10560

Rocky Mountain Subalpine Mesic-Wet Spruce-Fir Forest and Woodland

BpS Model/Description Version: Aug. 2020

|  |  |  |  |
| --- | --- | --- | --- |
| **Modelers** |  | **Reviewers** |  |
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Reviewer: Cathy Stewart

Vegetation Type

Forest and Woodland

Map Zones

10, 19

Geographic Range

This type occurs in the Northern Rockies, including western Montana, Idaho north of the Salmon River, and Wyoming.

This specific model was refined to fit the mapped distribution of 10560 in the LANDFIRE Biophysical Setting (BpS) layer. See the Comments section for more information on how this type was mapped and modeled.

Biophysical Site Description

Upper subalpine zone and mesic sites. Occurrences are typically found in locations with cold-air drainage or ponding, or where snowpacks linger late into the summer, such as north-facing slopes and high-elevation ravines. They can extend downward in elevation below the subalpine zone in places where cold-air ponding occurs; northerly and easterly aspects predominate. These forests are found on gentle to very steep mountain slopes, high-elevation ridgetops and upper slopes, plateau-like surfaces, basins, alluvial terraces, well-drained benches, and inactive stream terraces.

Vegetation Description

Engelmann spruce and subalpine fir dominate on most aspects, with lodgepole pine comprising a greater component on dryer sites or during earlier successional stages. *Vaccinium scoparium* is a common understory associate.

In the northern Rocky Mountains of northern Idaho and Montana, *Picea galuca* may be present, and *Tsuga mertensiana* occurs as small to large patches within the matrix of this mesic spruce-fir system in the most maritime of environments (the coldest and wettest of the more continental subalpine fir forests).

Mesic understory shrubs include *Menziesia ferruginea*, *Vaccinium membranaceum*, *Rhododendron albiflorum*, *Amelanchier alnifolia*, *Rubus parviflorus*, *Ledum glandulosum*, *Phyllodoce empetriformis*, and *Salix* spp. Herbaceous species include *Actaea rubra*, *Maianthemum stellatum*, *Cornus canadensis*, *Erigeron eximius*, *Gymnocarpium dryopteris*, *Rubus pedatus*, *Saxifraga bronchialis*, *Tiarella* spp., *Lupinus arcticus* ssp*. subalpinus*,and *Valeriana sitchensis*. Specific graminoids include *Luzula glabrata var. hitchcockii* or *Calamagrostis canadensis*.

BpS Dominant and Indicator Species

|  |  |  |
| --- | --- | --- |
| **Symbol** | **Scientific Name** | **Common Name** |
| PIEN | *Picea engelmannii* | Engelmann spruce |
| ABLA | *Abies lasiocarpa* | Subalpine fir |
| PICO | *Pinus contorta* | Lodgepole pine |

Species names are from the NRCS PLANTS database. Check species codes at http://plants.usda.gov.

Disturbance Description

Primarily long-interval stand-replacement fires. In some areas, spruce beetle can influence successional stage, species composition, and stand density. Spruce beetle may act to accelerate succession.

Fire Frequency

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Severity** | **Avg FI** | **Percent of All Fires** | **Min FI** | **Max FI** |
| Replacement | 180 | 100 | 100 | 600 |
| Moderate (Mixed) |  |  |  |  |
| Low (Surface) |  |  |  |  |
| All Fires | 180 | 100 |  |  |

Fire interval is expressed in years for each fire severity class and for all types of fire combined (All Fires). Average FI is the central tendency modeled. Percent of all fires is the percent of all fires modeled in that severity class. Minimum and Maximum FIs show the relative range of fire intervals as estimated by model contributors, if known.

Scale Description

Fires could range from thousands to ten-thousands of acres. Variability of climate, topography, and other site factors can result in a wide range of representation of successional stages on the landscape. Equilibrium landscapes are not likely to develop in areas <500,000ac.

Adjacency or Identification Concerns

Adjacent to drier, lower subalpine forests (lodgepole-spruce-fir) and to krummholz and alpine vegetation. This system typically has more precipitation and longer winters than lower subalpine types.

