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Ecologically Sensitive Invertebrate Taxa of Pacific Northwest Old-Growth Conifer Forests

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Executive Summary

The number of invertebrate species is so vast and the biology of most species so imperfectly known, that individual species can seldom be recognized as endangered or exclusively old-growth associated. The stategy utilized in this report is to propose that certain taxa might be useful as tools to monitor subtle changes in old-growth habitat. Since invertebrates are chacterized by shorter life-cycles and are far more sensitive to many environmental variables than the spotted owl, they offer promise as bio-indicators of forest health. Forty-eight species of diverse groups of arthropoods are herein proposed as potential indicator taxa. All of the species listed probably share the characteristic of being highly sensitive to environmental disturbance -- most have very restricted abilities for dispersal. Rare species whose local extinction may be a cause for alarm, and abundant old-growth associates whose numbers can be easily monitered without harming their viability, are both included. We recogize too that there are other species that may be of similar value that await to be recognized.

Introduction

There are a very large number of invertebrates which inhabit the conifer forests of the Pacific Northwest. While the general public might expect that entomologists should be familiar with a majority of them, in fact, most species are virtually unknown in a natural setting outside of a museum. We can state confidently that a large number of these species are associated with the mature stages of the forest cycle. We know less about those that can survive equally well in clear cuts, and even less about which species show differential survival in ancient forests versus mature managed stands. If there are unique species in old growth forests, most are probably associated with special micro-community types or specific ecological processes characteristic of old-growth forests.

There are three primary sources of information about invertebrate species characteristic of old-growth forests. The most extensive data set is that of Parsons (unpublished), who surveyed the soil fauna characteristic of old-growth forests and three early stages of succession (5-30 years post clear-cutting), each under 8 different moisture regimes for two years. This study, conducted at the H. J. Andrews Experimental Forest (Linn and Lane Counties, Oregon) was supplemented by studies by Moldenke and Lattin in 1990 (contrasting 35 year old forests with adjacent old-growth forests) and in 1991 (contrasting old-growth with adjacent 125-150 year old mature forest) in the same locality (Moldenke and Lattin, unpublished).

Since invertebrate diversity is high in these forests (Asquith et al. 1990; Lattin 1990; Lattin and Moldenke 1990; McIver et al. 1990; Moldenke 1990; Moldenke and Lattin 1990; Parsons et al. 1991), the continuity of population levels of species with specialized habits and

requirements could be a potentially useful indicator of total ecosystem function (McIver et al. 1992). The species discussed here represent organisms which are typically associated with old-growth forests, probably require old-growth forest conditions for reproduction (though adults may be encountered as they wander through other forest conditions in search of proper habitat) and may perform certain ecological processes integral to the function of the old-growth forest ecosystem. Several species are thought to be quite rare and their loss would be a indication for concern. However, most cited species are common, and by being abundant, offer potential for monitoring disturbance before it reaches a critical stage.

Litter and Soil Inhabitants

Forest growth and health requires efficient nutrient recycling, which in turn requires the participation of numerous species in myriad functional roles (Shaw et al. 1991). Although most of the required chemical reprocessing of litter is accomplished by bacteria and fungi, invertebrates indirectly regulate the processes through microbivory, predation on microbivores, modification of habitat through faecal production, transport of soil components across boundaries (mixing of litter and mineral soil) and the spread of microbial inoculum (Fitter 1985; Edwards et al. 1990). Proper aeration and soil water relations are also largely regulated by invertebrate activity.

Harpaphe haydeniana Wood (Diplopoda: family Xestodesmidae) -- Northwest Cyanide-Producing Millipede. Possibly the major species throughout the region that breaks litter down into the faecal pellets which are incorporated into the humus layer and thus enter the soil

food web. The leaves and needles ingested have already been invaded by fungi, but further decay processes require the physical crushing of the leaf cells, mixing with gut microbes and deposition as faecal pellets with increased surface/volume ratio. The aposematically-colored adults range widely, but it is likely that they require mature forest conditions for reproduction. The young are colorless, live deeply within the soil (often associated with mat-forming mycorrhizae) and perform an ecological role distinct from the adults. Intensity of color pattern varies throughout range (*H. haydeniana haydeniana* occurs from the Alaska panhandle to northern central California)(Buckett and Gardner 1968).

Promecognathus laevissimus Dejean (family: Carabidae) Long-Jawed Nimble Millipede Searcher. This beetle is considered the prime predator and specialized feeder upon the Northwest Cyanide-Producing Millipede (LaBonte, pers. commun.). Upon encountering a millipede, the Searcher straddles the body with its legs and moves forward to the head (if it ends up at the tail, a 50 percent chance, it turns around and searches out the neck). It grasps the neck with its specialized jaws and pinches/severs the ventral nerve cord of the millipede -- immediately paralyzing it. Upon attack, the millipede attempts to escape death by rolling into a ball in order to protect its neck. If the hunter is successful, the beetle then caches the millipede for leisurely feeding at a later time. This species may occur in two sympatric size forms, perhaps related to a diversity of food choices. This is a monotypic genus (only one species in the genus), highly specialized morphologically and not closely related to any other known ground-beetle in North America. The species lacks functional hind wings, having lost the power of flight during the course of its specialization. Although it can be found occasionally in clear cuts as an adult, it may be restricted to the mature forests for successful reproduction. It is distributed from

southwestern British Columbia to northern California in moist forest habitats (Lindroth, 1969).

