Appendix A: Landscape and Functional Connectivity Model Documentation

Landscape and Functional Connectivity Models

Overview

The landscape connectivity models were set up as two geographical modules: NSRV and Tablelands. The geographic separation was incorporated to address the differences in terrain and vegetation (movement habitat) between the RV and the Tablelands. The valley slopes present constraints to animal movement that are not present on the tablelands. The river valley and its tributary ravines are also the most significant route into the city and thus likely serves as a major access point supporting the other natural areas within the City. In the Tablelands, the natural areas are sparsely distributed within a highly developed matrix that discourages movement to varying degrees. Terrain is flat to undulating and does not limit potential travel routes. Instead, larger natural areas are connected as a string of Stepping Stones separated by some gap - where that gap is tolerable, species will cross, making that path a viable corridor. Where the gap is too large given the need of the species for security cover, the path is broken.

The data and landscapes necessitated different model mechanics to address the connectivity characteristics of the two areas. We have used a similar rating scheme, though, which will allow connectivity to be demonstrated as a seamless unit across Edmonton. Lastly, we have mapped aquatic linkages as a separate aspect of overall connectivity, attempting to illustrate where linkages have been broken. Summary metrics describing the characteristics of patches within the Edmonton natural network and the network itself are the final component of the analysis.

The RV and Tablelands Modules are provided in the first two sections of this appendix, followed by a description of the aquatic connectivity mapping elements. The last section summarizes the methods used to calculate and interpret the patch metrics.

Model Scoring

<u>Background</u>

The model design was based on permeability of landscape features for species common in urban landscapes and tolerant of human presence to some degree. It assumes resident populations are present in a landscape enclosed within a 2 mile radius of the City's boundary. Although connections to habitat outside the city are certainly possible, the most likely route into the City is through the river valley. Potential linkages to habitat outside the study area are addressed in part by this river valley component of the model. This modeling method is similar to the Landscape Model constructed by Vuilleumier and Prélaz-Droux (2002), which modeled a landscape in terms of the amount of friction presented to an indicator species.

Our Functional Connectivity Model incorporated several spatial scales to assess the level of connectivity from the perspective of smaller animal species through to larger, more mobile species. Although our indicator species were all animals, seed dispersal through wind or animal vectors should also be sufficiently addressed by the model, given the different spatial scales used. The model could also extend to dispersing individuals of other large mammal species (moose, lynx) not often observed in the urban river valley, but the assessment is not specifically designed to address these species.

The model addresses only the animal's security needs and the energetic costs of movement (i.e., the 'friction' created by physical and developed features and associated human activity that would present potential barriers to movement). The value of habitat within the valley to support these species, and therefore attract wildlife to certain locations, although important in predicting animal movement, was not included in this model. This is mainly because data regarding habitat quality (e.g., disturbance, vegetation community descriptions) were not available. Habitat quality from the perspective of patch size and shape is, however, addressed in the patch metrics analysis. The greenspace and natural parkland in the RV that would support movement are also large patches of habitat that would also support resident populations for a variety of species (i.e., act as Core Areas). Core areas, an important component of any ecological network, will be identified in this analysis.

Dataset Scoring System

Scores reflecting the direction and magnitude of influence on connectivity for each land use/cover element within the connectivity model are listed in the column beside the model element. Individual scores reflect the relative friction of a given landscape feature from the indicator species' perspective:

Friction Level	Score
High	-2
Moderately High	-1
Moderate	0
Moderately Low	1
Low	2

Final Score Ranking

Connectivity in an urban context is driven by the spatial distribution of vegetative cover or open (undeveloped) space that could provide security cover for movement (linkages) and larger habitat patches with resources to sustain plants or wildlife for some time. In the urban context, connectivity is also related to the extent of inhospitable / unsuitable habitat (matrix) that the animal must travel through to reach suitable habitat. The model first combines data contributing to each of these three components (patches, linkages and matrix) to identify where they lie on the landscape. It then examines potential barriers to movement (man-made features and land use) and their proximity to each other to determine areas with some form of effective connection, within a relatively inhospitable matrix.

Model Mechanics

This is a two part model that classifies the landscape in terms of permeability (the Landscape Model), then creates an additional analysis overlay to assess connectivity at various scales (Landscape Connectivity Model and Functional Connectivity Model or

Analysis). The landscape classification within the river valley sums the scores of variables present in a given location (where they overlap) to determine the relative level of friction for an animal moving through that area. For both the NSRV and Tablelands analyses, the models classify the landscape in terms of Habitat Patches, Linkages, Barriers and Matrix. The Matrix was handled differently for the NSRV and Tablelands Modules. The land use of the Matrix (unsuitable habitat adjacent usable habitat) in the NSRV is predominately recreational, and thus was considered a constant throughout the river valley. Where other, more intensive land use exists, it was addressed by the vegetation data. The Matrix of the Tablelands was identified using Land Use zoning data.

The functional connectivity analysis identifies connected habitat at 4 spatial scales corresponding to the gap crossing tolerance for small mammals (20 m), songbirds and amphibians (50 m), deer (100 m), and a theoretical maximum gap crossing distance of 2.5 times that for deer (250 m). The analysis identified each spatial level of connection using the following GIS calculations:

- **Good functionally connected habitat** = all patches and linkages within 20 m, edge to edge. GIS Calculation: Buffer [Patches, linkages}, 20 m; Union {BUFFERED Patches, linkages 20m}; Dissolve {UNION BUFFERED Patches, linkages 20 m}

- **Fair functionally connected habitat** = all patches and linkages within 50 m, edge to edge. GIS Calculation: Buffer [Patches, linkages}, 50 m; Union {BUFFERED Patches, linkages 50m}; Dissolve {UNION BUFFERED Patches, linkages 50 m}

- **Moderate functionally connected habitat** = all patches and linkages within 100 m, edge to edge. GIS Calculation: Buffer [Patches, linkages}, 100 m; Union {BUFFERED Patches, linkages 100m}; Dissolve {UNION BUFFERED Patches, linkages 100 m}

- **Poor functionally connected habitat** = all patches and linkages within 250 m, edge to edge. GIS Calculation: Buffer {Patches, linkages}, 250 m; Union {BUFFERED Patches, linkages 250m}; Dissolve {UNION BUFFERED Patches, linkages 250 m}

Next, to address overlap of Barriers within each type of connective habitat, Barriers were overlaid on each of the 4 resulting connective habitat layers and removed All Barriers (GIS Calculation: Barriers with score of <0 were then ERASED from Connected Habitat. The resulting set of 4 types of Connected Habitat formed the final mapping layers, which were displayed on a connective analysis map.

Specific spatial extents, dataset scoring and model assumptions for the two modules follow below.

River Valley Connectivity Model Module

<u>*Spatial Extent*</u>

The model includes the river valley and its tributary valleys below the top-of-bank only (clipped to the ARP boundary polygon) from the western to the eastern edge of the Intermunicipal Zone (a buffer 2 miles extending beyond the City boundary)

<u>*Variable Scoring Assumptions*</u>

- Abandoned gravel pits can offer good movement habitat if they are not fenced. Not knowing which sites are still active, we've assumed all to be active and fenced.
- Slope categories were derived from similar studies on movement in river valley terrain (Callaghan *et al.* 1999).
  - In that study, wolves occurred on slopes of <20% in 95% of telemetry locations. Elk avoided slopes of >30%. These two parameters formed the basis for our slope scoring elements
  - Although the Callaghan *et al.* 1999 study was in a mountain environment, it best represented the species and the terrain of concern for our assessment. Although studies assessing movement behavior for deer, fox and coyote in urban environments would have been ideal, such studies are unfortunately lacking.
- Vegetation of tributary ravines is untyped and assumed to be native throughout. Where developed areas exist, those have been identified as such in the ARP layer.

