Scoring and Ranking TRCA's Vegetation Communities, Flora, and Fauna Species

A methodology for assessing degree of conservation concern for terrestrial communities, vascular plants and vertebrates

Environmental Monitoring and Data Management Section

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1. Background

Effective 1998, Toronto Region Conservation Authority (TRCA) adopted the process for designating *Species of Conservation Concern* for the region. At that time, regional distribution data was used to assign native flora and fauna to one of three rank categories: regional concern, urban concern, or not of concern, and biological inventory work began to spot map those species designated as of "conservation concern". Later, an objective scoring method was developed. Applied since 2001, it standardized the process for determining the ranks, provided explanatory detail to ranks, and allowed for updates to be carried out as additional, or more current, data became available. At the same time, a similar method was developed to score and rank vegetation communities.

Under the method, TRCA biologists score regionally native vascular plants, vertebrates, and vegetation communities on a set of ecological sensitivity, habitat requirement and abundance criteria. The criteria scores are totalled and the local rank (L-rank) of conservation concern is assigned/adjusted according to the range into which the total score (conservation concern score) falls. Coincident with the initiation of the scoring method, the number of ranks was increased from 3 to 5 to better reflect the greater level of detail contained in the scores. Species of regional concern were categorized with greater resolution into L1 to L3 ranks. Species of concern in the urban zone were designated L4 and species not of concern L5.

During the first application of the scoring method, there were a small number of species recording a change in status; in some cases a species of concern, when scored, then ranked, did not meet the threshold for that status; in others a species that had not been recognized as of concern, became so, when the added criteria were taken into consideration.

The method is designed to support proactive conservation planning and management, by helping us to establish priorities for conservation efforts, including decisions regarding land use planning, identifying sites for protection, and habitat restoration activities. It allows TRCA to recognize threatened communities and species of regional concern at an earlier stage than would be possible using rarity-based criteria alone. It also provides a better understanding of which characteristics of individual species/communities most affect their sensitivity or risk of being lost from the Terrestrial Natural Heritage (TNH) system in the region. The ranks indicate the degree to which various communities/species are in need of protection and the score detail informs the conservation actions needed in order to enhance the prospects for success.

Flora are scored using four criteria: *local occurrence*, *population trend*, *habitat dependence*, and *sensitivity to development* impacts. Fauna are scored on seven criteria: *local occurrence*, *local population trend*, *continental or range-wide population trend*, *habitat dependence*, *sensitivity to development*, *area sensitivity*, and *patch isolation sensitivity*. Vegetation communities are scored only on *local occurrence* and *habitat dependence* which reflects basic geophysical requirements.

The method also denotes native species/communities that are suspected to have been extirpated from the region with an LX designation, and non-native (introduced) species/communities with an L+. Species/communities in these groups are not scored.

Scores undergo periodic updates, currently on an annual basis, in order to ensure that the most current regional data and wider knowledge with respect to species requirements is reflected in scores and ranks. Examples of new information include changes in local occurrence determined through TRCA's biological inventory work, published research that expands knowledge of a species' requirements, or updates to continental or range level abundance or distribution data.

The following sections outline the detailed scoring protocols for terrestrial and wetland vegetation communities, vascular plants (flora) and vertebrates (fauna).

2. Vegetation Communities

2.1 Introduction

Vegetation communities are mapped during TRCA biological inventory work, with community classification following the Ecological Land Classification for Southern Ontario (Lee *et al.* 1998) Communities are classified to the level of vegetation type. A little over 400 vegetation community types have been identified as present currently and/or historically in the Toronto region.

Differing conditions of soil, hydrology, and topography favour different vegetation communities, with some communities more general in their requirements, while others are highly-specific and support specialist species of concern. Conversely, vegetation communities alter physical conditions. For example, conifer-dominated communities modify the soil conditions and microclimate, creating a favourable environment for flora preferring cool exposures and acidic soils.

The ranking of vegetation communities helps us to more fully understand the effects of human activity, many of which are most observable at this scale (e.g. invasive species domination).

2.2 Scoring and Ranking

Rarity and ecological requirements are both considered in the scoring and ranking, through the equal weighting of the following occurrence-based and sensitivity-based criteria:

1. *Local Occurrence* (combines 2 equally weighted criteria):
    i. Local Distribution
    ii. Area Score
2. *Habitat Dependence* (Geophysical Requirements)

2.2.1 Local Occurrence

Vegetation communities are intermediate in scale between landscape habitat patches and species population occurrences. The quantity of a vegetation community can be measured as the actual area covered by that community within regional boundaries. On the other hand, distribution across the jurisdiction is an important consideration. Hence, the Local Occurrence score is the average of the Area Score and Local Distribution Score. It ranges from 1 to 5 in increments of 0.5.

The most recent 15 years of Ecological Land Classification (ELC) inventory provides the data source. If a community has been historically present, but not recorded in the TRCA jurisdiction during the relevant 15 year period, the it is assumed to have a low coverage and distribution, so is scored at the maximum for local occurrence (5 points). Otherwise the following steps are taken.

Area Score

First the total area (in hectares) of each vegetation type recorded in the TRCA jurisdiction is tallied. For any parcel that has been inventoried more than once in the preceding 15 years, the most recent ELC assessment data is used. The area total for each vegetation type is then divided by the total ELC-surveyed terrestrial natural cover area in the TRCA jurisdiction (excluding agricultural, manicured, and open aquatic polygons). The resulting proportion covered by the community type is multiplied by 100 to provide **relative area %**. Relative area is updated annually to incorporate new field data. The Area Score determined on a logarithmic scale, according to Table 1.

Table 1. Derivation of Area Score for vegetation communities

Score	Relative area (%)
5	< 0.001
4	0.001 to < 0.01
3	≥ 0.01 to 0.1
2	> 0.1 to 1
1	> 1

Local Distribution

Distribution scores are determined with reference to 10x10 km Universal Transverse Mercator (UTM) squares. For consistency with fauna, the square grid applied is the one used for mammal, bird and herpetofaunal atlas projects in Ontario (Cadman *et al.* 1987, 2007). The Toronto region is

completely covered by a total of forty-four 10x10 km squares. The score for Local Distribution is assigned according to the number of squares in which a community is found.

The maximum score (5 points), is assigned to the rarest communities, based on square occurrence. Currently 48 vegetation communities are recorded in just 1 square. The minimum score (1 point) is assigned to the communities having the highest square occurrence. The current maximum distribution is 35 squares; 4 communities have this distribution.

The method to calibrate the scores for counts between the extremes takes advantage of the fact that the relationship between the log of the vegetation community count by square count, and the square counts is approximately linear (Figure 1, R^2=0.69).

The upper limit to the log value range was set at 1.8 in 2001, this maximum corresponding to a 5.0 score (1.8/0.36 = 5.0). Figure 1 displays the plot for cumulative 2001 to 2015 data. Log values during this time period have remained within the original set limits of 0 through 1.8.

