Arthropods of Canadian Forests

Number 2 April 2006

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Formica haemorrhoidalis (photo by R. Higgins).

Welcome

Welcome to the second issue of *Arthropods of Canadian Forests*. This newsletter is a product of a collaboration between Natural Resources Canada—Canadian Forest Service and the Biological Survey of Canada (BSC)—Terrestrial Arthropods. The goal of the newsletter is to serve as a communication tool for encouraging information exchange and collaboration among those in Canada who work on forest arthropod biodiversity issues, including faunistics, systematics, conservation, disturbance ecology, and adaptive forest management. As well, the newsletter supports the Forest Arthropods Project of the BSC. This annual newsletter will be distributed electronically (as a pdf file) in early April. If you wish to be placed on the distribution list, please contact David Langor (see below for contact information).

Newsletter content will include project updates (short articles that introduce relevant Canadian projects); feature articles (overviews, summaries, commentaries, or syntheses); a graduate student section featuring brief summaries of thesis research, funding opportunities, employment notices, and other items of interest; brief news articles concerning meetings, symposia, collaboration opportunities, collecting trips, and other activities; and new publications and websites. Please consider submitting items to the *Arthropods of Canadian Forests* newsletter—articles in either official language are welcome. We also welcome comments on how we can improve the content and delivery of this newsletter.

Contributions of articles and other items of interest to students of forests and forest arthropods are welcomed by the editor. Submission in electronic format by email or CD is preferred. The copy deadline for the next issue is 31 January 2007.

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Cette publication est également disponible en français sous le titre *Arthropodes des forêts canadiennes*.

Canada

Natural Resources Canada / Ressources naturelles Canada
Canadian Forest Service / Service canadien des forêts

Canadian Museum of Nature / Musée canadien de la nature

Biological Survey of Canada Forest Arthropods Project—Progress Report

In 2003, the Biological Survey of Canada (BSC) initiated a new project on arthropod faunistics and systematics related to forested ecosystems. The primary goal of this project is to coordinate research on the diversity, ecology, and impacts of the arthropods of Canadian forests. There has been notable progress with all current activities organized through this project.

Project Database

The BSC continues to maintain and update a list of forest arthropod biodiversity projects in Canada and adjacent parts of the United States (see www.biology.ualberta.ca/bsc/english/forestprojectssummary.htm). This product highlights current activity in Canada and the northern United States and facilitates contact between researchers with complementary interests. As of early 2006, 63 projects were listed. Researchers are encouraged to regularly update their project descriptions and progress and add new projects as they arise. This is a particularly good forum for graduate students to advertise their new work.

Communications

Volume 1 of the *Arthropods of Canadian Forests* newsletter, published in April 2005, was distributed electronically in English and French to almost 175 recipients in 8 countries. Many recipients distributed it even more broadly, exactly the desired result. The large number of notes of appreciation that we have received indicate the need for such a forum, and the mailing list has grown significantly. In addition, the project web pages (www.biology.ualberta.ca/bsc/english/forests.htm) continue to be maintained and updated.

Symposia

A BSC-sponsored symposium, entitled "Maintaining Arthropods in Northern Forest Ecosystems," was held during the annual meeting of the Entomological Society of Canada in Canmore, Alberta, in November 2005. This symposium featured 6 papers that synthesized what is known about the structure and dynamics of selected arthropod assemblages (Carabidae, Staphylinidae, spiders, saproxylic arthropods, Lepidoptera, and aquatic arthropods) in managed boreal and north temperate forests. Speakers were Tim Work, Greg Pohl, Chris Buddle, Keith Summerville, John Richardson, John Spence, and David Langor. The papers from this symposium will be published in *The Canadian Entomologist*.

A second BSC-sponsored symposium at the same meeting, "Arthropods and Fire," organized by Rob Roughley, also focused to some extent on forest arthropod biodiversity.

Report on Bio-Blitz 2005 (Waterton Lakes National Park)

The fifth annual BSC Bio-Blitz occurred in Waterton Lakes National Park, Alberta, from 7 to 12 July 2005. The 27 enthusiastic participants from 5 provinces enjoyed good collecting and camaraderie as they collected in most habitats from the lake shores to alpine terrain. A report on this event appears elsewhere in this newsletter.

Cerambycidae of Canada and Alaska

This research and synthesis project resulted from a partnership between the Canadian Forest Service, the US Department of Agriculture Forest Service, Agriculture and Agri-Food Canada, the University of Cape Breton, and the BSC. The goal is to produce and publish a series of handbooks to the Cerambycidae (Coleoptera) of Canada and Alaska. Most of the large collections in Canada and Alaska have now been examined, and specimens identified and entered into a database. Revisionary work is near completion for the genus *Tetropium*, and other taxonomic work is under way. Some keys have already been developed and photographs prepared.

Report on Bio-Blitz 2005

Bio-Blitz 2005 in Waterton Lakes National Park (WLNP) was the fifth annual Bio-Blitz sponsored by the Biological Survey of Canada (Figure 1). The previous four Bio-Blitzes took place in predominantly grassland sites (Onefour, Alberta; Tall Grass Prairie Reserve, Manitoba; Peace River grasslands, Alberta; Aweme, Manitoba). The event in WLNP was, therefore, the first to include non-grassland ecosystems.

Several different ecological regions meet in WLNP, with biota of the Great Plains, northern Rocky Mountain, and Pacific Northwest overlapping within the park's boundaries. The park's four natural subregions—foothills parkland, montane, subalpine, and alpine—embrace 45 different vegetation types, including grasslands, shrublands, wetlands, lakes, spruce–fir, pine and aspen forests, and alpine areas. This high ecosite richness offered a wealth of arthropod-collecting opportunities that were embraced enthusiastically by 27 energetic participants, who collectively covered most of the park between 7 and 12 July.

Parks Canada personnel working in WLNP, in particular Conservation Biologist Cyndi Smith, were very supportive of this event and provided much in-kind support in the form of access to the research house (used as Bio-Blitz headquarters), free group camp sites, free park access and research permits, maps, and copious helpful advice. Collecting efforts afforded many opportunities to educate the general public about arthropods, biodiversity, and the importance of protected lands. Many Bio-Blitzers also participated in the annual WLNP butterfly count.

Some participants have already identified their collections and have submitted the data to a common database managed by WLNP. Thus far, there are many new records for the park and Alberta and even a few new records for Canada. For example, of the approximately 305 species of macro-moth species collected, the vast majority are new records for the park, 17 are new provincial records, and 1 is a new Canadian record. All data will eventually be accessible to the public, and specimens are being deposited in publicly accessible collections. Many Bio-Blitz participants have expressed strong interest in continuing to work in WLNP, and a group of moth enthusiasts returned for a visit in August 2005. We hope that the 2005 Bio-Blitz experience may give rise to a more long-term arthropod biodiversity survey of WLNP.

Figure 1. Waterton Lakes National Park, site of Bio-Blitz 2005. Left to right: Joe Shorthouse, Felix Sperling, Rob Roughley, and David Langor holding the flag of the Biological Survey of Canada (photo by Andrea Renelli).

Project Updates

Coastal Montane Biodiversity Initiatives: Revisiting Mount Cain, British Columbia

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Introduction

Threats to biodiversity are urgent matters, and understanding the assembly, dynamics, and structure of ecological communities, especially those containing rare taxa, is critical to ecology and conservation biology. Explaining observed patterns of species richness and abundance in space and time remains a central goal in community ecology. An interesting ecosystem in which to test ideas about ancient forest arthropod communities is the montane forest of Vancouver Island, which consists of a mosaic of high-elevation forest and wetland habitats that support a high diversity of arthropods (Figure 2). In 1996–1997, a comprehensive, integrated field study of biodiversity was initiated under the Coastal Montane Biodiversity Project (CMBP) (McNay, S.; Joy, J.; Voller, J. 1998. Managing coastal montane biodiversity. Unpubl. Rep., B.C. Ministry For., Victoria, BC) to provide a geo-referenced species list for coastal montane ecosystems. In addition to documenting the ground and canopy arthropod species of these forests, I implemented a structured arthropod inventory to record species richness and relative abundance patterns. In addition, hypotheses related to the effects of spatial and temporal variation on community assemblages were tested. This particular approach is concerned with defining the organizing principles that elicit community patterns associated with the various levels of complexity in arthropod forest communities, with emphasis on the canopy fauna. The long-term goal of this study is to generate a greater degree of predictability in the examination of temperate forest diversity issues by establishing structured inventories and cataloging species assemblages that encompass dynamic processes such as dispersal, beta diversity, and the effects of habitat loss and fragmentation on arthropods in ancient forests. This report is an update on three components of the Mount Cain arthropod research program: arthropod colonization of needle litter on the ground and in the canopy of amabilis fir (*Abies amabilis* (Dougl. ex Loud.) Dougl. ex J. Forbes), stratification and beta diversity of Staphylinidae, and a graduate student project on spider diversity.

Figure 2. Mount Cain, a montane forest ecosystem, Vancouver Island, British Columbia (photo by N. Winchester).

Sites and Sampling

Study sites were located at the Mount Cain CMBP site on northern Vancouver Island, British Columbia, Canada (50º13'N, 126º18'W). The CMBP was administered by the Ministry of Forests, the Ministry of Environment, Lands and Parks, and the University of Victoria, in collaboration with the Engelwood Logging Division of Canadian Forest Products on Tree Farm Licence No. 37.