Zacotus matthewsi LeConte (family: Carabidae) Matthew's Ground-beetle. This beetle appears to occur strictly in old-growth forests. It is flightless, infrequently collected and a dazzling metallic purple. Its habits have not been studied, but it is reputed to be either a snail or millipede feeder. It too is monotypic and unique phylogenetically. Its range includes the dense moist forests from Ketchikan, Alaska, south to northernmost California (Lindroth 1969, Kavanaugh 1992).

Pterostichus (Anilloferonia) rothi, *P. lanei* and *P. testacea* (family: Carabidae) Roth's, Lane and Dusky Grooved Ground-beetles. Although species of *Pterostichus* are dominant players in many ecosystems in the North Temperate Zone, these particular species are unique in that they are uncommon, localized, blind endemics. Presumably these species inhabit only the soil layers beneath the humus. Adults are flightless and appear to have very restricted home ranges. All life stages are undoubtedly predaceous, but food habits are unknown.

Fenderia capizzii Hatch (family: Staphylinidae) Capizzi's Blind Rove Beetle. The three preceding species belong to the Carabidae; rove beetles and spiders comprise the other two major groups of predators found in coniferous forest litter. Rove beetles have been poorly studied in this region. There are probably many species associated primarily with old-growth forests, but little quantitative data are available (e.g., *Tachinus semirufus*, *Philonthus* spp.). *Fenderia* is easily recognizable by its small size and nearly eyeless condition. In the Cascade Mountains of central Oregon, it appears to be strictly associated with old-growth forests, and information from other areas implies this is true elsewhere. It is known from the Olympic mountains of Washington (Moldenke, unpublished data) south along the coast to northern

California (Hatch 1957; Moore and Legner, 1975) and in the central Oregon Cascades (Parsons et al., 1991). It is a monotypic genus, not closely related to most other Staphylinidae. The generic name was given to honor Kenneth M. Fender, who tirelessly collected interesting beetles while delivering mail at McMinnville, Oregon. Joseph Capizzi, for whom the species is named, served as the respected extension agent for the Entomology Department at Oregon State University for many years. It is likely that other even smaller blind rove beetles (probably all unnamed) in the Leptotyphlinae would make useful indicator species as well (Coiffait, 1959, 1962).

Antrodiaetus pugnax (Araneae: family Antrodiaetidae) Ferocious Folding-Trap-Door Spider. Trap-door spiders are prominent predators throughout all stages of forest succession in Oregon, but *A. pugnax* occurs in high numbers chiefly in mature/ancient forests (McIver et al. 1992). It is one of the most important predators in these forests. Since the prey captured varies with the size of the spider as it grows (1/10 inch immature to 3/4 inch adult; 2 inch leg span adult male), and since the life cycle probably requires several years until the adult stage is reached, its populations probably impact those of nearly every other soil dweller (Coyle 1971). These spiders are found in large numbers throughout the forest floor, but the largest individuals nearly always are found within logs demonstrating advanced decay. The trap-door spiders excavate their silk-lined tubular burrows by rasping the wood with teeth on the base of their fangs. A unique indirect aspect of its biology is of considerable significance to ancient forest ecosystem function. *Antrodiaetus* is attacked and parasitized by the handsome iridescent fly, *Eulonchus tristis*; this fly species is of paramount importance for the pollination of numerous plant genera found on the shaded forest floor (native bee species will not fly in the shade;

Moldenke 1976).

Amblyopone oregonense (family: Formicidae) Oregon Archae-Ant This ant belongs to a genus distributed sparsely throughout the world; it is considered to be the most primitive living ant genus, both behaviorally and structurally, a "missing-link" between wasps and typical ants (Holdobbler and Wilson, 1990). Our northwestern species is a virtually unstudied, rare, subterranean, nearly blind creature that inhabits the old-growth growth of the Oregon Cascades (Moldenke, unpub. data). Unlike the complex populous societies that characterize most ant nests, the Oregon Archae-Ant probably never supports more than two to three dozen workers per nest (Traniello, 1982). Although the foundress' offspring are truly non-reproductive "workers", there is no division of labor within the family - each worker hunts or cares for the larvae solely on her own with little interaction with her sisters. Even the queen excavates and forages, until her family is well-established and she then turns vampire -- feeding exclusively on the blood of her own young. This unusual behavior does not harm the larvae which, though scarred, grow as rapidly as ones that have not been bled (Masuko 1986). The workers and young probably feed exclusively upon centipedes, which the workers paralyze with a powerful sting. Since there is no cooperation amongst the workers, the larvae have to be brought from the central nest to the location of the centipede in order to feed (Levieux 1983). As with their wasp forebears, the paralyzed centipede may last for weeks without decay, while the larvae finish-off a previous meal. Colony integration through "trophallaxis" (the sharing of chemicals passed from mouth to mouth between larvae, workers and queen) does not occur, though it does in all other social insects; communication between nestmates is extremely limited and rudimentary.

Scaphinotus hatchi (family: Carabidae) Hatch's Snail-Feeding Ground-Beetle. All species of *Scaphinotus* feed on molluscs throughout their life. Twelve species inhabit the Pacific Northwest, all of them primarily associated with old-growth forests. These are active, wide-ranging predators that are often seen in clearcuts, but reproduction may well be restricted to mature forests. Terrestrial molluscs are prominent inhabitants of western Oregon and Washington forests, but their role as herbivores and fungivores is unstudied. These beetles probably are their primary predators, and as such may play a pivotal role in the ecosystem. *Scaphinotus hatchi* is found only in the mature subalpine forests near Waldo Lake, Oregon (LaBonte pers. comm). It is the most splendidly iridescent form of the genus. *Scaphinotus* species in eastern North America are noted for their drastic population declines in recent decades.

