# The City of Surrey – Green Infrastructure Network (2011).

https://www.surrey.ca/sites/default/files/media/documents/EcosystemManagementStudy.pdf - Contact Pamela Zevit


**Aim:** to strategically manage the ecosystems throughout the City by defining a Green Infrastructure Network.

The key to this approach was the identification of;

- **Hubs** – contiguous areas of ecological importance at least 10 ha in size with a naturalness rating of ≥3 (semi natural).
- **Sites** – smaller areas of natural or semi-natural vegetation between 0.25 and 10 ha in size.
- **Potential corridors** –pathways that offer species and ecological process connection between hubs

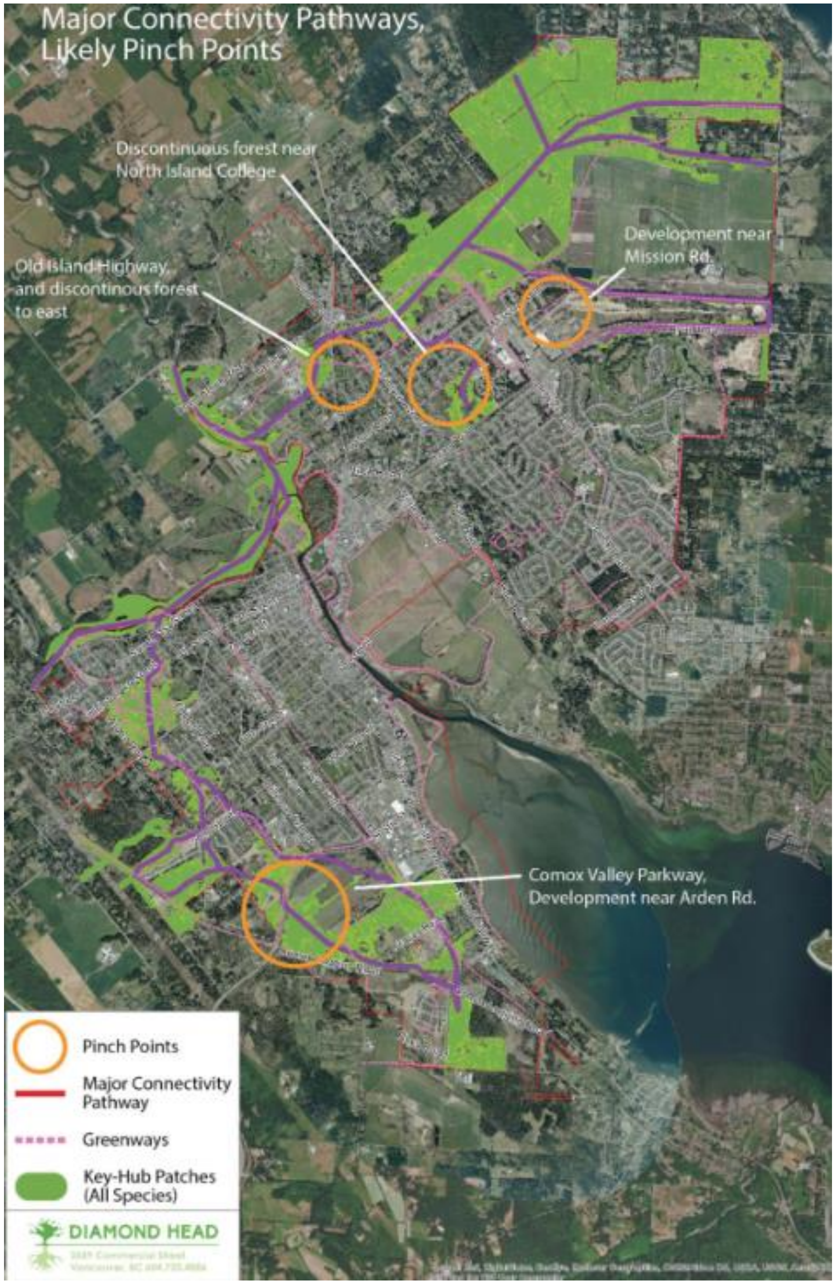
To determine the potential corridors; vegetation (including urban areas), watercourses and roads were overlayed in GIS. An impedance value (Table 2.5 of report) which measures the degree to which each landscape type inhibits wildlife use and movement was then allocated.