The study area consisted of a mosaic of ancient forest (e.g., yellow cedar [*Chamaecyparis nootkatensis* (D. Don) Spach] approximately 2000 years old) interspersed with subalpine ponds and different-aged stands of intensively managed forest in the Coastal Western Hemlock and Mountain Hemlock biogeoclimatic zones. The climate is characterized by short, cool, dry summers and long, wet winters with heavy snow cover. Mean annual precipitation ranges from 1700 to 5000 mm, of which 20–70% is snow.

The sample design and data collection for the CMBP were similar to those of my other canopy arthropod studies on Vancouver Island (e.g., Winchester and Ring 1996; Finnamore et al. n.d.). Five sites were selected from a subset of 50 CMBP transects, which provided a wide range in elevation (from 700 m to 1250 m above sea level). At each site a multiple-trap program (see Danks and Winchester 2000), which included eight sampling or trapping techniques, was undertaken. This program included aerial and ground Malaise and Lindgren traps, ground pan and pitfall traps, canopy branch and lichen collections and canopy and ground experimental litter bags. Traps were sampled every 2 weeks from May to October 1996. Specimens were sorted into target groups, and non-target specimens were stored as residuals. Voucher specimens continue to be deposited at the Pacific Forestry Centre and the Royal British Columbia Museum, both in Victoria, and in the Canadian National Collection, Ottawa.

Arthropod Colonization of Needles

In 1999, Laura Fagan completed her MSc master of science thesis on arthropod colonization of needle litter in the canopy of *A. amabilis* at Mount Cain. Her work provides a template to start testing hypotheses related to microhabitat associations of certain species. This work was recently published (Fagan et al. 2006) and is summarized briefly here.

Forest canopies support diverse assemblages of free-living mites. Our studies on Vancouver Island suggest that similarities in mite species between canopy and terrestrial soils is as high as 80–90%. However, confounding variation in habitat quality and resource patchiness between ground and canopy was not controlled for in previous comparative studies. We used experimental litter bags (Figure 3) with standardized microhabitat structure and resource quality to contrast the colonization dynamics of 129 mite species using needle accumulations on the ground or in the canopy of *A. amabilis* in a temperate montane forest. Mite abundance and species richness per litter bag were five to eight times greater on the ground than in the canopy, and composition differed markedly at family, genus, and species levels. Seventy-seven (57%) of the species were restricted to either ground or canopy litter bags, but many of these species were rare (n < 5). Of 49 "common" species, 15 (31%) were entirely restricted to one habitat, which is considerably lower than most published estimates. In total, 88% of canopy specialists had rare vagrants on the ground, whereas only 52% of ground specialists had rare vagrants in the canopy. Canonical correspondence analysis of mite community structure showed high species turnover through time and a high degree of specialization for early-, mid-, and late-succession stages of litter decomposition, for both ground and canopy mites. In addition, distinct assemblages of ground-specialist mites dominated at each elevation (800, 1000, and 1200 m), whereas few canopy-specialist mites had defined elevation preferences. This suggests

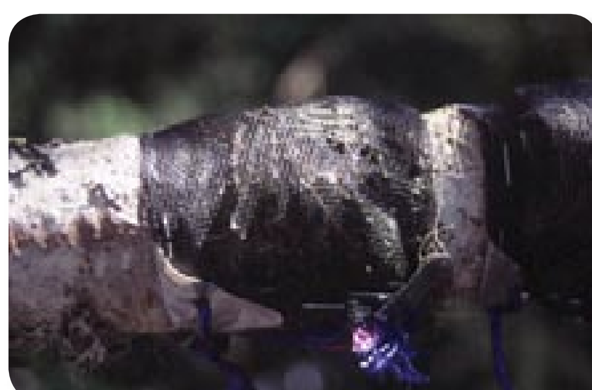

Figure 3. Experimental litter bags attached to *Abies amabilis*, 40 m from the ground (photo by N. Winchester).

that canopy mites may have greater tolerance for wide variation in environmental conditions than soil mites. The degree of species turnover between adjacent mountains also differed markedly, with 47% turnover of ground species but 63% turnover of canopy species between the two montane areas. Although ground and canopy assemblages were similar in terms of total biodiversity, it appears that local mite richness (alpha diversity) is greater on the ground, whereas species turnover between sites (beta diversity) is greater in the canopy.

Beta Diversity and Staphylinidae

In collaboration with Jan Klimaszewski, we have just identified 122 species of staphylinids from a total of 5430 individuals collected at Mount Cain. This data set illustrates the importance of integrating a multiple-trap program with a rigorous sample design (see Danks and Winchester 2000) and properly curating residual trap contents—here, Staphylinidae did not represent an original target group! A paper that will address some of the questions considered by Legendre et al. (2005) is being prepared. For example, is there significant spatial patchiness in the distribution of species? Analyses will include the effects of elevation in conjunction with a suite of environmental variables that were recorded by the CMBP team.

Biogeography and Araneae

Claudia Copley, assistant curator at the Royal British Columbia Museum, started her master of science degree in January 2006. She will be summarizing distribution patterns and testing island biogeography principles associated with spider distributions in ancient forests on Vancouver Island. An important component of this project is the spider fauna from Mount Cain, which has been identified to species by Don Buckle.

Conclusions

Although many countries, including Canada, signed the Convention on Biological Diversity (the Rio Convention) in 1992 and although the ecological, economic, and social importance of sustaining forest ecosystems has been clearly outlined, long-term, detailed arthropod studies that are integrated into sustainable forestry initiatives are lacking. To meet the stated goals of sustainable forest management and retention of biodiversity, an extensive plan of ecological research that includes arthropods is needed to catalog species assemblages and investigate dynamic processes, such as the dispersal of organisms and the effects of fragmentation of ancient forests. The study at Mount Cain clearly illustrates the benefits of taking the proper steps in biodiversity assessment and allowing research options to evolve. These biodiversity-driven projects require long-term commitments, including processing samples from multiple sampling programs, curating residual specimens, and enlisting the help of taxonomic experts.

At the heart of this work is the identification of species. I am indebted to numerous taxonomists for identifying specimens and for the advice that they continue to provide. These taxonomic contributions are invaluable and form the essence of our understanding of arthropod biodiversity.

For more information on this work, consult the following websites: http://www.for.gov.bc.ca/hre/comonbio/product.htm and http://web.uvic.ca/~canopy.

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Postfire Insect Succession in Boreal Forests

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The boreal forest is heavily influenced by fire, which is the major natural disturbance affecting the dynamics of this ecosystem. The boreal forest is actually a mosaic of stands of different successional stages that ensure the maintenance of biological diversity in time and space. Paradoxically, very little is known about the dynamics of burned forests and their contribution to biological diversity. A forest fire is an unpredictable event that generates an immense quantity of dead trees in very little time. Fire is not selective; it kills vigorous trees, reduces or eliminates competition between organisms and releases a plume of smoke that is highly attractive to many species. These very specific conditions differ from those that prevail when a tree dies from senescence, which makes burned deadwood a unique problem.

In response to the recommendations of the Commission to Review Public Forest Management in Quebec (Coulombe Commission), the Quebec government reduced the allowable softwood cut (fir, spruce, jack pine and larch) by 20%. As a result, increased salvage harvesting of burned timber becomes a measure that can contribute to maintaining the timber harvest volumes required by the forest industry. In the Scandinavian countries, where fire suppression effectiveness is such that only 0.01 % of the territory is burned annually, many pyrophilous, or fire-loving, species are on the red list of endangered species. The study of postfire insect succession in boreal forests is therefore important in order to define optimal ways of salvaging burned timber while conserving the biological diversity associated with these environments.

Sampling Design

In the early summer of 1999, a fire destroyed nearly 51 km^2 of the black spruce forest of Parc des Grands-Jardins in Quebec. Since this was a protected area, no burned timber was salvaged, which made it possible to begin our study. The short-term objectives were to 1) measure the impact of the fire on local insect populations and characterize the communities that re-colonize burned forests, and 2) determine the important variables in the selection of burned trees by wood-eating insects. This study was conducted in collaboration with researchers from the Université du Québec à Montréal and received support from the Quebec Department of Natural Resources and Wildlife and the Société des établissements de plein air du Québec. Michel St-Germain, a graduate student, concentrated his Master's degree on this project, studying saproxylic beetles that colonized the burned forests in the first two years after the fire, namely the summers of 2000 and 2001. The selected sites were also sampled in the summers of 2002, 2003 and 2004, thereby covering the first five years after the passage of the fire. This is a permanent sampling plot for the Laurentian Forestry Centre of the Canadian Forest Service (CFS-LFC) and will be resampled 10, 15, 20… years after the fire. This project will become a valuable study on postfire insect succession in boreal forests.

In 2000, 15 burned stands were selected: five 80-year-old stands (resulting from a fire in 1922), five 50-year-old stands and five 20-year-old stands resulting from logging carried out before the park was created. Five non-burned 80-year-old stands (resulting from the 1922 fire) were selected as control sites. In each site, a multi-directional barrier trap (Figure 4) and pitfall light trap (Figure 5) were used to measure the activity of saproxylic and soil-inhabiting insects and to characterize their communities. In addition, burned trees were felled each year. The logs were placed in rearing cages in the CFS-LFC field insectarium and insects emerging from them were collected (Figure 6). Reference specimens were mounted on pins and all other specimens were preserved in alcohol (70%) in a cold room at the CFS-LFC. The data is stored in a relational database, MicroSIGEB, which allows for effective management of the specimen collections (both mounted and preserved in alcohol).

