



Silvicultural Recommendations Conboy Lake National Wildlife Refuge

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ABSTRACT

During 2008 and 2009, I prepared silvicultural prescriptions for Forest Stands on the Conboy National Wildlife Refuge. This report, covering approximately 2,000 acres of forest in 26 separate forest stands, consists of recommendations for managing forests on the Refuge. Stands mostly consist of three types of forest; ponderosa pine stands, lodgepole and ponderosa pine stands, and mixed conifer stands with Douglas-fir, ponderosa pine, and grand fir as primary species.

Data were collected by the US Forest Service in 2002 for several stands, under a previous contract with USFWS. Data on remaining stands were collected as a part of the 2008-2009 effort.

USFWS personnel provided management direction for the Refuge and for the forest stands in this report. That direction, plus data gathered, were used to develop recommendations for management of the Refuge forest stands.

Recommended practices include thinnings in both ponderosa pine and mixed conifer stands; creation of small openings in various stands; removal of young trees that are colonizing meadows; maintenance and creation of snags; use of prescribed fire as a management tool, and removal of conifers that are overtopping and shading small stands of hardwoods (quaking aspen and Oregon White Oak).

I. Introduction

In summer, 2008, the US Fish and Wildlife Service (FWS) contracted with the Underwood Conservation District (UCD) to prepare recommendations for management of forest stands on the Conboy Lake National Wildlife Refuge. FWS managers were

interested in options for management that enhanced wildlife management objectives of the refuge, and in providing a margin of protection against wildfire.

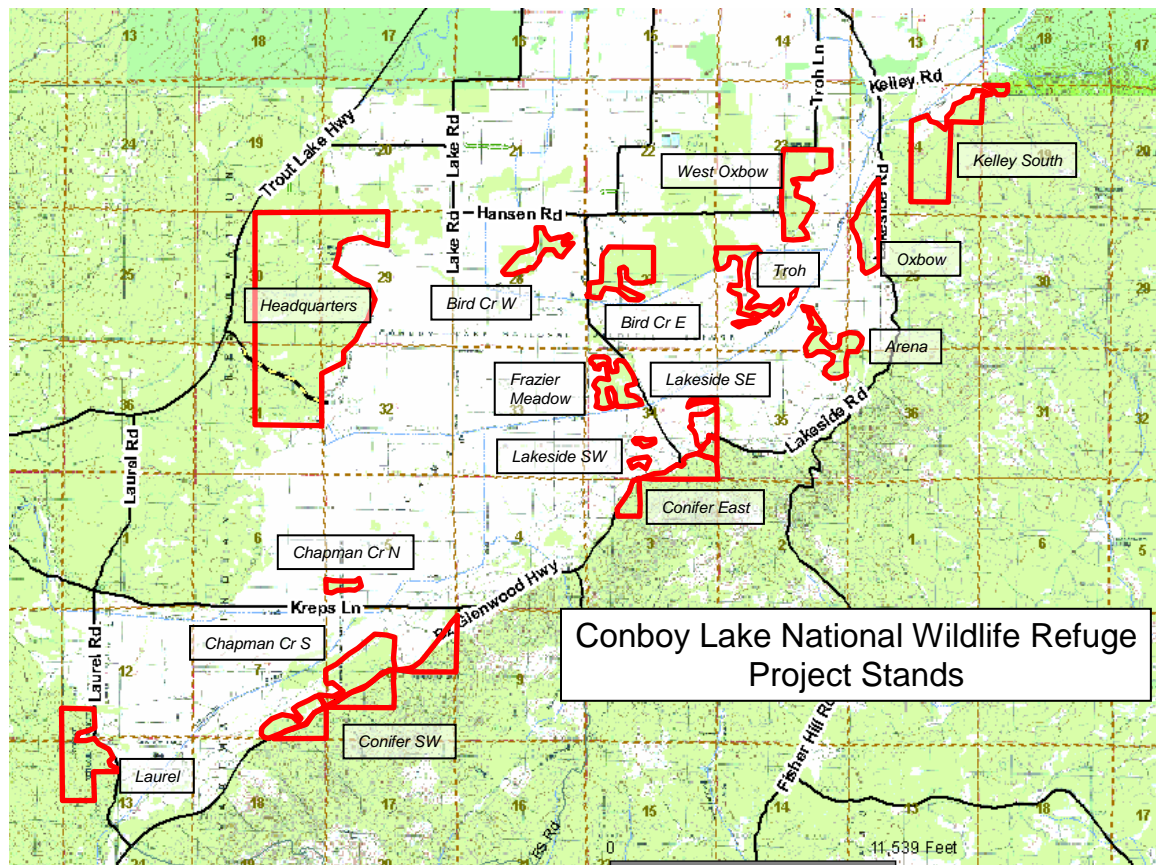
In 2002, the FWS contracted with the Gifford Pinchot National Forest to gather stand examination data on about 350 acres of Refuge forest stands. Data were collected, but no further work was accomplished at that time. In the 2008 contract with UCD, FWS provided that stand exam data, and asked for recommendations regarding additional stands, totaling about 1,900 acres.

This report describes the involved forest stands, and management recommendations for those forest stands.

II. Description of Study Area

The Conboy Lake National Wildlife Refuge occupies approximately 6,500 acres in the Glenwood Valley of southern Washington State, centering on the Conboy/Camas lake beds. The refuge provides important habitat for sandhill cranes, the Oregon spotted frog, and many other species of wildlife. Forest stands on the Refuge occupy approximately 2,000 acres, located on the periphery of the Refuge, and in isolated patches within the wetland complex.

Figure 1. Conboy Refuge Forest Stands



The Refuge lies at an elevation of about 1,800 feet. Most of the Refuge is located on the valley bottom, a shallow, marshy wetland. The area is located within the Klickitat River watershed. Outlet Creek and Bird Creek are the main streamcourses carrying water to the Klickitat. Both streams have been rerouted, to carry water from an extensive system of ditches in the Glenwood Valley, constructed by settlers to drain land for agriculture.

Refuge forest stands can be roughly lumped into 5 categories; (1) ponderosa pine (*Pinus ponderosa*) forest, located on the western edge of the refuge, and in slightly elevated locations within the wetland complex; (2), lodgepole pine (*Pinus contorta*) stands, occupying wet sites adjacent to wetlands and along streamcourses; (3) mixed conifer forest stands (Douglas-fir (*Pseudotsuga menziesii*), grand fir (*Abies grandis*), ponderosa pine, located on relatively moist, yet well-drained sites, primarily on northerly and easterly slopes; (4) Quaking Aspen (*Populus tremuloides*) stands located within the wetland complex, usually in association with lodgepole pine; and (5) Oregon White Oak (*Quercus garryana*) woodlands, small patches on shallow soils, usually associated with surrounding mixed conifer forests.