NSRV Landscape Model Variables

Connection Component Type	Variable	Element	Score	Friction Level	Buffer Width (m)	Dataset	File Name
Patch	*RVA Vegetation and NSR ARP ravines*[8]	Natural veg (forest, shrub or grassland)	2	Low		RVA vegetation layer	rva_veg_clip.shp
		Manicured lawns, agricultural fields	1	Moderately Low			
		Tributary ravines	2	Low		ARP boundary layer, clipped to exclude areas mapped in rva_vegetation_3TM.shp	New file created for analysis
Matrix	*RVA Vegetation and NSR ARP ravines*[1]	Developed urban landscape (exposed soils, built up areas, gravel pits)	-2	High		RVA vegetation layer	rva_veg_clip.shp
Linkage	*Rights-of-way (ROWs)*	Road ROW managed as parkland	0	Moderately High		Edmonton PINS data	PINS_road_rail_row.shp
		Pipelines	1	Moderately Low	20	IHS Super pipes dataset	pipeline_polyline.shp
		Powerlines	1	Moderately Low		Edmonton PINS data, reclassified to ID powerlines as Utility ROWs, but no SHP file created yet	PINS Sites.shp
Linkage	*Transportation and Utilities Corridor (TUC)*	TUC (minus any built roads)	1	Moderately Low		TUC layer	tuc_complete_dissolve.shp
Barrier	*NRCAN Hydrology*[9]	No SW	2	Low		Edmonton hydrology layers	hydro-merge.shp, rva_hydrology-line-
		Streams	1	Moderately Low	30		

[8] RVA refers to the River Valley Analysis.
[9] NRCAN refers to Natural Resource Canada data.

Connection Component Type	Variable	Element	Score	Friction Level	Buffer Width (m)	Dataset	File Name
		River	-2	High	30		1_3tm.shp
	NRCAN Roads[3]	Highway/Freeway	-2	High	20	City roads files & new rail file	NRCAN Roads, rails_dig.shp
		Arterial	-1	Moderately high	20		
		Ramp	-1	Moderately high	20		
		Rapid Transit/Railway	-1	Moderately high	20		
		Collector	-1	Moderately high	10		
		Local/Street	0	Moderately low	5		
		Service	0	Moderately low	5		
	NRCAN Slope[3]	Steep (>30%)	-1	Moderately High		DEM file (NRCAN)	rva_slope.shp
		Moderate (<=30% or >20%)	0	Moderately Low			
		Level to rolling (<=20%	1	Low			

NSRV Connectivity Analysis

Connection Component Type	Variable	Element	Score	Friction Level	Buffer (m)	Datasets	File name
Connected Habitat	*Connection Analysis*	Gaps of 20m b/n Patches/Linkages, edge to edge		Very Good Functional Connection		Created Layer - use in eventual overlay to illustrate connection at varied scales	new files
		Gaps of 50m b/n Patches/Linkages, edge to edge		Good Functional Connection			
		Gaps of 100m b/n Patches/Linkages, edge to edge		Fair Functional Connection			
		Gaps of 250m b/n Patches/Linkages, edge to edge		Poor Functional Connection			

ENA's Tablelands Connectivity Model Module

Spatial Extent

The model excludes the river valley and its tributary valleys below the top-of-bank only (clipped to the ARP boundary polygon) from the western to the eastern edge of the Intermunicipal Zone (a buffer 2 miles extending beyond the City boundary)

Variable Scoring Assumptions

- **Other Green Space** tends to be open lawn with sparse ornamental trees. Such areas offer limited security cover, and therefore only moderate connectivity.
- **ROW's** were all assumed to be moderately effective as a linkage due to limited tree cover. These areas are also typically grassed with only scattered ornamental trees to offer security cover. Rights-of-ways were also scored as a moderate influence because they do not appear to provide a consistently high level of connectivity, to a broad range of species. ROWs appear to be used by various small mammal species and some songbirds as movement habitat, but are not typically used over native habitat, where it exists (Mauritzen *et al.* 1999, Bolger *et al.* 2001). For invertebrates, ditches appear to allow for range expansion due to their connective function (DeMers 1993).
- **Patches and Linkage Clusters**: physically separate patches and linkages were assumed to be less accessible as the gap between adjacent components increased. 250 m was assumed to be the effective limit for large animals like deer to cross open areas (2.5 times the documented gap preference of deer). 100 m is the minimum mappable unit that can be shown at the Edmonton regional scale, so smaller scales of connectivity may not be viewable at this scale. They will, however, be evident at the finer scale.
- **Land Use**: we assumed that the more intensive the land use, the higher the level of resistance to movement through that matrix. More intensively developed lands have less vegetation and high levels of human activity that would discourage movement through them. Residential lands tend to be more extensively landscaped and thus offer moderate levels of friction to movement. Habitat alienation due to human activity will still influence animal use of these areas, another factor contributing to the moderately low friction score for this landscape class. Recreational facilities (other than parkland) are also often more landscaped than other intensively developed lands, and were given a moderately low friction score based on that, and habitat alienation potential.
- **Roads**: traffic and road width have both been found to influence road crossing behavior of animals ranging from deer to amphibians and birds. Generally, smaller roads seem to be less of a barrier, but larger freeways are almost a complete obstacle.

Dataset Manipulations (Data Preparation)

- **Remove the NSRV (use the ARP boundary) from the analysis -** the RV is addressed in a separate component of this model.
- **Edm Natural Areas dataset** should also exclude those Natural Areas within NSRV.

- **Zoning Dataset:** Reclassify data into broad LU Zones corresponding to categories below.
- **TUC:** remove any existing, built roads and confirm that road ROW PINS data are not included in this layer to avoid double counting.
- **Buffers** are in place to compensate for lack of true ROW data for all but manicured parkway bordering roads, for which data was available.
- **AB SRD Vegetation dataset**: include only those naturally vegetated areas outside the RV.
- **Pipelines ROWs for Tablelands**: Only those pipeline ROWs that remain undeveloped in the urban environment (i.e., remain as open space), as determined by aerial photography interpretation, were included in the analysis.
- **Habitat Patches:** Check all Habitat Patches to ensure no overlap - e.g., the Regional Natural Areas may overlap with ASRD Vegetation dataset

Buffers for Roads and Right-of-Ways

Transportation and Infrastructure ROWs - Typical ROW width in urban area, based on road design experience. Typical pipeline ROW width, based on industry experience. **Water** - Based on the width of set-back typically used at the top-of-bank for rivers. Assumed a smaller setback on smaller streams.

Tablelands Landscape Model Variables

Connection Component Type	Variable	Element	Score	Friction Level	Buffer (m)	Datasets	File name
	Edmonton Natural Areas in 2005	ESA, SNA and NA	2	Low		Newly created NA dataset	RV_NAs_Oct20.shp; NAs_noTUC-area.shp
		Enoch natural areas	2	Low		Newly created Enoch natural area data	enoch_project.shp
		Lois Hole Provincial Park	2	Low		Protected areas data	lois_hole_project.shp
		Regionally Significant Natural Areas w/in Inter-municipal Zone	2	Low		Regional NA dataset	reg_na_project.shp
	Regional, Adjacent Natural Areas	Naturally vegetated areas outside the City of Edmonton	2	Low		AB SRD Ctrl Parkland veg	natural_veg-erase-clip.shp
		Lakes, manmade, reservoir, river, streams	2	Low	30	NRCAN hydrology	Hydro_merge_new.shp, rva_hydrology-line-1_3tm.shp
Patch	*Lakes, Rivers and Wetlands*	Wetlands	2	Low		ASRD Native vegetation, RVA wetlands	rva_wetland.shp
		Road ROW	0	Moderate		Edmonton PINS data	road_rail_ROW_new.shp; Anthony-ext.shp
		Rail ROW	0	Moderate	20	Updated rails data	RV_rails-new2_link.shp
Linkage	*Rights-of-way (ROWs)*	Powerline ROW	1	Moderately low		NRCAN + updated data	Powerlines_all_project.shp

Connection Component Type	Variable	Element	Score	Friction Level	Buffer (m)	Datasets	File name
		Pipeline ROWs[10]	1	Moderately low	20	IHS pipeline data	pipelines_linkages.shp
	TUC	TUC (minus any built roads)	1	Moderately low		TUC layer	tuc_complete_dissolve.shp
		Edmonton cemeteries	1	Moderately low		Edmonton PINS dataset	PINS_cemetary-new.shp
		Edmonton school grounds	0	Moderate			PINS_Schools-new.shp
		Edmonton neighborhood parks	1	Moderately low			PINS_Parks-new.shp
		Edmonton golf courses	1	Moderately low			PINS_golf-new.shp
	Other Green Space	Edmonton sports fields	0	Moderate			sports_fields_project.shp
		SWMF (except dry ponds)	1	Moderately low			
Linkage	*Edmonton SWMFs*	SWMF (dry ponds)	0	Moderate		Edmonton SWMF locations	edm_SWMFs-project.shp
		Commercial	-2	High			
		Light Industrial	-2	High			
		Medium to Heavy Industrial	-2	High			
		Residential	-1	Moderate			
		Agricultural	1	Moderately low		Edmonton Land Use Zoning	Outly-Urban-clips.shp; strath-lub-clip-project.shp; Leduc-lub-clip-project.shp; zoning.shp
	Land Use Zones	Recreational (Parks)	1	Moderately low			
Matrix		Recreational (other than Parks)	0	Moderate		Edmonton Land Use Zoning	zoning.shp
Barriers	*Transportation*	Highway/Freeway	-2	High	20	City roads files	RVA_NRCAN_roads-

[10] Only those pipeline ROWs that remain undeveloped in the urban environment (i.e., remain as open space), as determined by aerial photography interpretation, were included in the analysis.