With the maximum score of 5 set as the score for the maximum log value, and the minimum score of 1 set for the theoretical minimum log value of 0, calibration between these end points is accomplished by dividing the log-community count value for the affected community by 0.36, then rounding to the nearest whole number within the 1 to 5 range (i.e. values below 0.5 are rounded up to a score of 1).

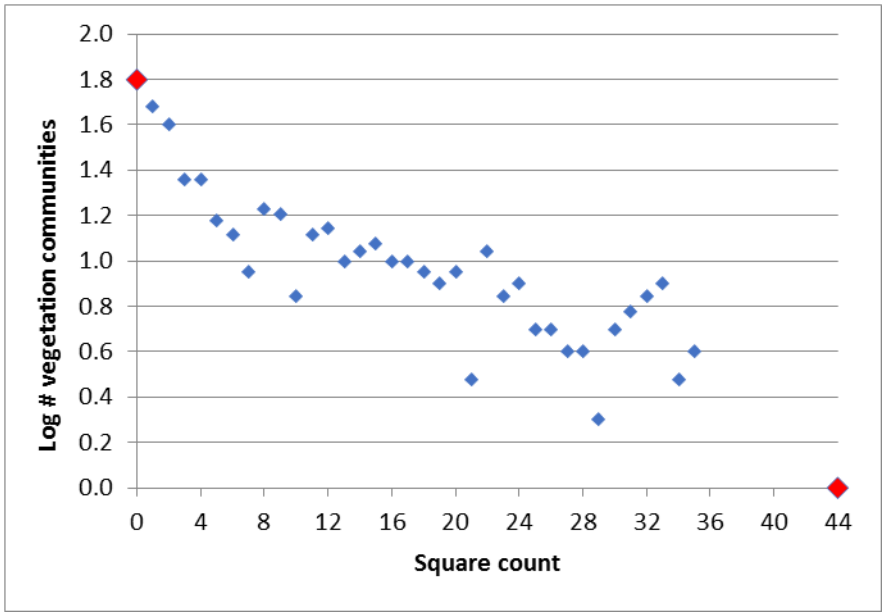

Figure 1. 2001-2015 vegetation communities (log of frequency) by # grid squares in TRCA (blue). Maximum and minimum values set for scoring calibration are shown in red.

Back-transformation of the log values results in Local Distribution scoring as shown in Table 2. It is not necessary to recalculate logs during the scoring process. Scores can be determined directly from the table.

Table 2. Assignment of Local Distribution score for vegetation communities

Score	Number of 10x10 km squares occupied
5	≤ 2
4	3 - 12
3	13 - 23
2	24 - 33
1	≥ 34

The result of the Local Distribution scoring process is shown in Figure 2, with half of all communities at the median score of 3, and a close to normal overall distribution.

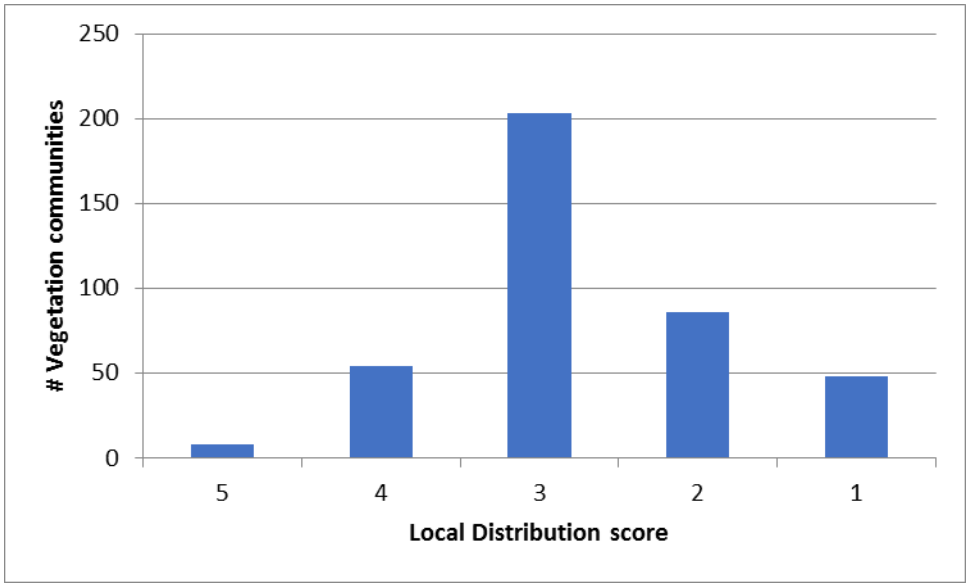

Figure 2. Frequency distribution of vegetation community Local Distribution scores. Data for 2001 -2015 are included.

2.2.2 Habitat Dependence (geophysical requirements)

Vegetation communities develop under geological, climatic, and hydrological regimes. Some occur under very specific conditions, while others are generalists, occurring on a wide range of soils, moisture regimes, etc. Specialist community types are likely to have been uncommon even in the natural ecosystem that existed prior to the growth of agricultural and urban land-use; they are also more likely to be altered dramatically by development impacts. The following highlights abiotic factors of importance regionally:

- *Aspect and Slope*. For example, is the community usually dependent on warm south-westerly or cool north-easterly exposures? Is it generally only found on tableland (upland outside of valleys)? Or can it occur on a wide variety of sites?

- *Hydrology*. Some communities require stringent hydrological conditions, such as wetland communities that need to have a particular moisture regime. Some forest types need a subtle combination of good drainage and the presence of groundwater. Changes in the level of ground water may impact them.

- *Soil Type*. Some communities usually require sandy soils, while others may require clay or organic soils. Generalist communities can be found on a variety of soil types.

- *pH*. Specialist communities such as bogs and fens need a certain pH regime.

- *Fertility or Nutrient status*. Some communities require a high level of fertility while others require a low level of available nutrients. In general, specialist native vegetation communities depend upon relatively low-fertility conditions.

- *Dynamics*. Communities such as bluffs, beaches, and dunes, are dynamic and depend upon ***natural*** erosion processes. Other communities depend upon periodic ground fire. Non-natural disturbances such as trampling in heavily-used recreation areas or storm runoff-caused gully erosion are not considered geophysical requirements; they are accounted for under sensitivity to development for affected species.

The Geophysical Requirements score assigns one point for each of the above factors that is of importance to the scored community, to a maximum of 5 points. If the factor is not relevant, it is left blank in the data form (refer to Section 5.0 and Appendix A). If a factor is minor or there is uncertainty with respect to its importance, a "0" is entered. This identifies the factor as having the potential to contribute to the score at a later update should new information indicate that it is appropriate to do so.

The Geophysical Requirements score ranges from 0 to 5, according to the number of requirements counted, as outlined in Table 3.

Table 3. Scores assigned by number of geophysical requirements for vegetation communities

Score	Number of geophysical requirements
5	5 - 6
4	4
3	3
2	2
1	1
0	0

The Vegetation Community Total Score is the sum of the Local Occurrence and Geophysical Requirements scores. It ranges from 1 – 10, with increments of 0.5.