Figure 4. Dr Christian Hébert of the CFS-LFC (on the right in the photograph) installs a barrier trap, accompanied by a student.

Figure 5. The Luminoc® used as a pitfall trap to collect soil-inhabiting insects.

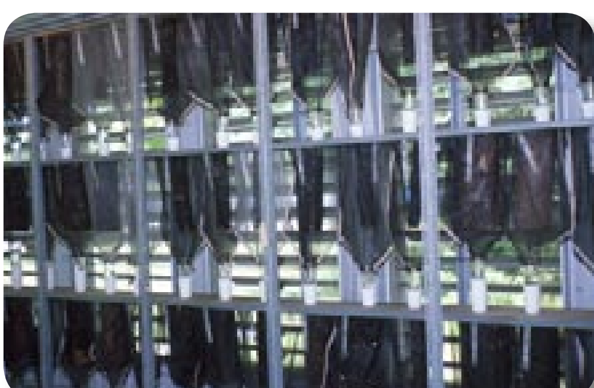

Figure 6. Logs in the rearing cages of the CFS-LFC field insectarium.

Summary Results

The results of the first two years of captures using multi-directional barrier traps and the collection of insects reared from logs formed the basis of Michel St-Germain's Master's thesis and have been published (St-Germain et al., 2004a and 2004b). The identification of insects collected in 2004 is not fully completed. Only a few results from barrier traps and insect rearings are presented.

In the two years following the fire, twice as many individuals and species of Coleoptera (beetles) were captured in burned forests than in unburned forests. Several species of Cerambycidae (sawyer beetles) and Elateridae (click beetles), as well as the Salpingidae *Sphaeriestes virescens* (Figure 7) were significantly more abundant after the fire, whereas *Epuraea* spp. (Nitidulidae) and *Rhizophagus dimidiatus* (Monotomidae) were negatively affected. Although captures were lower in the second sampling year following the fire, the decline in abundance of Elateridae did not subsequently continue. In fact, catches in 2002 and 2003 were comparable to those of 2000. No species of Elateridae emerged from the logs placed in the rearing cages. However, they dominated the Coleoptera communities captured in the barrier traps after the fire. They probably develop in the soil. Moreover, a significant increase in the abundance of Elateridae after a fire has been reported in Finland. Elateridae appear to be attracted to burned areas, where they feed on the roots of grasses, which are abundant after a fire.

Figure 7. *Sphaeriestes virescens* (Coleoptera: Salpingidae), a species associated with burned forests.

Several species of saproxylic beetles take advantage of a resource that suddenly becomes very abundant (dead burned trees) and of the absence of competition/predation after a fire to proliferate. This seems to be the case with *Sphaeriestes virescens*, the abundance of which declined continuously since the start of the study. In the logs placed in rearing cages, this species was found only in severely burned trees. A species of the same genus is red-listed in Scandinavia. Rearing in logs also showed that certain species have long life cycles. For example, species of the family Anobiidae emerged three years after the logs were placed in the rearing cages.

The logs placed in rearing cages also demonstrated that large, lightly burned trees were most heavily attacked by wood-eating species, particularly the whitespotted sawyer (*Monochamus scutellatus*), a species that is of concern to the forest industry because of the damage it causes. Our results show that salvage harvesting plans could be developed that would reduce losses caused by whitespotted sawyers and other wood-eating insects, while preserving biological diversity. In the year after the fire, salvage harvesting of burned timber should be focused first on lightly burned stands of trees of large diameter that are easy to access, i.e., on stands that are the most profitable but also the most vulnerable to attack by sawyers. Stands that are difficult to access (e.g., road system not developed) and therefore costly to salvage, should be dedicated to the conservation of biological diversity. Timber from stands of large-diameter trees that are severely burned should be salvaged in the second year since these trees are much less affected by wood-eating insects. Finally, salvage harvesting of timber from stands of small-diameter trees (either lightly or severely burned) does not appear problematic for the moment since they are of little interest to the industry. These stands also support epigaeic insect fauna similar to that in stands of large-diameter trees, which gives them value in terms of biological diversity conservation. Such a reconciliation of socioeconomic and ecological interests constitutes the very basis of the concept of sustainable development in forest management.

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A Coarse-Filter Approach to Conserving Arthropod Biodiversity in Canadian Forests

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Introduction

Arthropods (insects and spiders) are increasingly used to assess the response of forest biodiversity to management and recovery after disturbance because these organisms are responsive to environmental conditions, taxonomically and trophically diverse, ubiquitous, and easily sampled. Most work to date has focused on species-level responses in an effort to identify the species that can be used to assess biodiversity conservation measures. However, this fine-filter approach has met with only modest success. In particular, it has been difficult to find species whose utility as "indicators" can be extrapolated over large landscapes. Furthermore, the monitoring effort required to assess arthropod indicators over Canada's huge forested areas would be prohibitively expensive. It may be possible to overcome these constraints by coarse-filter approaches to conserving arthropod biodiversity.

The Forest Ecosite Classification (FEC) system is based on vegetation, soil, site, and productivity information (Beckingham et al. 1996). The hierarchical system has four levels—natural subregion, ecosite, ecosite phase, and plant community type. This system is useful for classifying and monitoring plant assemblages within Canadian forests. We asked whether the FEC might be a useful surrogate for arthropod biodiversity, especially for groups that inhabit the soil and litter (epigeic fauna). If so, it may be possible to indirectly monitor arthropod biodiversity over large areas.

Materials and Methods

This research was performed in the Foothills Model Forest in west-central Alberta, mostly on portions of the land base managed by West Fraser Timber Co. Ltd. This managed land base has been harvested for about 50 years and was recently classified and mapped according to the FEC system.

The initial phase of work was limited to the Upper Foothills Natural Subregion which has 13 ecosites (Figure 8; Beckingham et al. 1996). Most of the Upper Foothills landscape is characterized by c, d, and e ecosites. Ecosites c, d, e, and f each had several ecosite phases characterized by different dominant tree species. For each of these four ecosites, the phase dominated by lodgepole pine (*Pinus latifolia*), designated c1, d1, e1, and f1, was sampled, because this was the most common tree species. However, for the c and f ecosites, phases dominated by deciduous trees (mainly *Populus* spp.), designated c2 and f2, were also sampled to determine whether faunal composition is affected by dominant tree cover. For meadows (ecosite g), both shrub-dominated sites (g1) and forb-dominated sites (g2) were sampled. Two to seven sites (each a minimum of 4 ha in size) representing each ecosite and ecosite phase were sampled.

Pitfall traps were used to sample epigaeic arthropods from May to September 2004. Traps were emptied biweekly and samples were returned to the laboratory, where ground beetles (Carabidae), rove beetles (Staphylinidae), and spiders were extracted for identification. The Carabidae for 4 of the 8 sampling periods have now been identified, and these data have been subjected to preliminary analyses. Once the remainder of the carabids are identified, the complete data set (and data on spiders) will be fully analyzed.

Because of occasional trap disturbance, the catch of beetles was standardized to a selected number of trap-days. Also, species richness was standardized using rarefaction, which corrects for variable catch by calculating the expected number of species from the number of individuals collected. The relationships of beetle assemblages among harvesting and scarification treatments were examined using Bray-Curtis percent similarity measures.

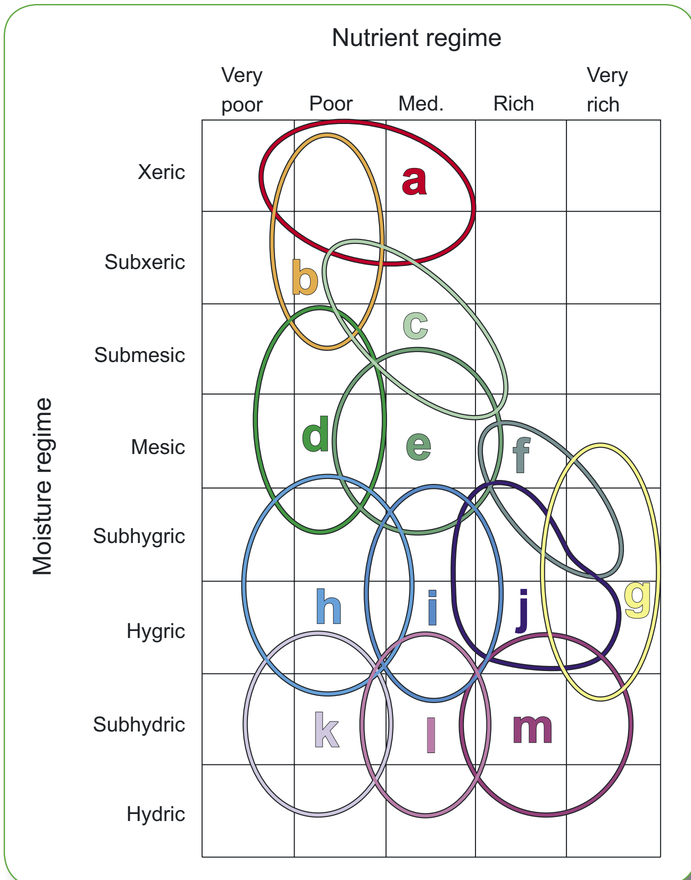

Figure 8. Classification of Upper Foothills ecosites on a soil moisture and nutrient grid: a = Grassland, b = Bearberry/Lichen, c = Hairy Wild Rye, d = Labrador Tea/Mesic, e = Tall Bilberry/ Arnica, f = Bracted Honeysuckle, g = Meadow, h = Labrador Tea/Subhygric, I = Labrador Tea/Horsetail, j = Horsetail, k = Bog, l = Poor Fen; m = Rich Fen.