Least cost path analysis was used to determine the best ecological routes between hubs. This is a GIS method used to assess connectivity between habitats sites by examining the condition of the intervening landscape. The analysis identifies pathways between hubs that offer the lowest cumulative resistance to the movement of plants and animal species. This was reviewed manually and minor adjustments made. Corridors were then made by buffering the least-cost path by 50m on each side for a total width of 100m.

Network evaluation – a scoring system was developed that assessed the relative ecological significance of different hubs and potential corridors (Table 2.6 of report). The scoring system assigns a composite “ecological significance score” out of 100 calculated using 12 metrics (e.g. average vegetation naturalness, number of biodiversity features etc.) that characterize the function and integrity of each hub or corridor. Each metric was weighted based on its importance to ecological function and integrity e.g. factors such as average naturalness, hub size and corridor length were of greatest importance.

# City of Courtenay – Landscape Connectivity Analysis (2019)

Contact Nancy Gothard




**Aim:** To assess greenspace connectivity from the perspective of three umbrella species (amphibian, mammal and bird) for conserving particular habitat and dispersal characteristics.

Step 1 – **Greenspace characterisation** - developed a land cover classification layer, and included height information for forest polygons to identify mature forest (height >24m), needed by the umbrella species.

Step 2 – **Species selection** - three umbrella species were selected, and their habitat requirements used to determine 'patches' of habitat. These were verified manually and by using species records e.g. eBird.

| Species | Median Dispersal (m) | Max Distance (m) | Min Patch Size (ha) | Land Cover Type | Disp. Road Limited? |
|---|---|---|---|---|---|
| Amphibian (red-legged frog) | 100 | 2500 | 0.05 | Riparian/wetland; mature moist forest | Yes |
| Mammal (red squirrel) | 100 | 1000 | 0.02 | Mature coniferous | No |
| Bird (brown creeper) | 88 | 2110 | 2.3 | Mature forest | No |

Step 3 – **Habitat path and link creation** - Straight line linkages were drawn between patches to the maximum dispersal distance for each species. Links were created using Conefor Inputs Tool for Arc GIS. If species dispersal was known to be limited by road any link that crossed a road was removed. Link and patch information for each species was feed into Conefor 2.6 for the calculation of connectivity metrics after attributing an area-weighted quality value to each patch.

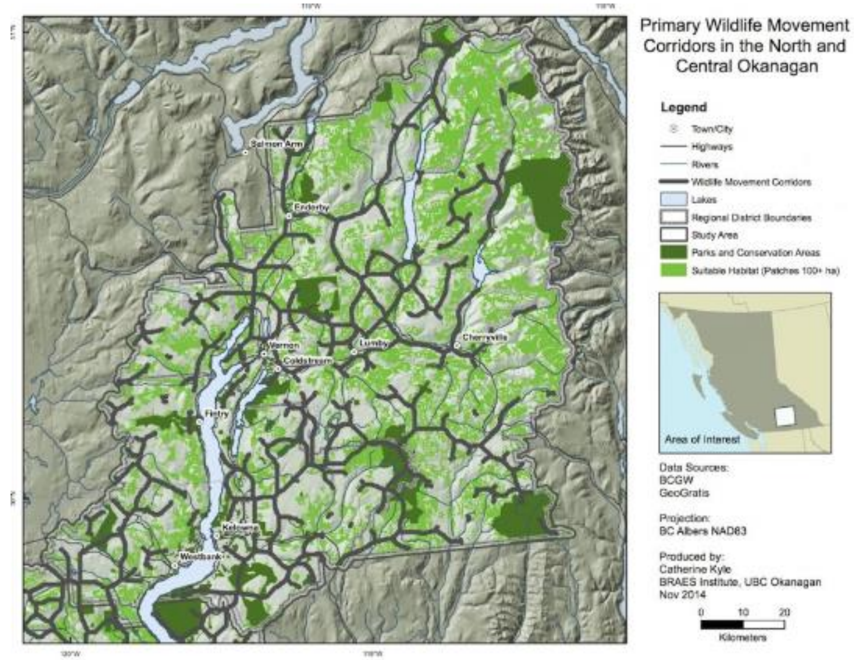
Step 4 – **Conefor metric selection** - Connectivity was measured using the Probability of Connectivity (PC) index and its component metrics. PC is the probability of dispersal between two patches.