Climate (severely dry conditions) is the primary driver of fire regimes in this system. Long-term changes in climate as well as interannual climate variability affect the frequency of fire in this system.

This BpS corresponds to the following habitat types (Pfister et al. 1977): ABLA/ALSI, ABLA/CAGE, ABLA/VASC, TSME/XETE, TSME/MEFE, TSME/CLUN, PICEA/GART, PICEA/LIBO, and PICEA/PHMA.

Issues or Problems

Native Uncharacteristic Conditions

Comments

Cathy Stewart reviewed this BpS during the 2015 BpS review. Stewart stated that windthrow is very prevalent in the Late Closed Class. The wind/weather/stress transition in that class originally had a probability of .0005, or a 2,000-yr return interval. Kori Blankenship reviewed the model for the same BpS in the PNW (map zone [MZ] 1, MZ07, MZ08, and MZ09) and found that it noted the susceptibility of Late Closed spruce-fir stands to windthrow and used a much higher probability for the late to mid wind/weather/stress transition. Blankenship used the PNW probability in this model for the Late Closed to Mid Open wind weather stress transition, which resulted in a small change in s-class percentages.

During LANDFIRE National, this model was corrupted and had to be recreated months after it was delivered for MZ10 and MZ19. Kathy Roche authored the model, but we were unable to get the model reviewed again prior to mapping. The comments from an earlier review that indicated the fire return interval (FRI) should be around 175yrs were incorporated into this version of the model.

This model produced anomalous results in LANDSUM, and was revised on 7/28/06 by Brendan Ward, LANDFIRE, Missoula Fire Sciences Lab. During revisions, it was discovered this model was intended for extremely cold, long-return interval systems representing a more rare type of site within the distribution of spruce-fir and was not representative of this system in the areas mapped to it in the LANDFIRE BpS layer. This current model was built from the previous version of the model delivered in January 2005 and was updated to reflect some of the characteristics of the revised model from April 2006. The disturbance and succession rates were further refined through dialogue with the modeler and the reviewer of a previous version. Notable changes include a fire frequency of around 175yrs; increased rates of insect disturbance; decreased durations in Class A, Class B, and Class C; and a slight probability that some wind/weather/stress events may transition to Class B. This model was reviewed by the modeler (Kathy Roche), Steve Barrett, and Jeff Jones on 7/28/06.

Succession Classes

**Mapping Rules**

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Upper Layer Lifeform** | **Height (m)** | **Canopy Cover (%)** | | | | | | | | | |
| **0-10** | **11-20** | **21-30** | **31-40** | **41 - 50** | **51-60** | **61-70** | **71-80** | **81-90** | **91-100** |
| Herb | 0-0.5 | A | A | A | A | A | A | A | A | A | A |
| Herb | 0.5-1.0 | A | A | A | A | A | A | A | A | A | A |
| Herb | >1.0 | A | A | A | A | A | A | A | A | A | A |
| Shrub | 0-0.5 | A | A | A | A | A | A | A | A | A | A |
| Shrub | 0.5-1.0 | A | A | A | A | A | A | A | A | A | A |
| Shrub | 1.0-3.0 | A | A | A | A | A | A | A | A | A | A |
| Shrub | >3.0 | A | A | A | A | A | A | A | A | A | A |
| Tree | 0-5 | A | A | A | A | A | A | A | A | A | A |
| Tree | 5-10 | C | C | C | C | B | B | B | B | B | B |
| Tree | 10-25 | C | C | C | C | D | D | D | D | D | D |
| Tree | 25-50 | C | C | C | C | D | D | D | D | D | D |
| Tree | >50 | C | C | C | C | D | D | D | D | D | D |

Succession class letters A-E are described in the Succession Class Description section. Some classes use a leafform distinction where a qualifier is added to the class letter: Brdl (broadleaf), Con (conifer), or Mix (mixed conifer and broadleaf). UN refers to uncharacteristic native or a combination of height and cover that would not be expected under the reference condition. NP refers to not possible or a combination of height and cover which is not physiologically possible for the species in the BpS.