2.3 Assignment of Rank

Local ranks (L-ranks) are assigned according to Table 4. Note that communities dominated by exotic species are not scored, and are assigned a rank of L+; plantations dominated by native species (but not naturally arising in response to environmental conditions and dispersal) are assigned a rank of L5.

Table 4. Assignment of local ranks (L-ranks) for vegetation communities

Total of Scores	L-rank	Level of conservation concern in Toronto region
1 – 2.5	L5	Generally secure; not of conservation concern unless it contains sensitive species or other features such as old growth; contributes to natural cover
3 – 4.5	L4	Generally secure in rural matrix; of conservation concern in the urban matrix
5 – 6	L3	Of regional concern; restricted in occurrence and/or requires specific site conditions; generally occurs in natural rather than cultural areas
6.5 – 8	L2	Of regional concern; typically occurs in less-disturbed natural areas and under highly specific site conditions; at risk of decline/disappearance from the region
8.5 – 10	L1	Of high level of concern in TRCA jurisdiction due to rarity, stringent habitat needs, and/or threat to habitat
n/a	L+	Community defined by alien species (e.g. Scots pine plantation, buckthorn thicket). Contributes to natural cover
n/a	n/a	Community designation too broad or vague to score (not a currently recognized Vegetation Type)

3.0 Flora Species

3.1 Introduction

For the purposes of this protocol, the term "flora" refers to vascular plants. Flora of conservation concern are point-mapped during TRCA biological inventory work and flora not of concern are listed for each site inventoried. Over 1850 vascular plants have been identified for the Toronto region.

3.2 Scoring and Ranking

The following criteria synthesize abundance-based and sensitivity-based considerations for flora; the total of the scores for the criteria is then used to assign an L-rank:

1. Local Occurrence
2. Population Trend

3. Habitat Dependence
4. Sensitivity to Development

3.2.1 Local Occurrence

Scores are assigned according to the count of 10x10 km UTM grid squares in which a species occurs (Table 5). If a species has not been recorded in the TRCA jurisdiction during the past 15 years, it is scored at the maximum of 5 points and is considered a candidate for extirpated L rank status (LX). Assignment of extirpated status to a historically present species requires strong evidence, however, such as having not been seen for many decades, the known destruction of its site, or where a diligent search of the only known historic location(s) comes up negative. Several flora species thought to have been extirpated from the Toronto region have been rediscovered after a century.

Table 5. Scoring Local Occurrence for flora species

Score	Number of 10x10 km squares occupied
5	0* – 2
4	3 – 6
3	7 – 15
2	16 – 27
1	28 – 44

*** A "0" square count is entered into the data form where there is no TRCA GIS database record, but a verified unmapped site record from an external source is known, or if all records are >15 years old (may or may not be extirpated).**

3.2.2 Population Trend

The Population Trend score is based on local information. It is estimated from TRCA data and natural history records. For this estimate, data is not limited to the previous 15 years. Rather the best available data is considered.

Population Trend for trees includes not only observable decline of existing populations but also consideration of recruitment success and its implications for long-term population trajectory. It is worth noting that it is possible for a native species to be increasing in population due to a tolerance of urban conditions not well-tolerated by competing species, e.g. the relatively rare red cedar (*Juniperus virginiana*), which is colonizing highway verges due to its tolerance of drought, salt, and compacted soils.

Table 6 outlines the Population Trend scores and their interpretations.

Table 6. Scoring for flora Population Trend

Score	Population Trend
1	Increasing
2	Apparently stable
3	Mild decline; 10-20% reduction in sites and/or populations; slightly reduced reproduction in the case of trees; or unknown (to be conservative the protocol assumes slight decline due to urbanization).
4	Moderate decline; 20-50% reduction in sites and/or populations; markedly reduced reproduction.
5	Severe decline; at least 50% reduction in sites and/or populations; little or no reproduction.

3.2.3 Habitat Dependence

The calculation of Habitat Dependence is done in two parts: first, the number of vegetation cohorts in which a species typically occurs (i.e. typical habitats) is determined and second, the specific dependency associations or germination requirements are reviewed and scored.

Vegetation cohorts (Table 7) were derived from the Ecological Land Classification (ELC) ecosite level (Lee *et al*. 1998). In some cases, similar ecosites or even higher ELC levels are amalgamated into one vegetation cohort. For example, sand dunes, classified under ELC as one community class comprising three ecosites, are treated as a single vegetation cohort, due to sufficiently similar characteristics for the purpose of scoring.

Table 7: List of vegetation cohorts for flora Habitat Dependence scoring

Vegetation cohort
01. pine forest (FOC1,FOM2,FOM5)
02. dry cedar forest (FOC2, FOM4)
03. dry hemlock mixed forest (FOM3)
04. moist hemlock forest (FOC3)
05. moist hemlock mixed forest (FOM6)
06. moist cedar & other conifer forest (FOC4,FOM7,FOM8,FOMA)
07. dry oak forest (FOD1,FOD2)
08. dry miscellaneous deciduous forest (FOD4-X, native canopy)

09. dry sugar maple forest (FOD5)
10. moist sugar maple forest (FOD6)
11. moist oak forest (FOD9)
12. lowland deciduous forest (FOD7-X, native canopy)
13. dry poplar-birch forest (FOD3, FOD4-J)
14. moist poplar-birch forest (FOD8)
15. exotic deciduous forest (FOD4-x,FOD7-x, exotic canopy)
16. deciduous & mixed plantation (CUP1,CUP2)
17. conifer plantation (CUP3)
18. hedgerow (CUH1)
19. hawthorn savannah & woodland (CUS1-1,CUW1-D)
20. cedar savannah & woodland (CUS1-2A,CUW1-1,CUW1-A1)
21. pine savannah & woodland (CUS1-A2,CUW1-A2)
22. deciduous savannah & woodland (CUS1-A1,CUS2-A,CUW1-A3,CUW2-A)
23. deciduous thicket (CUT1-1,CUT1-2,CUT1-3,CUT1-4,CUT1-5,CUT1-6,CUT1-A1,CUT1-D,CUT1-E,CUT1-F, CUT1-G)
24. mixed thicket (CUT1-A2)
25. conifer thicket (CUT1-A3)
26. exotic successional (CUT1-b,CUT1-c,CUS1-b,CUW1-b)
27. mineral conifer & mixed swamp (SWC1,SWC2,SWM1,SWM2,SWM3,SWMA)
28. organic conifer & mixed swamp (SWC3,SWC4,SWCA,SWM4,SWM5,SWM6)
29. mineral deciduous swamp (SWD1,SWD2,SWD3,SWD4)
30. organic deciduous swamp (SWD5,SWD6,SWD7)
31. mineral thicket swamp (SWT2)
32. organic thicket swamp (SWT3)
33. fen (FEO1,FES1,FET1)
34. mineral fen (MAM5,MAM2-7)
35. coastal meadow marsh (MAM4,MAM6)
36. kettle bog (BOS2,BOT2)
37. mineral meadow marsh (MAM2)
38. organic meadow marsh (MAM3)
39. mineral shallow marsh (MAS2)
40. organic shallow marsh (MAS3)
41. floating-leaved shallow aquatic (SAF1)
42. submerged & mixed shallow aquatic (SAS1,SAM1)
44. beach (BBO1,BBO1-1,BBO2-A,BBS1-2A,BBS1-A,BBT1-A)
45. dune (SDO1,SDS1,SDT1)
46. riparian bar (BBO1-3,BBO1-A,BBO2-B,BBS1-2B,BBT1-B)
47. bluff & clay barren (BLO1,BLS1,BLT1,CBO1,CBS1,CLS1,CLT1)
48. sand barren (SBO1,SBO2,SBS1,SBT1)
49. oak non-tallgrass savannah & woodland (CUS1-3,CUS1-3A,CUS1-3B, CUW1-2,CUW1-C)