III. Management Direction

An essential element in a silviculture prescription is a clear understanding of the management direction for a forest stand. The Conboy Lake National Wildlife Refuge currently does not have a management plan, spelling out written direction for management of the refuge. Management direction was determined from several sources:

- Acting Refuge Manager Lamont Glass, in Fall 2008
- Refuge Manager Shannon Ludwig, in spring 2009
- The Conboy Refuge Fire Management Plan (George, 2002)
- US Fish and Wildlife Biologists and Managers at a Conboy Refuge Management Review, July 2009
- Conservation Strategy for Landbirds of the East-Slope of the Cascade Mountains in Oregon and Washington (Altman, 2000)
- Habitat Management Plan for the Pend Oreille National Wildlife Refuge (June, 2005)

Biologists at the July 2009 Refuge review suggested using focal species as a focus for management recommendations for forest stands, and provided suggested species.

Incorporating all recommendations, the following Management guidelines were used in these prescriptions.

Refuge Goals:

- Manage for the conservation and recovery of endangered, threatened, and sensitive species and the habitats on which they depend
- Provide and enhance habitat for fall and spring migratory waterfowl
- Protect native habitats and wildlife representative of the natural biological diversity of the Conboy Refuge

- Provide a margin of protection to refuge structures and neighboring residences from future wildfires
- Restore and maintain forested wildlife habitats, including
 - open mature ponderosa pine forests
 - mixed conifer forests
 - lodgepole pine forests
 - quaking aspen stands
 - Oregon white oak stands
 - forest and meadow edge habitats
- Use Prescribed Fire in restoration efforts where appropriate

After consultation with the Refuge Manager and other biologists, the following focal species and habitat requirements were agreed to that would drive habitat requirements for refuge forest stands.

Table 1. Focal Species and Habitat Requirements for Conboy National Wildlife Refuge Forest Stands

Focal Species¹	Habitat Type	Habitat Structure	Life History Requirement	Other Benefiting Species
White-headed woodpecker	Ponderosa pine forest	Large patches of old forest with large trees and snags	Year round	Hammond's flycatcher, hairy woodpecker, brown creeper, white-breasted nuthatch, pygmy nuthatch
Chipping sparrow White-headed woodpecker	Ponderosa pine forest	Old forest with interspersed openings and dense thickets	Breeding	White-breasted nuthatch, hairy woodpecker, brown creeper, Townsend's solitaire, Hammond's flycatcher, Cassin's finch, western bluebird, western tanager, and pygmy nuthatch, Flammulated owl
Chipping Sparrow	Ponderosa pine forest	Open understory and regenerating pines	Breeding	Townsend's solitaire, Cassin's finch, American robin, dark-eyed junco, dusky flycatcher, and gray flycatcher
Vaux's swift Varied Thrush	Mixed conifer forest	Old forest with large snags	Breeding	Hairy woodpecker, golden-crowned kinglet, chestnut-backed chickadee, red-breasted nuthatch, winter wren, brown creeper, pileated woodpecker, Flammulated owl
Townsend's warbler	Mixed conifer forest	Old forest with overstory canopy closure	Breeding	Golden-crowned kinglet, chestnut-backed chickadee, pileated woodpecker
Varied Thrush Hermit Thrush	Mixed conifer forest	Old forest with multi-layer canopy and structural diversity	Breeding	Golden-crowned kinglet, chestnut-backed chickadee, Townsend's warbler, and winter wren
Olive-sided flycatcher	Mixed conifer forest	Old forest with edges and openings created	Breeding, foraging	Western tanager, Cassin's finch, western wood-peewee,

Focal Species¹	Habitat Type	Habitat Structure	Life History Requirement	Other Benefiting Species
		by wildland fire		mountain bluebird, northern flicker, American kestrel, American robin, elk, black-tailed deer
Red-naped sapsucker	Quaking aspen forest	Large aspen with younger aspen replacements	Breeding	Northern flicker, tree swallow, house wren, northern pygmy owl, western screech owl, mountain bluebird, ruffed grouse
Western gray squirrel (not positively identified on refuge)	Oregon White Oak	Oregon White Oak with canopy connectivity to conifers	Breeding, foraging	

¹Species identified on Refuge via informal surveys and incidental sightings. No comprehensive surveys for these upland species have been undertaken on the Refuge.

The flammulated owl and black-back woodpecker were also considered as focal species. However, they are quite rare on the Refuge (the Flammulated owl has not been sighted, but is presumed to exist; the black-back woodpecker has been sighted once), and their rarity would make them difficult species to monitor.

Habitat management objectives, and strategies by which to reach those objectives, are outlined using habitat needs of these focal species.

Silviculture prescriptions recommended in this report emphasize developing habitats that address the needs of focal species, meet other management objectives, and provide a variety of habitats. Treatments are prescribed to maintain tree vigor and resilience of forest stands, and to assist ecological processes associated with more open forest conditions that once occurred. However, prescriptions also are also aimed at maintaining some older forest conditions that are relatively rare in the managed forest landscape in the Glenwood area, and which address the needs of focal species. Dead and down trees, pockets of dense forest, and tree species diversity help to maintain habitat diversity, and conditions important to many species. If prescriptions were to focus entirely on maintaining healthy, vigorous trees and resistance to disturbance would be very limited in their value to many focal species. Conversely, prescriptions focusing on short-run development of dense forests with multiple canopy layers, down wood and snags, would result in forests more susceptible to large-scale disturbances that could result in loss of those same habitat features. Prescriptions in this report attempt to strike a balance.

IV. Methods

Stand delineation

Stands for which prescriptions were to be developed were outlined by Refuge Acting Manager Lamont Glass in 2008. Those maps were used to delineate forest stands, using aerial photos. Stands on which the Gifford Pinchot National Forest had gathered data

were already mapped on photos. Stands were reviewed on-the-ground to verify rough boundaries.

Stand boundaries are by no means exact. Tree species composition, tree size, and stand density varies considerably across the landscape. In the Headquarters area, several stands are almost pure ponderosa pine, but vary in tree size and density. A break was established where tree size varies, but it is by no means a strong demarcation.

Within the wetland complex on the Glenwood valley bottom, ponderosa pine occupies the higher part of the islands and peninsulas of conifer trees among the slightly lower wetlands. The lower parts of these islands, adjacent to the wetland, are mostly stocked with lodgepole pine and quaking aspen. There is a fuzzy line between the lodgepole pine stands and the ponderosa pine stands, so delineations are not precise. In several instances, no delineation of substands was attempted between the slightly higher ponderosa pine-lodgepole pine stands, and lower elevation areas dominated by lodgepole pine.

Mixed conifer stands, on the south and west edges of the Refuge, have small inclusions of Oregon white oak, growing where soils are very shallow. They were not mapped separate from the surrounding stand matrix.