Pterotus obscuripennis (family: Lampyridae, placement uncertain) Northwest Glow-Worm. This infrequently collected species is probably associated with the special soil conditions of mature/ancient forests. Most fireflies feed upon worms or molluscs, but this species has not been studied (perhaps enchytraeids, the oligochaete *Arctiostrotus perrieri*, testudinella snails or the eggs of banana slugs?). Larviform females and larvae produce a phosphorescent glow. This species is known from the moist forest types of western Washington and Oregon

Zarhipis integripennis (family: Phengodidae) Elaborately-Feathered Banded Glow-Worm. This is a relatively rare species, but it is such a unique creature that it merits close examination. The behavior and ecology of Banded Glow-Worms has been studied by Donald Linsdale (1961) and Darwin Tiemann (1967). These remarkable creatures, along with the closely related fireflies

("lightning-bugs"), generate a metabolic glow throughout their developmental period. Generally most of these glowing larvae metamorphose into flighted males and females familiar to all for their enchanting summer-evening flickering mating display. Several species of true fireflies (the genus, *Photinus*) differ from the normal course of development in that the females do not moult to a winged, adult stage; instead the female ("a glow-worm") resembles a mature larva without wings. The Phengodid Banded Glow-Worms carry this developmental characteristic to the extreme, and the female (always wingless) grows immensely larger than the male (one to two inches long; about 50-fold the male's weight). *Zarhipis integripennis* (and two additional related species from further south in California) feeds exclusively upon millipedes. In the Northwest these relatively rare celebrities have been found in the moist forests of western Washington and Oregon. A glow-worm captures a millipede by leaping on its back, curling around the slippery body, shimmying up to the head, and slitting the throat. The glow-worm will then tow the millipede to a site where it can be buried and fed upon at leisure. The adult male has elaborate antennae with which it locates the female by scent. The distantly related *Pterotus obscuripennis* (family placement uncertain) and the lightning bug *Ellychnia greeni* (family: Lampyridae) also inhabit mature forests of the Northwest. The function of the light to these beetles seems to be akin to warning coloration (Sivinski, 1981).

Paraphymatopus californicus? (family: Hepialidae) California Swollen-footed Pointed-Wing Moth. Hepialid moths are an ancient phylad of moths, probably dating to the very origins of butterfly/moth evolution. This is an extremely rare species, the only large hepialid of the Pacific Northwest. Moldenke (unpublished data) has thrice discovered groups of caterpillars (probably living communally) feeding on the mycorrhizae encompassing the root

system of achlorophyllaceous Indian pipe (*Monotropa uniflora*) and old-growth Douglas-fir (J. Wernz, Oregon State University, unpublished data); little else is known of the species which occurs in California and Oregon. Immatures take at least two years to develop. The adults do not feed, presumably live for a very short period and apparently fly for a maximum of 15 minutes per night (D. Wagner, Univ. Conn., pers. comm). The name is accompanied by a question mark, since there has not been a successful rearing of the *Monotropa*-associated caterpillers. Wagner, with his extensive experience in western Hepialidae (Wagner, 1985, 1989), has suggested the likelihood of this identity based on a rearing in California (DeBenedictus et al. 1990), and the known association of a related hepialid with conifer roots in New England (Wagner et al., 1991).

Taracus spp. (family: Ischyropsalidae) Snail-Feeding Skunk-Spiders and *Sabacon* spp. (family placement uncertain) Sundew-mouth Skunk-Spiders. These unstudied genera of Opilionida ("harvestmen", "daddy-long-legs") are characteristic of, and probably are largely restricted to, old-growth forests. *Taracus* are related to a rare group of skunk-spiders which feed on molluscs in Europe; they have enormously hypertrophied chelicerae (lobster-claw-like mouthparts) which allow them to exploit this unique food resource. *Sabacon*, in contrast, apparently feed by extending the pedipalps which are covered with gluey hairs to capture tiny prey (e.g., springtails, fungus-gnats; Torgersen and Moldenke, Oregon State University, unpub. data). Both genera are comprised of several unstudied species in our region. All skunk-spiders (the common name for Opilionids in German) possess enormous foul-smelling scent glands, which they disgorge when threatened.

Pseudachoreutes n. sp.(?) (Collembola: family Hypogastruridae) Orange and Blue

Springtail. Springtails are among the most abundant and widespread organisms in the world, however, this distinctive species seems characteristic of Pacific Northwest old-growth forests (Moldenke, unpub. data). It is usually bright blue with a orange head and prothorax. It has a massive head with specialized feeding appendages; unlike most springtails which are fungivores, this species may be a predator.

Tropidischia xanthostoma (family: Gryllacrididae) Long-Legged Twisted-Hip Cricket. This enormous cryptically-colored cricket occurs from British Columbia to northern California. It is seldom collected, probably being nocturnal in habit. Pitfall trapping results indicate that it may be strictly limited to old-growth forest conditions. It is presumed to be herbivorous, or a comminutor of general detritus, although this assumption needs to be tested. This is a monotypic genus, not closely related to our other native crickets in the genus *Pristoceuthophilus*. *Pristoceuthophilus* is a species-rich genus widely distributed in western North America, primarily found in mature forests. There are at least two species which are localized old-growth endemics (T. Cohen, San Diego State Univ., pers comm): one unnamed species from Jeddediah Smith State Park in northern California; and *P. tuberculatus* distributed along the immediate coast from Cape Perpetua, OR, to Eureka, CA. There are species of *Pristoceuthophilus* associated with the mature forests of the H. J. Andrews Experimental Forest, Oregon, *P. celatus, P. cercialis*, and *P. sargentae* (Lightfoot, 1986).