50. tallgrass savannah & woodland (TPS1,TPW1,TPW2-A)
51. tallgrass prairie (TPO1,TPO2)
52. meadow (CUM1)

Inclusions and complexes (Lee *et al.* 1998) are considered. For example, a species inhabiting sand barrens may often occur in sandy inclusions in a meadow. Meadow is not considered to be typical habitat in this case, and the meadow cohort is not counted for scoring purposes. The habitat dependence scoring process then follows three steps:

i. Count the number of typical habitats for the species using the cohorts list in Table 7 and apply the score from Table 8.

Table 8. Scoring for the number of typical habitats (vegetation cohorts) for flora species

Score	# Typical habitats
0	12+
1	10 – 11
2	8 – 9
3	6 – 7
4	3 – 5
5	≤ 2

ii. If the species receives the maximum score of 5, the scoring process is complete.
iii. If the score is less than 5, and the plant has a dependent association with another species (e.g. parasitism) that extends beyond the time of germination, add 2 points, up to the maximum. If there is a special condition (dependent association or ephemeral substrate condition) that only applies at the time of germination add one point, up to the maximum.

3.2.4 Sensitivity to Development

The proximity of urban development, or to a lesser degree, agriculture, brings with it indirect effects on native plants. Such effects may be positive, negative, or neutral with respect to individual species. The scoring method focusses on negative and positive impacts of importance to the persistence of species in the region.

Eight negative impacts are identified, six of which are selective on individual species and two that are more selective at the level of changes to habitat.

Impacts on individual species

1. *Removal* / *Collection* / *weeding*. Some plants are frequently dug or harvested for ornamental, food, or medicinal use. Others are removed because they are considered undesirable.

2. *Airborne contaminants*. Contaminants include nitrate enrichment from car exhaust, sulphur dioxide, particulates, ozone, etc. Some widely-dispersed contaminants can actually affect the whole region (ozone), while others are definitely more local (particulates). Pollutants from car exhaust affect all of southern Ontario but can be expected to be even higher next to major roads.

3. *Surface-borne contaminants*. Some pollutants can be directly dumped onto the soil or carried to the site by water, e.g. road salt, nutrient- and silt-laden runoff, oils & grease from roads, heavy metals, and alkaline detritus from building materials.

4. *Herbivory*. In developed areas, opportunistic herbivores (e.g. squirrels, deer, Canada geese) can increase in numbers to the point where they affect plant populations.

5. *Invasive species.* A species may be particularly prone to being out-competed by an invasive exotic species that occupies similar habitat but is more aggressive.

6. *Trampling and trail formation*. This leads to soil compaction, removal of ground flora and leaf litter. Sensitive species often have the following characteristics: they produce only one set of leaves per growing season; they have delicate rather than tough, fibrous stems and leaves; and they have delicate root systems that do not tolerate exposure or compaction.

Impacts affecting community on which species depend

7. *Hydrological changes*. Development often brings changes to the hydrological regime such as flooding, drainage or subtle decreases in groundwater and increases in evaporation.

8. *Dynamic Process* / *suppression of natural disturbance*. Land management may suppress the forces that support a species, such as fire suppression which affects prairie and savannah; and erosion control that affects bluff and coastal dune or beach communities. Production-oriented forestry practices which involve the removal or alteration of habitat structure (e.g. snags, logs, unproductive trees) are also considered under this criterion.

Some plants benefit from development-related disturbance. Two such benefits are also included in the scoring:

9. *Fertility*. The species benefits from increased nutrient loading as happens with fertilizer, agricultural or lawn runoff, storm water, or sedimentation.

10. *Soil disturbance*. The species benefits from soil disturbance such as ploughing, excavation, and dumping of fill.

The score ranges from 0 to 5 with a score of 2 being assigned for neutral or uncertain impact. Each species starts with a neutral score of 2. For each development-related negative impact, one point is added, while for each development-related benefit, a point is subtracted. The scores and their interpretations are shown in Table 9.

Table 9. Interpretation of the flora Sensitivity to Development score

Sum of Impacts	Score	Sensitivity to Development
-2	0	Species benefits significantly from development-related disturbance.
-1	1	Species benefits slightly from development-related disturbance
0	2	Negative impacts of development more-or-less offset by benefits, or unknown.
1	3	Significant negative impact from development.
2	4	Moderately severe negative impact from development.
3+	5	Severe negative impact from development.

3.3 Assignment of Local Rank

Local conservation ranks are assigned according to the sum of the criteria scores, which can range from 2 - 20 (Table 10). Also shown in this table are the designations and interpretations for extirpated species, hybrids and species for which native/exotic status is uncertain.

Table 10. Assignment of L-rank to flora species

Total of scores	L Rank	Level of Conservation Concern in Toronto region
2 – 10	L5	Able to withstand high levels of disturbance; generally secure throughout the jurisdiction, including the urban matrix. May be of very localized concern in highly degraded areas.
11 – 13	L4	Able to withstand some disturbance; generally secure in rural matrix; of concern in urban matrix.
14 – 16	L3	Able to withstand minor disturbance; generally secure in natural matrix; considered to be of regional concern.
17 – 18	L2	Unable to withstand disturbance; some criteria are very limiting factors; generally occur in high-quality natural areas, in natural matrix; probably rare in the TRCA jurisdiction; of concern regionally.
19 – 20	L1	Unable to withstand disturbance; many criteria are limiting factors; generally occur in high-quality natural areas in natural matrix; almost certainly rare in the TRCA jurisdiction; of concern regionally.
Not linked to rank but generally high	LX	Extirpated from our region with remote chance of rediscovery. Presumably highly sensitive.
Not scored until assessed	LH	Hybrid between two native species; not scored; a hybrid that is highly stable and behaves like a species (e.g. *Equisetum x nelsonii*) is not given this designation, but is scored and ranked.
Not scored	L+	Exotic; not native to the TRCA jurisdiction; includes hybrids between a native species and an exotic
Not scored	L+?	Origin uncertain or disputed, i.e. may or may not be native.

4.0 Fauna Species

4.1 Introduction

For the purposes of this protocol, "fauna" refers to vertebrate species that breed within the TRCA jurisdiction, whether migrants or year-round residents. The current count of regional fauna species includes 164 birds, 25 herpetiles, and 34 mammals.