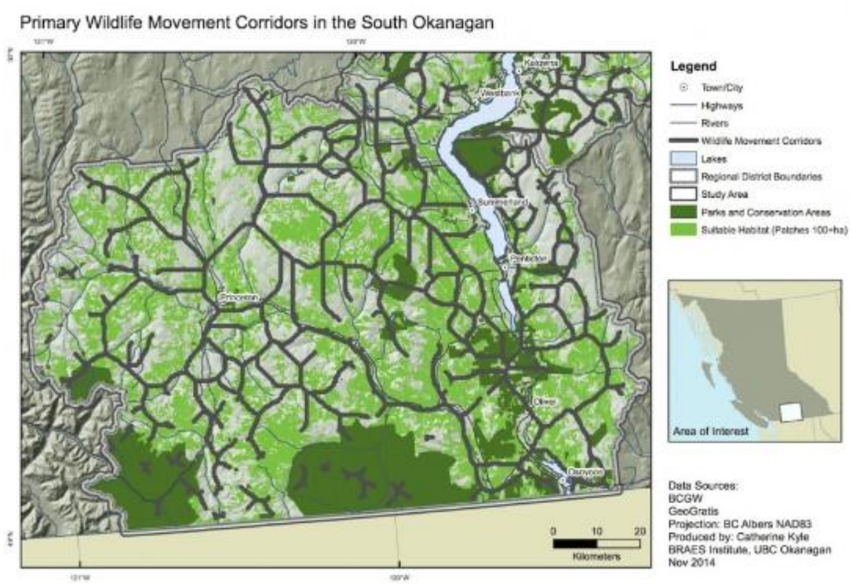
This analysis identified key patches which are the most important overall for each species. It also identified hub patches which are most important for each species for maintaining connectivity. The analysis also highlighted where connectivity could be improved.

# Corridors Connecting Habitats in The Okanagan Valley (2014)

https://complexity.ok.ubc.ca/2014/12/01/corridors-connecting-habitats-in-the-okanagan-valley/

Contact Dr. Lael Parrott UBC




**Aim:** to identify a terrestrial network of patches and corridors whose conservation or restoration may contribute to maintaining habitat connectivity for broad range of species in the Okanagan Valley.

**Identification of suitable natural habitat** – suitable natural habitat was any parcel of land in the study area having a relative biodiversity ranking ≥ moderate according to the methods established in the Biodiversity Conservation Strategy (BCS) and ≥ 100 ha. The method for determining biodiversity ranking used a weighted function to assess each parcel's conservation ranking, size and distance from a disturbance feature e.g. road, powerline. Additional weight was given to wetlands and riparian zones.

**Locating habitat corridors and linkages** – A connectivity value was assigned to each parcel of land based on a number of assumptions regarding the ability of a generic species to cross it e.g. connectivity is assumed to be higher in close proximity to water and on a gentle slope. Each parcel was classified as either; barrier, low, moderate or high connectivity depending on their connectivity value.