Results

A total of 10 596 specimens of Carabidae, representing 80 species, were collected. The catch of beetles was highest in the richest forest type (f1 and f2) and in the deciduous c2 stands (Figure 9). Deciduous stands (c2, f2) had higher catches than conifer stands of the same ecosites. Subhydric bogs and fens had the lowest catches.

Rarefaction-estimated species richness was highest in the treeless ecosites (a, g1, g2), bogs (k), and fens (l, m) (Figure 10). The xeric and nutrient-poor grasslands had the highest species richness of all ecosites, which probably reflects the fact that some of these sites had been recently disturbed by water runoff and railroad construction, which exposed the mineral soil and attracted a high diversity of beetles that thrive in disturbed sites. Thus, the sites monitored may not have been truly representative of this ecosite, which is extremely rare in the Upper Foothills.

Cluster analysis of Bray-Curtis percent similarity was initially performed for all ecosites and stands. Treeless ecosites (a, g) generally clustered together, as did subhydric bogs and fens. However, no clear cluster patterns were evident among treed ecosites. Cluster analysis including only the treed ecosites (b through f and h through j) and using log-transformed data revealed four groups of ecosites (Figure 11): subxeric stands (b), hygric stands dominated by spruce (h, i, j), deciduous stands (c2, f2), and submesic or mesic stands (c, d, e, most f1). A few stands did not group with others of the same ecosite or phase. Two f1 stands clustered with the deciduous stands; however, one of these had a much higher deciduous component than the other f1 stands.

Most species, including six of the eight most common species, were found in all or most of the eight forested ecosites. Some species were indicative of particular groups of forested ecosites (Table 1). Deciduous stands, treeless ecosites (grasslands and meadows), and subhydric sites (bogs and fens) had the most characteristic species.

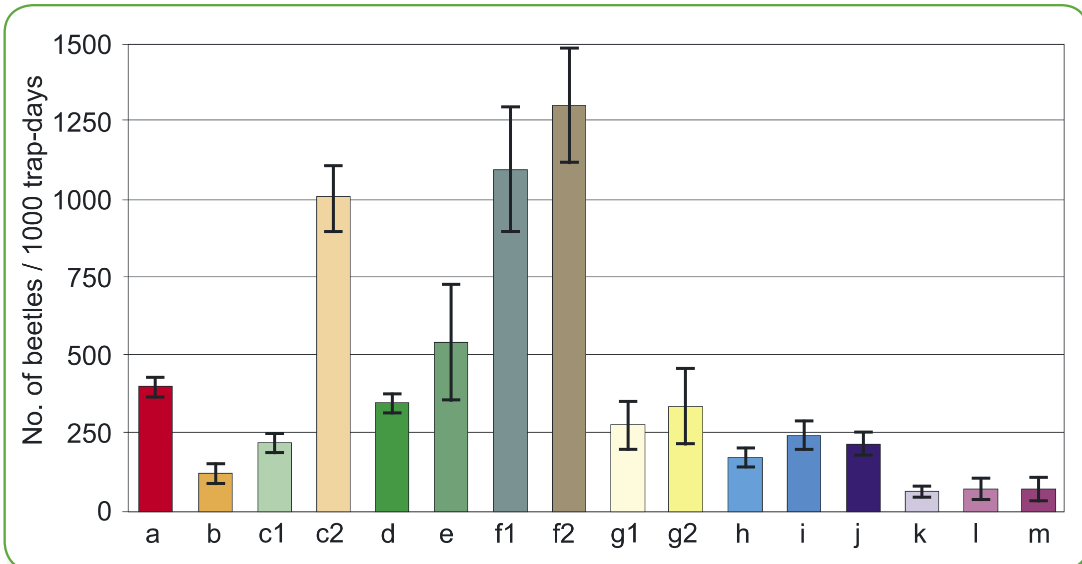

Figure 9. Standardized catch (mean number of beetles per 1000 trap-days) of carabid beetles for each ecosite and ecosite phase. Error bars represent standard error.

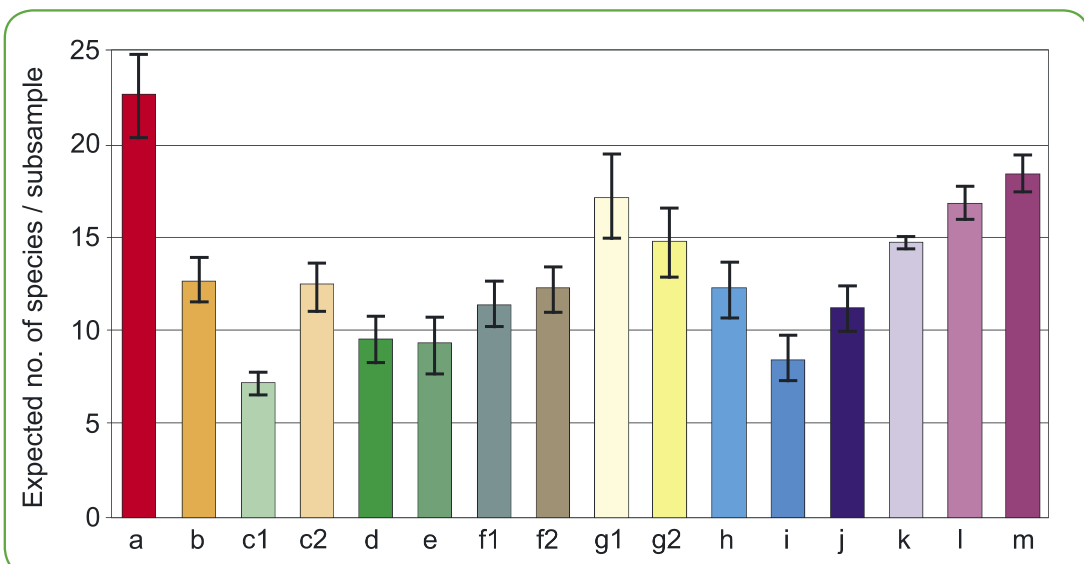

Figure 10. Rarefaction-estimated species richness of carabid beetles for each ecosite and ecosite phase (based on a subsample of 100 beetles). Error bars represent standard deviation.