4.2 Scoring and Ranking

Seven criteria were selected to set conservation priorities for terrestrial fauna in the TRCA region; the rationale and scoring method is outlined for each. The criteria were selected that would assist TRCA in identifying the species and species associations indicative of ecosystem quality, and those most sensitive to deterioration of the ecosystem in an urbanizing region. The selected criteria inform the conservation goal, i.e. to ensure the persistence/population viability of species known to be indigenous to this region through the protection and/or restoration of habitats. For consistency and ease of use, five points is the maximum score under each criterion, and all criteria are considered to be of equal weight.

The scores across criteria are totalled, and the range into which the total score (conservation concern score) falls is used to separate native fauna into L1 to L5 ranks. Exotic (introduced) species are not scored and are simply ranked L+, while extirpated species are denoted LX.

An additional point is accrued when the maximum 5 points has been scored in any one of the 4 ecology-based criteria. This "bonus point" strategy is designed to ensure that highly sensitive species which are still relatively abundant are properly flagged as facing threats associated with further development. Thus the theoretical maximum score is 39 points (5 points for each of the 7 criteria, plus a "bonus" point for each of the 4 ecology-based criteria).

The scoring system incorporates a precautionary principle: where there is a strong degree of uncertainty due to lack of information, a score of 2 points is recorded (except for the Local Occurrence criterion where either one or five points are recorded, see Section *3.2.1*.). Species are considered research priorities if there is a profound lack of data, or they score much lower than would be expected on the basis of staff field experience.

4.2.1 Local Occurrence

Local occurrence is scored for all fauna species for which records exist for the preceding 10 years. (Fauna species – given their mobility – tend to respond more rapidly than flora species to changes in the ecosystem.) If a species has been recorded in one grid square in that time period or has not been recorded in the TRCA jurisdiction for more than 10 years it is assigned the maximum local occurrence score of 5 points and is considered a potential candidate for extirpated status (LX).

For regionally extant species, an indication of the number of 10 km x 10 km squares in which a species is represented is the most complete occurrence information currently available for the entire region.

Using the Universal Transverse Mercator (UTM) grid system, the TRCA region covers all or part of forty-four 10 km squares. These are the squares used by the mammal, bird and herpetofaunal

atlases in Ontario (Cadman *et al.* 1987, 2007). The square grid is the same as is applied for flora and vegetation communities under this protocol.

Local occurrence is scored on the total number of squares that each species has been found in over the previous decade (Table 11). For birds only, occurrence in a square requires possible, probable or confirmed breeding records, and does not consider records of migrants that are simply passing through the region.

Table 11. Scoring Local Occurrence for fauna species

Score	# 10x10 km squares
5	0 - 1
4	2 - 5
3	6 - 10
2	11 - 15
1	16 - 20
0	>20

Where data is lacking for a species not known to be rare, local occurrence is conservatively scored at 1 point (i.e. corresponding to approximately half of the total 10 km squares). If a species is known to be rare, and data is lacking, it is scored at the maximum, 5 points. A higher level of concern provides additional impetus to fill the data gap in a situation such as this.

Formalized biological inventories and surveys have been conducted across the region for the majority of bird and all of the native frog species (all taxa that indicate presence by audible, habitual vocalizations) annually for the past 15 years. Hence, data deficiency most often occurs for mammals (particularly bats) and non-vocal herpetofauna (salamanders, newts, turtles and snakes).

4.2.2 Population Trend

Two criteria are considered here: long-term local and long-term continental (or North American species range) population trend, each scoring between 0 and 5 points.

Continental Population Trend

For all species other than birds, the scoring method considers "long-term" to be greater than 15 years, but less than 30 years.

For birds, continent-wide trend analyses covering the period from 1966 to the present are now available from the United States Geological Survey (USGS) Breeding Bird Survey (BBS) for every species within the TRCA jurisdiction (http://www.mbr-pwrc.usgs.gov/bbs/). The source recommends the application of a series of credibility measures when using this data. The BBS trend data are provided in three categories. The "Red" category reflects data with important deficiencies (e.g. very low abundance); the "Yellow" category reflects data with some deficiencies (e.g. small sample size); and the "Blue" category reflects data of the highest quality within this data set.

Under the TRCA method, with reference to Table 12, species with "Red" trend data are conservatively assigned 2 points for long-term trend. Species with "Blue" trend data are scored on the trend data. Species provided with "Yellow" trend data are adjusted by 1 point towards the median of the scoring range to reflect the degree of uncertainty. For example, a species in the "Yellow" category showing a decreasing trend in the -1 to -5% range is adjusted from 4 points to 3 points; the score for a "Yellow" category species showing an increasing trend of >5% is modified from 0 points to 1 point.

Changes in the direction of trend over time are taken into account. As an example, the double-crested cormorant *(Phalacrocorax auritus*) experienced a dramatic decline for multiple decades, followed by a steady increase for more than a decade. In recent scoring this was considered a long term increase.

Table 12. List of criteria for scoring Continent-wide Population Trend for fauna

Score	Continental/range-wide Population Trend
0	Increase of >5% per year
1	Increase of 0.1% to 5% per year
2	Status unknown (u), or population stable
3	Small decrease of 0.1% to 1% per year
4	Decrease of 1% to 5% per year
5	Decrease of >5% per year

More information on population trends is available for birds than for any other group of vertebrates. Due to data deficiency, most mammals and herpetofauna score 2 points for uncertainty as a precaution.

Local Population Trend

Until 2013, scores for Local Population Trend for all fauna were based on TRCA data, TRCA staff consensus and technical reviewers, following Table 12. By 2013, sufficient fauna data had been collected throughout the region for a sufficiently long period that a more rigorous approach to scoring local trend was possible.

The Local Population Trend is now calculated by comparing the current 10 year period's grid square count for each species with the count for the initial 10 year period (2001-2010). It is anticipated that by comparing 10 year periods, the year-to-year variability in regional inventory coverage will not unduly affect the assessment. The difference between the initial and current grid square counts for a species are converted into a Local Population Trend score using Table 13.

Table 13. Scoring Local Population Trend for fauna

Local Population Trend score	Change in regional grid square count
0	Large increase of >15 regional grid squares
1	Increase of 4 to 14 regional grid squares
2	Status unknown (u), or population stable (change falls between -3 to +3 grid squares)
3	Decrease 4 to 8 regional grid squares
4	Decrease of 9 to 14 regional grid squares
5	Large decrease of > -15 grid squares

4.2.3 Habitat Dependence

This criterion considers the degree to which a species can be classified as a specialist in its ecological requirements. Specialists are likely to have more difficulty adapting to human induced changes in the environment than are generalist species that freely make use of a variety of habitats and food sources. Some species require more than one specific habitat, or are dependent upon very specific conditions within one or more habitat type. These species are the most vulnerable to environmental change because there are more conditions attached to their continued survival.

The scoring protocol is adapted from the method proposed by Heagy (1997) for identifying land-bird conservation priorities. It scores habitat requirements of species based on a list of habitat types (Table 14).