**Description**

Class A 16 Early Development 1 - All Structures

Indicator Species

|  |  |  |  |
| --- | --- | --- | --- |
| **Symbol** | **Scientific Name** | **Common Name** | **Canopy Position** |
| PIEN | Picea engelmannii | Engelmann spruce | Upper |
| ABLA | Abies lasiocarpa | Subalpine fir | Mid-Upper |
| PICO | Pinus contorta | Lodgepole pine | Upper |

Description

Early succession stage. There can be extended periods (as long as 300yrs) of grass/seedling stage after fire-replacing events. This stage may occupy 3-50% or more of the landscape, depending upon climatic conditions and variability of FRIs.

*Maximum Tree Size Class*  
Sapling >4.5ft; <5" DBH

Class B 26 Mid Development 1 - Closed

Indicator Species

|  |  |  |  |
| --- | --- | --- | --- |
| **Symbol** | **Scientific Name** | **Common Name** | **Canopy Position** |
| PIEN | Picea engelmannii | Engelmann spruce | Upper |
| ABLA | Abies lasiocarpa | Subalpine fir | Mid-Upper |
| PICO | Pinus contorta | Lodgepole pine | Upper |

Description

High-density saplings to poles. May occupy 5-50% of the landscape. Competition/maintenance was modeled to represent the stem-excluding phase of more pure lodgepole pine stands.

*Maximum Tree Size Class*  
Pole 5-9" DBH

Class C 20 Mid Development 1 - Open

Indicator Species

|  |  |  |  |
| --- | --- | --- | --- |
| **Symbol** | **Scientific Name** | **Common Name** | **Canopy Position** |
| PIEN | Picea engelmannii | Engelmann spruce | Upper |
| ABLA | Abies lasiocarpa | Subalpine fir | Mid-Upper |
| PICO | Pinus contorta | Lodgepole pine | Upper |

Description

Low-density saplings to poles. Primarily occurs after insects, disease, or weather stress thins denser stands. Occupies 3-50% of landscape.

*Maximum Tree Size Class*  
Pole 5-9" DBH

Class D 38 Late Development 1 - Closed

Indicator Species

|  |  |  |  |
| --- | --- | --- | --- |
| **Symbol** | **Scientific Name** | **Common Name** | **Canopy Position** |
| PIEN | Picea engelmannii | Engelmann spruce | Upper |
| ABLA | Abies lasiocarpa | Subalpine fir | Upper |

Description

Pole-size to larger diameter trees. This stage occupies 15-50% of the landscape. These sands are susceptible to windthrow.

*Maximum Tree Size Class*  
Large 21-33" DBH

Model Parameters

Deterministic Transitions

|  |  |  |  |
| --- | --- | --- | --- |
| **From Class** | **Begins at (yr)** | **Succeeds to** | **After (years)** |
| Early1:ALL | 0 | Mid1:CLS | 29 |
| Mid1:CLS | 30 | Late1:CLS | 100 |
| Mid1:OPN | 50 | Late1:CLS | 100 |
| Late1:CLS | 100 | Late1:CLS | 999 |