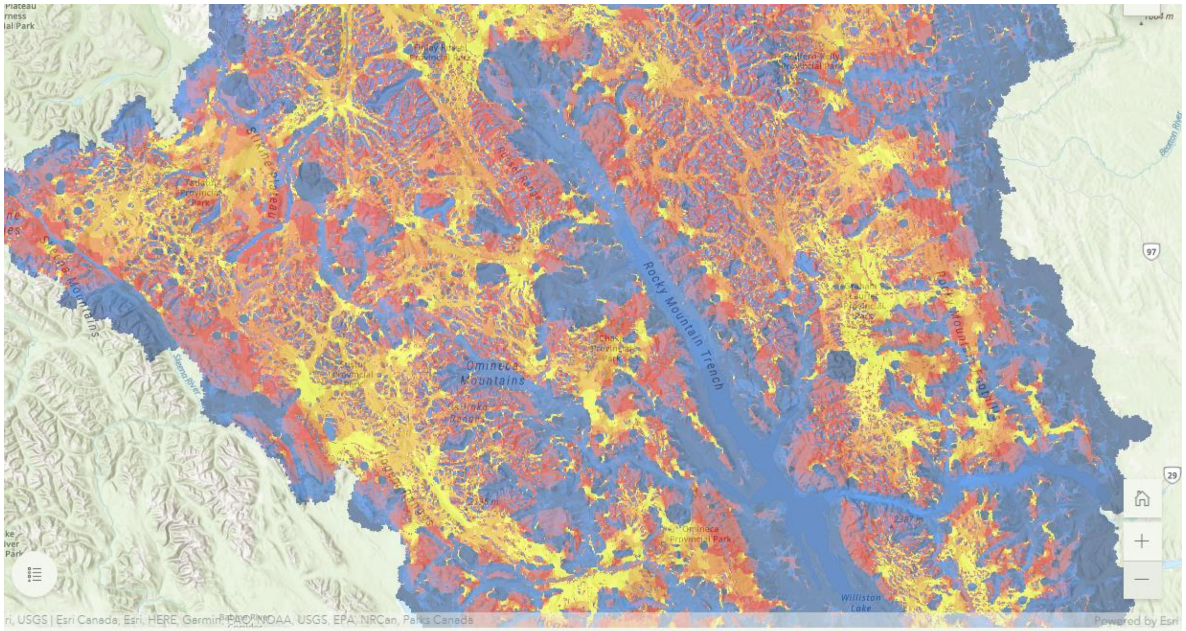
**Resistance of movement** - The unclassified values on the BCS Habitat Connectivity map were used to establish resistances to wildlife movement across the landscape. The Circuitscape program (www.circuitscape.org) was then applied to the resistances to identify least-cost movement paths for wildlife through the study area. The output is a network of lines on a map representing the most likely routes of species movement. Further analysis with Circuitscape identified secondary and tertiary links.

The study noted that this analysis was not species specific and may not be appropriate for all species types.

# Systematic Conservation Planning in Tsay Keh Dene Territory

https://storymaps.arcgis.com/stories/68f4ecd86de6433eab8b22a4ccf937c4

Contact Christopher Morgan




Landscape connectivity across greater Tsay Keh Dene Territory. Use the buttons in the bottom right corner to zoom. A map key is available on the bottom left.

**Aim:** to develop a conservation planning tool for the Tsay Keh Dene that considered biodiversity, climate change and landscape connectivity. The tool is a means of countering industry and identifying climate resilient landscapes for protection.

The traditional knowledge of the Tsay Keh Dene was interwoven with western science datasets on wildlife habitat and key ecosystems with the help of Chu Cho Environmental.

Step 1 – **Collated data layers** – by marrying two ways of knowing the project developed a number of data layers for several species (inc. grizzly bear, fisher, western toad, rusty blackbird etc.), ecosystems and important landscapes for conservation. Three cultural layers were produced highlighting areas important to Tsay Keh Dene for their spiritual and subsistence value.

Step 2 – **Forest pattern and process** – This group of layers sought to capture biodiverse forest based on vegetation type, climate, age, wildfire occurrence and other natural disturbances. The aim was to identify a representative collection of wooded habitats for a range of species.