Chionea-like (Tipulidae) Wingless Old-Growth Cranefly. This species, which probably belongs to an as yet unnamed genus, is typical of old-growth forest conditions in the H. J. Andrews Experimental Forest. All the specimens which have been found are apterous females; the male may be winged and not encountered in the same samples, or possibly the species is

parthenogenetic.

Fallen Log and Decaying Wood Community

The decomposition of coarse woody debris and its slow release of nutrients and CO_2, is an enormously complex process in a natural ecosystem. In the Pacific Northwest many hundreds of invertebrate species have evolved to utilize logs for food or habitat (Harmon et al., 1986; Schowalter et al. 1991, Moldenke et al., unpublished data). Though many of these species may have similar ecologic roles, we do not understand the natural process thoroughly enough to state whether some/many are redundant for system function. However, the diversity of species itself, may be a useful management tool to detect changing effects the logs may be exerting on the old-growth forest system. Some species of particular interest might be:

Usechimorpha barberi (family: Zopheridae) This beetle species lives in, and feeds upon polyporous shelf-fungi. The dorsal surface of this species, and related species of zopherids, is highly irregular; when disturbed these species feign death after dropping to the litter (they are then nearly impossible to distinguish from a small bark chip). This is a rare species, known only from western Oregon (Hatch, 1965).

Psydrus piceus (family: Carabidae) Pitch-colored Bark-dwelling Carabid Beetle. This species lives under the loose bark of dead logs, a very unusual habitat for North American carabid beetles. This is an uncommon species, and the only species in its genus; this species is often treated as belonging to a monotypic tribe. It is a strong flier with undiscovered

larval habits (Lindroth, 1969).

Henoticoides lorna (family: Cryptophagidae) Silky-Furred Fungus-Beetle. Little is known of the habits of these beetles; they are presumed to eat fungi.

Cryptocercus punctulatus (family: Cryptocereidae) Colonial Wood-Feeding Roach. This species is a true relic -- a link between the roaches and the termites. It shares with the termites the habit of consuming wood, possessing cellulose-digesting intestinal symbionts, and a communal habit. With the roaches it shares a general body shape and lack of a true social caste system. This species lives in the Siskiyou Mountain region of Oregon/California, the west side of the southern Cascade Mountains, and disjunctly in the southeastern United States (Cleveland et al, 1934; McKittrick, 1964).

Epilohmannia n. sp. (Acari: Cryptostigmata) Although most oribatid mites are strictly fungivores or bacterivores, there are some species that feed exclusively on wood. This distinctive species is widespread in the Pacific Northwest and is found both in rotting logs and in the general forest litter. Its presence is characteristic of mature forests (Moldenke and Fichter 1988). It is very large (for a mite) and is easily distinguished from the myriad other oribatid species in the soil. As an indicator species, it has the potential to be easily quantified in rather small sample volumes.

Ligidium gracile (Isopoda: family Ligidiidae) Northwest Forest Sowbug. This is an abundant native sowbug. It seems to be the major arthropod species involved in the crucial ecosystem function of finally shredding highly-decayed ("class 4-5", in the terminology of foresters) logs and metamorphosing them into faecal pellets that enter the soil itself. It is one of our few native terrestrial isopod species (there are species that have been introduced) and is

therefore readily identifiable. It is probably highly susceptible to changes in moisture and temperature and might function as an indicator of edge effect or climate change.

Agathidium jasperinum (family: Leiodidae) Shiny Jasper Slime-Mold Beetle. This species is representative of the community of species (all poorly studied) associated with slime-molds (Lawernce and Newton, 1980; Russell, 1979b.). This beetle and its relatives feed only upon slime-molds (myxomycetes), those truly unique life-forms often prominent in ancient forests (Wheeler, 1984). This species appears to live only in old-growth forests. Species of this genus are strongly contractile, forming a nearly spherical "pill-beetle", when disturbed. Some members of their genus feed exclusively upon the sporulating stage of slime molds, whereas others feed exclusively upon the migratory plasmodial stage. Slime molds represent evanescent resources, the shortest maturation periods known (2-4 days; Crowson 1981) for any beetle are recorded for these species.

Arctiostrotus perrieri (Oligochaeta: family Megascolecidae) Perrier's Mossy-Log Earthworm. A native species of earthworm which is characteristic of the uppermost litter layers and rotten logs (most often where moss grows on top of fallen logs), which may sometimes be found arboreally. Though nearly unstudied biologically (Fender 1990), it probably responds characteristically to climatic parameters and could provide an efficient biological index for numerous management practices. Like the sowbug, its relatively large size (for an invertebrate) and abundance, implies that it may have a large role in nutrient recycling in mature forests.

Lichen and Moss Community (Arboreal and Terrestrial)

Recent studies have highlighted the roles of these overlooked plants in our Northwestern conifer forests. Many of the lichens fix nitrogen and represent the major input of nitrogen into a mature forest. Epiphytic mosses and lichens account for up to 25 percent of the total photosynthetic energy capture in Pacific Northwest forests. Many species of invertebrates inhabiting this community are endemic, but the canopy fauna of mature forests has hardly been studied (Voegtlin 1982; Schowalter, 1989).

Acalypta saundersi (family: Tingidae) Saunder's Moss-Feeding Lace-Bug. This is a heuristic example of old-growth forest ecology. Two species of moss-feeding lacebugs occur throughout western Oregon and Washington -- one living in open areas the other in old-growth forests (Lattin, 1990; Lattin and Moldenke 1990). The species adapted to clearings is usually flightless, but 5 percent of all the populations are winged -- thus permitting colonization of new sites. The old-growth species is always wingless, as are all of its closest relatives in undisturbed forest conditions throughout the North Temperate Zone in the New and Old World.

Caurinus dectes (family Boreidae) Armor-Clad Funny-Bug. Loren Russell (1979a) discovered this liverwort-feeding species, and for several years entomologists were puzzled as to what order of insects it belonged! Russell's thesis research (Oregon State University, 1979b) has documented numerous features of its biology, but it and its relatives remain very rare enigmas of the mysterious ancient forests. Both adults and larvae of the Funny-Bug are specialized nocturnal feeders on leafy liverworts, generally those growing epiphytically on branches or downed logs. The nearly legless larvae do most of their feeding inside the stem of the liverwort shoot. Eggs hatching in the spring mature into Funny-Bugs in the wet fall.

The related *Boreus californicus* and *B. elegans*, California and Elegant Wingless Leaping Scorpionflies, feed diurnally upon terrestrial mosses. The larvae feed upon the lower stems, eating primarily the older dead moss leaves (Cooper, 1974). The poor-quality diet is correlated with a two year developmental period before the larger dark colored or metallic green adult stage is achieved. Both *Caurinus* and *Boreus* are known from scattered localities throughout western Washington and Oregon; *Boreus* occurs from British Columbia to northern California. The adults of all boreid scorpionflies are flightless; the female has lost all traces of both pairs of wings, but the male retains rudiments of the front pair that serve as forceps to anchor the female on his back during mating.

Listemus formosus (family: Byrrhidae) Pretty Moss-Beetle. This species is representative of a family of beetles which feed upon moss. Byrrhids feed upon a diversity of moss species in many habitats, but *L. formosus* may be associated only with terrestrial moss in mature forests. Byrrhids of the genus *Lioon* are known to inhabit epiphytic old-growth mosses (L. Russell, unpub. data).

Camisia carrolli (Cryptostigmata) Carroll's Crotonoid Moss-Mite. This species of oribatid mite is restricted to the high canopy of old-growth forests. It, and other species (Andre and Voegtlin, 1981; Voegtlin, 1982) of microarthropods, may be very sensitive indicators of changes in epiphytic and epiphyllous microbial growth rates caused by changes in atmospheric pollution.

Arboreal Canopy Insects

Phytocoris nobilis (family Miridae) Noble Fir Predaceous Plant-Bug. This genus of agile, rapid predators is a major part of the predatory arthropod community on most perennial woody plants in North America where over 200 species are known (Stonedahl, 1984, 1988). Most species of *Phytocoris*, however, exhibit strong fidelity to a single genus of plants. This species is found almost exclusively on noble fir (*Abies procera*), throughout the distribution of that species in the subalpine Cascade Mountains from central Washington to southern Oregon and also in a few isolated localities in the Coast Range. The collections have been made in old-growth forests (Cooper, 1981).

Riparian Insect Community

Riparian insects are not well-studied in the Northwest. However, Kavanaugh's studies of *Nebria* et al. (Carabidae) are exemplary. The usual ecological correlates in such studies have been the particle size of substrate, speed of flowing water, and the presence/absence of shade -- not the distinction between old-growth versus rotation age forests. From our own experience, we currently propose only one potential sensitive indicator species.

Wygodzinsky and Stys

Boreostolus americanus, (family: Enicocephalidae) Large West American Unique-Headed Bug. This flightless species lives under rocks along small rapid streams in forested habitats. It is a predator, probably feeding upon small invertebrates found in its habitat. Phylogenetically, the enicocephalid bugs derive from the most primitive of all the world's known bug fauna. There are two species in this genus, one living in eastern Siberia,

the other known from three localities in Oregon and one in Colorado. The nearest relative of this genus lives in Tierra del Fuego; this insect is considered to be a true relic (Wygodzinsky and Schmidt, 1991).

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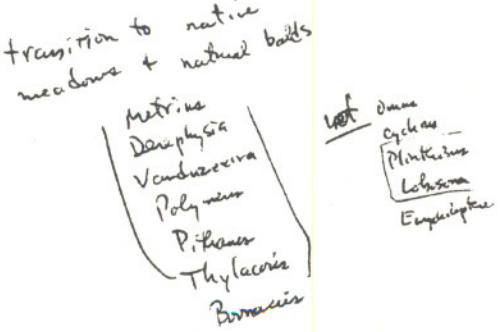
A list of species follows, as one reviews the narratives several points become apparent. The first is that most of the species are either wingless or flightless. This means that their dispersal abilities well be very limited and severe habitat fragmentation will represent barriers for movement and dispersal. Secondly, this flightless condition reflects habitat stability or permanence over a long period of time. These species are often the only members of their genus and are highly disjunct. In addition, these species show similar distribution patterns on the west side of the Cascade Range from British Columbia south to western Oregon.

The limited vagility (ability to move freely) of these species means that they would be influenced by the fragmentation of the landscape and affected by habitat alterations. Just how they would respond to corridors is unknown; there is no information available concerning the use of corridors and these species. Since their presence and flightless condition suggests a prolonged occurrence in the area, one might project that dispersal would be very slow.



List of Species

Insecta

Orthoptera

Acrididae

Boonacris alticola Rehn and Randell

Gryllacrididae: Rhaphidophorinae

Pristoceuthophilus celatus (Scudder)

Pristoceuthophilus cercialis Caudell

Pristoceuthophilus sargentae Gurney

Tropidischia xanthostoma (Scudder)

Hemiptera: Heteroptera

Enicocephalidae

Boreostolus americanus Wygodzinsky and Stys

Lygaeidae

Plinthisus longisetosus Barber

Thylochromus nitidulus Barber

Miridae

Eurychilopterella sp. nov.

Phytocoris nobilis Stonedahl

Pithanus maerkelii (Herrich-Schaeffer)

Polymerus castelleja Schwartz

Scutelleridae

Vanduzeeina borealis californica VanDuzee

Tingidae

Acalypta lillianus Torre-Bueno

Acalypta saundersi Downes

Derephysia foliacea (Fallen)

Coleoptera

Carabidae

Cychrus tuberculatus Harris

Metrius contractus Eschscholtz

Promecognathus laevissimus Dejean

Zacotus matthewsii LeConte

Cicindelidae

Omus dejeani Reiche

Curculionidae

Lobosoma horridum Mannerheim

Diplopoda

Polydesmida

Xestodesmidae

Harpaphe haydeniana haydeniana (Wood)

Orthoptera: Acrididae

Boonacris alticola Rehn and Randell

This is a wingless species of grasshopper that lives in open areas of the forest. The species occurs in the Cascade Mountains and in the Coast Range in Oregon. The populations are separated from each other by the heavier forested areas. On the H. J. Andrews Forest, the species is found chiefly at the upper elevations in the silver fir zone and in the higher meadows on the ridges.

Orthoptera: Gryllacrididae: Rhaphidophorinae

Pristoceuthophilus celatus (Scudder)

Pristoceuthophilus cercialis Caudell

Pristoceuthophilus sargentae Gurney

These three species are camel crickets. They are completely wingless and flightless. They occur in dark moist areas generally on the forest floor in heavily wooded areas. The species are found in old-growth forests in the hemlock and silver fir zones. *Pristoceuthophilus celatus* is found from northern California to British Columbia on the west side of the Cascade Range; *P. cercialis* occurs in western Oregon and Washington and extends east to the Rocky Mountains; and *P. sargentae* is known only in the Three Sisters - McKenzie Pass area of Oregon.

Although these three species usually occur on the forest floor, specimens of the latter

species have been found more than 35 meters above the ground on the trunks of coniferous trees.

Tropidischia xanthostoma (Scudder)

This too is a wingless species found in old-growth forests and especially in the riparian zone. Like the species of *Pristoceuthophilus*, it occurs under logs and debris in most areas. The species occurs in the Coast Range and on the west side of the Cascade Mountains from central California north to British Columbia.

Hemiptera: Heteroptera: Enicocephalidae

Boreostolus americanus Wygodzinsky and Stys

This is a most unusual species of bug. It lives under rocks along small streams in forested habitats. It is flightless. It is a predator, feeding upon small arthropods found in its habitat. It is a very primitive insect with very distinct distribution. There are two species in the genus, one found in the Amur River region of eastern Siberia and the other, in Oregon and a single locality in Northwest Colorado. In Oregon it is known only from Indian Soda Springs east of Medford, H. J. Andrews Forest east of Eugene, and House Rock Campground east of Sweet Home. The nearest relative of this genus lives in Tierra del Fuego, Chile. This insect is considered to be a relic.

Hemiptera: Heteroptera: Lygaeidae

Plinthisus longisetosus Barber

This very small bug lives in the litter layer in mature forests. It is flightless, the wings reduced to small pads. The bug feeds upon seeds of overstory plants. A related species in the east feeds upon hemlock seeds only. The insect is characteristically found in litter samples taken from mature forests. The flightless condition restricts movement across the landscape. The species has been reported from California and western Oregon.

Hemiptera: Heteroptera: Lygaeidae

Thylochromus nitidulus Barber

This handsome bug occurs in the litter layer under manzanita bushes on the west side of the Cascade Mountains. It has been reported from northern California as well. It feeds only on the seeds of manzanita. All specimens seen have been flightless, with the wings reduced to pads. This means that dispersal ability is limited. The species is characteristic of drier habitats in the forest where manzanita grows. It is considered a xeric component of the fauna, already in place on the forest. It is a potentially interesting species because of the concern over global climate change.

Hemiptera: Heteroptera: Miridae

Eurychilopterella sp. nov.

This is a very rare insect, known only from a few specimens. The largest series was taken from sticky traps placed on the upper trunks of several old growth Douglas-fir trees on the H. J. Andrews Forest in western Oregon. Subsequently, a few additional specimens have been taken in similar habitats in southern Oregon. Another species has just been discovered on a very localized species of *Cupressus* in the vicinity of Santa Cruz, California. This is a predaceous insect and appears to have a specialized habitat on tree trunks.

Hemiptera: Heteroptera: Miridae

Phytocoris nobilis Stonedahl

This is a large, predaceous bug that lives chiefly on *Abies procera* Rehd. and *A. amabilis* (Dougl.) Forbes. The species was described from the H. J. Andrews Forest east of Eugene. It is found on the west slope of the Cascade Mountains and in the Coast Mountains where noble fir occurs. Thus, it is known from the south central Cascade Range of Oregon north to Stevens Pass, Washington and a few localities in the Coast Range where *A. procera* is found. It occurs chiefly on the trunks and branches of the mature trees. Its mottled color pattern blends in well with the substrate.

Hemiptera: Heteroptera: Miridae

Pithanus maerkelii (Herrich-Schaeffer)

This is a Holarctic species that feeds on grass. It has a widespread range in northern North

America but occurrence is very local, generally in grassy balds or meadows found in forested areas in the Pacific Northwest (i.e., top of Mary's Peak in the Coast Range, and the upper meadows of the H. J. Andrews Forest). It is a typical inhabitant of such forest habitats. It is chiefly flightless with fully winged individuals being very rare. Dispersal would be slow under normal conditions.

Hemiptera: Heteroptera: Miridae

Polymerus castelleja Schwartz

This plant-feeding bug occurs on indian paint brush and was recently described from the H. J. Andrews Forest where it occurs on that plant. The species has a very limited known distribution in western Oregon.

Hemiptera: Heteroptera: Scutelleridae

Vanduzeeina borealis californica Van Duzee.

This shield bug has a wide, but highly local distribution in western North America. The subspecies extends from the Yukon Territory south along the Cascade Range as far south as the H. J. Andrews Forest where it occurs on a high, rocky ledges at about 5200 feet (Lattin, unpblished). The nearest record is Mt. Hood, Oregon. This is a cold, dry-adapted species that is found around the bases of high elevation grasses. It is phytophagous, presumably feeding on grass roots. Species of this genus are rarely collected - only 30 to 50 specimens

known for the genus. Its habitat seems quite specific, embedded as it is in mature forests.

Hemiptera: Heteroptera: Tingidae

Acalypta lillianis Torre-Bueno

This is a species of moss lacebug that is a cold, dry relic of colder times, found on the high ridges of the forests of the H. J. Andrews. This is the southernmost record of the species whose distribution extends northward to the Yukon Territory (Drake and Lattin, 1963). The individuals from the H. J. Andrews Forest were flightless but the species is known to have a small percentage of winged individuals in other parts of its range. The insect feeds upon moss.

Acalypta saundersi Downes

Another species of moss lacebug and one of considerable interest. It was described from Goldstream, British Columbia and subsequently found in western Washington and Oregon. This species feeds on moss, usually moss found on fallen logs found in mature forests. This is a completely flightless species, no functionally winged individuals have been collected. It belongs to a group of species found throughout the world. They are all flightless. These other species occur in areas of great stability - i.e., the Ozarks, the Appalachians and the Mexican Highlands of North America. The flightless condition suggests great antiquity and stability of place. Lack of functional wings suggests very low vagility (Drake and Lattin,

1963; Lattin and Moldenke, 1990).

Derephysia foliacea (Fallen)

This handsome lacebug is widespread in the Old World but has a very small range in North America/Central Coast Range and thus far, the grassy meadows of the H. J. Andrews Forest in the central Cascade Mountains. Evidence suggests that this is a native species in North America rather than an introduction. Little is known of its habits, even in Europe. There is a suggestion that the immature stages may be associated with ants. It does appear to have a brief dispersal flight in late summer (Lattin, 1987).

Coleoptera: Carabidae

Cychrus tuberculatus Harris

This flightless ground-beetle occurs on the forest floor where it is a specialized predator of terrestrial molluscs. The species is found in western British Columbia, western Washington and western Oregon in habitats similar to those on the H. J. Andrews Forest. It is part of a group of flightless, ground-inhabiting beetles characteristic of mature forests. Two other closely related, but distinct species, occur in the Wasatch Mountains (*C. hemphillii* Horn) and in north-eastern Washington, southeastern British Columbia and northern Idaho (*C. rickseckeri* Le Conte).

Coleoptera: Carabidae

Metrius contractus Eschscholtz

This is a flightless ground-beetle found in open areas in forests. The range of this species includes southwestern British Columbia, western Washington and western Oregon. It is a predatory species. It is of particular interest because it is the only species in this genus *Metrius* and the genus *Metrius* is the only member of the tribe Metriini. It is one of a specialized group of ground-beetles found in the forests of the Pacific Northwest.

Coleoptera: Carabidae

Promecognathus laevissimus Dejean

This predaceous ground-beetle lives in mature forests on the west side of the Cascade Mountains from southwestern British Columbia south to western Oregon. It is a specialized predator of millipedes, particularly the localized *Harpaphe haydeniana haydeniana* (Wood), one of the important anthropods responsible for chewing up the organic matter in the litter layer. This species too is in an isolated genus that is contained in an isolated tribe.

Coleoptera: Carabidae

Zacotus matthewsii LeConte

This is a rather rare ground-beetle found on the floor of mature forests. It is flightless as are

the other ground-beetles cited here. It has a distribution similar to most of the others listed - i.e., southwestern British Columbia, western Washington and western Oregon. There is a subspecies known from the forests of southeastern British Columbia, eastern Washington, northern Idaho and northeastern Oregon. Like the others discussed, *Z. matthewsii* is the only species in the genus and the genus is the only member of the tribe Zacotinii.

Coleoptera: Cicindelidae

Omus dejeani Reiche

This is a flightless, nocturnal, tiger beetle found in the forests from southwestern British Columbia south to western Oregon. It occurs on the forest floor of mature forests. It is unusual because most tiger beetles are winged and good fliers and are active during the daytime. The larvae of these beetles live in small holes in the ground waiting for prey to pass by. They too are predaceous.