Data Collection

Each stand was examined by a walk-through, in which informal plot data were collected. For stands in which the USFS had previously collected data, that information was used. In larger stands, such as the Headquarters area, plots were taken on a grid. In small, narrow stands within the wetland matrix, the plots were picked in what appeared to be representative locations. As such, the plot information does not provide any valid statistical representation; rather, it provides some measured, although informal, data from which to describe stands.

Data collected in walk-through surveys include:

- Tree species
- Diameter at Breast Height (dbh), measured with a diameter tape or Biltmore stick. Trees were measured to the nearest 2-inch size class (e.g. 6-inch, 8-inch, 10-inch)
- Heights on a few sample trees. Total height was measured with a 100-foot long tape and a clinometer
- Ages on a few sample trees. Breast-height ages were measured using an increment borer.
- Visual evidence of damaging agents.
- Fuel Residue Type (using Maxwell, 1980). In some stands, the Maxwell publication was not available when the survey was done. In those cases, a type was assigned using stand photographs.
- Surrounding plant composition (percent cover). A visual estimate of the percent cover of associated vegetation was made. Since the field work was done during fall, when many forbs had dried up, plant diversity is probably underestimated.

Trees 5 inches dbh and larger were sampled via variable plot sampling, using a basal area factor of 40. Trees smaller than 5 inches dbh were sampled via a 1/100 acre fixed size plot.

Additional sampling was done in a few stands to look at tree ages and heights.

Data from the USFS stand exams were already summarized, in hardcopy printouts. These data summaries were used to create tables of information, included in Microsoft Excel spreadsheets in Appendix D. Data from walk-through exams were summarized using a US Forest Service computer program, the Forest Vegetation Simulator. Electronic copies of printouts from the Forest Vegetation Simulator, plus summaries from those data, are also included in Appendix D. Hardcopies of USFS Stand exams and my walk-through exams are included in Appendix F (one hardcopy only, delivered to Shannon Ludwig).

In addition to field sampling and walk-through visits, I gathered local information from Harold Cole, former Refuge manager, and Steve Hoodenpyl, long-term local resident.

Insect and diseases were noted during walk-through examinations, and from information on the USFS Stand examinations. Elizabeth Willhite, a US Forest Service Entomologist with the Westside Service Center in Sandy, OR visited the Refuge with me, and provided a report (Appendix B).

V. Results and Discussion

1. Stands dominated by ponderosa pine (*Pinus ponderosa*)

Arena PP
Chapman Cr North
Chapman Creek South 1
Headquarters 1
Headquarters 2
Headquarters 4
Lakeside Southeast
West Oxbow Open Pine

These Conboy Lake Refuge forest sites are occupied by stands primarily composed of 60-100 year old ponderosa pine. Two of the stands (Headquarters 1 and 2) are part of the forested landscape directly west of Conboy Lake. The other ponderosa pine stands are scattered along the edges of Conboy Lake wetlands, and are usually associated with adjacent stands of lodgepole pine and quaking aspen. In these cases, as mentioned previously, ponderosa pine occupies slightly higher, better drained sites.

A. Desired Future Condition

Key management objectives for the ponderosa pine stands on the Conboy Lake Refuge include

- Protect native habitats and wildlife representative of the natural biological diversity of the Conboy Refuge
- Provide a margin of protection to refuge structures and neighboring residences from future wildfires
- Restore and maintain the health of wildlife habitats, including
 - open mature ponderosa pine forests
 - forest and meadow edge habitats
 - Use Prescribed Fire in restoration efforts where appropriate
- Use Habitat Requirements for two focal species, the White-Headed Woodpecker and Chipping Sparrow, in determining specific criteria.

Stands that help to meet these objectives would be large patches of older forest with large snags. Stands would be dominated by large, well-spaced ponderosa pine trees, with some areas of small trees in even-age groups one to several acres in size. 10 or more trees per acre would be 21 inches in diameter or larger. At least one tree per acre would be greater than 31 inches in diameter. Stands would include about 2 snags per acre that are greater than 8 inches in diameter, at least one of which is greater than 25 inches in diameter.

Understory trees and secondary forest canopies would be generally absent. Scattered areas, representing about 10% of the landscape, would consist of more dense forest, with greater development of understory trees, including grand fir and Douglas-fir, and snags. Ground fires would be a frequent visitor to these forests, possibly every 5 to 45 years. The forest structure would not be uniform; rather, it would be a mosaic of different ages and sizes, although generally very open in nature. Over time, many of the large trees would be very old, on the order of 300 years. Endemic levels of insects and diseases, windfall, and other disturbance regimes contributing to ecological processes common in these forests would occur. Snags and down logs would be present, although not evenly distributed on the landscape. Small openings would naturally regenerate with ponderosa pine seedlings, a few of which would survive and grow to maturity. Occasional large Douglas-fir would be present. Near the edges of Conboy Lake and its adjacent grasslands, the forest would provide a valuable ecotone, but disturbances (fire, flooding) would keep the forest from encroaching on the open lands.

B. Species composition and plant association

These stands are dominated by ponderosa pine, with lesser amounts of lodgepole pine, Douglas-fir, and grand fir present. An occasional western white pine (*Pinus monticola*) and western larch (*Larix occidentalis*) may be found. Common understory shrubs and herbs include snowberry (*Symphocarpus spp.*); wild rose (*rosa spp.*), bitterbrush (*purshia tridentata*), bracken fern (*Pteridium aquilinum*), various native bunchgrasses and other grass species. Ecologically, these stands

lie between the *Abies grandis* and *Pinus ponderosa* zones (Franklin and Dyrness, 1973) and are similar to but drier than the grand fir/pinegrass and grand fir/elk sedge plant communities on the Gifford Pinchot National Forest to the west (Topik, 1989). Conboy Refuge ponderosa pine stands are probably climax to grand fir where soils are deep, but climax to Ponderosa pine or Douglas-fir where soils are very shallow. Even after approximately 100 years of fire exclusion, only minor grand fir invasion has occurred in most of the ponderosa pine forest stands.

C. Stand development history

Ponderosa pine stands on the Conboy refuge have followed a development history similar to others on the eastern slopes of the Cascade Range. In presettlement times, frequent, low-intensity ground fires probably were the predominant disturbance influencing these forests, and were key in maintaining more open conditions than we see today. Descriptions of presettlement vegetation in the area, such as narratives from the McClellan



Ponderosa pines in Chapman Creek North

expedition in 1853, describe the open nature of forests at that time. An 1875 Government Land Office Survey of Township 6N, Range 12 E (comprising most of the forest stands on the Conboy refuge) characterizes the vegetation at the time “The timber is chiefly pine, with a sprinkling of tamarack, fir and oak. The numerous large pines and level nature of the land affords a remarkable fine opening for the turpentine business. The bunch grass being quite plentiful makes the land desirable for grazing purposes” (BLM, online land records).

