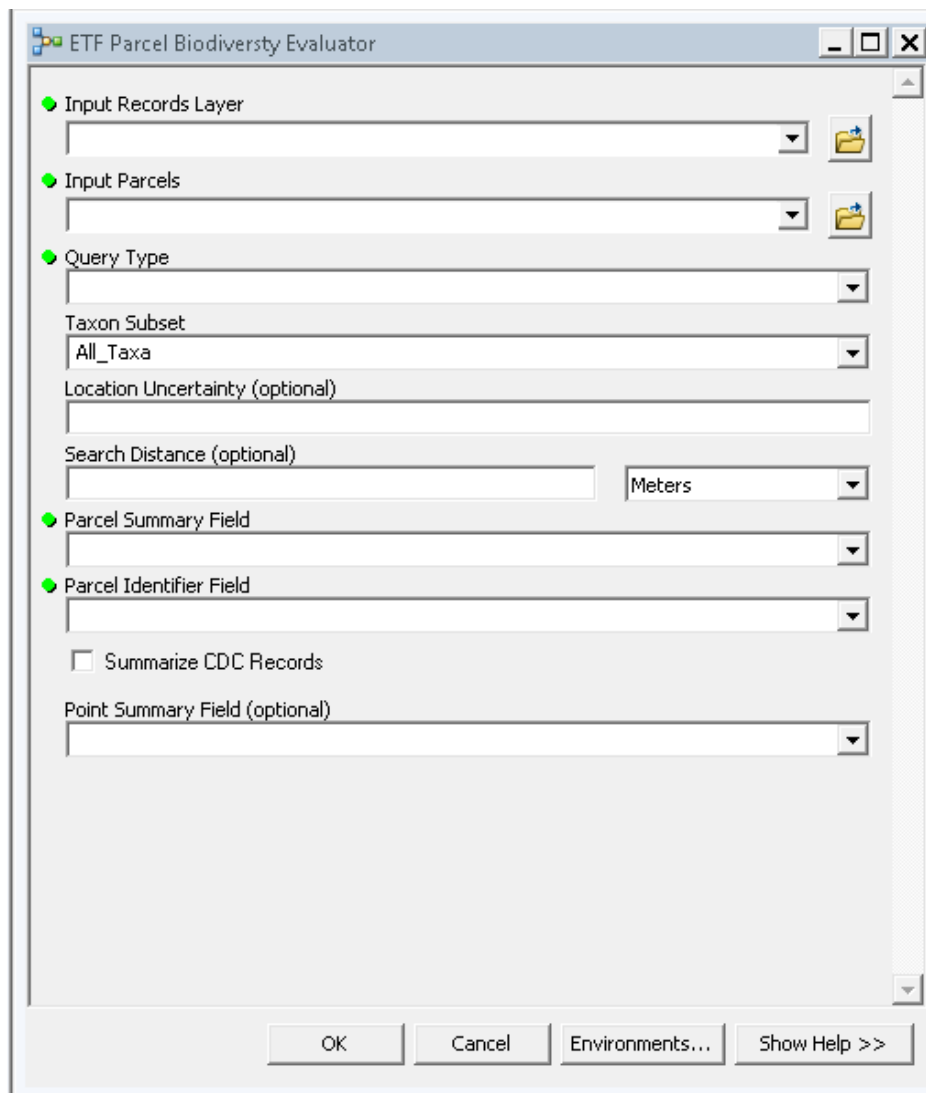
Figure 2. User interface of the *ETF Parcel Biodiversity Evaluator.*

Possible Query Types
- Find parcels containing Rare species
- Find parcels containing Protected species
- Find parcels containing Rare or Protected Species
- Find parcels containing Rare and Protected Species

User customization
- Select *parcel layer* used in the evaluation
    - E.g., wetlands, PIDs
- Select *subset of taxa* to report
    - Vertebrates, Invertebrates, Vascular Flora, Nonvascular flora, All Taxa
- Select a *search distance* for records outside parcel boundaries
    - e.g., search for, and include, points up to 500 m from the parcel boundary