Probabilistic Transitions

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Disturbance Type** | **Disturbance occurs In** | **Moves vegetation to** | **Disturbance Probability** | **Return Interval (yrs)** | **Reset Age to New Class Start Age After Disturbance?** | **Years Since Last Disturbance** |
| Replacement Fire | Early1:ALL | Early1:ALL | 0.005 | 200 | Yes | 0 |
| Wind or Weather or Stress | Mid1:OPN | Mid1:OPN | 0.0005 | 2000 | No | 0 |
| Wind or Weather or Stress | Mid1:OPN | Early1:ALL | 0.0005 | 2000 | Yes | 0 |
| Insects or Disease | Mid1:OPN | Mid1:OPN | 0.001 | 1000 | No | 0 |
| Replacement Fire | Mid1:OPN | Early1:ALL | 0.005 | 200 | Yes | 0 |
| Wind or Weather or Stress | Mid1:CLS | Mid1:OPN | 0.0005 | 2000 | Yes | 0 |
| Wind or Weather or Stress | Mid1:CLS | Early1:ALL | 0.0005 | 2000 | Yes | 0 |
| Insects or Disease | Mid1:CLS | Mid1:OPN | 0.002 | 500 | Yes | 0 |
| Competition or Maintenance | Mid1:CLS | Mid1:OPN | 0.002 | 500 | Yes | 0 |
| Replacement Fire | Mid1:CLS | Early1:ALL | 0.005 | 200 | Yes | 0 |
| Wind or Weather or Stress | Late1:CLS | Early1:ALL | 0.0005 | 2000 | Yes | 0 |
| Insects or Disease | Late1:CLS | Mid1:OPN | 0.002 | 500 | Yes | 0 |
| Replacement Fire | Late1:CLS | Early1:ALL | 0.0066 | 152 | Yes | 0 |
| Wind or Weather or Stress | Late1:CLS | Mid1:OPN | 0.007 | 143 | Yes | 0 |

References

Alexander R.R., G.R. Hoffman and J.M Wirsing. 1986. Forest vegetation of the Medicine Bow National Forest in southeastern Wyoming: a habitat type classification. Research Paper RM-271. Fort Collins, CO: Rocky Mountain Forest and Range Experiment Station.

Alexander, R.R. 1986. Silvicultural systems and cutting methods for old-growth spruce-fir forests in the central and southern Rocky Mountains. General Technical Report RM-126. Fort Collins, CO: Rocky Mountain Forest and Range Experiment Station.

Alexander, R.R. 1988. Forest vegetation on national forests in the Rocky Mountain and Intermountain regions: habitat types and community types. General Technical Report RM-162. Fort Collins, CO: Rocky Mountain Forest and Range Experiment Station.

Alexander, R.R. and O. Engelby. 1983. Engelmann spruce - subalpine fir. In: Silvicultural systems for the major forest types of the United States. Agriculture Handbook 445. Washington, D.C: US Dept. of Agriculture.

Aplet, G.H., R.D. Laven and F.W. Smith. 1988. Patterns of community dynamics in Colorado Engelmann spruce and subalpine fir forests. Ecology 69: 312-319.

Arno, S.F. 2000. Fire in western forest ecosystems. Pages 97-120 in: J.K. Brown and J. Kapler-Smith, eds. Wildland fire in ecosystems: effects of fire on flora. Gen. Tech. Rep. RMRS-GTR-42-vol. 2. Ogden, UT: USDA Forest Service, Rocky Mountain Research Station. 257 pp.

Baker, W.L. and R. Knight. 2000. Roads and forest fragmentation in the Southern Rocky Mountains. Pages 97-122 in: R. Knight, F.W. Smith, W.H. Romme and W.L. Baker, eds. Forest fragmentation in the Southern Rocky Mountains. Boulder, Colorado: University Press of Colorado.

Baker, W.L. 2000. Measuring and analyzing forest fragmentation in the Rocky Mountains and western United States. Pages 55-94 in: R. Knight, F.W. Smith, W.H. Romme and W.L. Baker, eds. Forest fragmentation in the Southern Rocky Mountains. Boulder, Colorado: University Press of Colorado.

Baker, W.L. and K. F. Kipfmueller. 2001. Spatial ecology of pre-Euro-American fires in a Southern Rocky Mountain subalpine forest landscape. The Professional Geographer 53(2): 248-262.

Baker, W.L. and T.T. Veblen. 1990. Spruce Beetles and Fires in the Nineteenth-Century Subalpine forests of Western Colorado, U.S.A. Arctic and Alpine Research 22(1): 65-80.

Baker, W.L. 1994. Landscape Structure Measurements for Watersheds in the Medicine Bow National Forest Using GIS Analysis. Department of Geography and Recreation, Univ. of Wyoming. Prepared under agreement with the USDA Forest Service, Medicine Bow NF. On file at Medicine Bow-Routt NFs and Thunder Basin NG Supervisor’s Office, Laramie, WY.