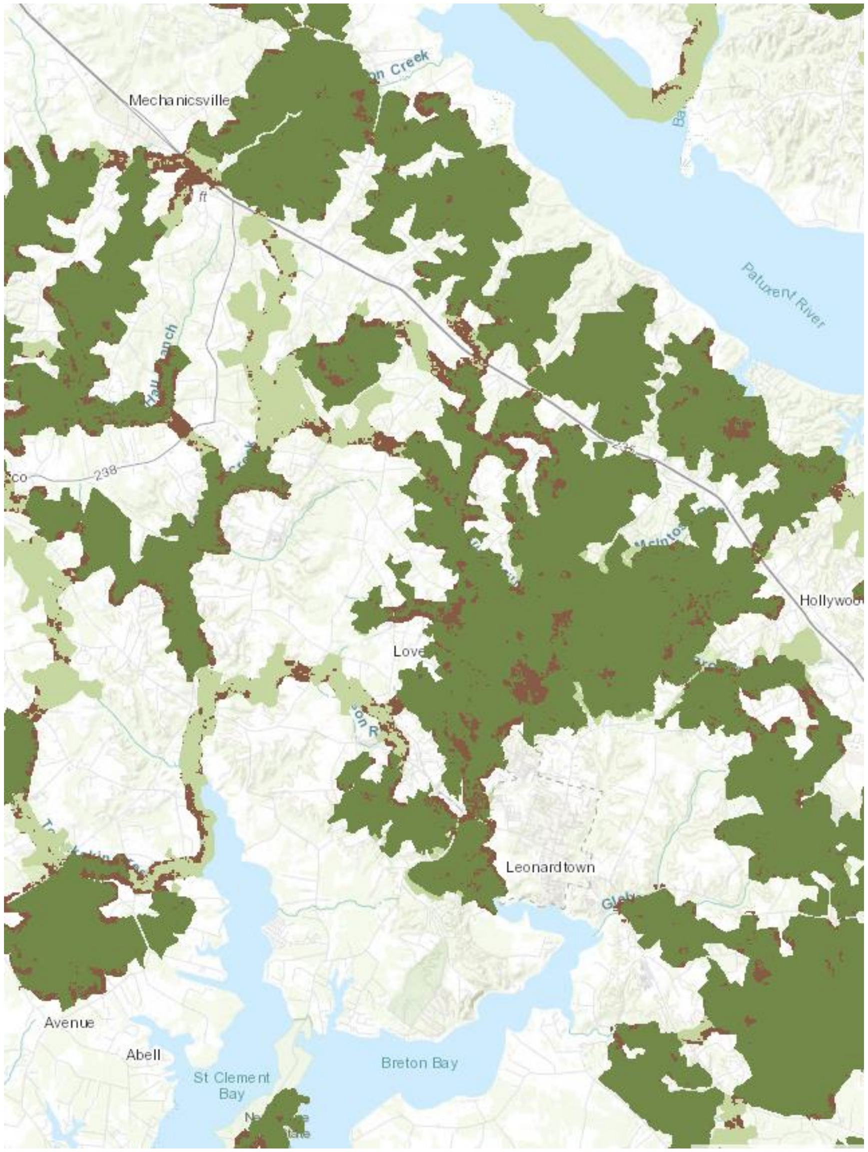
Step 3 – **Biotic Refugia (climate change)** – identified locations resistant to climatic changes that can serve as havens for wildlife.

Step 4 – **Connectivity** - map produced depicting the ability of wildlife to move between habitats and avoid human development (model to be confirmed).

# Maryland's Green Infrastructure Assessment (began in 1997)

https://www.conservationfund.org/images/programs/files/Marylands_Green_Infrastructure_Assessment_and_Greenprint_Program.pdf

https://geodata.md.gov/greenprint/




**Aim:** to provide maps which government agencies and private land trusts can use as a means of rapid assessment to help focus their land acquisition efforts.

The Green Infrastructure layer for the region was developed within GIS.

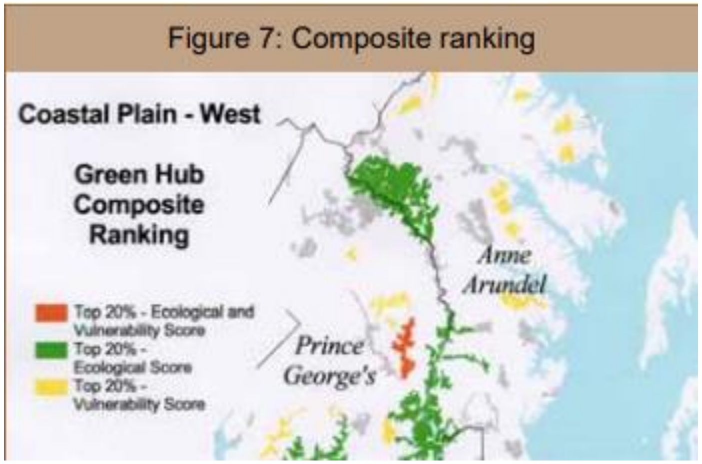
Step 1: from satellite imagery landcover was characterised.