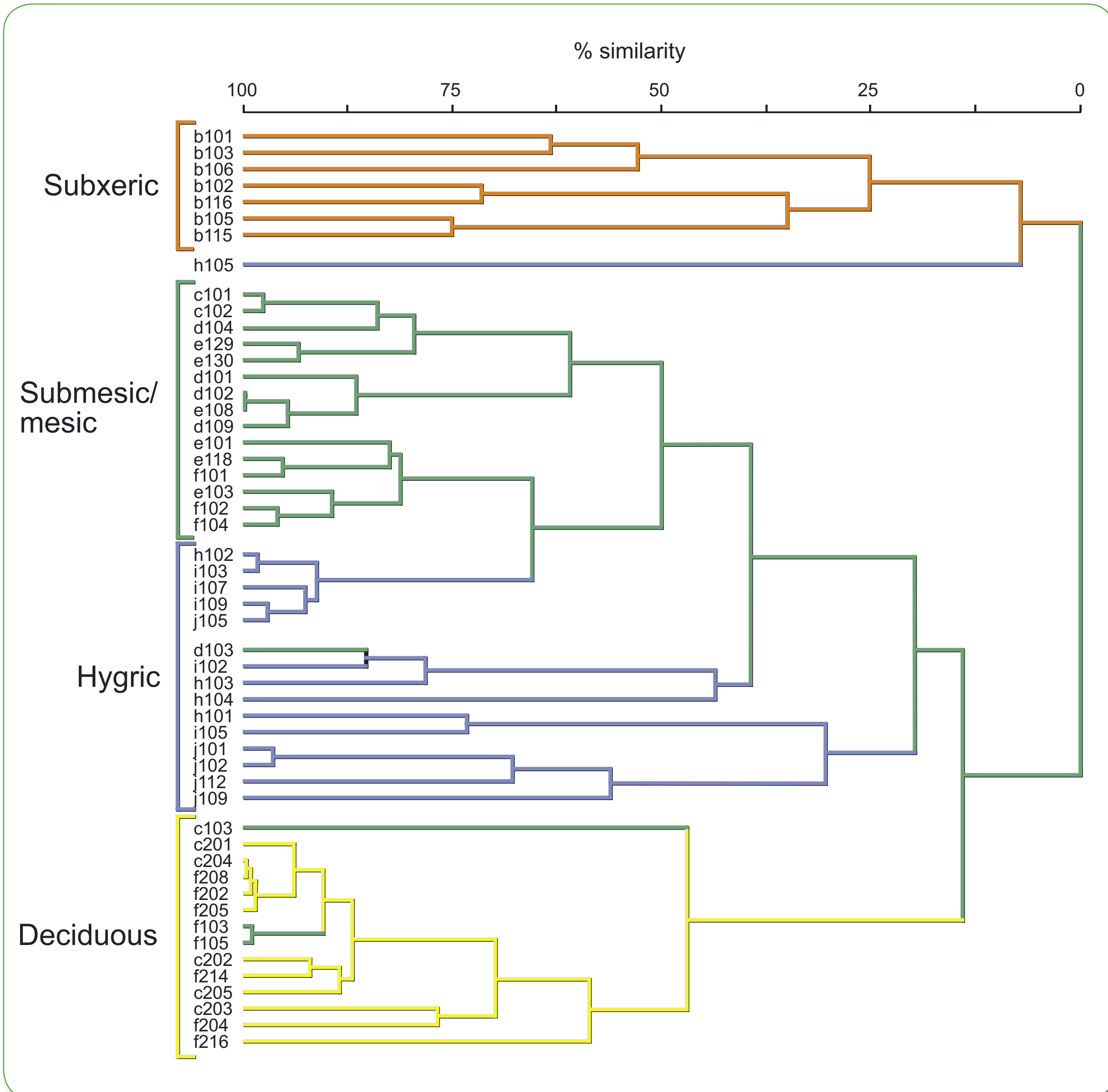

Figure 11. Cluster analysis of Bray-Curtis percent similarity for forested ecosites (b through f and h through j, as defined for Figure 8).

Table 1. Carabid species indicative of groups of forested and nonforested ecosites in the Upper Foothills Subregion

Ecosite groups[a]	Characteristic species
Subxeric forest (b1)	*Carabus taedatus* Fabricius
	Notiophilus directus Casey
Submesic or mesic coniferous forest (c1, d1, e1, f1)	*Nebria crassicornis intermedia* Van Dyke
	Pterostichus brevicornis (Kirby)
Hygric coniferous forest (h1, i1, j1)	*Pterostichus punctatissimus* (Randall)
	Trechus apicalis Motschulsky
Submesic or mesic deciduous forest (c2, f2)	*Agonum retractum* LeConte
	Calosoma frigidum Kirby
	Leistus ferruginosus Mannerheim
	Platynus decentis (Say)
	Pterostichus riparius (Dejean)
Treeless grasslands and meadows (a1, g1, g2)	*Agonum cupreum* Dejean
	10 *Amara* spp.
	10 *Bembidion* spp.
	3 *Harpalus* spp.
Subhydric treed bogs and fens (k1, l1, m1)	*Agonum gratiosum* (Mannerheim)
	Dyschirius nigricornis Motschulsky
	Dyschirius timidus Lindroth

[a]See Figure 8 for further definitions of ecosites.

Discussion

These results are preliminary. There is an enormous amount of data yet to be considered, specifically, half of the carabid catch and all of the staphylinids and spiders. It will be another year before final results are available.

In this study, the treeless ecosites, fens, and bogs had characteristic faunas, including many rarely collected species and many species that were not found in forested sites. These ecosites, some of which are relatively rare in the Upper Foothills Subregion (especially grasslands and meadows), should have high conservation value and should be protected from destruction and degradation.

Among the forested ecosites, moisture had a stronger influence than soil nutrients in determining distribution of species; however, soil nutrient richness had a stronger (positive) influence on carabid abundance. Tree composition, at least in terms of coniferous or deciduous, had a strong influence on species abundance (higher in deciduous stands) and species composition (many species strongly preferred deciduous stands). As deciduous stands are relatively uncommon in the Upper Foothills Subregion, such stands should be a high priority for preservation.

In conclusion, the FEC has shown some initial promise as a coarse-filter approach for conserving epigaeic arthropod biodiversity. In addition to completing the species identifications and data analyses for this initial study, additional fieldwork will be undertaken in 2006, mostly in Jasper National Park, to sample some ecosites in the Montane and Lower Subalpine natural subregions. Work will expand into boreal forests in 2007.

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Pyrophilous Beetles and Postfire Salvage Logging: A Hot Issue for Sustainable Forest Management and Biodiversity Conservation

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Throughout the circumpolar boreal forest, natural disturbances like wildfire play important ecological roles in maintaining habitat variability and biodiversity (Rowe and Scotter 1973; Johnson et al. 1998; Bergeron et al. 2001). Variation in the timing and severity of forest fires creates a mosaic of different stand types and ages across the boreal landscape (Bonan and Shugart 1989), and the resulting variation in successional habitats supports the biotic diversity that characterizes the boreal region. Boreal ecosystems today are affected by many simultaneous and potentially interacting environmental stressors, with uncertain ecological consequences (Schneider 2002). Industrial forest management, fire suppression, global climate change, and increasing economic demand for both timber and non-timber resources (e.g., oil and natural gas) contribute markedly to the disturbance regimes in many areas. The combined effects of these disturbances against a background of naturally occurring wildfire and other disturbances will undoubtedly be complex and difficult to assess for many species. Clearly, meeting the simultaneous goals of continued ecological functioning of boreal ecosystems and sustainable forest management will depend on a better understanding of the ecological consequences of combining natural and anthropogenic disturbances.

Many boreal species display adaptations to a regime of regular disturbance by fire. For example, some plant species, such as jack pine (*Pinus banksiana* Lamb.), possess serotinous cones that are closed with resin and remain in the crown until opened by extreme heat (Muir and Lotan 1985; Johnson and Gutsell 1993; Radeloff et al. 2004), others, such as fireweed (*Epilobium angustifolium* L.), are able to quickly disperse into burned areas to take advantage of the sudden postfire flush of nutrient availability (Rowe 1983). Research on birds has shown that several species, such as the black-backed woodpecker (*Picoides arcticus* Swainson) and the three-toed woodpecker (*Picoides tridactylus* L.), are associated with burned forest habitats, presumably because they are attracted by the increased availability of insect prey (Hutto 1995; Hoyt and Hannon 2002). Many species of insects are considered to be adapted to fire or "pyrophilous" (fire-loving) (Evans 1971; Wikars 1997). Probably the most striking example of a pyrophilous insect is the black fire beetle, *Melanophila acuminata* (DeGeer) (Buprestidae). Individuals of this species have a pair of specialized infrared-detecting metathoracic organs, which enable them to rapidly colonize fire-killed trees (Evans 1962, 1966; Schmitz et al. 1997).

Fire-killed trees represent an important input of dead wood or coarse woody debris on the landscape, and this substrate is now widely recognized as critical for maintaining biodiversity in managed forests (Esseen et al. 1997; Ehnström 2001; Harmon 2001; Grove 2002). Species associated with dead wood are called "saproxylic" (Speight 1989), and research in Australia (Grove 2002), Canada (Hammond et al. 2001, 2004; Saint-Germain et al. 2004), and Europe (Siitonen and Martikainen 1994; Økland et al. 1996; Martikainen 2001; Siitonen 2001; Kappes and Topp 2004; Martikainen and Kaila 2004) has suggested that saproxylic insects are particularly sensitive to intensive forest management because of its effects on volume, exposure, and piece size of deadwood. Many saproxylic insects in Fennoscandian boreal forests either have been extirpated or are currently threatened by reductions in deadwood volume (Siitonen and Martikainen 1994; Martikainen 2001; Siitonen 2001; Grove 2002). In Sweden, for example, Ehnström (2001) reported that more than 1000 beetle species depend directly on dead trees for their survival and that many of those species are currently ""red-listed". In another study, Siitonen and Martikainen (1994) found that several saproxylic species that were absent from Fennoscandian boreal forests were still present in Russian forest stands close to the Finnish border, where deadwood volumes were still relatively high. This northern European situation may offer a glimpse of the future of Canadian boreal forests. Alternatively, we may be able to use this knowledge to develop our own sustainable forest management strategies.

Canadian forest managers interested in managing coarse woody debris on the landscape face an additional challenge. Despite increased fire suppression efforts that have been undertaken to safeguard human lives and property, wildfires are still relatively common. More than 7500 wildfires occur each year in Canada, covering an average of 2.8 million ha (range 0.7 million to 7.6 million ha) and consuming approximately 70 million m^3 ($1 billion worth) of merchantable timber (Natural Resources Canada 2005). Postfire salvage logging is now used to recover some of the economic value of burned timber (Nappi et al. 2004). Salvage operations are generally conducted 1–3 years after a fire to reduce further economic losses due to degradation of timber by wood-boring beetles (Ross 1960; de Groot and Nott 2004). However, because this practice combines the effects of wildfire and forest harvesting on the same sites, it not only results in the reduction of deadwood on the landscape, but also contributes to multifactorial environmental stress. Very little is known about the short- and long-term ecological consequences of postfire salvage logging, and few predisturbance management guidelines are in place (Lindenmayer et al. 2004; Nappi et al. 2004; Donato et al. 2006). In addition, there will likely be an increasing economic emphasis on postfire salvage to maintain current timber quotas over the next century, given predictions of dramatic increases in the occurrence of wildfire, especially in western boreal ecosystems (Overpeck et al. 1990; Flannigan and van Wagner 1991; Wotton and Flannigan 1993). As a result, postfire salvage logging has become an important issue in biodiversity conservation and sustainable forest management (Lindenmayer et al. 2004; Donato et al. 2006).