Barrett, S.W. 1994. Fire regimes on andesitic mountain terrain in northeastern Yellowstone National Park. International Journal of Wildland Fire 4: 65-76.

Buechling, A. and W.L. Baker. 2004. A fire history from tree rings in a high-elevation forest of Rocky Mountain National Park. Canadian Journal of Forest Research 34: 1259-1273.

Buskirk, S.W., W.H. Romme, F.W. Smith and R. Knight. 2000. An overview of forest fragmentation in the Southern Rocky Mountains. Pages 3-14 in: R. Knight, F.W. Smith, W.H. Romme and W.L. Baker, eds. Forest Fragmentation in the Southern Rocky Mountains. Boulder, Colorado: University Press of Colorado.

Clagg, H.B. 1975. Fire ecology in high-elevation forests in Colorado. M.S. Thesis, Colorado State University, Fort Collins, Colorado.

Coleman, M.D., T.M. Hinckley, G. McNaughton and B.A. Smit. 1992. Root cold hardiness and native distribution of sub-alpine conifers. Canadian Journal of Forest Research 22(7): 932-938.

Crane, M.F. and W.C. Fisher. 1986. Fire ecology of the forested habitat types of central Idaho. General Technical Report INT-218, USDA Forest Service. 86 pp.

Despain, D.G. 1973. Vegetation of the Big Horn Mountains in relation to substrate and climate. Ecological Monographs 43:329-355.

Despain, D.G. and R.E. Sellers. 1977. Natural fire in Yellowstone National Park. Western Wildlands, summer 1977.

Dillon, G. K., D. Knight and C. Meyer. 2003. Historic variability for upland vegetation in the Medicine Bow National Forest. Department of Botany, Univ. of Wyoming: prepared under agreement with the USDA Forest Service Medicine Bow NF 1102-0003-98-043.

Graham, R.T. A.E. Harvey, M.F. Jurgensen, T.B. Jain, J.R. Tonn and D.S. Page-Dumrose. 1994. Managing coarse woody debris in forests of the Rocky Mountains. Research Paper INT-RP-477. Fort Collins, CO: USDA Forest Service, Intermountain Research Station.

Griggs, R.F. 1938. Timberlines in the Northern Rocky Mountains. Ecology 19(4): 548-564.

Griggs, R.F. 1946. The timberlines of Northern America and their interpretation. Ecology 27(4): 275-289.

Hinds, T.E., F.G. Hawksworth and R.W. Davidson. 1965. Beetle-killed Engelmann spruce: Its deterioration in Colorado. J. For. 63(7): 536-542.

Jenkins, M.J., C.A. Dicus and E.G. Hebertson. 1998. Post-fire succession and disturbance interactions on an intermountain subalpine spruce-fir forest. Pages 219-229 in: T.L. Pruden and L.A. Brennan, eds. Proceedings, Symposium: Fire in Ecosystem Management: Shifting the paradigm from suppression to prescription. Tall Timbers Fire Ecology Conference Proceedings, No. 20. Tall Timbers Research Station, Tallahassee, FL.

Jones, G.P., and S.M. Ogle. 2000. Characterization abstracts for vegetation types on the Bighorn, Medicine Bow, and Shoshone National Forests. Laramie. Prepared for USDA Forest Service, Region 2, by George Jones and Steve Ogle, WYNDD, UW, Laramie WY.

Kane, T.L., B.G. Brown and R. Sharman. 1999. A preliminary climatology of upper level turbulence reports. Preprints pages 363-367 in: 8th Conf. on Aviation, Range and Aerospace Meterology, 10-15 January. Dallas, TX: American Meteorology Society.

Kipfmueller, K.F. and W.L. Baker. 2000. A fire-history of a subalpine forest in south-eastern Wyoming, USA. Journal of Biogeography 27: 71-85.