Low-intensity ground fires probably burned through open ponderosa pine stands frequently enough to kill young sapling and seedling trees, and to reduce shrub density, thereby maintaining open forest stands. Evers and others (unpublished USFS paper) place similar forests to the Conboy ponderosa pine stands in their Fire Group Two: Warm, dry Douglas-fir and grand fir (referring to climax plant species, not the seral dominant ponderosa pine). They estimated that these plant communities see a fire return interval of 5 to 45 years. Agee (1993) mentions a return interval calculated at 7-20 years at Pringle Falls, in central Oregon. George (2002) estimates the fire return interval in Conboy ponderosa pine stands at 8 to 20 years.

While fire return intervals are understandably inexact, it is clear that presettlement ponderosa pine forests in the Conboy area saw fires at least every several decades.

The role of fire in ponderosa pine forest has been well documented. Young ponderosa pine have thin bark and are fire-susceptible, but after the sapling stage, the species develops thick bark and is resistant to death by fire (Arno, 1977). Larger pines were able to survive light, ground fires that killed young ponderosa pine, Douglas-fir, and grand fir. The open crown structure and lack of vertical canopy structure of ponderosa pine forests allows for dissipation of heat from ground fires, and lessens the chance of crown fires, which cause the most mortality (USDA Forest Service, Fire Effects Information System).

Fire prevention, beginning in the late 1800s and early 1900s, mostly removed the influence of fire on forest succession in ponderosa pine stands. Conboy ponderosa pine stands probably fall into Agee's (1993) fire group 3, "warm, moist ponderosa pine habitat types. These sites will support dense thickets of ponderosa pine in the absence of frequent fires". Logging has also played an important role. Ponderosa pine forests on the Conboy refuge were logged in the late 1800s and early 1900s, removing most of the mature trees. Another factor may have been an outbreak of pine butterfly (*Noeophasia menapia*) in the late 1800s. Areas of the Yakama Reservation, to the north of Conboy, experienced extensive defoliation of mature ponderosa pine by this insect from 1893 through 1895 (Weaver, 1961).

Subsequent regeneration was mainly ponderosa pine – even without fire as a disturbance factor, there has been limited colonization by Douglas-fir and by shade-tolerant grand fir, unlike mixed conifer stands on the refuge, and on more moist environments to the west. However, the lack of fires has probably resulted in an increased density in the ponderosa pine stands.

D. Soils

Soil types classified in ponderosa pine stands include Guler Stony Sandy Loam, Fanal Sandy Loam, Kreft Sandy Loam, Sedigal Sandy Loam, and Kaiders Sandy Loam. Soils are mostly deep and well-drained, in volcanic ash and colluvium from basalt. Low water holding capacity in these soils is the primary reason they are occupied by stands of ponderosa pine – they are effectively too dry for Douglas-fir and grand fir to thrive.

In the Headquarters area, particularly in the Headquarters 2 stand, areas of extremely shallow soils and surface rock are interspersed with areas of deeper soils. The rocky sites support ponderosa pine, but stocking levels are lower than surrounding areas with deeper soils. They are quite effectively dry. They are characterized by surface rock, little grass cover, low tree stocking, and an abundance of rabbitbrush (*Chrysothamnus nauseosus*) and bitterbrush (*Purshia tridentata*).

E. Stand Density

Most ponderosa pine stands on the Conboy Lake Refuge are densely stocked (see Table 1). Understory tree species are mostly lodgepole pine, Douglas-fir, ponderosa pine and grand fir. Pure ponderosa pine stands often contain large numbers of small trees.

Table 1. Ponderosa Pine Stands

Stand	Trees Per Acre	DBH	Basal Area	SDI	Remarks
Arena PP	274	13.4	270	440	Almost pure ponderosa pine
Chapman Cr North	191	16.9	296	442	Almost pure ponderosa pine. Part underburned in past. Some trees as large as 40 inches dbh.
Chapman Cr South 1	1412	3.8	112	300.6	Stand contains some DF, GF, LPP, oak, and Pacific yew (<i>Taxus brevifolia</i>). Most of stand is open, with 137 tpa in ponderosa pine. Heavy Douglas-fir regeneration contributed to the TPA total. Some trees as large as 39 inches dbh
Headquarters 1	407(346PP)	9.73(10.4PP)	210(205PP)	390(370PP)	Almost pure ponderosa pine. Part underburned in past
Headquarters 2	405	8.6	162	315	Almost pure ponderosa pine
Headquarters 4	570(233PP)	8(11.3PP)	201(161PP)	401(282PP)	Mixed ponderosa pine and lodgepole pine
Lakeside Southeast	627(311PP) (312)	6.8(8.4PP)	161(120PP)	342(236PP)	Stand contains some small Oregon 'white oak
West Oxbow Open Pine	96	17.5	160	235	Open stand, ponderosa pine

Stand Density Index (SDI, Reineke, 1933) was used as an indicator of stand density. See appendix C for a description of SDI.

An SDI of about 270 is considered well stocked in eastern Oregon and Washington (Cochran, 1994). Ponderosa pine stand densities at Conboy generally exceed this number based on my informal plots. Densities do vary a great deal; because of this, summaries such as Table 1 are generalizations. It appears that stands often regenerated in small, relatively even-age groups, and those groups are usually of similar size. It is common to find small areas where trees average 18 to 20 inches in diameter, at a relatively wide spacing, next to areas where trees

average only 10 inches in diameter and are more closely spaced. The Headquarters area contains many small areas with surface rock and very shallow soils. Those sites support lighter tree stocking.

F. Stand Structure and Age

Most measured trees in the Conboy Lake ponderosa pine stands were less than 100 years old (age at breast height). There are some larger, undoubtedly older trees (e.g. Chapman Creek North, Chapman Creek South 1) which I could not core with an increment borer. However, these older trees are not common. The preponderance of younger trees, and the evidence from old logging stumps, indicate that most have regenerated since logging operations removed previous stands.

Ages of trees vary, and trees are often in small, even-age groups. A small area (about 2 acres) in Headquarters 1, for example, contained roughly 3 age classes. An older group (trees about 20 inches in diameter) was composed of trees 90-110 years old. An adjacent group of smaller trees (10-12 inches in diameter) was 50-70 years old. Finally, an adjacent group of saplings were about 15 years old (see photo below). Agee (1993) cites studies suggesting “a pattern of periodic tree establishment at a small scale” from researchers in the northwest and in Arizona.



Tree ages in Headquarters 1 stand. Larger trees in the foreground were about 100 years old; regeneration on the left was about 15, and background patch was 50-70.

Stands mostly do not have well-developed layers, but small groups do have some trees in intermediate and suppressed crown positions.