The habitat classification system for the scoring protocol within the Habitat Dependence criteria category is as follows:

Table 14. List of habitat types used in calculation of Habitat Dependence for fauna

Deep open water (lacustrine)
Shallow open water (lacustrine)
Open water (riverine)
Marsh/Meadow marsh
Thicket swamp
Deciduous swamp
Mixed swamp
Coniferous swamp
Fen/Bog/Peatland
Beach/Bar/Sand dune
Clay mudflat
Bluff
Tallgrass prairie, Savannah
Deciduous forest
Mixed forest
Coniferous forest
Cultural forest (early successional species)
Cultural plantation (largely conifer)
Cultural open forest (25 to 50% trees: regenerating trees, grazed forests, cutover forest)
Cultural thicket (>50% shrub)
Cultural open thicket (25 to 50% shrub)
Cultural grassland (graminoid-dominated)
Cultural forb meadow (herb-dominated)
Agricultural pasture
Agricultural cropland
Urban/Suburban land (lawns, backyards, rooftops, formal parks)

The more specific habitat requirements of a species are then considered; these additional requirements fall into two categories: (1) additional habitat factors (Table 15), and (2) special nest site microhabitat needs. For non-avian species, "nest site" also considers any special requirements related to parental care of dependent young.

Table 15. List of additional habitat factors used in calculation of Habitat Dependence score for fauna

Specialized Vegetation Association, e.g. yellow birch/hemlock association or a stand of one tree species.
Vegetation Structure, e.g. mature forest, secondary forest, understorey, tall grass, dense thickets, decaying stumps or logs.
Spatial Landscape Requirements, e.g. edge, interior, near water, near open land, close knit habitat matrix, etc.
Physical Characteristics, e.g. valley bottoms, cliffs, etc.
Moisture or Substrate Conditions, e.g. mesic, dry, humid, or arid ambient climate, sandy soil versus loam, etc.

Nest Site Microhabitat Needs

This includes existing cavity, existing hawk or crow nest (some owl species), bank, hollow tree/chimney, cliff/building, decaying log, intact leaf litter, aquatic vegetation, need for isolation, nursery location (bats), etc.

Some species must have a particular association of several specific habitats such as mature forest and wetland; for example, amphibians which utilize discrete but specific aquatic and terrestrial habitat types will typically not score a point from the habitat type list since the overall number of habitat types will exceed three types. However, this is compensated by scoring via the point accrued for an additional habitat factor under Table 15, "Spatial Landscape Requirements … requires close-knit habitat matrix".

Consideration of all of the foregoing provides the information to assign a Habitat Dependence score according to Table 16.

Table 16. Allocation of points in scoring of Habitat Dependence for fauna

Score	Habitat Dependence
1	Species typically found in no more than three of the listed habitat types
Up to 3 additional points	Score 1 additional point for each Additional Habitat Factor (Table 15), where applicable
1	Species has specialized nest site requirements

4.2.4 Area Sensitivity

Area Sensitivity is an important consideration, since species requiring a large area of habitat are most threatened since habitat area and habitat connectivity decline with growing development. Species requirements exist along a continuum and do not fit into neat "area sensitive" and "not area sensitive" categories, and the scoring method reflects this.

Conceptually, Area Sensitivity may overlap with other criteria such as Habitat Dependence and dispersal capacity (mobility). Since Habitat Dependence and Patch Isolation Sensitivity are scoring criteria, the scoring method limits the Area Sensitivity criterion to consider the area of one or more specific habitats that are required to maintain the needs of a breeding pair, or breeding colony (in the case of a colonial breeder). For species that must move between specific habitats, the area between them is not included; this is taken into account under the Patch Isolation Sensitivity criterion.

In addition to size requirements for blocks of habitat, the typical length of linear requirements for species foraging in riparian habitats are considered.

Under the protocol, species that require two separated habitats, e.g. a wetland and terrestrial habitat, at different points in the life cycle, score for both habitats. A forest salamander that breeds in forest vernal pools within the forest patch would score only for the size of forest required, while a frog that migrates from a forest to a marsh to breed would score for the combined area of both habitats.

Birds which are known to forage over wide areas but nest as pairs or colonies are scored based on the size of breeding habitat required.

Area Sensitivity Scoring

The protocol scores points for the minimum requirement of the species according to the range of habitat size categories in Table 17.

Table 17. Assignment of Area Sensitivity scores for fauna

Score	Area Sensitivity
5	> 100+ ha in area or 30+ km in length (riparian habitat)
4	20+ ha in area or 20+ km in length (riparian habitat)
3	5+ ha in area or 10+ km in length (riparian habitat)
2	1+ ha in area or 1+ km in length (riparian habitat); or area requirement unknown
1	< 1 ha in area or < 1 km in length, or species not area sensitive

4.2.5 Patch Isolation Sensitivity

Patch Isolation Sensitivity for fauna considers the overall response of fauna species to fragmentation and isolation of habitat patches. Patch isolation sensitivity is closely related to mobility and dispersal potential for a species. This criterion considers migration between breeding, summer and winter habitat, movements between roosts, nests and feeding habitats, post-breeding dispersal, and colonization of vacant habitats but not the large scale seasonal migrations that many bird species embark on. Scores under this criterion provide information of importance to population viability and meta-population dynamics.

One of the main aspects considered is the physical ability or the predisposition of a species to move about within the landscape and is related to the connectivity of habitat within a landscape. The second consideration is the potential impact that roads have on fauna species that are known to be mobile, but also the nature of such mobility. Thus most bird species score fairly low for this criterion since the power of flight overcomes obstacles such as roads (although they prefer to forage and move along connecting corridors), whereas many herpetofauna score very high (since their life cycle requires them to move at ground level between different habitat types which may increase likelihood of roadkill).

The scoring of species for conservation priorities here relates directly to local conservation management potential for species in the Toronto region. The focus is on local mobility requirements of individuals breeding in the region, including movements such as dispersal of young to new territories, but not the larger spatial and temporal scale migration requirements of species such as migratory birds and bats.

Dispersal mobility is considered in 3 contexts: 1) dispersal of juveniles to new territories following breeding; 2) adults dispersing from one habitat to another in search of new resources or a mate; and, 3) individuals seeking a new location after their original habitat has been degraded or destroyed.

The scoring of Patch Isolation Sensitivity (Table 18) takes into account factors including the size of the animal involved, endurance (e.g. susceptibility to desiccation or starvation), and behaviour, (e.g. speed of travel, need for cover, ability to travel at night, etc.) as well as how habitat-specific a species is. Information on typical local-scale migration, dispersal or foraging movements of a species is considered for the score where this is available through literature searches. Otherwise the species is scored on the basis of staff observations or reasonable assumption.

Table 18. Patch Isolation Sensitivity scoring system

Score	Patch Isolation Sensitivity
5	Highly restricted by limited physical capacity and/or incidence of road-kill has severe impact at the local population level.
4	Restricted by limited physical capacity and/or incidence of road-kill has some impact at the local population level.
3	Somewhat mobile provided there is continuity of habitat corridors, and/or susceptible to road-kill, but little impact at the local population level.
2	Mobile with availability of "stepping stone" habitats, and/or incidence of road-kill is negligible, or sensitivity to patch isolation is unknown (see text).
1	Unlimited mobility - species is highly mobile but is not susceptible to road-kill.