For the past 3 years, we have been examining the effects of postfire salvage logging on saproxylic beetles in boreal north-central Alberta. Fieldwork for this study was conducted in and around a severe, large-scale (about 120 000 ha) wildfire that occurred from 27 May to 4 June 2001 near the hamlet of Chisholm, Alberta (54°55', 114°10'W). Fire severity was very high as a result of drought-related fuel buildup (a common condition under fire suppression throughout the west) and extreme weather conditions, such that few trees survived and mineral soil was exposed over large areas (Quintilio et al. 2001). Before the fire, the area was dominated by pure and mixed stands of white spruce (*Picea glauca* (Moench) Voss), black spruce (*Picea mariana* (Mill.) BSP), trembling aspen (*Populus tremuloides* Michx.), balsam poplar (*Populus balsamifera* L.), and jack pine, with minor elements of balsam fir (*Abies balsamea* (L.)), larch (*Larix laricina* (Du Roi) K. Koch), and paper birch (*Betula papyrifera* Marsh.). Our study focused on mixed stands of white spruce (60% of total stems) and trembling aspen (40%).

To examine beetle responses to postfire salvage logging, we selected sites according to four stand treatment categories: GRN (green), reference sites that had not been burned or harvested in more than 100 years; BRN (burned), sites that were consumed by the Chisholm fire; HAR (unburned, harvested), sites that were logged by clear-cutting in 2001; and SAL (salvaged), sites that were burned by the Chisholm fire and then salvaged during the winter of 2001–2002. Each site consisted of an individual stand of trees (3–30 ha) selected on the basis of predisturbance stand characteristics (age, tree species composition, stem density, soil characteristics) and accessibility, determined initially from forest inventory maps and then verified on the ground. Six sites were selected for each stand treatment category (total 24 sites) and the minimum distance between any two sites was 1 km.

Saproxylic beetles were sampled using flight-intercept traps (Kaila 1993; Hammond 1997; Hammond et al. 2001, 2004) attached to white spruce trees and stumps (Figure 12). These traps consisted of a thin (0.3 cm) piece of clear plastic (20 cm × 30 cm) above a heavy cloth funnel that led to a plastic sample cup (100 mL) containing about 30 mL of silicate-free ethylene glycol (GM Dex-Cool, Oshawa, Ontario). A total of 120 traps were deployed in this study. At each of the GRN and BRN sites, four traps were attached to standing dead white spruce trees at approximately 1.5 m above the ground, whereas at each of the HAR and SAL sites, the four traps were attached to stumps because of the scarcity of available trees. To account

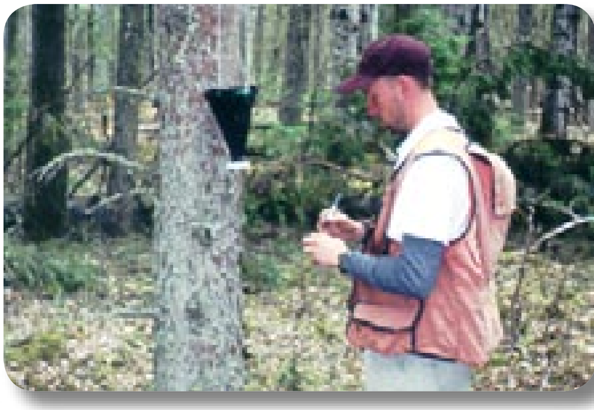

Figure 12. Tyler Cobb checking a window trap attached to a snag (photo by T. Cobb).

Figure 13. A common pyrophilous cerambycid beetle, *Monochamus s. scutellatus* (photo by P. Debnam).

for the possible confounding effect of trap height, an additional two traps per site were placed at the base of the standing trees at the GRN and BRN sites. All traps were serviced biweekly during the frost-free months (April to September) of 2002 and 2003; all collected beetles were removed, and the ethylene glycol replaced. Beetle specimens were stored in 70% ethanol for later identification.

To date, a total of 12 719 saproxylic beetles representing 266 species from 49 families have been collected and identified. Analysis of these data is still in progress, but already several interesting patterns are emerging. In particular, postfire salvage logging appears to alter species richness and species composition more than either fire or harvesting alone, which suggests that the combined effect of these two disturbances is cumulative. Moreover, several pyrophilous, wood-boring species, including *Melanophila acuminata* and the cerambycids *Acmaeops proteus* (Kirby) and *Monochamus s. scutellatus* (Say) (Figure 13) were negatively affected by salvage logging, which suggests that this group may be of particular interest in the development of guidelines for managing postfire salvage logging. Experimental work is now under way to better understand the functional roles of these species in terms of woody debris decomposition and nutrient cycling in burned stands and thus to more fully assess the ecological consequences of salvaging burned timber. For more information on this project, please contact Tyler Cobb (tcobb@ualberta.ca).

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Graduate Student Focus

Coarse Woody Debris as Refugia for Ants in the Cool, Moist Sub-boreal Forests of British Columbia

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Despite the growing international appreciation of the ecological role of ants in forest ecosystems, there have been few investigations of this fauna in Canada. When I began my research 3 years ago, I discovered that, in particular, little was known about ant communities in the cool, moist sub-boreal forests of British Columbia with respect to composition, specific habitat requirements, interactions with other fauna, and faunal responses to the seral changes that are typical in these intensely managed forests. Through my research, I am seeking to develop a basic understanding of ant faunal composition and ecology in these stands. Here I summarize progress that has been made in understanding habitat requirements.

Ants (Figure 14) are members of a thermophilic taxon found in great abundance when conditions are warm and dry. Under ideal conditions, ants can exploit a great variety of nesting sites, although most use soil. With increasing latitude, the soil becomes cool, and ants must seek out nesting sites that allow them to maximize heat gain. Nests may be built under rocks, which have a higher

Figure 14. *Formica aserva* with pupa, a common species in coarse woody debris (photo by R. Higgins).

specific heat than soil, or thatched nests may be constructed in which the sloped thatch maximizes solar exposure. In these environments, woody debris, which is used for nesting in most habitats, becomes increasingly important. For example, the proportion of ant species that nest in coarse woody debris (CWD) is less than 10% in Nevada (latitude 38ºN), about 35% in North Dakota (48ºN), and almost 60% near Prince George, British Columbia (53ºN). In my study area, some 300 km west of Prince George, in still cooler and wetter forests, 15 (94%) of the 16 species of ants identified are associated with CWD.

There are several possible explanations for this north–south cline in use of CWD for nesting. First, CWD has a higher specific heat than soil and can absorb more heat during the day and hold it longer through the night, as confirmed by temperature monitoring during my study. Second, CWD is elevated above the ground and low vegetation, which improves insulation and heat gain. Third, with the rise in soil moisture after harvesting operations, CWD helps to keep ant colonies away from moisture that would act as a heat sink. Fourth, CWD provides a malleable yet stable matrix for nest construction.

In the moist, cool sub-boreal forests of British Columbia, ants are at the edge of their thermal tolerance. Despite an abundance of CWD in nonharvested closed-canopy stands, the ant fauna is largely absent. For example, in nonharvested stands, only 3% of pieces of CWD (n = 333) hosted ants, whereas the proportion was 88% of pieces (n = 553) in clear-cut stands 15 years after harvest. The thermal advantages afforded by CWD can be offset by canopy closure with seral development. A shading experiment performed during the past field season confirmed the need for nest insulation.

In 2005, I concluded my field research. I now have a good species list and a better understanding of specific habitat requirements, I have quantified how frequently bears feed upon ants nesting in CWD, and I have data detailing the change in ant community composition with seral development.

Dynamics of a Lepidoptera Assemblage in Managed Boreal Forests of Alberta, Canada

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Habitat change caused by forest management practices can strongly affect insect assemblages by altering microhabitat features, tree species composition, and canopy structure. I am trying to assess how logging alters insect communities by evaluating the impacts of forest cover type, retention harvest, and prescribed burning on a Lepidoptera assemblage. Lepidoptera, one of the most diverse orders of insects fulfills important functional roles, and many species respond to environmental perturbations.

My work is part of the Ecosystem Management Emulating Natural Disturbance (EMEND) project, which was established in 1997 in the boreal forests of northern Alberta, approximately 90 km northwest of Peace River (56°44'N, 118°20'W). The core EMEND research work focuses, among other objectives, on the effect of cover type, treatment (harvest and burning), and their interactions on arthropod diversity. My study will examine, analyze, and interpret patterns of species abundance, diversity, and community assemblages of moths in response to postharvest forest regeneration over a period of 3 years. The project has the following specific objectives:

1. To determine post-treatment moth assemblages at the EMEND research site and to evaluate treatment effects on relative abundance, species richness, evenness, community assemblages, and trophic interactions.
2. To determine the post-treatment defoliator assemblages (caterpillars) associated with understory shrub species at the EMEND site and to evaluate treatment effect on richness,

species diversity, functional diversity, and species composition.

3. To determine the parasitoid complex of selected understory larval species at the EMEND site and to evaluate the effects of treatment on these complexes.