Connection Component Type	Variable	Element	Score	Friction Level	Buffer (m)	Datasets	File name
		Arterial	-1	Moderately high	20		with-railways1_3tm.shp; Anthony-ext.shp
		Ramp	-1	Moderately high	20		
		Rapid Transit	-1	Moderately high	20		
		Collector	-1	Moderately high	10		
		Local/Street	0	Moderate	5		
		Service	0	Moderate	5		
		Railway	0	Moderate	5	Updated rails data	RV_rails-new2_link.shp

Tablelands Connectivity Analysis

Connection Component Type	Variable	Element	Friction Level	Buffer (m)	Datasets	File name
Connected Habitat	**Connection Analysis**	Gaps of 20m b/n Patches/Linkages, edge to edge	Good Functional Connection	20	Created Layers	new files
		Gaps of 50m b/n Patches/Linkages, edge to edge	Fair Functional Connection	50		
		Gaps of 100m b/n Patches/Linkages, edge to edge	Moderate Structural Connection	100		
		Gaps of 250m b/n Patches/Linkages, edge to edge	Poor Structural Connection	250		

Aquatic Linkages Map

Background

The previous two models addressed both terrestrial and semi-aquatic linkages. Aquatic systems were included in them, but for their functional value as a connective route (valley) or habitat for semi-aquatic species, and as a potential barrier (streams and rivers). This map uses the data on hydrology and built infrastructure to identify aquatic linkages and any gaps that have been created by diversion, culverts etc.

Spatial Extent

Includes the city study area to approximate the Intermunicipal Planning Zone (effectively a buffer 2 miles outside the City boundary).

Mapping Elements

Connection Component Type	Variable	Element	Dataset	File Name
Aquatic Linkage	Hydrology	Streams	NRCAN hydrology	hydro_merge_clip.shp, hydroline-clip.shp
		Lakes		
		Rivers		
		Wetlands	RVA wetlands	rva_veg-clip.shp
		SWMF	City SWMF file	SWMF-clip.shp
Barriers	Roads	All roads	City Roads file	Roads-clip-new.shp; Anthony-ext.shp
Edmonton Natural Areas Mapping Base Layers	Other base layer elements			
Edmonton Natural Areas	Natural Areas	All Natural Areas	2005 NA file and new NA file	RV_NAs_Oct20.shp; NAs_noTUC-area.shr

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Appendix B: Glossary of Terms Used in this Report

Glossary of Terms Used in This Report

Aquatic organism: Fish, invertebrate animal species and microbial organisms (e.g., bacteria) that reside exclusively in water.

Connectivity: The concept of connectivity is used to describe how the spatial arrangements and the quality of elements in the landscape affect the movement of organisms among habitat patches (Merriam 1984, 1991; Taylor et al. 1993; Forman 1995 in Bennett 2003). In an urban context, connective landscapes are described in terms of relatively permeable habitat patches and linkages, separated by a less permeable matrix and barriers.

Core area: A patch of habitat that contains a sub-population from which species could disperse to other smaller habitat patches, thus contributing to sustainable population at the landscape scale (Forman 1995). Core areas vary with species, due to species specific habitat requirements, thus discussion of management of Core Areas must be tied to species of management concern, or indicators representative of a more diverse suite of species.

Corridor: Any space, usually linear in shape, that improves the ability of organisms to move among patches of their habitat (Hilty *et. al 2006)*. Although naturally-vegetated, linear strips can also be corridors (Bennett 2002), for this assessment we identified only disturbed corridors (transportation and utility rights-of-way) (i.e., we excluded linear Natural Areas).

Ecological Network: A means of achieving connectivity within a landscape, through a linked system of habitat (patches, linkages and permeable matrix types)(Forman 1995, Hilty *et al.* 2006).

Edge: The portion of an ecosystem near its perimeter, where influences of the surroundings prevent development of interior environmental conditions. (Edge effect refers to the processes creating the distinctive species composition or abundance in this outer border of the ecosystem.) (Forman 1995)

GIS: Geographic Information System, computer software that allows spatial analysis and display of the qualities and characteristics of a landscape.

Habitat: The ecosystem in which a given species lives, or the conditions within that ecosystem that provide resources suitable for a given species (modified from Forman 1995).

Habitat Patch: A relatively homogenous, unfragmented, nonlinear area of habitat that differs from its surroundings (Forman 1995). Within this assessment, habitat patches are all considered capable of sustaining populations of plants and wildlife. Such sites included Natural Areas within Edmonton's tablelands and river valley system and within the Intermunicipal Zone, provincial parks, regionally significant natural areas, and native habitat patches larger than 1 ha.

Linkages (Linkage Habitats): Arrangements of vegetated areas that enhance connectivity for species, communities or ecological processes (modified from Bennett 2003). In an urban, highly disturbed environment, linkage is typically provided by Stepping Stones or Corridors. In the context of our assessment, we have considered Stepping Stones and Corridors as distinct forms of linkage habitat.

Landscape: An area (usually large and at a regional scale) where a cluster of local ecosystems is repeated in similar form (Forman 1995). In this analysis, we considered Edmonton and the adjacent Intermunicipal Planning Fringe to comprise a landscape.

Matrix: The matrix is the background ecosystem or land use in which habitat patches lie on a landscape (Forman 1995, Hilty et al. 2006). The matrix in a developed landscape can be quite complex given the variety of land uses present and is best thought of as comprising a gradient of permeability that can range from very permeable to a complete barrier (Hilty et al. 2006). Permeability is related to the quality of the matrix and the distance separating more suitable habitat patches, and is therefore, species-specific. In this assessment, we defined relative permeability of the matrix from the perspective of two large mammals (deer and coyote).

Metapopulation = a population of populations, or a system of local populations (demes) connected by movements of individuals (dispersal) among the population units (Hilty et al. 2006).

Minimum Viable Population = population at or above which the probability of extinction is reduced to an acceptable level over a given period of time (Schaffer 1981, Samson 1983, Lemkhul 1984, Gilpin and Soule 1986, Lacy 1993/94, Henriksen 1997).

Natural Area: Naturally-vegetated areas within the City of Edmonton (on the Tablelands and in the North Saskatchewan River valley system) that are greater than or equal to 1.0 ha. These areas are surrounded by human-modified lands and are readily distinguishable by a well-defined edge.

Natural Vegetation: Plant species composition and cover comprising predominantly native species not planted by humans. Human impacts and exotic species are often present, but native species are usually dominant (Forman 1995)

NSRV: North Saskatchewan River Valley System (this includes the tributary ravines).

Restoration: Efforts to restore or re-establish habitat in lands degraded by past land use to improve connectivity or other ecological processes. Restoration can be either passive (relying on succession to replace natural vegetation) or active (planting or managing habitat to restore natural vegetation)(Hilty *et al.* 2006).

Source: A growing or stable population in which reproduction is greater than mortalities, such that individuals must disperse to new habitat.