Reporting Functions

A number of basic reporting functions are available:

- a count of the parcels and points satisfied by the query
  - e.g,. "13 Parcels satisfied the query; 81 points satisfied the query"
- exported feature classes of the points and parcels satisfied by the query
- a table indicating the frequency of returned polygons of each type is returned with the parcel area summed
- summaries of the returned point records by parcel (including mean and maximum RRP scores, number of rare and protected species)
- an exported RRP layer symbolized by mean RRP score

Possible questions that can be explored using this tool:

1. On which parcels have rare and/or protected species been observed?
2. What is the parcel count and total area of land on which rare and/or protected species have been found?
3. What are the rare and/or protected species that have been observed on each parcel?
4. How many rare and/or protected species have been found on each parcel?
5. What are the mean and maximum RRP rankings of each parcel (including only intersecting points, or including nearby points)
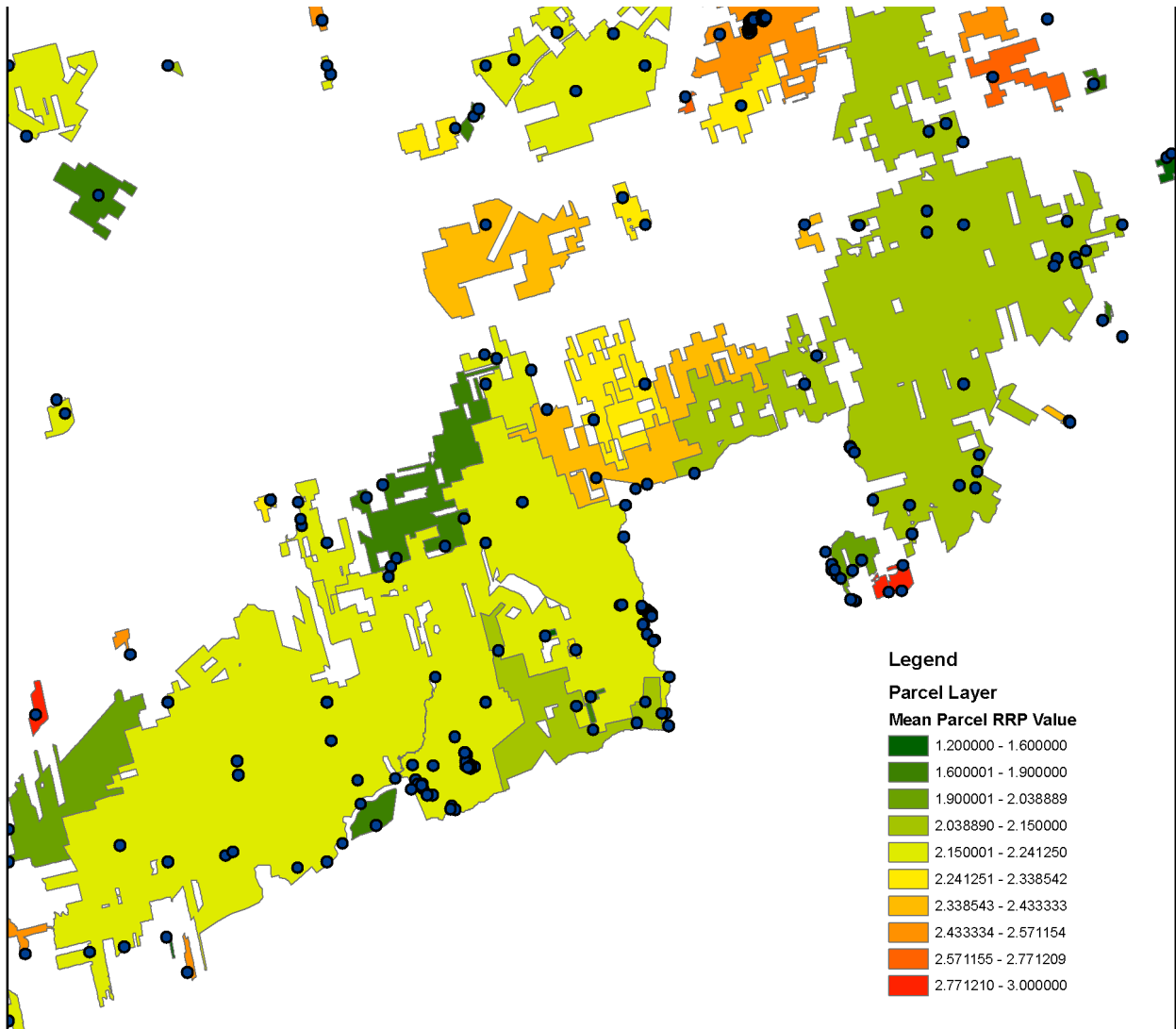
Figure 3. Mean biodiversity significance by property in southern Albert County, as mapped by the Rare Biodiversity Parcel Evaluator. Blue dots are rare species locations buffered by 150 m. Known biodiversity value is increasing as shading goes from green to yellow to red.