Trees occupying dominant and co-dominant crown positions are growing well in most cases. Most larger trees have adequate crown size, are growing well, and appear healthy. Despite high stand densities in places, Conboy Lake ponderosa pine stands appear overall in good shape.

Snags, particularly large ones, are uncommon in Conboy Lake ponderosa pine stands. Areas that have been underburned apparently did not cause much mortality, since they also have few standing dead trees. Snags may be particularly important to White-headed and Lewis' woodpeckers, which are dependent on ponderosa pine forests (Altman, 2000), species that have been recorded at Conboy Lake. Flammulated owls, not recorded at Conboy Lake, also use ponderosa pine habitats.

The American Bird Conservancy (Altman, 2000) suggests managing for old forest conditions and large snags in ponderosa pine forests, in order to provide for species dependent on these forests. They propose maintaining 10 trees per acre over 20 inches with two of those being greater than 31 inches. Currently, Conboy Lake Refuge ponderosa pine stands are deficient in trees larger than 31 inches.

Table 2 displays current stand conditions as they relate to habitat requirements for the White-headed woodpecker.

Table 2. Ponderosa pine stands and habitat requirements for the White-headed woodpecker.

Stand	Stand Type	TPA>21 inches	TPA>31 inches	Approx. Stand Size	Snags per Acre
Arena PP	PP	28.6	8.4	50	0
Chapman Cr North	PP	39.5	5.8	20	4.2 (24")
Chapman Cr South 1	PP	19.1	2.2	25	22 (5.1)
Headquarters 1	PP	18.7	.34	400	19.8 (8.9)
Headquarters 2	PP	0	0	100	22 (<5)
Headquarters 4	PP	8.1	0	35	0
Lakeside Southeast	PP	22.7	0	25	0
West Oxbow Open Pine	PP	24.6	0	15	0

G. Pathogens

For the most part, ponderosa pine stands on the Conboy Lake refuge are healthy. Dwarf mistletoe (*Arceuthobium campylopodum*.) occurs throughout the stands, most noticeably in Chapman Creek. Armillaria root disease (*Armillaria spp.*), western pine beetle (*Dendroctonus brevicornis*), and mountain pine beetle (*Dendroctonus ponderosae*) are most likely present, but were not observed. Willhite (2008 report, Appendix B) noted that ponderosa pine growing in overly dense stands are susceptible to mountain pine beetle and western pine beetle, and recommends density control in order to grow large ponderosa pine stands.

H. Fuels

In general, Conboy Lake National Wildlife Refuge ponderosa pine stands contain light fuel loadings. The relatively young stands do not have a lot of mortality, and have low amounts of ground fuels. There is some development of ladder fuels as young saplings increase in number. Crown closure is increasing due to increased stand density over time.

Several stands (Arena PP, Chapman Creek North, Lakeside Southeast, West Oxbow Open Pine) have relatively widely spaced stems and light fuels. Stands adjacent to lodgepole pine stands on the valley bottom, such as Troh PP, have higher stocking and generally higher fuels. A couple of stands, Headquarters 1 and Chapman Cr North, were underburned in the late 1980s.

Stands in the Headquarters area, particularly Headquarters 2, contain areas with surface rock, sparse vegetation, and low tree density. Fuels in these areas are very light due to the sparse vegetation.

Table 3. Ponderosa pine stand fuels

Stand	Fuel Type	Est. Fuel Loading (tons/ac)
Arena PP	1-PP-4	.84
Chapman Cr North	5-PP-4	8.5
Chapman Cr South 1	1-PP-4	.84
Headquarters 1	4-PP-4 and 3-PP-3	12.9
Headquarters 2	2-PP-3	6.43
Headquarters 4	4-PP & Ass-3	12.9
Lakeside Southeast	1-PP-4	.84
West Oxbow Open Pine	1-PP-4	.84

I. Recommended Practices

Several stand management practices would help to meet management objectives for Conboy Lake Refuge ponderosa pine stands. Those practices include reducing stand density, underburning, creating snags, and reducing invasion of adjacent meadows. Recommended practices are summarized below. Recommendations specific to each stand are included in the appendix.

Reducing Stand Density

Ponderosa pine stands on the Conboy Lake Refuge are dense, probably at the high edge of their range of natural variation. Reducing this density will enhance individual tree vigor, promoting development of large, old-growth pines in the future, help provide for habitat for species adapted to open pine stands, and will provide a margin of protection from future insect outbreaks and wildfires. Reducing stand density may also allow for the re-introduction of light ground fires in a future prescribed burning program. Many modern ponderosa pine forests will probably need some type of density reduction before reintroducing fire; build-up of duff, and reduction of individual tree vigor in dense stands after

years of fire exclusion may make it difficult to immediately reintroduce fire (Arno, 2005).

- For about 35% of the stand, thin to a stand density index of about 100-135. This equates to a spacing of about 18-30 feet. Wide spacing should allow for high diameter growth rates of 10 rings per inch, or 2 inches dbh growth in a decade. That will allow stands to develop trees in excess of 30 inches diameter in three decades.

- On an additional 35% of the stand, thin to a stand density index of about 180. This equates to a spacing of about 15-25 feet. This will still allow for good tree growth, but will also allow for some density-related mortality in stands.

Since ponderosa pine often grow in small, even-age groups, larger trees (>20 inches dbh) may occur in relatively tightly spaced groups, surrounded by groups of smaller trees. In order to retain as many large trees as possible, thin more lightly amongst groups of large trees. Remove small trees occurring within those groups of larger trees, and thin surrounding groups of smaller trees more heavily. Groups of large trees may be a good place in which to create snags, helping to provide large, dead trees and also to provide additional growing space for remaining large trees.

- Maintain about 15% of the stand intact, with no treatment, in patches 2-5 acres in size.

- Create small openings in about 15% of the stand, in sizes from .5 to 2 acres. These small openings will favor species such as the chipping sparrow. Small openings could be contiguous to very widely spaced areas, in order to allow for maximum growth on large ponderosa pine trees.

Varying the size and intensity of treatments in these stands probably mimics the manner in which fire treated this landscape. Historic ground fires most likely burned in a non-uniform manner, flaring up in small areas where the stand was dense, burning as a ground fire in other areas, and not burning some areas at all. Treating the landscape in such a non-uniform manner may mimic historic disturbance patterns.

See individual stand prescriptions for more detail.

Prescribed Fire

A future practice that would mimic the historic role of fire in these forests would be the implementation of “underburning”, using light controlled burns to remove fuels, kill some small trees, and remove ladder fuels in ponderosa pine stands. Underburning was successfully implemented in 1989 on a portion of the Headquarters 1 stand, and in Chapman Creek North. The Headquarters burn removed some saplings and seedlings, but does not appear to have killed larger



Fuel break on the south end of Headquarters 1. On the left, the stand was underburned. On the right, no underburning has been done

trees.

