Extension Note 2

Northern Flying Squirrels and Red Squirrels: Is There Life after Beetles and Logging?

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Introduction

In north central BC, the current mountain pine beetle outbreak, and the management response to it, is changing the forest environment. In the public media rhetoric such as 'devastation' and 'environmental disaster' have been common descriptors of the consequences of the beetle; with a desire to 'repair' the damage through logging and re-planting. But what are the actual impacts, how rapidly will recovery occur, and how can we reduce economic losses while maintaining ecological values? There are many efforts underway to address those questions. In this note I report on progress looking at our two tree squirrels: the northern flying squirrel (*Glaucomys sabrinus*) and the red squirrel (*Tamiasciuris hudsonicus*).

Both of these species are common in our forests, and play many ecological roles. They are prey for many carnivores with the red squirrel, for example, being a staple of the northern goshawk and other daytime predators. The flying squirrel, a nocturnal animal, is prey to nighttime predators such as owls. In turn, both squirrel species can be significant predators on nesting birds. The red squirrel consumes conifer seed, spreads seed through caching behaviour, and uses trees for nesting and escape. The flying squirrel depends on trees for its main mode of locomotion (gliding) as well as for nesting, and for tree lichens as a food source. Both species consume fungi, including above ground ('mushrooms') and below ground ('truffles') most of which are ectomycorrhizal species (associated with tree roots) important for tree growth. The flying squirrel is famous for its use of truffles, and has been shown to be an effective dispersal agent for fungal spores.

One could expect all these resources important to the squirrels (i.e. habitat quality) to be severely diminished by logging and perhaps also with tree mortality from the beetle.

In this study, we used live–trapping to examine the effect of time since major disturbance (natural and logging), and the pattern of disturbance (fragmentation), on squirrel presence and abundance. This was designed as an extensive sampling program to test predictions from models built using more intensive, localized field study (e.g. Cotton and Parker 2000). Results from this study and other field projects will support another BV Centre project, which is using modeling to simulate potential ecological consequences, through time, of the interaction of natural disturbance and logging.

The study area is the Nadina Forest District of the Northern Interior Forest Region (BC Ministry of Forests and Range), and includes the Lakes Timber Supply Area (TSA) and the Morice TSA. Forests of the Lakes TSA are dominated by lodgepole pine and are at the heart of the beetle outbreak. The Morice TSA is on the leading edge of the outbreak (Eng et al. 2005) and has more diverse terrain and tree species composition.

Squirrel Presence and Abundance

In the first year of the study (2004/05) we found that the presence of a squirrel at a trap location was not negatively affected, and possibly positively affected, by the amount of edge (one measure of fragmentation) in the immediate surroundings (see Steventon et al. 2005).

We also found that capture probability (the probability of catching a squirrel if it was there) was low in summer and early fall, especially for the flying squirrel, but picked up dramatically in mid to late fall. Imperfect detection of target organisms is a nuisance in many studies – we know when we catch a squirrel that it was present, but when we fail to catch a squirrel we don't know for certain if it wasn't there, or if it was there but we failed to capture it. This requires us to estimate capture probability in order to adjust our results (Steventon et al. 2005).

Northern flying squirrel in a mountain pine beetle attacked stand.
Photo: B. Borrett

Building on those first year results, in the second year (2005/06) we changed the focus to examining squirrel abundance in response to time since disturbance (forest age) and the short-term effect of the current mountain pine beetle outbreak. We also shifted our trapping season later into the fall and winter to take advantage of the higher capture probability.

Thirty 9 hectare trapping grids were placed at sites of varying mean predicted habitat quality. The basic assumption was that resources required by the squirrels (food, nesting, and escape) increase with forest age and productivity. We had sites in the Fulton Lake area where beetle attack was very light, the North Road area where heavy attack was recent (green and red attack), and in the SE Ootsa area (just outside northern Tweedsmuir Park) where attack has been heavy for about 10 years and much of the lodgepole pine is dead and 'grey'.

We then evaluated[1] support for alternative habitat quality recovery assumptions after logging or natural disturbance (Figure 1) using the live trapping data, and examined whether there was evidence of an additional beetle-attack effect. The weight of evidence (5:1) supports the assumption that both species follow the 'rapid recovery' curve rather then the 'slower recovery' curve. However, it is possible the truth lies somewhere in between.