Kipfmueller, K.F. 1997. A fire history of a subalpine forest in southeastern Wyoming. Thesis. University of Wyoming. Laramie, WY.

Kipfmueller, K.F. and W.L. Baker. 1998a. A comparison of three techniques to date stand-replacing fires in lodgepole pine forests. Forest Ecology and Management 104: 171-177.

Kipfmueller, K.F. and W.L. Baker. 2000. A fire history of a subalpine forest in southeastern Wyoming, USA. Journal of Biogeography 27: 71-85.

Knight, D.H. 1987. Ecosystem studies in the subalpine coniferous forests of Wyoming. In: Management of subalpine forests: building on 50 years of research: Proceedings of a Technical Conference. General Technical Report RM-149. Fort Collins, CO: USDA Forest Service Rocky Mountain Forest and Range Experiment Station.

Knight, D.H. 1994. Mountains and Plains, The Ecology of Wyoming Landscapes. Yale University Press, New Haven, CT.

Knight, D.H. and W.A. Reiners. 2000. Natural patterns in southern Rocky Mountain landscapes and their relevance to forest management. Pages 15-30 in: R. Knight, F.W. Smith, W.H. Romme and W.L. Baker, eds. Forest fragmentation in the Southern Rocky Mountains. Boulder, Colorado: University Press of Colorado.

Knight, D.H., A.D. Anderson, G.T. Baxter, K.L. Diem, M. Parker, P.A. Rechard, P.C. Singleton, J.F. Thilenius, A.L. Ward and R.W. Weeks. 1975. Final report: the Medicine Bow ecology project: the potential sensitivity of various ecosystem components to winter precipitation management in the Medicine Bow Mountains, Wyoming. Prepared for the Division of Atmospheric Water Resources Management, Bureau of Reclamation, USDI, Denver, CO by the Rocky Mountain Forest and Range Experiment Station, USFS and the Wyoming Water Resource Research Institute.

Logan, J.A., J.M. Schmid and M.S. Mehl. 1980. A computer program to calculate susceptibility of spruce-fir stands to spruce beetle outbreaks. USDA Forest Service Research Note RM-303. Fort Collins, CO: Rocky Mountain Forest and Range Experiment Station.

Loope, L.L. and G.E. Gruell. 1973. The ecological role of fire in the Jackson Hole area, northwestern Wyoming. Quaternary Research 3(3): 425-443.

Mehl, M. 1992. Old-growth descriptions for the major forest cover types in the Rocky Mountain region. In: Old-growth forests in the Southwest and Rocky Mountain regions. Proceedings of a workshop. Gen. Tech. Report RM-213. Fort Collins, CO: USDA Forest Service, Rocky Mountain Forest and Range Experiment Station.

Merrill, E.H., T.W. Kohley, M.E. Herdendorf, W.A. Reiners, K.L. Driese, R.W. Marrs and S.A. Anderson. 1996. Wyoming GAP analysis project final report. University of Wyoming Department of Physiology and Department of Botany, Wyoming Cooperative Fish and Wildlife Research Unit and USGS Biological Resources Division. Available: http://www.sdvc.uwyo.edu/wbn/abstract.html

Meyer, C.B. and D.H. Knight. 2001. Historic variability of upland vegetation in the Bighorn National Forest, Wyoming. Draft report, 30 November 2001.

Mielke, J.L. 1950. Rate of deterioration of beetle-killed Engelmann spruce. J. For. 48(12): 882-888.

Moir, W.H. 1992. Ecological concepts in old-growth forest definition. In: Old-growth forests in the Southwest and Rocky Mountain regions. Proceedings of a workshop. Gen. Tech. Report RM-213. Fort Collins, CO: USDA Forest Service, Rocky Mountain Forest and Range Experiment Station.

NatureServe. 2007. International Ecological Classification Standard: Terrestrial Ecological Classifications. NatureServe Central Databases. Arlington, VA. Data current as of 10 February 2007.