Stepping stone: A vegetated area that may provide resources to sustain an organism for some time, but is generally used as a temporary stop while moving through the matrix route toward more suitable habitat patches (modified from Forman 1995). Stepping stones are separated by short gaps from each other, corridors or habitat patches and are most useful for mobile, relatively disturbance-tolerant species (Bennett 2002).

Sustainability: The ability of a site to continue to exist as a vigorous, biologically diverse site that will continue along a natural trajectory of change, regulated by natural process and dominated by native species, even when future conditions on surrounding lands have changed.

Wildlife : Vertebrate and invertebrate animal species.

Appendix C: Landscape Metrics Analysis

Landscape Metrics Analysis

Patch size and distribution metrics have been well studied over the past decade, since landscape ecology first emerged as a science. Various measures have been introduced to characterize the spatial distribution and function of ecological networks. Mitchell (2006), in his review of 'best' metrics, those with correlation and limited overlap, identified those listed in the table below. Nodal weight, the extent to which a patch (or here, a cluster of patches) would satisfy the territorial requirements of an indicator species has also been used as a descriptor of functional within an ecological network (Linehan *et al.* 1995, Rudd *et al.* 2002). We used both sets of metrics to describe Edmonton's Ecological Network, calculating metrics for the natural areas within the river valley, on the tablelands and over the entire Edmonton study area. A summary of the metrics, and the formulae used for the calculations follows in the table below.

Table A1. Landscape Metrics Formulas

Natural Areas	Formula (after McGarigal and Marks 1995)
Individual Patches	
Mean patch size	MN=AVERAGE(patch areas)
Median patch size	MED=MEDIAN(patch areas)
Std. Dev. patch size	SDN=STDEV(patch areas)
Range of patch sizes	
Histogram of patch sizes	
Proportion of landscape occupied by patches	PLAND=sum(patch areas)/total study area
Average perimeter to area ratio	AVGPAR=AVERAGE(patch perimeters/patch areas)
Patch density	PD=number patches/total study area
Nodal Weight	NW=patch area/minimum patch size [a] x 10
Connected Patches [b]	
Area of connected patches and linkages	SUM(area of structurally connected patches and linkages)
Number of connected patches and linkages	COUNT(area of poor functionally connected patches and linkages)
Clustered Nodal Weight	NW= clustered patch area/minimum patch size x 10

[a] Minimum patch size = an arbitrary size of patch selected based on the management objectives of a given ecological network. For example, the patch size could relate to the area requirements of a population of a species of interest.

[b] Calculated for each spatial scale of connectivity: structural and good, fair and poor functional connection.

Nodal Weight Analysis

The average nodal weight analysis provides an indication of the ability of the ecological network to meet management objectives. For example, the analysis could test how well the current Edmonton ecological network provides for a diverse and sustainable population of plant and wildlife species. Using an indicator species with similar area and habitat requirements for the plant and animal community of interest, one can determine a minimum patch size. If the average nodal weight of individual patches and connected patches and linkages is equal to or greater than 10, that minimum requirement is satisfactorily met for the indicator species. Values below 10 indicate that insufficient area is available in the network, on average. A similar comparison on the range of individual patches and connected habitats will indicate the proportion of suitable patches within the network.

To conduct this analysis, we used 5 indicator species, each indicative of a different wildlife community (and due to the scale of area requirements, plant community). We selected 'test' indicator species known to occur commonly within Edmonton (deer, coyote, porcupine, chickadee, vole). For each indicator species, we identified the minimum patch size based on the following criteria.

Minimum patch size was related to the area requirements of a local population of the species of interest. We assumed a management goal of a viable population[11] in most patches within the network. We used a patch population of about 5 individuals, which is 1/100 of the minimum viable population[12] required to sustain a species over the long term. This also assumes that the viability of these patches is related to dispersal from Core Areas[13] to which they retain a connection. Genetically, an effective (breeding) population of 50 individuals is thought to allow a species to persist in the short term, 500 to 5000 in the long term (Franklin 1980, Soule 1980, Shaffer 1981, 1983; Samson 1983, Brussard 1985, Samson et al. 1985, Lande 1987, Berger 1990, Thomas 1990, Henriksen 1997, Belovsky et al. 1999; reviewed by Snaith and Beazley 2002). We assumed a minimum viable population size of 500 as an appropriate target in the urban context, where population density is likely to be lower than in a less developed ecosystem, and habitat patches small and abundant.

[11] **Viable Population=** a population that will continue to exist and to function naturally so that, over the long term, reproductive rates remain higher than or equal to rates of loss (Salwasser et al. 1984, Newmark 1985).

[12] **Minimum Viable Population** = population at or above which the probability of extinction is reduced to an acceptable level over a given period of time (Schaffer 1981, Samson 1983, Lemkhul 1984, Gilpin and Soule 1986, Lacy 1993/94, Henriksen 1997).

[13] **Core Area** = patch of habitat that contains a large sub-population from which species could disperse to other smaller habitat patches, thus contributing to a sustainable population at the landscape scale (Forman 1995). Core area size varies with species, due to species specific habitat requirements, thus discussion of management of Core Areas must be tied to species of management concern.

Table A2. Minimum Patch Size Used in the Nodal Weight Analysis

Species	Territory (ha) [a] or Density (number per ha)	Minimum Patch Size [b] (ha)
Red-backed vole [c]	20 voles/ha	0.25
Black-capped chickadee [d]	0.5 ha	2.5
Porcupine [e]	7 / 100 h	71 ha
Coyote [e]	1.05 / 100 ha	476
Deer [f]	1.5 / 100 ha	333

[a] Territory size was used for the chickadee, a species that does not typically have overlapping territories. Territory size can result in misleading minimum critical area calculation for species with territory overlap or non-adjacent territories (Snaith and Beazley 2002). Density was used for the other species as they can have overlap in home range. Both density and territory size fail to account for variation in natural systems and hence represent an ideal.

[b] Minimum Patch Size = area to sustain 5 individuals of the indicator species. [c] Data for local densities of red-backed voles was not available. Westworth et al. (1984) and Boutin et al. (1996) reported density of red-backed vole in aspen forest of Alberta and the Yukon of 20 voles/ha.

[d] Black-capped chickadee territory size

[e] Banfield (1974) reported porcupine densities ranging from 7.7-10.8 animals / 100 ha in Maine and 2.3 – 3.0 animals / 100 ha in New Brunswick. More recent or local data was not available, however because this species is relatively common in the City, and particularly the river valley, and represents a species typically present at a moderate density level, we included it in this assessment, using the lower density reported for Maine (the most similar of the two study areas to ours)..

[f] Pruss (2002) reported coyote densities of between 0.87 and 1.05 coyotes/100 ha in Elk Island National Park (EINP), an average of 0.96 animals / 100 ha, a much more rural context than the Edmonton study area. Atwood *et al.* (2004) found coyote home range sizes along a gradient of suburban to exurban to rural habitat in the Eastern States ranged between 2.97-23.48 animals / 100 ha, with much smaller range sizes in suburban areas than rural areas. Coyote density within Edmonton is not known. Instead we used the lower of Pruss's densities, as this provided a better local estimate.

[g] EINP aerial survey in spring 2006 found deer density of 0.93 deer / km^2. Folinsbee (1993) winter survey of Edmonton found a white-tailed deer density of 1.5 deer / 100 ha. We used Folinsbee's estimate as it best represented local conditions.