Within the larger EMEND experimental template, my work focuses on two cover types, conifer-dominated (>70% of canopy trees are coniferous) and deciduous-dominated (>70% deciduous), and two harvesting treatments, 20% and 50% green-tree retention. Compartments chosen for study are each 8 to 10 ha, and there are three replicates of each combination of cover type and harvest treatment. The effects of treatment (harvesting) will be compared with results for unharvested controls and burned stands of each of the two cover types. Adult moths were sampled in 2005 using ultraviolet light traps (one trap per compartment) (Figure 15). Also, larvae feeding on understory plants were sampled and reared in the laboratory until emergence. Identification of moths to the species level is under way. Moths will then be grouped according to functional and ecological groups, on the basis of their feeding guilds, habitat use, host plant species, host plant range, and seasonality. My work is continuing in 2006.

Figure 15. Esther Kamunya checking ultraviolet light trap (photo by E. Kamunya).

Carabid Beetle Assemblages in Jack Pine Forests in Southeastern Manitoba

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Insect communities in managed forests may be affected by reforestation strategies, and these effects may occur at different stages of forest succession. These communities are typically examined by means of chronosequence study designs, in which space is substituted for time. From 1991 to 1994, the influence of succession and regeneration type on carabid beetle assemblages was studied in naturally regenerating and planted jack pine (*Pinus banksiana* Lamb.) forests using a chronosequence study design. I sampled carabid communities at the same sites in 2003–2004 and examined changes over the intervening period. Carabid beetles were collected by continuous pitfall trapping (Figure 16) in planted and naturally regenerating forests 15, 25, 35, and 50 years of age. Carabid catch, site-level diversity measures, beta diversity, and assemblage composition were examined for the influence of forest age and regeneration type. The degree to which the 2003–2004 results of these measures were predicted by the 1991–1994 data was also examined. Habitat characteristics at the study

Figure 16. Kathleen Ryan checking a pitfall trap (photo by K. Ryan).

sites were measured and used to explore relations between the composition of the assemblages in 2003–2004 and these habitat characteristics.

In 2003–2004, carabid species diversity decreased with forest age, but total beetle catch, number of species, and species evenness were not significantly influenced by stand age. Regeneration type did not significantly affect total catch, species richness, or species evenness. In 2003, species diversity was higher in young planted sites than in young natural sites, but among older sites diversity tended to be higher in natural sites. Beta diversity was not significantly affected by regeneration type overall, but older plantations were more similar to one another than they were to corresponding natural sites. Results from the 1991–1994 collection period predicted those of the 2003–2004 collection period for all measures; however, predictions were better for total catch, species richness, and species diversity. Assemblage composition was distinctly for young sites compared to older sites. There was little influence of regeneration type, although in 15-year-old forests, the composition of carabid beetle assemblages differed between planted and naturally regenerating forests. Assemblages at sites older than 15 years tended to be affected by shrub development, which tended to be higher at planted sites. In this study, carabid assemblages were primarily influenced by forest age, but some effects of regeneration type were evident more than 50 years after reforestation. Chronosequence study designs adequately predict successional trajectories among carabid beetle assemblages in forests.

Diversity of Cecidomyiidae (Diptera) Living in Deadwood in a Quebec Hardwood Forest

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The habitat created on the forest floor by fallen logs is known to sustain a great diversity of insect life. Surveys of the deadwood insect community have documented that some of the most abundant Diptera in deadwood are the gall midges (Cecidomyiidae), but few studies have identified collected specimens to the species level. This lack of species-level identification means that it has been impossible to determine the ecological roles of gall midge species and communities in deadwood, since cecidomyiid species generally occupy different trophic groups. To resolve these questions concerning gall midge diversity and ecology, my master of science research focused on a species-level inventory of an old-growth forest community of Cecidomyiidae living in deadwood. I also examined associations of the studied midge communities with the decay stages and tree species of host logs.

Cecidomyiidae were collected from the insect community living in fallen wood in the old-growth forest at Mont Saint-Hilaire, Quebec, from June until September 2004. A total of 24 392 specimens representing 323 species and morphospecies were collected in 28 emergence traps (Figure 17) set over American beech (*Fagus grandifolia* Ehrh.) and sugar maple (*Acer saccharum* Marsh.) logs at two different stages of decay. Given that the latest recorded survey reported that 100 Cecidomyiidae species (mostly of agricultural relevance) have been recorded in Canada, the 323 species recorded in this study probably triples the number of recorded Canadian cecidomyiid species. Analysis of known

Figure 17. Duncan Selby servicing an emergence trap (photo by G. Gilbert).

and inferred feeding habits showed that most species were fungivores, detritivores, or predators, with many of the predatory species feeding on other Cecidomyiidae. The most numerous species was the paedogenic species *Miastor metraloas* Meinert (17 002 individuals collected).

The 3555 individuals and 197 species most accurately representing distinct, non-paedogenic species were analyzed to determine host associations. Significantly more specimens were collected in logs that were in an advanced stage of decay, and analysis of indicator species also showed that the most abundant species were associated with this decay stage. Overall species richness was not significantly different between decay stages or tree species; however, nonmetric multidimensional scaling indicated that the species assemblages associated with decay stage and tree species were significantly different despite the similar species richness. The fact that overall measures of diversity (species richness and abundance) did not reflect differences in species assemblages illustrates the importance of accurate, species-level identification in the ecological study of arthropods living in dead wood.

News and Events

Bio-Blitz 2006—Gros Morne National Park

In collaboration with the Newfoundland and Labrador Department of Environment and Conservation and Parks Canada, the Biological Survey of Canada (BSC) will hold its sixth annual Bio-Blitz in Gros Morne National Park (GMNP), Newfoundland, 5–10 July 2006. This will be the first Bio-Blitz held in eastern Canada (the previous five events were held in Alberta and Manitoba).

GMNP was designated a UNESCO World Heritage Site in 1987. Beyond its awe-inspiring scenic beauty, GMNP boasts an incredible biotic richness and is internationally acclaimed for its unique combination of geologic features. GMNP is dominated by two distinct landscapes: a coastal lowland bordering the Gulf of St. Lawrence and the alpine plateau of the Long Range Mountains. These provide habitats for a diverse array of flora and fauna representing a unique mixture of temperate, boreal, and arctic species (Figures 18, 19, and 20). Major plant community types include coastal scrub (tuckamore), lowland bogs, riverine thickets, balsam fir (*Abies balsamea* (L.) and black spruce (*Picea mariana* (Mill.) BSP) forests, heath barrens, sedge meadows, tundra, serpentine barrens, and intertidal salt marshes. The park is home to over 700 species of flowering plants, 400 species of bryophytes, and 400 species of lichens. This remarkable diversity is due to the wide range of habitats provided by bedrock types, soil development, exposure, altitude range, and proximity to the ocean. On the hills, conditions are cooler, windier, and moister than on the lowlands. Hiking from the seashore up into the Long Range Mountains is a bit like traveling into the past, to a time when Newfoundland was covered with arctic plants and animals. From seashore to highland tundra, there are many unusual niches in the park for you to explore and sample! Rare species are usually found in rare habitats, and Gros Morne National Park, like the rest of the Great Northern Peninsula, has no shortage of either. The entomological fauna of the park has not been well collected. You are invited to take advantage of this unique opportunity to collect in one of Canada's most scenic and biologically diverse locations. In addition, participants will be able to collect in other interesting and rare habitats on the west coast of Newfoundland. Stay tuned to the BSC website for updates or contact David Langor (780-435-7330; dlangor@nrcan.gc.ca).

Figure 18. Tablelands of Gros Morne National Park (photo by T. Knight).

Figure 19. Arctic–alpine environment of the Long Range Plateau, Gros Morne National Park (photo by T. Knight).

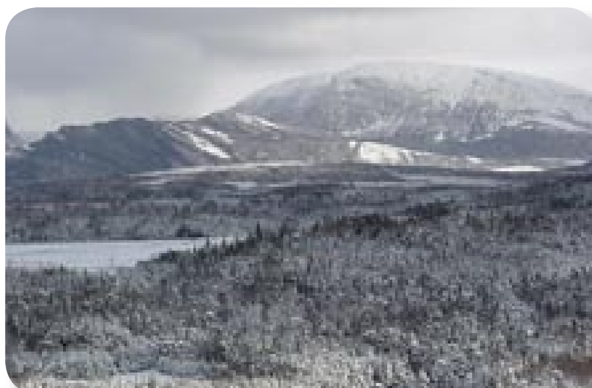

Figure 20. Gros Morne Mountain and spruce–fir forests, Gros Morne National Park (photo by T. Knight).

Website

Chris Majka has put together an interesting and useful website to highlight particularly fascinating species of beetles found in Atlantic Canada. Although the focus is primarily on the Maritime provinces (Nova Scotia, New Brunswick, and Prince Edward Island), some attention is also given to Newfoundland. The intention is to profile the fauna for the general layperson and to provide resources and tools for researchers who are interested in Coleoptera. http://www.chebucto.ns.ca/Environment/NHR/atlantic_coleoptera.html.