Pennanen, J. 2002. Forest age distribution under mixed-severity fire regimes – A simulation-based analysis for middle boreal Fennoscandia. Silva Fennica: quarterly issues: 36(1): 213-231.

Pfister, R.D., B.L. Kovalchik, S.F. Arno and R.C. Presby. 1977. Forest habitat types of Montana. General Technical Report INT-34. Ogden, UT: USDA Forest Service, Intermountain Forest and Range Experiment Station. 174 pp.

Schmid, J.M. and R.H. Frye. 1977. Spruce beetle in the Rockies. Spruce beetle in the Rockies. General Technical Report RM 49. Fort Collins, CO: USDA Forest Service, Rocky Mountain Forest and Range Experiment Station. 38 pp.

Schmid, J.M. and R.C. Beckwith. 1977. The spruce beetle. Pest Leaflet 127. USDA Forest Service. 7 pp.

Schmid, J.M. and R.H. Frye. 1976. Stand ratings for spruce beetles. Research Note RM-309. Fort Collins, CO: USDA Forest Service, Rocky Mountain Forest and Range Experiment Station.

Schmid, J.M. and S.A. Mata. 1996. Natural variability of specific forest insect populations and their associated effects in Colorado. General Technical Report RM-GTR-275. Fort, Collins, CO: USDA FS Rocky Mountain Forest and Range Experiment Station.

Schmid, J.M. and T.E. Hinds. 1974. Development of spruce-fir stands following spruce beetle outbreaks. Research Paper RM-131. Fort Collins, CO: USDA Forest Service, Rocky Mountain Forest and Range Experiment Station.

Schmidt, K.M., J.P. Menakis, C.C. Hardy, W.J. Hann and D.L. Bunnell. 2002. Development of coarse-scale spatial data for wildland fire and fuel management. Gen. Tech. Rep. RMRS-GTR-87. Fort Collins, CO: USDA Forest Service, Rocky Mountain Research Station. 41 pp. + CD.

Schrupp, D.L., W.A. Reiners, T.G. Thompson, L.E. O'Brien, J.A. Kindler, M.B. Wunder, J.F. Lowsky, J.C Buoy, L. Satcowitz, A.L. Cade, J.D. Stark, K.L. Driese, T.W. Owens, S.J. Russo and F. D'Erchia. 2000. Colorado Gap Analysis Program: A geographical approach to planning for biological diversity - final report. Denver, CO: USGS Biological Resource Division, Gap Analysis Program and Colorado Division of Wildlife.

Sherriff, R., T.T. Veblen and J.S. Sibold. 2001. Fire history in high elevation subalpine forests in the Colorado Front Range. Ecoscience 8: 369-380.

Sibold, J. 2001. The forest fire regime of an upper montane and subalpine forest, Wild Basin, Rocky Mountain National Park. M.S. Thesis, University of Colorado, Boulder, CO.

Stahelin, R. 1943. Factors influencing the natural restocking of high altitude burns by coniferous trees in the central Rocky Mountains. Ecology 24: 19-30.

Veblen, T.T., K.S. Hadley and M.S. Reid. 1991. Disturbance and stand development of a Colorado subalpine forest. Journal of Biogeography (1991)18: 707-716.

Veblen, T.T., K.S. Hadley, E.M. Nel, T. Kitzberger, M.S. Reid and R. Villalba. 1994. Disturbance regime and disturbance interactions in a Rocky Mountain subalpine forest. Journal of Ecology 82: 125-135.

Veblen, T.T., K.S. Hadley, M.S. Reid and A.J. Rebertus. 1989. Blowdown and stand development in a Colorado subalpine forest. Canadian Journal of Forest Resources. Vol 19: 1218-1225.

Veblen, T.T. and T. Kitzberger. 2002. Inter-hemispheric comparison of fire history: The Colorado Front Range, U.S.A. and the Northern Patagonian Andes, Argentina. Plant Ecology, in press.

Whipple, S.A. and R.L. Dix. 1979. Age structure and successional dynamics of a Colorado subalpine forest. American Midland Naturalist 101: 142-158.