Implementation of underburning should follow initial treatments to reduce stand density. It may be valuable, however, to initiate some prescribed fire treatments on a small scale. It may help to refine prescribed fire techniques, and it may help to hold back the development of ladder fuels, if tree removal projects are not feasible in the short run. In ponderosa pine stands surrounded by open refuge habitat (such as Troh and Bird Creek East) the ability to use prescribed fire may be limited by surrounding conditions.

It may be that prescribed fire treatments will not be feasible in future years, due to nearby developments, air quality concerns, or lack of personnel skills and necessary equipment. In that case, small tree removal, and burning or chipping of small slash may help to mimic the effects of prescribed ground fires, and create similar conditions on the ground. However, ponderosa pine stands probably provide the best opportunities for use of prescribed fire on the Conboy Lake Refuge.

Snag Creation

Conboy Lake Refuge ponderosa pine stands are relatively young, and do not contain a large number of dead trees. Only 10 snags were captured on survey plots in these stands in fall 2008.

An estimate of snag numbers to manage for in ponderosa pine forests is presented in “Conservation Strategy for Landbirds of the East-slope of the Cascade Mountains in Oregon and Washington” (Altman, 2000). For the White-Headed Woodpecker the following snag parameters are recommended:

- Provide for at least 10 trees per acre greater than 20 inches dbh
- At least 2 of the 10 trees per acre should be greater than 31 inches dbh
- Provide for 1.4 snags per acre greater than 8 inches dbh
- 50% of the 1.4 snags per acre should exceed 25 inches dbh
- Maintain crown closure of 10-40%
- Patch size should be 350 acres if old-growth, 700 acres when 26-75% of the area is old-growth

Stand densities mentioned earlier will allow for future, large snags. Unthinned areas will develop snags in the near term, although not as large as target requirements. Existing snags may be a good criterion for selecting patches to remain unthinned, as logging operations sometimes result in loss of snags due to safety concerns. Snags could also be created in the near term by killing some living trees by cutting or by prescribed fire.

Reducing Meadow Invasion

While not as extensive as with lodgepole pine stands, there are some areas where young ponderosa pine are invading open areas on the Conboy Lake Refuge. Given the value of these open areas for the sandhill crane, control of this type conversion would be valuable.

Saplings and seedlings should be removed by cutting with chainsaws. The resulting slash could be lopped and scattered,

piled and burned, or piled and left to decompose and provide habitat for small mammals. It would be preferable to perform this treatment when stems are small (less than 10-15 feet tall, 0-3 inches in diameter), to reduce costs and fuel levels. Where larger stems need to be removed, check with local markets to see if there might be a user for small material. This might help to reduce costs of removal. The Mt. Adams Resource Stewards, or a local logger may be helpful in determining if there is market value for material.



2. Lodgepole Pine/Ponderosa Pine Stands

Arena LP
Bird Creek East LP
Bird Creek East PP
Bird Creek West
Frazier Meadow LP
Frazier Meadow PP
Headquarters 3
Headquarters 3-1
Lakeside Southwest 2
Troh LP
Troh PP
West Oxbow

These Conboy Lake Refuge forest sites are occupied by stands primarily composed of 40-100 year old Lodgepole pine and ponderosa pine. These stands are located on the Glenwood Valley bottom, or along streamcourses on the edge of the valley. Lodgepole pine occupies low areas and depressions on the local landscape, adjacent to wet meadows. Further away from wet meadow edges, on slightly higher terrain, stands change to a mixture of lodgepole pine and ponderosa pine. Some areas in the middle of these stands are almost pure ponderosa pine. In these cases, data are separated into “PP” and “LP” areas, although management of the stand would probably be done as one.



Lodgepole Pine in West Oxbow

A. Desired Future Condition

Key management objectives for the lodgepole pine/ponderosa pine stands on the Conboy Lake Refuge include

- Protect native habitats and wildlife representative of the natural biological diversity of the Conboy Lake Refuge
- Provide a margin of protection to refuge structures and neighboring residences from future wildfires
- Protect native habitats and wildlife representative of the natural biological diversity of the Conboy Lake Refuge
- Restore and maintain the health of wildlife habitats, including
 - Lodgepole/ponderosa pine forests
 - forest and meadow edge habitats
 - Use Prescribed Fire in restoration efforts where appropriate
- Use Habitat Requirements for the Black-backed woodpecker as a focal species for stand management

- Where ecologically appropriate, manage for late-successional conditions; larger, older lodgepole pine and ponderosa pine.
- Manage for large tracts (>1,000 acres)
- In burned or insect-killed forest, leave mortality rather than salvage, or maintain >40% as unsalvaged

Although the black-backed woodpecker was suggested as a focal species, it will be difficult for the Conboy Refuge to create sufficient habitat for this species. The black-backed woodpecker has a 150-acre home range, with at least 50 acres being old-growth lodgepole pine (pers. Communication, Joe Engler). Conboy Refuge lodgepole pine stands are simply too small and fragmented to fulfill many of these requirements. Studies also show that the species favors newly burned forests, where insect prey is most available, and decadent forests that have not undergone salvage harvests (Nappi and Drapeau, 2009; Lewis, Rodrick and Azerrad, 2003), conditions not present on the refuge.

Black-backed woodpeckers do focus on larger trees in situations where no fire has occurred (pers. Communication, Joe Engler). Therefore, the best strategy for Conboy Refuge lodgepole pine stands may be to create more open conditions that favor development of large individual trees, combined with dense forest that favors snag development, and which helps to lessen the chance of windthrow.

Stands that help meet these objectives would be forests dominated by healthy, vigorous lodgepole pine and ponderosa pine, along with snags and down wood from endemic levels of mortality, and sections of decadent forest. Stands would be even-aged, but a variety of age and size classes would be represented across the landscape. Understories would have varying fuel levels, including large down logs. Stands would provide a valuable ecotone for adjacent open grasslands and wetlands. Snags would be numerous. Stands would be healthy, with endemic levels of mountain pine beetle and other insect use. When fires occur on these forests, the patchiness of structure would allow fire managers to control the fire within the stand as necessary. Fires and other disturbances would leave areas with large numbers of snags and down wood. Disturbances and management actions (fire, flooding, cutting or hand-pulling of seedlings and saplings) would prevent lodgepole pine from encroaching on adjacent open lands.

B. Species Composition and plant association

These relatively wet, cold forest stands are dominated by lodgepole pine and ponderosa pine. Small clones of quaking aspen are often located alongside these stands. Lesser amounts of Douglas-fir and grand fir occur in understories. Lodgepole/ponderosa pine stands on the Conboy Lake Refuge also host a few uncommon tree species for the Glenwood Valley. Two small subalpine fir (*Abies lasiocarpa*) seedlings were noted in West Oxbow. Headquarters 3 contains a few western hemlock (*Tsuga heterophylla*), western redcedar (*Thuja plicata*), western white pine, and noble fir (*Abies procera*).