Nearctic Arachnologists' Forum

As an offshoot to the successful Nearctic Spider Database (accessible at http://canadianarachnology.webhop.net), the Nearctic Arachnologists' Forum (accessible at http://arachnidforum.webhop.net) was created in January 2006 with the following goals and features:

1. assistance with identifications
2. announcements of new publications
3. discussions of arachnid biology and systematics
4. student, postdoctoral, and employment opportunities
5. meeting, conference, and course announcements
6. networking and collaborative opportunities and requests

The forum permits image uploads and is also syndicated via XML for subscribers with RSS readers or plug-ins. Topics of recent discussions have ranged from winter pitfall trapping techniques and arachnid activity to the number of spider species in various states and provinces. Posts and queries are always welcome.

Meetings

Environmental Impacts of Non-Native Insects and Fungi: The Canadian Forest Service and the Biological Survey of Canada are organizing a symposium entitled "Environmental Impacts of Non-Native Insects and Fungi," to be held at the Holiday Inn Midtown Hotel, Montréal, Quebec, on 17 November 2006. This symposium is scheduled to precede the Joint Annual Meeting of the Entomological Society of Canada and the Entomological Society of Quebec, 18–22 November 2006. The symposium will focus on science related to the environmental consequences of invasion. A series of presentations will provide background on the biological invasion of Canada, focus on some key science questions, and provide some synthesis. This event will generate the necessary interest to produce a "state-of-the-science" report, develop a set of specific recommendations that will help provide the needed detail to underpin the Canadian Invasive Alien Species Strategic Plan.

The following topics are among those planned for the symposium:

- Diversity of non-native arthropods and fungi in Canada
- Ecological impacts of invasive insects and fungi on forest ecosystems
- Ecological impacts of invasive arthropods and fungi in grasslands
- Nontarget impacts of biocontrol
- Quiet invasives: how nonindigenous ground beetles have changed North American ground beetle communities
- Modeling the spread and ecological impact of invasive species under a changing climate
- Strategies for conserving genetic diversity of trees threatened by invasive species
- Living with invasives: potential solutions for managing invasives and conserving species diversity

2006 International Meeting of Carabidologists: To honor George E. Ball's 80th birthday, an international meeting of carabidologists will take place from 7 to 10 June 2006, hosted by the Section of Invertebrate Zoology at the Carnegie Museum of Natural History in Pittsburgh, Pennsylvania. The four-day event will include a series of invited talks on carabid beetles and, more specifically, on George's contributions to the field, with poster sessions, entertaining presentations, mixers, and specimen-sharing opportunities. Participants will be able to visit and study in the Carnegie Museum's insect collection, hold planning meetings for collaborative projects, and join in local fieldwork and a barbecue after the meeting. Best of all, there will be a sumptuous banquet in George's honor, where we can socialize and tell George our stories and listen to his. We anticipate that selected papers from the meeting will be published in the *Annals of the Carnegie Museum*.

The registration form, details on the Pittsburgh venue, places to stay and eat, things to do and see, directions to the museum, the schedule of events as it develops, a list of registered participants, and contacts for answering questions are or will shortly be available at http://nature.berkeley.edu/~kiplingw/ICM2006Main.html. You are invited to attend this event, but register soon to save your place! Early registration may allow us to get a block of discount rooms at local hotels. The registration fee is only US$35/person for actively employed scientists (e.g., university and museum staff members). Student registration is FREE! Guests who are not attending the talks may attend some of the other events for free. There will be additional fees for those attending the banquet and the combined field trip and barbecue (see details on the registration form). Attendees must pay for their own travel and lodging. Please donate money to the meeting effort if you can. This event has no external funding, and donations will be used to help attendees who have financial needs, to enhance the refreshments, and to defray incidental costs. Please pass the word to other carabidologists and to students and colleagues of George Ball around the world.

Organizing committee: Kipling Will, David Maddison, James Liebherr, David Kavanaugh, Terry Erwin, Robert Davidson, John Rawlins.

Alaska Entomological Society

During 2006, the first year of its existence, the Alaska Entomological Society will be guided by an interim Board. At the first meeting of the society, officers will be elected and the constitution and bylaws will be ratified.

Membership is open to anyone interested in any aspect of entomology in Alaska or the circumpolar north. The society has the following objectives:

(a) Promote and support the study and appreciation of entomology in Alaska

(b) Provide a forum for those interested in the study of entomology in Alaska

(c) Disseminate scientific information on entomology in Alaska

(d) Promote professional and social interaction among the general membership

(e) Achieve closer cooperation and understanding among members so that they may work together in the common cause of furthering the appreciation and knowledge of entomology in Alaska.

For a copy of the constitution and bylaws and a membership application form, please e-mail James Kruse at jkruse@fs.fed.us.

Requests for Cooperation

Lloyd Hollett (Newfoundland Insectarium) is involved in a new project to establish an insectarium in Israel. The project is being coordinated by Ted Miller, a medical doctor in Jerusalem. Site selection is currently under way, with the opening projected to occur in late 2008 or early 2009. We are soliciting donations of specimens and technical assistance. For more information, contact Lloyd at lloydh@nf.sympatico.ca.

New Publications

Buddle, C.M.; Langor, D.W.; Pohl G.R.; Spence, J.R. 2006. Arthropod responses to harvesting and wildfire: implications for emulation of natural disturbance in forest management. Biol. Conserv. 128:346–357.

Cannings, R.A.; Cannings, S.G.; Ramsay, L.R.; Hutchings, G.E. 2005. Four species of Odonata new to British Columbia, Canada. Not. Odonatol. 6:45–49.

Cannings, R.A.; Simaika, J.P. 2005. *Lestes disjunctus* Selys and *L. forcipatus* Rambur (Odonata: Lestidae): an evaluation of status and distribution in British Columbia. J. Entomol. Soc. B. C. 102:57–63.

Catling, P.M.; Cannings, R.A.; Brunelle, P.M. 2005. An annotated checklist of the Odonata of Canada. Bull. Am. Odonatol. 8:100–118.

Fagan, L.L.; Didham, R.K.; Winchester, N.N.; Behan-Pelletier, V.; Clayton, M.; Lindquist, E.; Ring, R.A. 2006. An experimental assessment of biodiversity and species turnover in terrestrial versus canopy leaf litter. Oecologia 147:335–347.

Klimaszewski, J.; Langor, D.W.; Work, T.T.; Pelletier, G.; Hammond, H.E.J.; Germain, C. 2005. The effects of patch harvesting and site preparation on ground beetles (Coleoptera: Carabidae) in Canadian boreal forests. Can. J. For. Res. 35:2616–2628.

Klimaszewski, J.; Majka, C.G.; Langor, D. 2006. Review of the North American *Tarphiota* Casey, with a description of a new seashore-inhabiting *Atheta* species exhibiting convergent characteristics (Coleoptera: Staphylinidae: Aleocharinae). Entomol. Sci. 9:67–78.

Klimaszewski, J.; Pelletier, G.; Maruyama, M.; Hlavac, P. 2005. Canadian species of the *Zyras* group of genera and review of the types from America north of Mexico (Coleoptera, Staphylinidae, Aleocharinae). Rev. Suisse Zool. 112:703–733.

Larrivée, M.; Fahrig, L.; Drapeau, P. 2005. Effects of a recent wildfire and clearcuts on ground-dwelling boreal spider assemblages. Can. J. For. Res. 35:2575–2588.

Latty, E.F.; Werner, S.M.; Mladenoff, D.J.; Raffa, K.F.; Sickley, T.A. 2006. Response of ground beetle (Carabidae) assemblages to logging history in northern hardwood-hemlock forests. For. Ecol. Manage. 222:335–347.

Lessard, J.-P.; Buddle, C.M. 2005. The effects of urbanization on ant assemblages (Hymenoptera: Formicidae) associated with the Molson Nature Reserve, Quebec. Can. Entomol. 137:215–225.

Majka, C.G. 2005. The linden bark borer *Chrysoclista linneella* (Clerck) (Lepidoptera: Agonoxenidae) infesting linden (*Tilia europea* L.) in Nova Scotia. Can. Entomol. 137:620–621.

Pearce, J.L.; Schuurman, D.; Barber, K.N.; Larrivée, M.; Venier, L.A.; McKee, J.; McKenney, D. 2005. Pitfall trap designs to maximize invertebrate captures and minimize captures of nontarget vertebrates. Can. Entomol. 137:233–250.

Pearce, J.L.; Venier, L.A.; Eccles, G.; Pedlar, J.; McKenney, D. 2005. Habitat islands, forest edge and spring-active invertebrate assemblages. Biodivers. Conserv. 14:2949–2969.

Pohl, G.R.; Langor, D.W.; Landry, J.-F.; Spence, J.R. 2004. Moths and butterflies (Lepidoptera) of the boreal mixedwood forest near Lac La Biche, Alberta, including new provincial records. Can. Field Nat. 118(4):530–549.

Saint-Germain, M.; Larrivée, M.; Drapeau, P.; Fahrig, L.; Buddle, C.M. 2005. Short-term response of ground beetles (Coleoptera: Carabidae) to fire and logging in a spruce-dominated boreal landscape. For. Ecol. Manage. 212:118–126.

Summerville, K.S.; Crist, T.O. 2005. Temporal patterns of species accumulation in a survey of Lepidoptera in a beech-maple forest. Biodivers. Conserv. 67:341–351.

Summerville, K.S.; Wilson, T.D.; Veech, J.A.; Crist, T.O. 2006. Effect of body size and niche breadth on spatial partitioning of species diversity. Divers. Distrib. 12:91–100.

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