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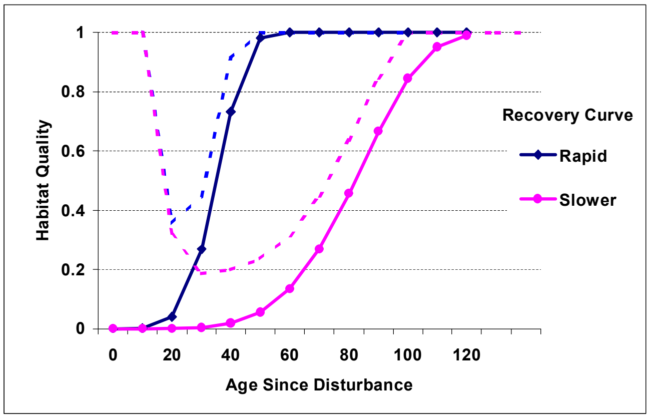
[1] We applied a model comparison approach using Akaike's Information Criteria (AIC). This approach looks at the relative strength of evidence for alternative models rather than 'rejecting' or 'accepting' arbitrary null hypotheses.

In another interior BC study Ransome et al. (2004) found that managed 30 to 40 year old lodgepole pine stands (not affected by beetle) provided good habitat for both species, supporting the rapid recovery assumption.

Figure 1. Habitat recovery assumptions. Dashed lines represent 75% mortality beetle-attacked stands, solid lines represent clear-cuts. The curves shown are for an average productivity (site index) stand. Curves were shifted on the x axis either right (lower site index) or left (higher site index) proportional to site index.



On average, flying squirrel and red squirrel density increased with increasing predicted habitat score (Figure 2). Predicted low value grids were consistently low density, but there was high variability for higher scoring grids that was not explained by the simple habitat models. There was only weak evidence for a small negative effect of the beetle attack. Stone (1995), working in beetle-killed lodgepole pine forests of Utah (3-8 years post beetle), reported generally increased abundance of flying squirrels with increasing stand mortality (0-96%); increased red squirrel abundance with moderate kill, then declining with heavy kill.

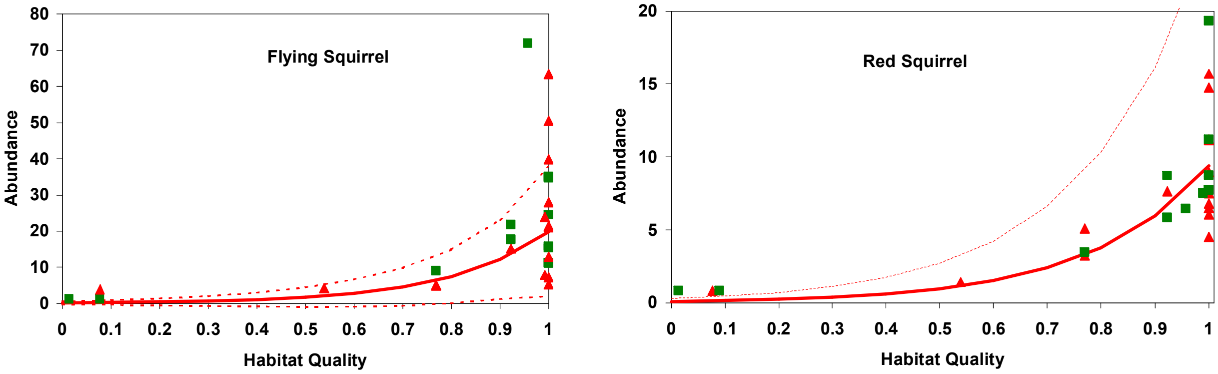


Figure 2. Predicted squirrel abundance (red lines; dashed lines indicate 95% confidence intervals) as an exponential function of the 'Rapid Recovery' habitat quality score. The individual symbols represent the Expected Value of abundance for individual grids. Red triangles are grids in the SE Ootsa area where extensive mountain pine beetle mortality has occurred over the past 10 years. Green squares are for grids in the North Road and Fulton areas where beetle kill just occurred in the last few years, or are not yet attacked.

High variability in squirrel abundance is the norm reported in most studies. It is becoming a dominant belief among squirrel researchers that micro-habitat features not reflected in coarse-scale habitat mapping, and temporally fluctuating local food resources, drive local squirrel distribution and abundance.

It may be that surviving mature trees and/or understory in the beetle attacked stands are sufficient to maintain fungal and other food sources, or perhaps the animals adjust their habits. More detailed field investigation of food resources in the grids, and food habits study of the animals, would be needed to address those questions.