The most common shrub in lodgepole/ponderosa pine stands is *Spirea*. *Spirea* dominates the understory in pure stands of lodgepole pine, in wet, cold sites. Other common shrubs and forbs include serviceberry, snowberry, wild rose, and trailing blackberry.

C. Stand development history

Unlike ponderosa pine, lodgepole pine is not maintained by frequent, low-intensity fire. Lodgepole pine is adapted to fire in a different way. The species has thin bark, and the species is susceptible to cambium damage and kill by fire (Evers and others, unpublished paper). Lodgepole pine grows fast, and is relatively short-lived, usually not surviving more than 150 or 200 years (Arno, 1977). Mature, dense stands are susceptible to attacks by the mountain pine beetle, which can kill the majority of trees in a stand. Large, stand-replacement fires, such as the Yellowstone fires of 1988, burned in stands that had earlier outbreaks of mountain pine beetles (Lynch and others, 2006). Trees occupying low sites with high water tables, such as at Conboy, are also subjected to periodic windthrow, adding fuel for later wildfires.

Lodgepole pine is well adapted to regrowing after fire. The tree colonizes and grows quickly on open, disturbed sites. The tree exhibits fast juvenile growth, and quickly becomes established. The species is very tolerant of growing season frost, and does well on valley bottoms, depressions, and other sites where cold air accumulates and growing season frost can be a problem.

Lodgepole pine has probably long occupied the sites on which it occurs on the Conboy Lake Refuge. As stands age, and mortality occurs, stands lose trees to age, windthrow, or insects and disease. Periodic fires on the edges of the adjacent wetlands, burning in the fall during dry years, could ignite the lodgepole pine stands. The resulting fires would kill the thin-bark lodgepole pine. Subsequent fires might result, consuming the dead snags and down trees from the previous fire. Lodgepole pine regeneration would quickly recolonize the site.

Lodgepole/ponderosa pine stands on the Conboy Lake Refuge have probably also been influenced by the settlement history of the valley. Settlers drained the valley to accommodate agriculture; as water levels receded, lodgepole pine probably expanded the area which it occupied. Currently, there is some lodgepole pine mortality that is related to flooding, as the Refuge is managed for higher water levels. In some areas, lodgepole pine is encroaching on adjacent meadows.

D. Soils

Three soils are mapped in Lodgepole/ponderosa pine stands, Kreft, Sedigal, and Fanal Sandy Loams. These soils are mostly deep and well-drained, in volcanic ash and colluvium from basalt. It is likely that these sites also contain associated soil types such as Conboy or Grayland series, which are on old lake bottoms and are poorly drained.

E. Stand Density

Lodgepole/ponderosa pine stands on the Conboy Lake refuge are densely stocked (Table 3) and are reasonably healthy at this time. Lodgepole pine is quite intolerant of shade, thus needs room to grow well. Lodgepole pine can, however, grow at very dense levels, with little individual tree growth. Conboy Lake Refuge stands are still growing at moderate rates.

Table 3 Lodgepole Pine Stands

Stand_ID	Trees Per Acre	DBH	Basal Area	SDI	Remarks
Arena LP	274(147LP)	9.9(12.3LP)	146(120LP)	270(203LP)	Mixed stand with Lodgepole pine, ponderosa pine, and Aspen. Fomes Pini noted in lodgepole pine
Bird Creek East LP	625(575LP)	7.6(7.9LP)	195(195LP)	399(393LP)	All trees > 5 inches dbh are lodgepole pine
Bird Creek East PP	537(384PP)	(11.6PP)	325 (280PP)	583(485PP)	Stand contains some lodgepole pine
Bird Creek West	440(296LP)	10.6(10.8LP)	270(188LP)	484(335LP)	Minor species = ponderosa pine. Encroachment on adjacent meadows is occurring
Frazier Meadow LP	351(176LP)	9.2(12.2LP)	163(144LP)	309(244LP)	Minor species = quaking aspen. Encroachment on adjacent meadows is occurring
Frazier Meadow PP	413 (407)	10.8 (10.6)	260 (250)	464(447)	Stand contains some small lodgepole pine
Headquarters 3	614(545LP)	6.5(6.8LP)	200(191LP)	406(383LP)	Minor species = grand fir, Oregon white oak
Headquarters 3-1	9507	1.2	80	334	*Small stand with large amount of small regeneration. Numbers in () are trees > 5 inches dbh
Lakeside Southwest 2	676(510LP)	7.0(6.1LP)	183(102LP)	385(228LP)	Minor species = ponderosa pine. Encroachment on adjacent meadows is occurring
Troh LP	562(322LP)	8.9(11.1LP)	242(216LP)	466(380LP)	Minor species = ponderosa pine, quaking aspen. Encroachment on adjacent meadows is occurring
Troh PP	739(439PP) (439)	6.8(8.5PP) (8.5)	184(172PP)	394(337PP)	Stand contains some small lodgepole pine
WestOxbow	400(377LP)	10.4(7.7LP)	236(123LP)	426(249LP)	Minor species = ponderosa pine. Encroachment on adjacent meadows is occurring.

F. Stand Structure and Age

Lodgepole/ponderosa pine stands are mostly 1-storied stands, with ages ranging from 35 to 95 years old. Most stands appear to be in the range of 80 years old, similar to ponderosa pine stands. These stands most likely regenerated following logging.

G. Damaging Agents

Lodgepole/ponderosa pine stands on the Conboy Lake Refuge are generally healthy. Dwarf mistletoe (*Arceuthobium americanum*) was noted in many stands, and probably occurs in all. Fomes pini, a heart-rotting fungus, was noted in the Arena LP stand.

In her report for this project, Entomologist Elizabeth Willhite noted the presence of dwarf mistletoe and western gall rust (*Endocronartium harknessii*). In a brief survey, she found little evidence of bark beetles in lodgepole pine, and a small amount in ponderosa pine. It appears that much of the recent mortality in lodgepole pine comes from high water tables. Water near the surface does not allow sufficient root growth for trees to grow vigorously, predisposing them to damaging agents. Also, high water tables and shallow root systems lead to windthrow.

These damaging agents have beneficial effects for wildlife as well. Mistletoe deforms branches, providing structural variety in tree crowns and nesting or perching sites for birds. Dead trees provide some snags in these generally snag-deficient stands, and eventually down wood. In the long run, however, Willhite noted that stands are nearing age and density where they are susceptible to insect outbreaks, such as mountain pine beetle. This insect can build up in mature lodgepole pine stands, and cause large-scale mortality. Mountain pine beetle outbreaks have the potential to affect nearby lands as well as stands on the refuge. In lodgepole pine, mountain pine beetle tends to attack larger trees, which have thick phloem and a larger food supply (Amman, McGregor, and Dolph, 1990; I&D report in Appendix B).