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Table C1. List of NAs with Area and Nodal Weight for Each Indicator Species

Natural Area	Area (m^2)	Nodal Weight for Indicator Species				
		Red-backed Vole	Black-capped Chickadee	Porcupine	Coyote	Deer
NE 10	16.29	651.5	65.2	2.3	0.3	0.5
NE 8	12.06	482.5	48.3	1.7	0.3	0.4
NE 002	8.49	339.8	34.0	1.2	0.2	0.3
NE 24	11.45	457.9	45.8	1.6	0.2	0.3
NE 52	4.05	162.1	16.2	0.6	0.1	0.1
NE 8002	21.61	864.3	86.4	3.0	0.5	0.6
NE 221	5.31	212.2	21.2	0.7	0.1	0.2
NE 8006	6.90	275.9	27.6	1.0	0.1	0.2
NE 244	4.97	198.9	19.9	0.7	0.1	0.1
SE 5012	6.55	261.9	26.2	0.9	0.1	0.2
SE 5009	2.14	85.7	8.6	0.3	0.0	0.1
SE 5008	6.51	260.4	26.0	0.9	0.1	0.2
SE 107	5.85	234.0	23.4	0.8	0.1	0.2
SE 5002	14.90	596.0	59.6	2.1	0.3	0.4
SE 20	5.88	235.0	23.5	0.8	0.1	0.2
SW 26	5.36	214.2	21.4	0.8	0.1	0.2
SW 1	2.14	85.5	8.5	0.3	0.0	0.1
SW 2	3.24	129.6	13.0	0.5	0.1	0.1
NW 339	6.68	267.1	26.7	0.9	0.1	0.2
NW 7021	12.07	483.0	48.3	1.7	0.3	0.4
NW 254	7.59	303.6	30.4	1.1	0.2	0.2
NW 7012	4.94	197.6	19.8	0.7	0.1	0.1
NW 110	2.71	108.3	10.8	0.4	0.1	0.1
NW 7060C	2.83	113.2	11.3	0.4	0.1	0.1
NW 7060D	1.47	58.8	5.9	0.2	0.0	0.0
NW 7060A	13.25	530.1	53.0	1.9	0.3	0.4
NW 7024	11.66	466.3	46.6	1.6	0.2	0.4
NW 7090B	3.08	123.1	12.3	0.4	0.1	0.1
NW 7090E	4.47	178.7	17.9	0.6	0.1	0.1
NE 8099	12.51	500.3	50.0	1.8	0.3	0.4
NE 8096	9.25	370.2	37.0	1.3	0.2	0.3
NE 247	1.61	64.4	6.4	0.2	0.0	0.0
NE 8081	13.53	541.2	54.1	1.9	0.3	0.4
SE 5094	10.14	405.4	40.5	1.4	0.2	0.3
SE 5090	8.07	322.9	32.3	1.1	0.2	0.2
NE 8003	6.98	279.0	27.9	1.0	0.1	0.2
NE 8011A	4.04	161.6	16.2	0.6	0.1	0.1
NE 133	7.01	280.6	28.1	1.0	0.1	0.2

Natural Area	Area (m^2)	Nodal Weight for Indicator Species				
		Red-backed Vole	Black-capped Chickadee	Porcupine	Coyote	Deer
NE 8010	7.56	302.4	30.2	1.1	0.2	0.2
NE 8005	6.14	245.6	24.6	0.9	0.1	0.2
NE 8082	3.51	140.4	14.0	0.5	0.1	0.1
NE 8097	4.03	161.2	16.1	0.6	0.1	0.1
NE 8091	13.54	541.7	54.2	1.9	0.3	0.4
NE 8094	10.37	414.9	41.5	1.5	0.2	0.3
NE 8089	1.90	76.2	7.6	0.3	0.0	0.1
NW 7017B	1.36	54.6	5.5	0.2	0.0	0.0
NW 7018	18.28	731.4	73.1	2.6	0.4	0.5
NW 65	13.14	525.6	52.6	1.9	0.3	0.4
NW 7090D	9.07	362.7	36.3	1.3	0.2	0.3
NW 7035B	1.47	58.8	5.9	0.2	0.0	0.0
NW 7035A	23.75	949.9	95.0	3.3	0.5	0.7
NW 7004D	1.38	55.4	5.5	0.2	0.0	0.0
NW 7004B	1.47	58.7	5.9	0.2	0.0	0.0
NW 7004C	1.71	68.4	6.8	0.2	0.0	0.1
NW 7004A	4.19	167.8	16.8	0.6	0.1	0.1
NW 139	3.44	137.6	13.8	0.5	0.1	0.1
NW 7026	42.43	1697.4	169.7	6.0	0.9	1.3
NW 7051B	1.60	64.1	6.4	0.2	0.0	0.0
NW 7051A	22.11	884.4	88.4	3.1	0.5	0.7
NW 7011	3.97	158.9	15.9	0.6	0.1	0.1
NW 7009B	5.11	204.5	20.5	0.7	0.1	0.2
NW 7009A	26.57	1062.7	106.3	3.7	0.6	0.8
NW 275	3.80	152.1	15.2	0.5	0.1	0.1
NW 302	39.40	1575.9	157.6	5.5	0.8	1.2
NW 318	25.34	1013.8	101.4	3.6	0.5	0.8
NW 355	11.55	461.9	46.2	1.6	0.2	0.3
SW 6002	1.37	54.8	5.5	0.2	0.0	0.0
SW 86	5.47	218.6	21.9	0.8	0.1	0.2
SW 6001	6.69	267.6	26.8	0.9	0.1	0.2
SW 74	1.12	44.7	4.5	0.2	0.0	0.0
SW 31	3.95	157.8	15.8	0.6	0.1	0.1
SE 5016	9.82	392.7	39.3	1.4	0.2	0.3
SE 5004	47.52	1900.7	190.1	6.7	1.0	1.4
SE 5010	20.69	827.7	82.8	2.9	0.4	0.6
SE 5015	1.10	44.2	4.4	0.2	0.0	0.0
SE 238	7.08	283.4	28.3	1.0	0.1	0.2
SE 5007	46.15	1846.1	184.6	6.5	1.0	1.4
NW 7016	17.35	694.0	69.4	2.4	0.4	0.5

Natural Area	Area (m^2)	Nodal Weight for Indicator Species				
		Red-backed Vole	Black-capped Chickadee	Porcupine	Coyote	Deer
NW 7017A	1.30	52.1	5.2	0.2	0.0	0.0
NE 235	1.96	78.6	7.9	0.3	0.0	0.1
SE 5097	1.68	67.3	6.7	0.2	0.0	0.1
SE 225	2.59	103.5	10.3	0.4	0.1	0.1
SE 5091	2.43	97.4	9.7	0.3	0.1	0.1
SE 206	1.86	74.2	7.4	0.3	0.0	0.1
SE 197	4.06	162.3	16.2	0.6	0.1	0.1
SE 199	5.21	208.4	20.8	0.7	0.1	0.2
SE 174	2.81	112.5	11.2	0.4	0.1	0.1
SE 159	1.34	53.7	5.4	0.2	0.0	0.0
SE 65	1.73	69.0	6.9	0.2	0.0	0.1
SE 12	6.47	258.9	25.9	0.9	0.1	0.2
SE 8	3.41	136.5	13.6	0.5	0.1	0.1
SE 9	3.57	142.9	14.3	0.5	0.1	0.1
SE 130	1.87	74.8	7.5	0.3	0.0	0.1
SE 74	2.76	110.3	11.0	0.4	0.1	0.1
SE 73	3.13	125.3	12.5	0.4	0.1	0.1
SE 132	4.63	185.3	18.5	0.7	0.1	0.1
SE 135	4.47	178.8	17.9	0.6	0.1	0.1
SE 106	1.03	41.2	4.1	0.1	0.0	0.0
SE 36	1.78	71.1	7.1	0.3	0.0	0.1
SE 32	2.84	113.7	11.4	0.4	0.1	0.1
SE 30	1.41	56.5	5.7	0.2	0.0	0.0
SE 110	1.66	66.6	6.7	0.2	0.0	0.0
SE 119	6.59	263.5	26.4	0.9	0.1	0.2
SE 114	1.16	46.3	4.6	0.2	0.0	0.0
SE 117	1.42	57.0	5.7	0.2	0.0	0.0
SE 5005	2.31	92.5	9.3	0.3	0.0	0.1
SE 45	1.25	49.9	5.0	0.2	0.0	0.0
SW 7	3.79	151.6	15.2	0.5	0.1	0.1
SW 27	1.76	70.5	7.1	0.2	0.0	0.1
SW 40	3.95	158.2	15.8	0.6	0.1	0.1
SW 51	1.77	70.9	7.1	0.2	0.0	0.1
SW 103	4.25	170.2	17.0	0.6	0.1	0.1
NW 390	8.69	347.4	34.7	1.2	0.2	0.3
NW 386	5.15	206.1	20.6	0.7	0.1	0.2
NW 354	10.82	432.8	43.3	1.5	0.2	0.3
NW 358	2.00	80.2	8.0	0.3	0.0	0.1
NW 357	9.08	363.2	36.3	1.3	0.2	0.3
NW 328	2.23	89.2	8.9	0.3	0.0	0.1