4.2.6 Sensitivity to Development

This criterion considers indirect impacts from development as opposed to direct loss of habitat. Agricultural and urban development are both considered, although agricultural environments themselves are often threatened by urbanization. Both residential and industrial developments are included under the urban category.

This criterion considers the fact that habitats which may appear suitable in type and size may in fact be unsuitable because of external influences from adjacent land use. These include the negative "edge effects" of patchy habitat in an urban/agricultural matrix, in addition to the impacts resulting from human use of natural areas in and around settlements.

The overall effect of development may be positive, negative or neutral for a given species. For example, a species that indirectly benefits from agriculture through the use of fallow fields may receive more benefit than loss from agricultural development.

Scoring for this criterion is qualitative and based on observation and consultation of key literature sources. Twelve negative and 2 positive Matrix Influences have been identified as listed below. Each species receives a +1 count for each negative influence that applies and a -1 count for each positive Influence. The sum of these positive and negative impact counts is converted to a 5 point scoring system according to Table 19.

Sensitivity to Development - Negative Influences

1. Clearing – understorey, snags, marsh vegetation, i.e. loss through manicuring
2. Removal of wood - logging, fuel wood collection
3. Soil compaction (from trampling or vehicles)
4. Drainage
5. Dumping
6. Exotic species
7. Predation/parasitism/competition
8. Flushing (causing abandonment of nest)
9. Removal (hunting, collection)
10. Persecution (e.g. of species considered pests or vermin)
11. Sensitivity to pesticides (bio-accumulation)
12. Sensitivity to obstacles (roads, fences, buildings)

Sensitivity to Development - Positive Influences

13. Additional food source
14. Nesting/denning location (includes provision of sites for winter shelter)

Table 19. Assigning the Sensitivity to Development score for fauna

Sum of impacts	Points scored	Description
<0	0	Benefits from development-related disturbance
0	1	No overall benefit or detriment from development-related disturbances (neutral)
1	2	Slight negative impact from development-related disturbances, or effects unknown
2	3	Moderate negative impact from development-related disturbances
3	4	Moderately severe negative impact from development-related disturbances
4+	5	Very severe negative impact from development-related disturbances

4.2.7 Additional Points

As noted in Section 4.2, an additional point is accrued when the maximum of 5 points has been scored in any one of the 4 ecology-based criteria (to a maximum of 4 additional points). The purpose is to enhance the contribution of sensitivity over current rarity to the ranking process. Early recognition of sensitivity informs proactive action, e.g. the protection or restoration of suitable habitat, before the sensitive species becomes exceedingly rare.

4.3 Assignment of Local Rank

Local conservation ranks are assigned according to the sum of the criteria scores, which can range from 2 - 39 (Table 20). Also shown in this table are the designations and interpretations for extirpated species, hybrids and species for which native/exotic status is uncertain.

Table 20. Assignment of Local Rank for fauna

Score range	L Rank
2-9	L5
10-14	L4
15-19	L3
20-24	L2
25+	L1

5.0 Data management and addition of species/communities

Scores and ranks for each vegetation community and flora and fauna species, along with names and supplemental information are stored in a Microsoft Access database. Separate data entry forms for vegetation communities, flora, and fauna steer the biologist through the scoring process to ensure consistency (Appendix A). When updates are performed, previous data are retained within the database form and can be viewed for tracking and reference.

It is possible for new native species to be found in the TRCA jurisdiction. The decision to add a species to the database includes a determination with respect to whether the affected species should be considered locally native. A species that is within or close to its recognized range, but that has not been recorded in the jurisdiction previously, is added to the database, scored and ranked. An expected climate change effect is the northward expansion of some species' ranges

over time. These are and will continue to be considered on a case by case basis when updates occur. A species that is added in this situation will likely be very limited in distribution when first scored, and therefore will most likely receive the maximum score for local occurrence. The consideration of all criteria in the scoring helps to offset this high score, which, if considered alone, may or may not be considered a good representation of sensitivity.

When new species are added, literature research is conducted and sensitivities and requirements are recorded in the database.