Step 2: into the GIS database they added layers highlighting; roads, streams, topographic features, wetland and biological records.

Step 3: hubs and corridors where then identified;

- Hubs - mapped the network of large blocks of intact forest and wetland.
- Corridors – linear features such as streams and ridgelines linked the hubs together.

Step 4: GIS was used to assess the vulnerability of the network to development based on proximity to population centres, protected open space etc. The ecological value of the components was also undertaken. Sites were ranked according to ecological value, vulnerability to growth and current degree of protection.



## Similarities between Approach

Table 1 Presentation of the similarities between Ecological Connectivity Mapping

| First Nation/Local Government | Structural vs Functional | Size of hub (ha) | Used a landcover layer | Used roads, streams, wetlands | Includes Cultural values | Used biological records | Used hub and corridor approach | Used GIS | Used ranking system | Used least cost path analysis | Used Conefor model | Used Circuitscape |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **City of Surrey** | Structural | ≥10 | Yes | Yes | - | Yes | Yes | Yes | Yes | Yes | - | - |
| **City of Courtenay** | Functional | ≤2.6 | Yes | Yes | - | Yes | Yes | Yes | Yes | Yes | Yes | No |
| **Okanagan Valley** | Structural | ≥100 | Yes | Yes | Yes? | - | Yes | Yes | Yes | ? | No | Yes |
| **Tsay Keh Dene** | Both | - | Yes | Yes | Yes | Yes | ? | Yes | Yes | ? | TBC | TBC |
| **Maryland** | Structural | - | Yes | Yes | - | Yes | Yes | Yes | Yes | ? | - | - |

Guidelines for conserving connectivity through ecological networks and corridors – IUCN (2020)
https://portals.iucn.org/library/sites/library/files/documents/PAG-030-En.pdf

**Table 1.** Common approaches to connectivity modelling (Urban & Keitt, 2001; McRae, 2006; Theobald, 2006; Rudnick et al., 2012; http://conservationcorridor.org/corridor-toolbox/).

| Model type | Brief explanation |
|---|---|
| **Least-cost** | Estimates the surface area of the least-cost movement path from one location (source patch) to another (destination patch) that an individual or process would likely take, assuming knowledge of the destination location, moving across a surface represented by 'costs' (https://corridordesign.org; McRae et al., 2014). Either the single shortest path from one location to another or the full surface area of least-cost distances can be used. Cost-distance surface areas that were created from single, pairwise, factorial or randomly placed locations can be combined. |
| **Circuit theory** | Adapted from electrical circuits, circuit theory identifies connectivity by modelling random walkers moving from sources across a surface of resistances to destinations (grounds), allowing multiple pathway options (McRae, 2006; https://circuitscape.org). |
| **Graph theory** | Graph theory is the study of graphs that formally represent a network of interconnected objects. Graph theory provides the basis for nearly all connectivity methods, including least-cost and circuit theory. In addition, to prioritise ecological corridors, graph-theoretic metrics can be applied across a 'land- or seascape graph' where patches are nodes and areas of connectivity are edges (Urban and Keitt, 2001; Theobald, 2006; University of Lleida, 2007). |
| **Resistant kernel** | Based on least-cost movement from all locations across a land or seascape, implemented using a kernel (moving window) approach (Compton et al., 2007). This approach calculates a relative density of dispersing individuals around source locations. |
| **Reserve design** | An approach to guide systematic multi-objective planning to support spatial decision-making about the design of terrestrial, freshwater and marine reserves and management areas (e.g. Moilanen et al., 2008; White et al., 2013). |
| **Individual-based modelling** | Simulates movement paths of individuals by following postulated rules. The estimated relative frequency of use is mapped (Horne et al., 2007; Ament et al., 2014; Allen et al., 2016). |