Natural Area	Area (m^2)	Nodal Weight for Indicator Species				
		Red-backed Vole	Black-capped Chickadee	Porcupine	Coyote	Deer
NW 292	13.33	533.3	53.3	1.9	0.3	0.4
NW 279	3.97	159.0	15.9	0.6	0.1	0.1
NW 264	4.99	199.5	19.9	0.7	0.1	0.1
NW 195	1.06	42.5	4.2	0.1	0.0	0.0
NW 161	1.88	75.2	7.5	0.3	0.0	0.1
NW 167	12.26	490.4	49.0	1.7	0.3	0.4
NW 117	2.50	100.0	10.0	0.4	0.1	0.1
NW 122	2.78	111.2	11.1	0.4	0.1	0.1
NW 78	1.66	66.4	6.6	0.2	0.0	0.0
NW 127	3.39	135.4	13.5	0.5	0.1	0.1
NW 104	6.61	264.4	26.4	0.9	0.1	0.2
NW 142	1.90	75.8	7.6	0.3	0.0	0.1
NW 135	4.50	179.9	18.0	0.6	0.1	0.1
NW 66	1.44	57.7	5.8	0.2	0.0	0.0
NW 68	1.62	65.0	6.5	0.2	0.0	0.0
NW 38	1.61	64.6	6.5	0.2	0.0	0.0
NW 70	5.81	232.2	23.2	0.8	0.1	0.2
NW 76	2.52	100.9	10.1	0.4	0.1	0.1
NW 77	1.74	69.5	6.9	0.2	0.0	0.1
NW 37	3.06	122.3	12.2	0.4	0.1	0.1
NW 44	6.03	241.3	24.1	0.8	0.1	0.2
NW 43	1.22	48.8	4.9	0.2	0.0	0.0
NW 46	13.37	534.6	53.5	1.9	0.3	0.4
NW 8	2.59	103.4	10.3	0.4	0.1	0.1
NW 10	23.17	926.6	92.7	3.3	0.5	0.7
NE 8087	6.60	264.1	26.4	0.9	0.1	0.2
NE 8088	6.96	278.4	27.8	1.0	0.1	0.2
NE 160	2.55	102.0	10.2	0.4	0.1	0.1
NE 171	3.66	146.3	14.6	0.5	0.1	0.1
NE 219	4.77	190.9	19.1	0.7	0.1	0.1
NE 179	5.10	204.0	20.4	0.7	0.1	0.2
NE 127	5.27	210.9	21.1	0.7	0.1	0.2
NE 122	1.35	54.1	5.4	0.2	0.0	0.0
NE 113	5.15	205.9	20.6	0.7	0.1	0.2
NE 73	2.05	81.9	8.2	0.3	0.0	0.1
NE 137	3.77	150.8	15.1	0.5	0.1	0.1
NE 142	3.17	126.7	12.7	0.4	0.1	0.1
NE 138	2.08	83.3	8.3	0.3	0.0	0.1
NE 139	1.04	41.5	4.2	0.1	0.0	0.0
NE 89	6.85	273.8	27.4	1.0	0.1	0.2

Natural Area	Area (m^2)	Nodal Weight for Indicator Species				
		Red-backed Vole	Black-capped Chickadee	Porcupine	Coyote	Deer
NE 86	3.16	126.2	12.6	0.4	0.1	0.1
NE 84	4.11	164.5	16.5	0.6	0.1	0.1
NE 59	3.64	145.5	14.6	0.5	0.1	0.1
NE 54	3.24	129.6	13.0	0.5	0.1	0.1
NE 57	3.96	158.4	15.8	0.6	0.1	0.1
NE 69	1.88	75.1	7.5	0.3	0.0	0.1
NE 74	2.30	92.0	9.2	0.3	0.0	0.1
NE 46	2.27	91.0	9.1	0.3	0.0	0.1
NE 27	2.42	96.9	9.7	0.3	0.1	0.1
NE 28	6.11	244.2	24.4	0.9	0.1	0.2
NE 31	6.15	245.9	24.6	0.9	0.1	0.2
NE 001	9.23	369.2	36.9	1.3	0.2	0.3
NE 3	2.46	98.2	9.8	0.3	0.1	0.1
NE 9	1.37	54.8	5.5	0.2	0.0	0.0
NE 18	4.16	166.3	16.6	0.6	0.1	0.1
NE 20	3.91	156.4	15.6	0.6	0.1	0.1
NE 13	2.47	98.9	9.9	0.3	0.1	0.1
NE 32	3.10	123.9	12.4	0.4	0.1	0.1
NE 40	2.12	84.9	8.5	0.3	0.0	0.1
NE 38	2.85	113.8	11.4	0.4	0.1	0.1
NE 42	9.13	365.1	36.5	1.3	0.2	0.3
NE 500	4.69	187.6	18.8	0.7	0.1	0.1
NE 501	4.79	191.6	19.2	0.7	0.1	0.1
NE 502	1.18	47.1	4.7	0.2	0.0	0.0
NE 503	2.31	92.3	9.2	0.3	0.0	0.1
NE 504	5.26	210.5	21.1	0.7	0.1	0.2
NE 505	1.40	56.1	5.6	0.2	0.0	0.0
NE 506	3.19	127.7	12.8	0.4	0.1	0.1
NE 507	1.07	42.7	4.3	0.2	0.0	0.0
NE 508	2.21	88.4	8.8	0.3	0.0	0.1
NE 509	5.35	213.9	21.4	0.8	0.1	0.2
NE 510	2.98	119.4	11.9	0.4	0.1	0.1
NE 511	1.70	67.9	6.8	0.2	0.0	0.1
NE 512	1.25	50.0	5.0	0.2	0.0	0.0
NE 513	4.91	196.2	19.6	0.7	0.1	0.1
NE 515	1.26	50.2	5.0	0.2	0.0	0.0
NW 602	1.89	75.8	7.6	0.3	0.0	0.1
NW 603	4.20	167.9	16.8	0.6	0.1	0.1
NW 604	3.49	139.7	14.0	0.5	0.1	0.1
NE 520	2.26	90.3	9.0	0.3	0.0	0.1

Natural Area	Area (m^2)	Nodal Weight for Indicator Species				
		Red-backed Vole	Black-capped Chickadee	Porcupine	Coyote	Deer
NE 521	1.90	76.0	7.6	0.3	0.0	0.1
NE 522	1.22	48.9	4.9	0.2	0.0	0.0
NE 523	2.41	96.3	9.6	0.3	0.1	0.1
NE 524	1.69	67.8	6.8	0.2	0.0	0.1
NE 525	3.87	154.9	15.5	0.5	0.1	0.1
NE 526	5.30	212.2	21.2	0.7	0.1	0.2
NE 528	1.55	62.1	6.2	0.2	0.0	0.0
NE 529	3.21	128.5	12.8	0.5	0.1	0.1
NE 530	3.94	157.5	15.7	0.6	0.1	0.1
NW 619	8.63	345.1	34.5	1.2	0.2	0.3
NW 623	1.63	65.2	6.5	0.2	0.0	0.0
NW 624	2.62	104.9	10.5	0.4	0.1	0.1
NW 660	2.33	93.4	9.3	0.3	0.0	0.1
NW 631	7.94	317.6	31.8	1.1	0.2	0.2
NW 632	7.86	314.6	31.5	1.1	0.2	0.2
NW 633	7.11	284.5	28.5	1.0	0.1	0.2
SE 400	1.52	60.8	6.1	0.2	0.0	0.0
SE 401	1.08	43.4	4.3	0.2	0.0	0.0
NW 636	4.56	182.5	18.3	0.6	0.1	0.1
NW 637	2.98	119.2	11.9	0.4	0.1	0.1
SE 402	2.85	114.0	11.4	0.4	0.1	0.1
SW 700	1.55	61.9	6.2	0.2	0.0	0.0
SW 701	1.62	64.7	6.5	0.2	0.0	0.0
NW 638	3.18	127.3	12.7	0.4	0.1	0.1
NW 639	1.50	60.1	6.0	0.2	0.0	0.0
NW 640	4.09	163.6	16.4	0.6	0.1	0.1
NW 641	1.02	40.6	4.1	0.1	0.0	0.0
SW 702	1.78	71.2	7.1	0.3	0.0	0.1
SE 403	3.36	134.6	13.5	0.5	0.1	0.1
SE 404	1.69	67.4	6.7	0.2	0.0	0.1
SW 703	1.82	72.9	7.3	0.3	0.0	0.1
NW 313	6.68	267.1	26.7	0.9	0.1	0.2
NW 661	9.61	384.5	38.5	1.4	0.2	0.3
NW 642	2.73	109.0	10.9	0.4	0.1	0.1
SE 405	1.70	67.9	6.8	0.2	0.0	0.1
SE 406	5.48	219.0	21.9	0.8	0.1	0.2
SE 407	1.35	54.1	5.4	0.2	0.0	0.0
SW 704	14.97	598.7	59.9	2.1	0.3	0.4
SW 705	2.80	112.1	11.2	0.4	0.1	0.1
SW 706	11.11	444.4	44.4	1.6	0.2	0.3