6.0 References

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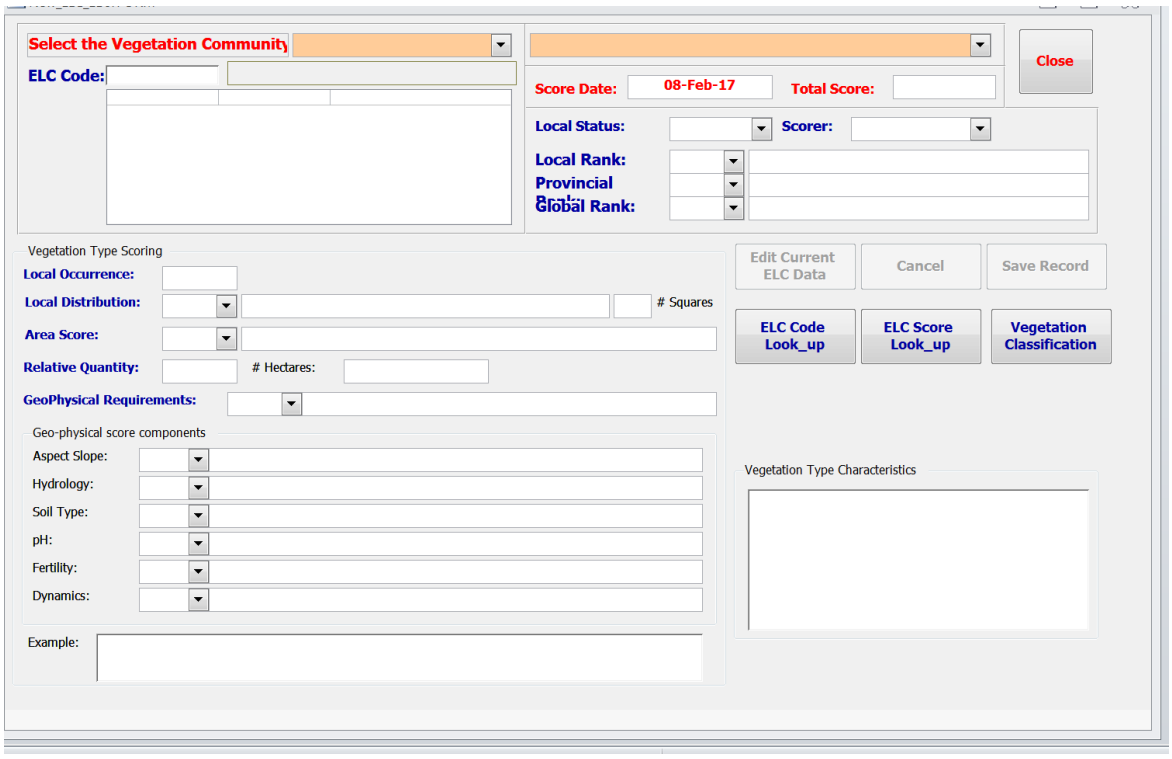
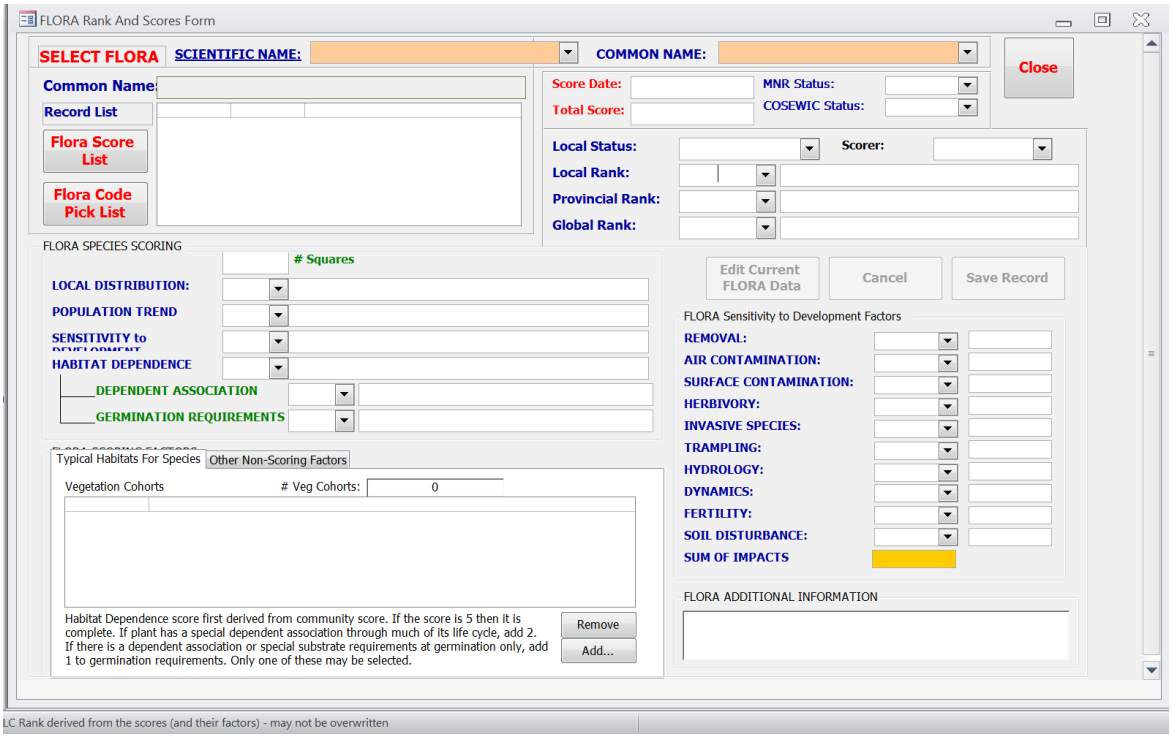
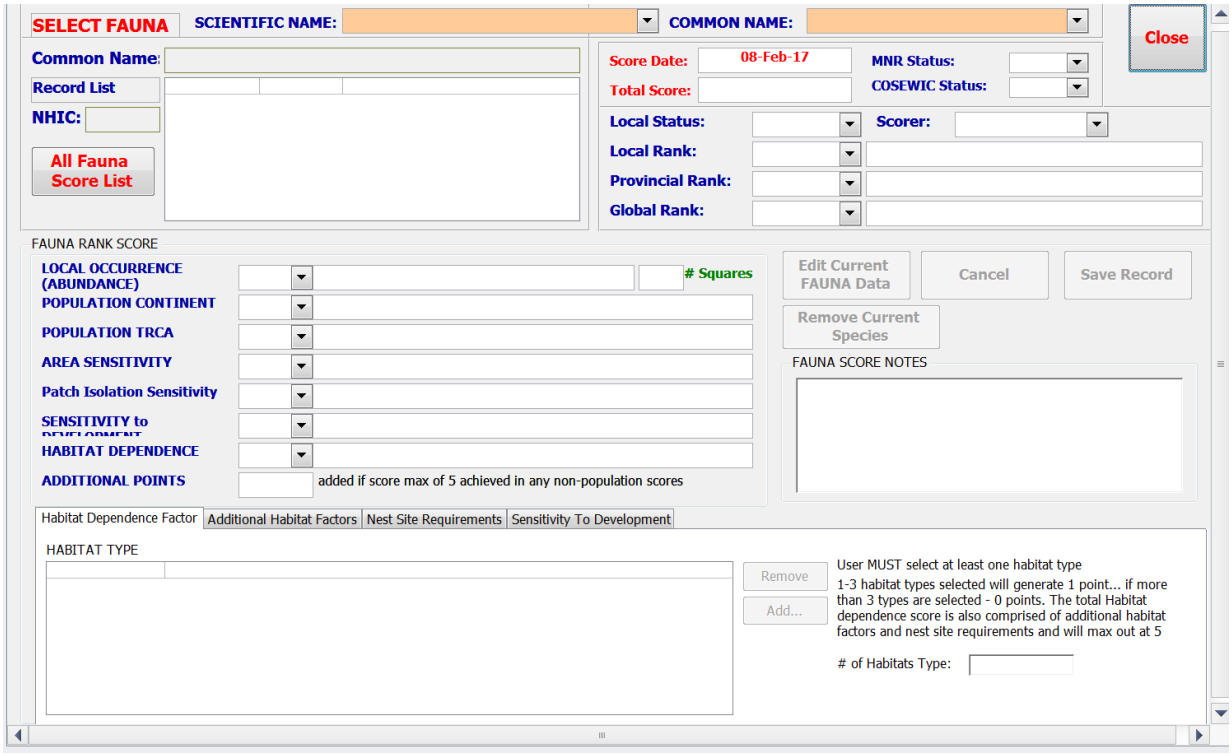
Appendix A: Data entry forms for vegetation community flora and fauna scoring and ranking






SELECT FAUNA
SCIENTIFIC NAME:
COMMON NAME:
Close
Common Name:
Record List
NHIC:
All Fauna Score List
Score Date:
08-Feb-17
Total Score:
MNR Status:
COSEWIC Status:
Local Status:
Scorer:
Local Rank:
Provincial Rank:
Global Rank:
FAUNA RANK SCORE
LOCAL OCCURRENCE (ABUNDANCE)
Squares
POPULATION CONTINENT
POPULATION TRCA
AREA SENSITIVITY
Patch Isolation Sensitivity
SENSITIVITY to
HABITAT DEPENDENCE
ADDITIONAL POINTS
added if score max of 5 achieved in any non-population scores
Edit Current FAUNA Data
Cancel
Save Record
Remove Current Species
FAUNA SCORE NOTES
Habitat Dependence Factor
Additional Habitat Factors
Nest Site Requirements
Sensitivity To Development
HABITAT TYPE
Remove
Add...
User MUST select at least one habitat type
1-3 habitat types selected will generate 1 point... if more than 3 types are selected - 0 points. The total Habitat dependence score is also comprised of additional habitat factors and nest site requirements and will max out at 5
# of Habitats Type: