# Dry Forests and Grasslands

Stand Structures, Range Habitats, and Small Mammals as Indicators of Biodiversity

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The dry forest ecosystems of the southern interior of B.C. are represented by three biogeoclimatic zones: Interior Douglas-fir (IDF), Ponderosa pine (PP) and the Bunchgrass (BG) zone. Douglas-fir and ponderosa pine forests provide an important source of timber for the forest industry. Dry Douglas-fir forests also offer a wide range of non-timber values, including range use by cattle in the myriad grassland openings in these forests. Consequently, various uneven-aged harvesting regimes (individual tree selection (ITS) and patch cuts) have been proposed to maintain a balanced distribution of age classes for timber, range, biodiversity, and recreational objectives. Structural attributes of forest stands are increasingly recognized as crucial to the understanding and enlightened management of forest ecosystems. Both harvestable timber for the forest industry and conservation of biodiversity need to be maintained through time, and these objectives need to be aligned with harvesting systems based on natural disturbance processes. For example, large live trees, snags, and logs provide attributes of mature forest habitat, maintain structural diversity, and provide continuity in the regenerating forest.

An "open" forest canopy of Douglas-fir with some lodgepole pine and understory grasslands and shrublands is typical of these dry ecosystems. To date, "forest range" habitats in IDF forests have received little attention in terms of maintaining biodiversity. B.C.'s grasslands are most prevalent in the arid valley bottoms which coincide with popular and rapidly growing urban centres. Grassland habitats represent less than 1% of B.C.'s landbase, and this limited habitat is critical to the survival of an estimated 30% of the province's threatened or endangered species. Grasslands, both "open range" in the BG zone, and "forest range" in IDF and PP forests, are very important for the ranching industry, which has been grazing livestock within B.C. since the 1850's. Cattle grazing occurs in most areas of the southern interior IDF, PP, and BG zones.

*Cattle grazing in ponderosa pine forest*

## Scientific Studies

This brochure reports on two studies:

A. Dry Douglas-fir forests: Stand structure, "forest range" openings, and maintenance of biodiversity using small mammal indicators

B. "Open range" habitats: grasslands and shrublands with populations of Great Basin pocket mice, western harvest mice, and montane voles.

## Study A

A crucial question is: are we able to maintain stand structure and "forest range" attributes for cattle grazing in managed dry Douglas-fir forests as these ecosystems become increasingly valuable as sources of wood fibre? One way to measure biodiversity and ecological sustainability is to compare specific features of managed forests with unmanaged mature/old-growth forests by way of "keystone structures" and "ecological indicators" such as small mammal species. This quest is critical to future productivity (timber supply) and ecological features (biodiversity) of second-growth forests. Certification processes will likely focus on the issue of sustainability of managed forests to provide timber and ecological services through time.

*Red-backed vole*

*Long-tailed vole*

*Heather vole*

The southern red-backed vole is considered to be a "keystone species" of late successional conditions in temperate and boreal forests. Forests with Douglas-fir, spruce, and true firs, as dominant tree species, provide forest-floor conditions of abundant stumps, rotting logs, and exposed roots that provide moisture and hypogeous fungi for red-backed voles. The presence of understory shrubs and young conifers also appear to be important habitat elements for this species, and may help to modify microclimatic conditions. This microtine is a critical prey species for several carnivores such as marten and various birds of prey. In addition, red-backed voles consume mycorrhizal fungal sporocarps and disperse these spores via their fecal pellets. Thus, this species should provide an indication of the effectiveness of residual stand structures to maintain biodiversity in partially harvested Douglas-fir stands.

A second species is the long-tailed vole which prefers early successional vegetation after harvesting, particularly an abundance of herbs and shrubs providing food and cover on clearcuts. Population changes in the long-tailed vole appear to be annual, but may be multi-annual where herbs and shrubs persist. Thus, this species may be a good indicator of the maintenance of grassland habitat. Multi-annual population fluctuations appear to require a minimum level of vegetative cover to generate increases in abundance of voles.

A third small mammal species, the heather vole, may also occur in openings in Douglas-fir forests. Heather voles are uncommon and found primarily in dry, open coniferous forests with an understory of low shrubs, as well as shrubby vegetation on the borders of forests and in moist, mossy meadows. This species should also provide an indication that sufficient patches of grassland/shrubland are being maintained in these managed forests.

We predicted that, at 10-12 years after partial harvesting of dry Douglas-fir forests, with higher levels of partial cutting of Douglas-fir across a gradient of (a) uncut, (b) historical cut, (c) individual tree selection (ITS), and (d) patch cut:

(1) abundance and diversity of stand structure attributes, and abundance of red-backed voles, will decline;

(2) "forest range" conditions based on cattle forage species in the understory vegetation, and abundance of long-tailed vole and heather vole populations, will be maintained or increase.

Stand structure attributes and selected mammals were sampled during 2006-2008 in replicated units of Douglas-fir stands with these harvesting treatments, near Summerland in south-central B.C., Canada.

*Patch cut in Douglas-fir forest*

*Individual tree selection in Douglas-fir forest*

*Historical cut in Douglas-fir forest*

*Uncut Douglas-fir forest*

## Response in Stand Structure

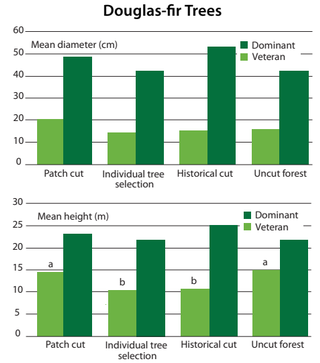
Mean density of overstory trees was similar among stands ranging from 785 to 1402 stems/ha. Relative species composition of four conifers was similar among stands. Mean species diversity of the overstory conifers was different among stands, with highest levels in the uncut forest and ITS stands. Mean species diversity of total conifers was similar among stands, but mean structural diversity was different, being higher in the harvested than uncut stands.

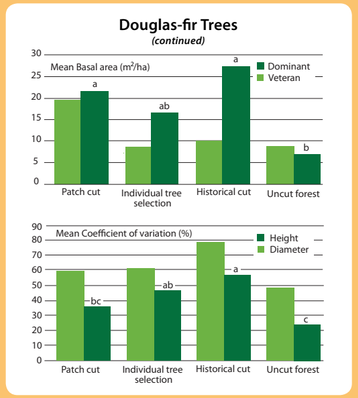
Mean diameters of dominant and veteran Douglas-fir were similar among treatment stands. Mean height of veteran Douglas-fir also followed this pattern, but dominant Douglas-fir were highest in the patch cut and uncut forest stands. Mean basal area of dominant Douglas-fir were similar, but veteran fir were different among treatment stands, with higher levels of basal area in the three harvested stands than the uncut forest. The mean coefficient of variation for diameters of Douglas-fir was similar among stands, but for heights was different. The ITS and historical cut stands had a greater range of heights than the uncut forest, with the patch cut and ITS being similar.

There were no differences in measured parameters of understory vegetation among treatments, but there were 5 plant species for cattle forage.

| Parameter | Patch Cut | Individual Tree Selection | Historical cut | Uncut forest |
|---|---|---|---|---|
| *Overstory conifers* | | | | |
| Density (stems/ha) | 785 | 872 | 815 | 1402 |
| Species diversity | $0.30^{b}$ | $0.88^{ab}$ | $0.37^{b}$ | $1.36^{a}$ |
| *Total conifers* | 1662 | 2125 | 1435 | 2092 |
| Douglas-fir | 1285 | 1560 | 1328 | 655 |
| Lodgepole pine | 323 | 518 | 58 | 380 |
| Subalpine fir | 0 | 0 | 38 | 1015 |
| Interior spruce | 2 | 45 | 10 | 42 |
| Ponderosa pine | $52^{a}$ | $2^{b}$ | $3^{b}$ | $0^{b}$ |
| Species diversity | 0.86 | 0.82 | 0.52 | 1.30 |
| Structural diversity | $1.78^{a}$ | $1.76^{a}$ | $1.66^{a}$ | $1.37^{b}$ |

*Mean stand density of overstory (> 3 m height) coniferous trees, and abundance of understory (< 3 m height) conifers, and abundance, species composition, and diversity of total conifers. Within a row, values followed by different letters are significantly different.*

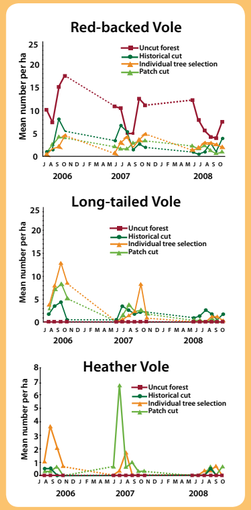



## Response of Small Mammals

Red-backed voles persisted in our 10- to 12 year-old harvested sites and the historical cut stands. However, mean abundance was less (but not statistically) than that recorded in our uncut forest stands.

Responses of long-tailed voles and heather voles provided an indication that openings within the harvested stands had sufficient herbs and shrubs to support these two species.




## Inferences to timber, biodiversity, and range

Our study used "keystone structures" and "ecological indicators" as inferences to managing dry Douglas-fir forests for timber, biodiversity, and range attributes. Forest structures included densities and sizes of Douglas-fir, and species and structural diversity of total conifers. Forest stand structure and its inherent value to timber and biodiversity seemed to be maintained in the harvested stands. Closed-canopy forest structure sustained populations of red-backed voles in the

*Continued on back*

harvested stands. Development of understory vegetation in harvest-origin openings did not differ across the levels of partial cutting, and did provide at least five plant species for cattle forage. Understory development in patch cut and ITS stands maintained viable populations of long-tailed voles and heather voles. These three small mammal indicators, with their myriad ecosystem functions, represent both late and early successional conditions in these IDF forests, which need to be managed for multiple objectives. This mandate will become crucial as we approach the end of the harvest era for lodgepole pine, owing to the mountain pine beetle outbreak, and enter Douglas-fir forests on a much larger scale.

## Study B

### Response of Small Mammals

*Old field habitat with native bunchgrass and forage species*

*Sagebrush habitat with native bunchgrasses*

*Ponderosa pine forest with native bunchgrasses and balsamroot*

In the PP and BG zones, there are three species: the Great Basin pocket mouse, western harvest mouse, and montane vole that could serve as indicators of habitat maintenance in "open ranges": old fields, sagebrush with native bunchgrasses, and ponderosa pine forest.

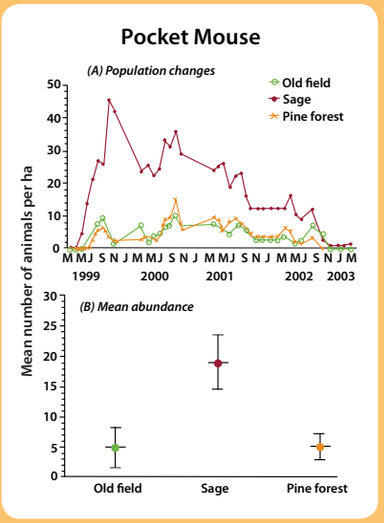
The pocket mouse is a species of arid and semi-arid habitats where sagebrush and bunchgrasses are dominant. It also occurs in ponderosa pine forests. The western harvest mouse is associated with dry grasslands of the Okanagan and Similkameen valleys. Dominant vegetation of these grasslands includes bluebunch wheatgrass, big sagebrush, and antelopebrush. Habitat types utilized by harvest mice include shrub-steppe rangeland, old fields, dry gullies and overgrown grassy areas bordering cultivated fields. Both of these species could act as indicators to determine if sufficient "open range" habitats of grassland and shrubland are being maintained in these two zones.

The montane vole prefers arid short grassland at lower elevations and in valley bottoms. This vole is similar to the meadow vole in many of its habits with some limited evidence reported for both multi-annual and annual cycles of abundance. Montane voles prefer perennial grassland habitats that provide both cover and food sources such as grasses, sedges, forbs, and shrubs. Thus, they are an excellent indicator of the maintenance of grassland habitat.

*Great Basin pocket mouse*

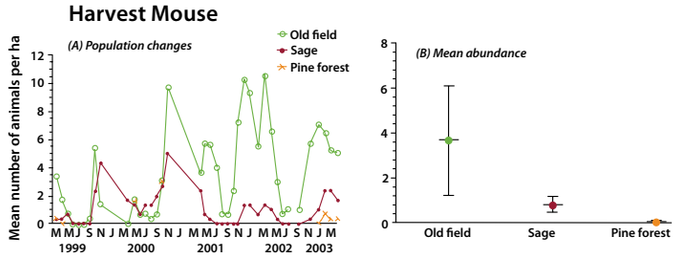
*Western harvest mouse*

*Montane vole*

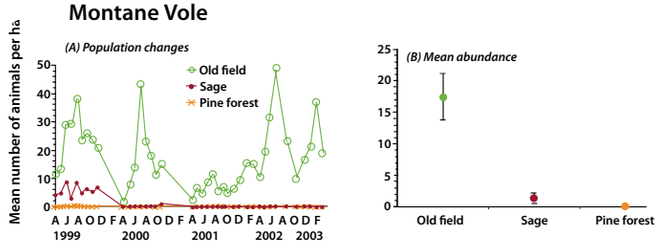



Highest mean overall density per ha of pocket mice consistently occurred in the sage habitat (19.0) compared with the old field (5.0) or pine forest (5.1) habitats. Population changes were similar between the old field and pine forest habitats. The sagebrush sites had the highest species richness of herbs and total species diversity of vascular plants of the three habitats. Structural diversity (number of layers of vegetation and relative abundance in each layer) of shrubs was comparable in the sage and pine forest habitats with a negligible shrub layer in the old field habitat. Thus, the cover provided by sagebrush and the richness and diversity of seed-bearing plants likely contributed to the preference for sage habitats by pocket mice.

Western harvest mice occurred primarily in the old field habitats reaching annual peaks in abundance, ranging from 5.3 to 10.5 animals per ha, in the fall and early winter months. Mean overall abundance of western harvest mice per ha was highest in the old field (3.7) compared with the sage (0.8) and pine forest (0.05) habitats.




Mean abundance of montane voles was consistently different among sites, with the old field habitat having the highest overall mean numbers (17/ha).




### Open Range Habitats and Conservation

The preference for sagebrush habitats by the pocket mouse, and its apparently poor dispersal ability, suggests that such sites, including old fields, need to be conserved as non-linear components within a mosaic of natural and managed habitats. Western harvest mice and montane voles, on the other hand, may do well in linear and non-linear habitats with a high biomass and structural diversity of grasses and forbs. Various configurations of linear habitats in the form of hedgerows, field edges, fence lines, roadsides, and ditches may provide sufficient habitat for the harvest mouse and montane vole if the vegetative component is maintained. To this end, linear habitats created within and bordering fields of agricultural crops (forages, tree fruits and vineyards) could help curb the eroding habitat base for these species.

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