Coledoptera: Curculionidae

Lobosoma horridum Mannerheim

This is a small, flightless weevil that lives on the forest floor in the litter layer. Like the flightless ground-beetles, its range includes British Columbia, western Washington and western Oregon. It is a characteristic inhabitant of the litter layer in mature forests where it feeds on plant materials. Like so many of the listed taxa, it is the only member of the genus

Lobosoma, in a tribe that contains only four genera.

Diplopoda: Polydesmida: Xestodesmidae

Harpaphe haydeniana haydeniana (Wood).

This distinctively-marked millipede is a characteristic organism found on the forest floor. It is a very important shredder of litter, starting the nutrient cycling process. The adults are found in the litter layer and the immature stages deeper down. The species is brightly marked and produces hydrocyanic gas when disturbed. There is a specialized predator, *Promecognathus laevissimus*, that is able to feed on this millipede without being damaged by the cyanide.

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Table 1. Insects associated with course woody debris in Western Oregon Cascades.

Species	Feeding habitats[a]	Stage in log[b]	Recorded hosts/habitats
Buprestis aurulenta L.	Xylo	Imm	Psme,Abies,Pinus,Picea
Leptura obliterata Hald.	Xylo	Imm	Psme,Tshe,Abies,Picea,Pinus,Sequ.
Spondylis upiformis Mann.	Xylo	Imm	roots of pine or fir ??
Silvanus bidentatus F.	Pred-Scav?	Ad+Imm	subcortical
Cossonus ponderosae VanD.	Xylo?	Ad+Imm	under bark of Pinus
Pissodes piperi Hopkins	Xylo?	Imm	Abies; root crown of damaged trees
latycerus oregonensis Westw.	Xylo	Ad?+Imm	rotting Quercus, Acer, Alnus, Fraxinus
Platypus wilsoni Swaine	Xylo-Fung	Ad+Imm	Psme,Abies,Tshe
Dendroctonus pseudotsugae Hopk.	Xylo	Ad+Imm	Psme,Tshe,Larix; under bark
Gnathotrichus retusus (LeC.)	Xylo-Fung	Ad+Imm	Psme,Pinus,Picea,Alnus, Populus; in sapwood
Trypodendron lineatum (Ol.)	Xylo-Fung	Ad+Imm	Psme,Abies, Tshe,Picea,Pinus,Thpl; in sapwood
Ostoma ferruginea (L.)	Fung	Ad+Imm	Fung-Polyporaceae; under bark
Medetera aldrichii Wheeler	Pred	Imm	Prey-bark beetles & woodborers
Xylophagus cinctus DeGeer	Pred	Imm	under bark
Camponotus spp.	Pred-Scav	Ad+Imm	mine wood of various conifers
Urocerus albicornis (F.)	Xylo-Fung	Imm	Abies,Psme,Tshe,Thpl, Pinus, Picea
Zootermopsis angusticollis (Hagen)	Xylo	Ad+Imm	many kinds of wood

[a] Xylo: feeds on wood, Pred: predaceous, Fung: fungi; Scav: scavenger.

[b] AD: adult, Imm: immature.

Illustrations:

Plate 1

a: *Fenderia capizzii* (ex Parsons et al., 1991)
b: *Promecognathus laevissimus* (ex Lindroth, 1969)
c: *Amblyopone* sp. (ex Holdobber and Wilson, 1990)
d: *Zarhipis integripennis* (ex Hatch, 1962; plate 21)
e: *Pterotus obscuripennis* (ex Hatch, 1962; plate 20)
f: *Ellychnia greeni* (ex Hatch, 1962; plate 20)

Plate 2

a: *Phytocoris nobilis* (ex Parsons et al., 1991)
b: *Ligidium gracile* (ex Parsons et al., 1991)
c: *Usechimorpha barberi* (ex Hatch, 1965; plate 10)
d: *Acalypta saundersi* (ex Lattin and Moldenke, 1990)

Plate 3

Promecognathus laevissimus attacking *Harpaphe haydeniana*
(ex Parsons et al., 1991; cover illustration)

Plate 4

Female Banded Glow-Worm starting to remove the head of a millipede on which to feed. The glow-worm had just previously overtaken the millipede, and slit its throat to kill it. Subsequently it will tow it to a protected crevice in the soil and feed by entering the body through the point of decapitation. Male with feathery antennae watches from nearby mushroom.

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Cossonus ponderosae VanD.	Xylo?	Ad+Imm	under bark of Pinus
Pissodes piperi Hopkins	Xylo?	Imm	Abies; root crown of damaged trees
latycerus oregonensis Westw.	Xylo	Ad?+Imm	rotting Quercus, Acer, Alnus, Fraxinus
Platypus wilsoni Swaine	Xylo-Fung	Ad+Imm	Psme,Abies,Tshe
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Trypodendron lineatum (Ol.)	Xylo-Fung	Ad+Imm	Psme,Abies, Tshe,Picea,Pinus,Thpl; in sapwood
Ostoma ferruginea (L.)	Fung	Ad+Imm	Fung-Polyporaceae; under bark
Medetera aldrichii Wheeler	Pred	Imm	Prey-bark beetles & woodborers
Xylophagus cinctus DeGeer	Pred	Imm	under bark
Camponotus spp.	Pred-Scav	Ad+Imm	mine wood of various conifers
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Zootermopsis angusticollis (Hagen)	Xylo	Ad+Imm	many kinds of wood

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