Natural Area	Area (m²)	Nodal Weight for Indicator Species				
		Red-backed Vole	Black-capped Chickadee	Porcupine	Coyote	Deer
SW 707	9.21	368.5	36.8	1.3	0.2	0.3
SE 408	1.47	58.8	5.9	0.2	0.0	0.0
SE 410	2.85	114.2	11.4	0.4	0.1	0.1
SE 411	3.59	143.5	14.4	0.5	0.1	0.1
SE 412	2.04	81.4	8.1	0.3	0.0	0.1
SW 709	3.99	159.8	16.0	0.6	0.1	0.1
SW 710	1.65	66.0	6.6	0.2	0.0	0.0
SW 711	8.15	325.8	32.6	1.1	0.2	0.2
SE 413	2.76	110.4	11.0	0.4	0.1	0.1
SW 712	17.93	717.3	71.7	2.5	0.4	0.5
NW 643	5.59	223.5	22.3	0.8	0.1	0.2
NW 644	1.67	66.8	6.7	0.2	0.0	0.1
NE 531	4.12	164.9	16.5	0.6	0.1	0.1
NE 8020	3.06	122.4	12.2	0.4	0.1	0.1
NE 532	3.42	136.8	13.7	0.5	0.1	0.1
NW 645	7.76	310.2	31.0	1.1	0.2	0.2
NW 646	4.99	199.6	20.0	0.7	0.1	0.1
NW 647	6.19	247.6	24.8	0.9	0.1	0.2
NW 649	9.62	384.8	38.5	1.4	0.2	0.3
NW 650	2.91	116.5	11.6	0.4	0.1	0.1
NW 651	1.38	55.0	5.5	0.2	0.0	0.0
NW 652	1.32	52.8	5.3	0.2	0.0	0.0
NW 653	2.21	88.2	8.8	0.3	0.0	0.1
NW 662	1.58	63.3	6.3	0.2	0.0	0.0
NW 663	3.98	159.2	15.9	0.6	0.1	0.1
SW 713	5.09	203.5	20.4	0.7	0.1	0.2
SE 414	5.61	224.5	22.5	0.8	0.1	0.2
SE 415	2.61	104.4	10.4	0.4	0.1	0.1
SE 416	5.47	218.8	21.9	0.8	0.1	0.2
SE 417	14.67	586.9	58.7	2.1	0.3	0.4
NW 384	17.15	685.8	68.6	2.4	0.4	0.5
NW 7010	2.89	115.8	11.6	0.4	0.1	0.1
NW 7010	14.62	584.9	58.5	2.1	0.3	0.4
NW 7010	5.17	206.9	20.7	0.7	0.1	0.2
RV 1	1.02	40.6	4.1	0.1	0.0	0.0
RV 10	1.48	59.2	5.9	0.2	0.0	0.0
RV 11	1.48	59.3	5.9	0.2	0.0	0.0
RV 12	1.53	61.4	6.1	0.2	0.0	0.0
RV 13	1.54	61.5	6.2	0.2	0.0	0.0
RV 14	1.56	62.3	6.2	0.2	0.0	0.0

Natural Area	Area (m^2)	Nodal Weight for Indicator Species				
		Red-backed Vole	Black-capped Chickadee	Porcupine	Coyote	Deer
RV 15	1.57	62.8	6.3	0.2	0.0	0.0
RV 16	1.60	64.1	6.4	0.2	0.0	0.0
RV 17	1.66	66.5	6.6	0.2	0.0	0.0
RV 18	1.68	67.1	6.7	0.2	0.0	0.1
RV 19	1.71	68.3	6.8	0.2	0.0	0.1
RV 2	1.04	41.5	4.2	0.1	0.0	0.0
RV 20	1.74	69.5	7.0	0.2	0.0	0.1
RV 21	1.82	72.6	7.3	0.3	0.0	0.1
RV 22	1.85	74.0	7.4	0.3	0.0	0.1
RV 23	1.92	76.9	7.7	0.3	0.0	0.1
RV 24	2.05	82.0	8.2	0.3	0.0	0.1
RV 25	2.11	84.4	8.4	0.3	0.0	0.1
RV 26	2.27	90.8	9.1	0.3	0.0	0.1
RV 27	2.10	84.0	8.4	0.3	0.0	0.1
RV 28	2.12	84.9	8.5	0.3	0.0	0.1
RV 3	1.05	42.1	4.2	0.1	0.0	0.0
RV 30	2.49	99.4	9.9	0.4	0.1	0.1
RV 31	2.76	110.5	11.0	0.4	0.1	0.1
RV 32	2.92	116.7	11.7	0.4	0.1	0.1
RV 33	2.93	117.2	11.7	0.4	0.1	0.1
RV 34	3.11	124.5	12.5	0.4	0.1	0.1
RV 35	3.17	126.8	12.7	0.4	0.1	0.1
RV 36	3.23	129.0	12.9	0.5	0.1	0.1
RV 37	3.35	133.9	13.4	0.5	0.1	0.1
RV 38	3.37	135.0	13.5	0.5	0.1	0.1
RV 39	3.48	139.2	13.9	0.5	0.1	0.1
RV 4	1.17	47.0	4.7	0.2	0.0	0.0
RV 40	3.79	151.5	15.1	0.5	0.1	0.1
RV 41	3.80	152.0	15.2	0.5	0.1	0.1
RV 42	3.83	153.2	15.3	0.5	0.1	0.1
RV 43	3.94	157.5	15.7	0.6	0.1	0.1
RV 44	4.21	168.3	16.8	0.6	0.1	0.1
RV 45	4.16	166.2	16.6	0.6	0.1	0.1
RV 46	4.36	174.4	17.4	0.6	0.1	0.1
RV 47	4.39	175.7	17.6	0.6	0.1	0.1
RV 48	4.70	188.0	18.8	0.7	0.1	0.1
RV 5	1.23	49.3	4.9	0.2	0.0	0.0
RV 50	4.83	193.2	19.3	0.7	0.1	0.1
RV 51	5.18	207.3	20.7	0.7	0.1	0.2
RV 52	5.41	216.3	21.6	0.8	0.1	0.2

