Indicator	Health of Forest Ecosystems
Measure(s)	Red Squirrel Abundance (Douglas Squirrels in the Lower Mainland)
Justification	Red squirrels are a ubiquitous element of coniferous forests in BC. They cache and eat conifer seeds and provide prey to a host of meso-carnivores including lynx, bobcat, pine marten, fox, great horned owl and northern goshawk. They have a high reproductive rate, and maintain exclusive, defended year-round territories. A long-term change in red squirrel density would signal a change in seed availability and/or forest habitat integrity and would have cascading effects through higher trophic levels.
Description	Red squirrels regularly emit an audible rattle, especially when their territories are invaded. This protocol involves walking a transect (a section of a trail) and recording the location of rattles heard along the way. This will result in an estimate of relative squirrel abundance through time.
Measurement Frequency	The protocol should be repeated every year at the same time of the year.
Biome	Forests
Pre-test Sampling Strategy	Find a location that is not difficult to access and where there are abundant squirrels. It is best to sample mid-June – mid-July or September as that avoids the months when young squirrels are dispersing and the frequency of rattles increases.
Sampling Strategy	Locate as many transects in a given area as possible (up to 5). Sample them annually but in a different order each year. Sampling involves walking a defined segment of trail and recording squirrel rattles or chattering.
Protocol Source	Karl Larsen, Thompson Rivers University
Unit(s) of Measure	Red squirrel rattles
QA/QC	Repeatability on subsequent days
Analysis	A trend of relative abundance through time will be possible with this data In the future there may be an opportunity to calibrate the rattle data with some more precise work on squirrel density.

Detailed Protocol

- Locate and establish transects

Identify a forest area inhabited by squirrels. Find a location that is not difficult to access, where there are abundant squirrels, and where there is a trail that traverses the squirrel habitat. Establish 5 transects if possible. A transect is a length of trail about 300 m long. Each transect should be independent of all the others so that you are not hearing the same individuals on more than one transect. They can be end to end on a trail, but leave a space between them long enough that you are not hearing squirrels from the previous segment (Figure 1). Mark the beginning and the end of each transect so that it is repeatable in subsequent years. The transect does not have to be straight. Follow a trail beginning a few hundred metres from a trail head if it is busy. If possible, determine how wide the transect is (how far it is possible to hear/disturb the squirrels), and include that information. This can be done by visually locating each squirrel with bionoculars and estimating the distance. After a few transects you will be able to give a maximum distance. You may be able to hear further than the maximum distance, but the squirrels are not being disturbed enough to respond to your presence.

- Data collection

It is best to sample mid-June – mid-July or September as that avoids the months when young squirrels are dispersing and the frequency of rattles increases.

Walk the transect either in the morning (before 10:00) or late afternoon (16:00-18:00). Record the location along the transect where each vocalization is heard and on which side of the transect. A red squirrel chatter (rattle) is easily identifiable. To familiarize yourself with the sound listen to this recording: http://content.lib.utah.edu/cdm4/item_viewer.php?CISOROOT=/wss&CISOPTR=2693. The chatter begins at about 15 seconds. Record the date, time, your name, forest type, weather and any other observations (predators, other trail users, etc.). Repeat the transect 3 days in a row at the same time. In alternate years begin at the opposite end of the transects (Figure 1).

At the same time, keep a record of established middens (piles of cone material) along the transect. Take a GPS location at each midden. If the timing of the survey is in the autumn, note if there is fresh cone material on each midden. If transects are surveyed in the early summer, an autumn midden check can be undertaken if possible.

- Materials
    - Binoculars
    - GPS
    - Permanent markers: pins or tags
    - Datasheet and pencil (or appropriate field hardware such as iPad)
- Personnel Resources
    - One person or more at multiple transects

Figure 1. Red squirrel transects along a trail.