Figure 3. Total number of rare species by property in southern Albert County, as mapped by the Rare Biodiversity Parcel Evaluator. Blue dots are rare species locations buffered by 150 m. Known biodiversity value is increasing as shading goes from green to yellow to red.
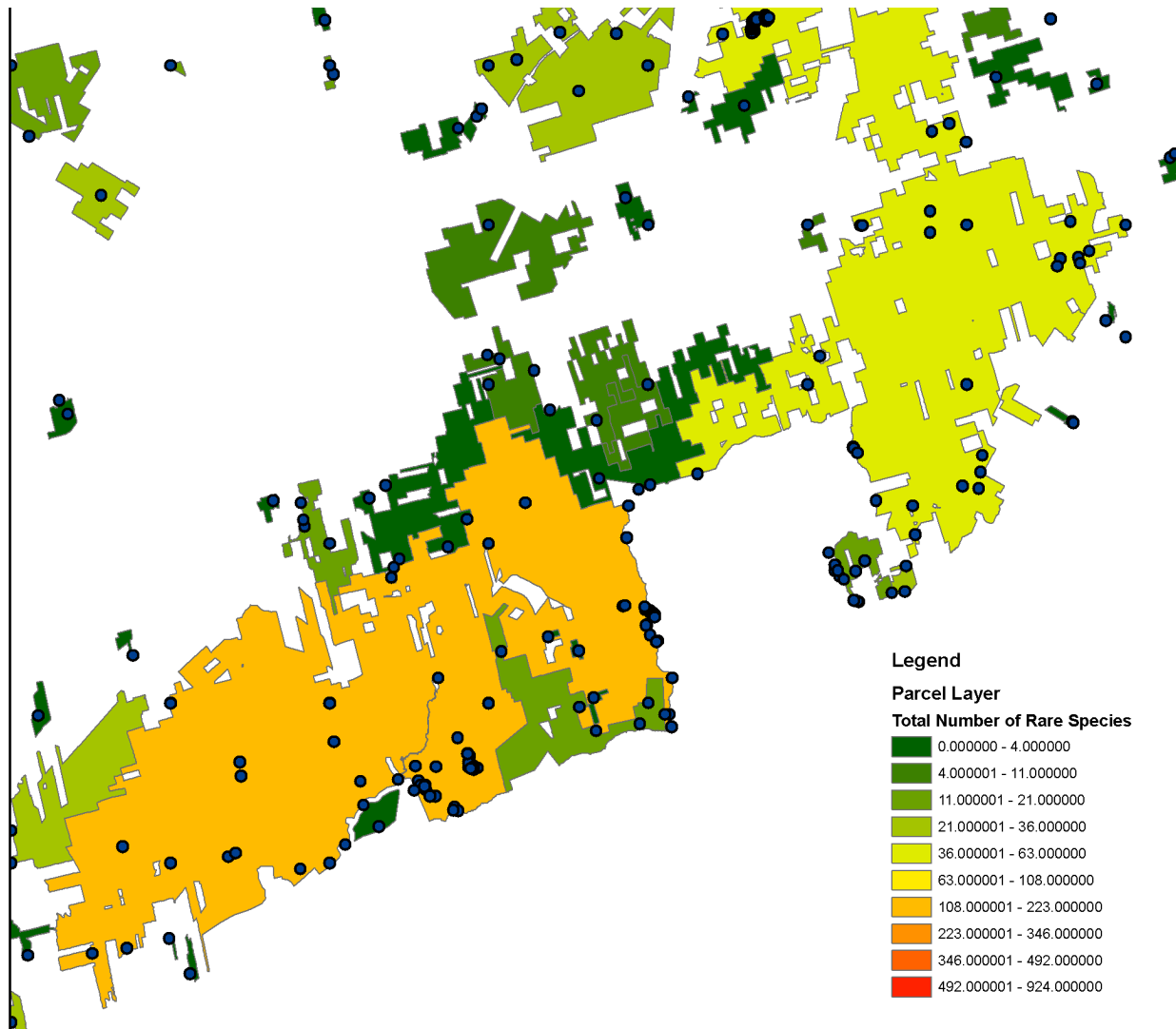
3.4. **ETF Rare Biodiversity Hotspot Evaluator**

The Rare Biodiversity 'Hotspot' Evaluator tool generates a continuous-surface raster model of rare and protected taxa occurrences within New Brunswick.

Using the foundational RRP layer points, and category and weighting values assigned by the RRP Parser, Hotspot surfaces:

- Are not tied to any specific polygon layers
- Can indicate the level of significance to rare and protected taxa on a continuous basis across the province
- Can be overlaid on parcel datasets to show locations of high concentrations of rare and/or protected fauna, independent of parcel boundaries.

3.5. **Evaluation of Deployed Tools**

Tools will be reviewed and evaluated by DELG and DNR. Bugs in operation, software constraints and requested improvements will be brought forth to the AC CDC team and ongoing updated releases will be provided.

3.6. **Future Development**

- Future improvements to ETF tools could include:
    - option for complex, customized user queries using ArcGIS SQL functions
    - option to evaluate specific species, species groups or subsets of parcels
        - currently this can only be achieved by first subsetting the RRP layer and the parcel layer before running the Parcel and Hotspot tools

4.0 Conclusions

This ETF project has made an important and lasting contribution to conservation in New Brunswick.

The 16,774 new rare species records added to the AC CDC database under the project will continue to inform the management of biodiversity in perpetuity through their use in responding to the hundreds of data requests AC CDC receives annually from environmental consultants, government biologists and land managers, natural resource companies, environmental NGOs, academics and others. As a partner organization, DNR automatically receives updated versions of our database, thus the project's new rare species records will contribute significantly to their biodiversity conservation efforts as well. The new records will also help inform species' status assessments at the provincial and federal levels through the foreseeable future.

The 58,353 New Brunswick rare species occurrence records that AC CDC has provided to DELG through this project represents 49 times more data than the 1,193 records in the 1995 Environmentally Significant Area database previously used by DELG to screen for biodiversity values. This new data and the biodiversity GIS tools derived from it will obviously greatly enhance the ability of DELG staff to determine which EIAs and WAWA permit applications may need further scrutiny by a Technical Review Committee, which will ultimately allow much improved mitigation of development-related impacts on rare species. The knowledge of rare species locations provided by AC CDC data is especially crucial for species protected under the NB Endangered Species Act, preventing DELG from inadvertently permitting developments that contravene the act. Other potential DELG uses of the newly available AC CDC rare species data include incorporation into the *Balanced Approach for Wetland Management* project within the *Long Term Wetland Strategy* currently under development, and the determination of areas where wetland restoration efforts could be directed.

As with all non-member organizations receiving data from AC CDC, the access to AC CDC data that DELG has received through this project lasts for one fiscal year (in this case, the 2014-2015

fiscal year). After that time, ongoing additions and improvements to the AC CDC database will have made the current data out of date and an update to DELG will be required. AC CDC hopes that DELG will continue to utilize the many advantages that having access to AC CDC data provides, either through membership with AC CDC or through additional support through the Environmental Trust Fund.