Natural Area	Area (m^2)	Nodal Weight for Indicator Species				
		Red-backed Vole	Black-capped Chickadee	Porcupine	Coyote	Deer
RV 53	5.46	218.3	21.8	0.8	0.1	0.2
RV 54	5.58	223.0	22.3	0.8	0.1	0.2
RV 55	6.04	241.5	24.1	0.9	0.1	0.2
RV 56	7.31	292.5	29.2	1.0	0.2	0.2
RV 57	7.29	291.7	29.2	1.0	0.2	0.2
RV 59	8.20	327.9	32.8	1.2	0.2	0.2
RV 6	1.22	49.0	4.9	0.2	0.0	0.0
RV 60	9.61	384.2	38.4	1.4	0.2	0.3
RV 61	10.90	436.1	43.6	1.5	0.2	0.3
RV 62	13.06	522.3	52.2	1.8	0.3	0.4
RV 63	14.13	565.3	56.5	2.0	0.3	0.4
RV 64	15.01	600.3	60.0	2.1	0.3	0.5
RV 65	17.07	682.8	68.3	2.4	0.4	0.5
RV 66	17.50	700.0	70.0	2.5	0.4	0.5
RV 67	17.65	706.2	70.6	2.5	0.4	0.5
RV 7	1.19	47.6	4.8	0.2	0.0	0.0
RV 70	20.70	827.9	82.8	2.9	0.4	0.6
RV 71	19.80	792.0	79.2	2.8	0.4	0.6
RV 72	24.37	974.8	97.5	3.4	0.5	0.7
RV 74	25.70	1028.0	102.8	3.6	0.5	0.8
RV 75	26.44	1057.8	105.8	3.7	0.6	0.8
RV 76	27.20	1088.2	108.8	3.8	0.6	0.8
RV 79	28.92	1156.8	115.7	4.1	0.6	0.9
RV 80	29.13	1165.1	116.5	4.1	0.6	0.9
RV 81	39.69	1587.6	158.8	5.6	0.8	1.2
RV 82	40.19	1607.8	160.8	5.7	0.8	1.2
RV 87	47.56	1902.3	190.2	6.7	1.0	1.4
RV 88	32.37	1294.7	129.5	4.6	0.7	1.0
RV 9	1.43	57.2	5.7	0.2	0.0	0.0
RV 92	126.46	5058.4	505.8	17.8	2.7	3.8
RV 95	134.52	5380.8	538.1	18.9	2.8	4.0
RV 100	184.51	7380.3	738.0	26.0	3.9	5.5
RV 101	217.73	8709.1	870.9	30.7	4.6	6.5
RV 101	25.42	1016.6	101.7	3.6	0.5	0.8
RV 102a	3.13	125.1	12.5	0.4	0.1	0.1
RV 102b	17.96	718.3	71.8	2.5	0.4	0.5
RV 102c	199.59	7983.5	798.4	28.1	4.2	6.0
RV 103a	3.63	145.3	14.5	0.5	0.1	0.1
RV 103b	193.37	7734.9	773.5	27.2	4.1	5.8
RV 103c	96.70	3868.0	386.8	13.6	2.0	2.9

Natural Area	Area (m^2)	Nodal Weight for Indicator Species				
		Red-backed Vole	Black-capped Chickadee	Porcupine	Coyote	Deer
RV 104	416.52	16660.7	1666.1	58.7	8.8	12.5
RV 105a	31.23	1249.1	124.9	4.4	0.7	0.9
RV 105b	2.50	99.9	10.0	0.4	0.1	0.1
RV 105c	40.44	1617.6	161.8	5.7	0.8	1.2
RV 105d	58.70	2347.9	234.8	8.3	1.2	1.8
RV 105e	4.58	183.0	18.3	0.6	0.1	0.1
RV 105f	8.71	348.2	34.8	1.2	0.2	0.3
RV 105g	22.94	917.4	91.7	3.2	0.5	0.7
RV 105h	20.26	810.3	81.0	2.9	0.4	0.6
RV 105i	5.53	221.3	22.1	0.8	0.1	0.2
RV 105j	12.22	488.9	48.9	1.7	0.3	0.4
RV 105k	42.00	1679.9	168.0	5.9	0.9	1.3
RV 105l	11.39	455.6	45.6	1.6	0.2	0.3
RV 105m	89.61	3584.5	358.5	12.6	1.9	2.7
RV 105n	9.78	391.1	39.1	1.4	0.2	0.3
RV 105o	31.35	1254.1	125.4	4.4	0.7	0.9
RV 105p	10.69	427.6	42.8	1.5	0.2	0.3
RV 105q	23.93	957.0	95.7	3.4	0.5	0.7
RV 105r	30.73	1229.1	122.9	4.3	0.6	0.9
RV 106a	3.33	133.4	13.3	0.5	0.1	0.1
RV 106b	153.49	6139.8	614.0	21.6	3.2	4.6
RV 106c	100.41	4016.3	401.6	14.1	2.1	3.0
RV 106d	40.36	1614.6	161.5	5.7	0.8	1.2
RV 106e	554.15	22166.0	2216.6	78.0	11.6	16.6
RV 29	1.93	77.2	7.7	0.3	0.0	0.1
RV 49a	2.67	106.7	10.7	0.4	0.1	0.1
RV 49b	1.34	53.8	5.4	0.2	0.0	0.0
RV 58a	1.99	79.5	8.0	0.3	0.0	0.1
RV 58b	2.11	84.3	8.4	0.3	0.0	0.1
RV 58c	1.41	56.4	5.6	0.2	0.0	0.0
RV 68	17.23	689.3	68.9	2.4	0.4	0.5
RV 69a	14.98	599.3	59.9	2.1	0.3	0.4
RV 69b	2.73	109.2	10.9	0.4	0.1	0.1
RV 73a	1.52	60.6	6.1	0.2	0.0	0.0
RV 73b	22.49	899.7	90.0	3.2	0.5	0.7
RV 77a	20.67	827.0	82.7	2.9	0.4	0.6
RV 77b	5.15	205.9	20.6	0.7	0.1	0.2
RV 78a	26.43	1057.3	105.7	3.7	0.6	0.8
RV 78b	1.74	69.4	6.9	0.2	0.0	0.1
RV 83a	25.13	1005.2	100.5	3.5	0.5	0.8

Natural Area	Area (m^2)	Nodal Weight for Indicator Species				
		Red-backed Vole	Black-capped Chickadee	Porcupine	Coyote	Deer
RV 83b	14.92	597.0	59.7	2.1	0.3	0.4
RV 84	1.38	55.2	5.5	0.2	0.0	0.0
RV 85a	9.93	397.3	39.7	1.4	0.2	0.3
RV 85b	33.94	1357.6	135.8	4.8	0.7	1.0
RV 86	45.87	1834.9	183.5	6.5	1.0	1.4
RV 89a	36.51	1460.5	146.0	5.1	0.8	1.1
RV 89b	37.60	1503.9	150.4	5.3	0.8	1.1
RV 89c	16.02	640.7	64.1	2.3	0.3	0.5
RV 90	111.63	4465.2	446.5	15.7	2.3	3.4
RV 93a	51.62	2064.6	206.5	7.3	1.1	1.6
RV 93b	72.46	2898.2	289.8	10.2	1.5	2.2
RV 94a	82.60	3304.1	330.4	11.6	1.7	2.5
RV 94b	1.37	54.6	5.5	0.2	0.0	0.0
RV 96a	46.79	1871.5	187.1	6.6	1.0	1.4
RV 96b	19.23	769.4	76.9	2.7	0.4	0.6
RV 96c	18.83	753.1	75.3	2.7	0.4	0.6
RV 96d	52.02	2080.9	208.1	7.3	1.1	1.6
RV 97a	4.15	166.0	16.6	0.6	0.1	0.1
RV 97b	10.21	408.3	40.8	1.4	0.2	0.3
RV 97c	46.32	1852.7	185.3	6.5	1.0	1.4
RV 97d	41.95	1678.0	167.8	5.9	0.9	1.3
RV 97e	19.92	797.0	79.7	2.8	0.4	0.6
RV 97f	14.66	586.4	58.6	2.1	0.3	0.4
RV 97g	1.15	45.8	4.6	0.2	0.0	0.0
RV 98a	143.98	5759.2	575.9	20.3	3.0	4.3
RV 98b	2.53	101.4	10.1	0.4	0.1	0.1
RV 98c	6.47	258.6	25.9	0.9	0.1	0.2
RV 99a	6.62	264.9	26.5	0.9	0.1	0.2
RV 99b	16.97	678.9	67.9	2.4	0.4	0.5
RV 99c	67.58	2703.3	270.3	9.5	1.4	2.0
RV 99d	31.17	1246.8	124.7	4.4	0.7	0.9
RV 99e	1.76	70.2	7.0	0.2	0.0	0.1
RV 99f	37.16	1486.4	148.6	5.2	0.8	1.1
Total	**6384.22**					
Mean	**14.81**	**592.5**	**59.3**	**2.1**	**0.3**	**0.4**
Median	**4.12**					