This study could only look at presence and abundance of squirrels, and not other potentially more sensitive but difficult indicators of habitat change such as reproduction and survival. Eventually serious changes in those parameters will be reflected in abundance, but there can be substantive delay or the effects can be masked by movements among sites. We are now looking at how we might collect reproductive data in a cost-effective manner. Mean body weight, a measurable indication of condition, was slightly lower for squirrels captured in SE Ootsa, hinting at a possible subtle effect.

Further data analysis is required to determine if we can better estimate capture probability and thus reduce uncertainty in the estimated abundance and predicted response to habitat models. There is a trade-off between trapping intensity (number of traps per site and number of visits per site), and number of sites that can be sampled for a given cost. Optimizing that trade-off to best answer the questions of interest is an avenue of further investigation.

Conclusions

So, is there life after beetles and logging? So far, from a squirrel perspective, the answer is a qualified ‘yes’. Beetle impact on squirrel abundance appears minimal to date and logging, while clearly detrimental in the short to mid term, likely allows more rapid recovery then previously thought. My working hypothesis (recovery curves presented earlier) is that abundance for many species (such as squirrels) will begin declining in beetle-killed forests after about 10 years, but the depth of decline will be much less than for harvested stands. Monitoring will be needed to test those assumptions.

Clearly, the beetle outbreak and resulting salvage program are changing forest habitats, and species responses will likely vary. Bunnell et al. (2004) conducted a literature review of potential vertebrate responses to the beetle outbreak and large-scale salvage logging, predicting that about 65% of species will be positively or neutrally affected. There are some species likely to be severely disadvantaged; many more will likely change in abundance and distribution, and community interactions can be expected to change.

For historical perspective, the mature forests of today that provide forest products and wildlife habitat are the result of natural disturbance in the past; our forest ecosystems are adapted to disturbance and have a high capacity for recovery. While the current beetle outbreak is of exceptional scale in our life time, and in part may be the product of human induced or natural climate change, it is likely not unprecedented.

Reconstruction of disturbance history for the pine-dominated dry-cool sub-boreal spruce biogeoclimatic subzone (SBSdk) suggested a period of intense and sustained disturbance in the mid 1800’s (Figure 3).

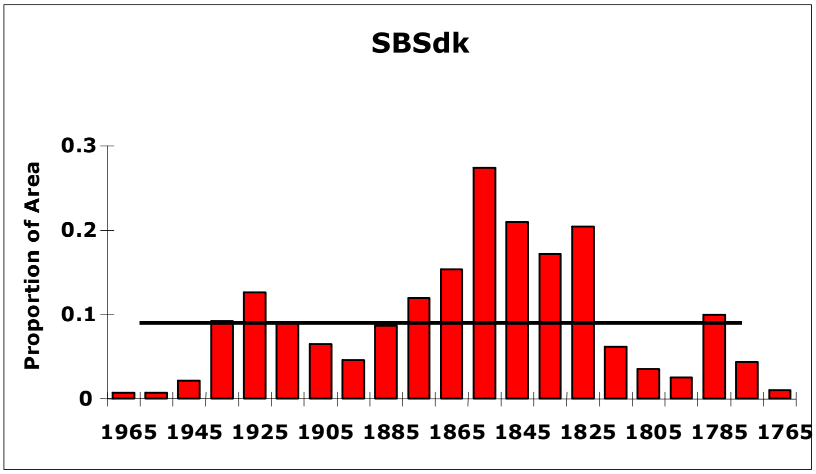


Figure 3. Reconstructed non-logging disturbance rate by decade for the SBSdk (adapted from Steventon 1997). The horizontal line is the mean. Many of the stands of today originated during active disturbance periods starting ~170 and ~80 years ago.

Coincidentally, John McLean, working for the Hudson Bay Company at Fort St. James in the early 1830's noted[2] when describing the territory of northern New Caledonia:

"...*unfortunately, however, the woods are decaying rapidly, particularly several varieties of fir*[3]*, which are being destroyed by an insect that preys on the bark: when the country is denuded of this ornament, and its ridges have become bald, it will present a very desolate appearance*".

While the current beetle outbreak is perhaps not outside the historic norm, how the future will unfold with climate change affecting natural disturbance agents, interacting with intensive human use of the landscape, remains an open question.

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[2] John McLean's Notes of a Twenty-Five Year's Service in the Hudson's Bay Territory. The Publications of the Champlain Society. 1932. (Obtained from National Archives Library).

[3] I suspect 'fir' was used in lay terminology of the time to mean conifers.

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The views represented in this note represent the opinions of the author, and do not necessarily represent the views of either the BV Research Centre or the Ministry of Forests and Range

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