H. Fuels

Conby Lake Refuge Lodgepole/ponderosa pine stands generally do not have heavy fuel levels, but do have greater amounts of fuel than ponderosa pine stands. In a few areas, such as the southern end of Bird Creek East and in West Oxbow, heavy windthrow and high water has left a heavy fuelbed of dead and down trees. Ladder fuels are more of a concern than with ponderosa pine stands, Many lodgepole pine stands have crowns low to the ground, or many dead limbs within 10 feet of the ground.

Table 4. Lodgepole/ponderosa pine fuels

Stand	Fuel Type	Est. Fuel Loading (Tons/ac)	Comments
Arena PP/LP	1-LP-2	3	
Bird Creek East LP	1-LP-2	3	Heavy windthrow on southwest corner (near Eagle nest). Light windthrow in remainder of stand
Bird Creek East PP	3-PP-3		
Bird Creek West	3-LP-3	23	Heavy mortality in eastern portion of stand. May be related to rising water levels
Frazier Meadow LP	2-LP-3	16.8	Moderate windthrow in western side of stand
Frazier Meadow PP	5-PP-4		
Headquarters 3	2-LP-3 and 1-LP-3	16.8	Very dense stand
Headquarters 3-1	Lighter than 1-LP-1		Small stand of young trees – appears to be an old fire
Lakeside Southwest 2	1-LP-1		Dense, young lodgepole pine, very light fuels
Troh LP	1-LP-3, 2-LP-3	16.8	Dense lodgepole pine; some windthrow and mortality occurring
Troh PP	2-PP-3		
WestOxbow	2-LP-3	16.8	Heavy mortality in part of stand, appears to be water table-related. Some windthrow in stand

I. Recommended Practices

Several stand management practices would help to meet management objectives for Conboy Lake Refuge lodgepole/ponderosa pine stands. Those practices include reducing stand density, creating small openings, creating snags, and reducing invasion of adjacent meadows. Practices are summarized below. Individual stand prescriptions are included in the appendix. Tree removal operations will be more difficult in lodgepole/ponderosa pine stands than in others on the Refuge; although a moderately valuable firewood, lodgepole

pine does not have high commercial value. There may be a nearby market for Hop Poles in the Yakima Valley, there has been some history of this in the past (personal communication, Steve Hoodenpyl, long-time local resident). Removal will also be difficult in many of the lodgepole/ponderosa pine stands, where high water tables complicate the ability to remove trees in an ecologically sensitive manner. Finally, thinning these stands may subject the remaining trees to increased windthrow.

Reducing Stand Density

Lodgepole pine/ponderosa pine stands on the Conboy Lake Refuge are currently densely stocked, and relatively healthy at this time. The age of these stands, plus their density, indicate a high probability that the situation will change in coming decades. As trees age and individual tree vigor declines, the stands will become subject to insects and diseases. Resulting mortality will increase ground fuels, and the likelihood of a moderate to severe fire will occur.

In areas where the stand is a mixture of ponderosa pine and lodgepole pine, a thinning, replicating the density called for in ponderosa pine stands, would improve stand vigor. Willhite (see Insect and Disease Report) recommends favoring ponderosa pine in these circumstances, since mountain pine beetle prefer to attack lodgepole pine in mixed stands of these species. In these areas, thin to a spacing of approximately 20-30 feet, favoring ponderosa pine.

Reducing density in areas of pure lodgepole pine, a relatively short-lived species, will not necessarily translate into long-term stand health; even thinned stands are susceptible to insects such as the mountain pine beetle, and other pathogens (see Insect and Disease Report). In addition, there is value in retaining some areas of unthinned stand, which may provide superior habitat for species such as the black-backed woodpecker. Stand density reduction efforts should focus on areas of mixed ponderosa pine and lodgepole pine, and should focus on removing lodgepole pine.

Avoid thinning on the western and southwestern edges of stands, particularly those which are lower in elevation, adjacent to wetlands. These areas are quite susceptible to windthrow.

Creating Small Openings

An alternative treatment for areas of pure lodgepole pine would be to create small openings, rather than thin entire stands. Creating openings may help to break up the continuity of the stand and fuels, help maintain adjacent stand vigor, and still maintain some of the relatively dense cover that provides valuable wildlife habitat adjacent to Refuge meadows and wetlands. A few ¼ to 1-acre openings, especially placed on the leeward side of the stand, may help to maintain vigor of adjacent trees, create openings for open-forest dependent wildlife, and develop some new patches of young lodgepole pine. A firewood-focused operation might

be able to remove trees via ATV or horse logging, limiting disturbance to the adjacent wetlands. If removal via some type of sale is totally unreasonable, cutting, piling and burning could be accomplished. Since lodgepole pine reseeds prolifically, there should be no need to plant the openings.

Snag Creation

Conboy Lake Refuge lodgepole/ponderosa pine stands are relatively young, and do not contain a large number of dead trees, although there appear to be more than in ponderosa pine stands. Snags in Conboy Lake Refuge lodgepole pine stands provide valuable structural diversity, food sources, and perches for ecotones along wetlands.

Snag recommendations for lodgepole pine stands:

- In thinnings, as with ponderosa pine stands, provide for 1.4 snags per acre greater than 8 inches dbh, with 50% exceeding 25 inches dbh, where possible
- Provide 2 snags per acre in matrix of stand and in created openings. Select some larger lodgepole pine to create snags.
- When selecting areas in which to create openings, avoid areas with existing snags in order to preserve them, if safety considerations would mean loss of snags in work operations.

Reducing Meadow Invasion

Lodgepole pine often invade adjacent meadows, increasing the area of young forest and decreasing open areas that are valuable for sandhill cranes. Given the wildlife value of open areas, control of this type of type conversion would be valuable. Saplings and seedlings should be removed by cutting with chainsaws. The resulting slash could be lopped and scattered, piled and burned, or piled and left to decompose and provide habitat for small mammals. It would be preferable to perform this treatment when stems are small (less than 10-15 feet tall, 0-3 inches in diameter), to reduce costs and fuel levels. Where larger stems need to be removed, check with local markets to see if there might be a user for small material. This might help to reduce costs of removal. The Mt. Adams Resource Stewards, or a local logger may be helpful in determining if there is market value for material. Finally, consider mastication of young trees; equipment is available that can not only cut down young saplings, but also grind up the resulting slash, reducing near-term fire hazard.

3. Mixed Conifer Stands

Chapman Cr South 2
Conifer East 1
Conifer East 2
Conifer East 3
Conifer SW 1
Conifer SW 2
Conifer SW 3
Kelley South
Lakeside Southwest 1
Laurel
Oxbow1



Douglas-fir in Conifer SW 1

These Conboy Lake Refuge stands are stocked with Douglas-fir, ponderosa pine, and grand fir as primary tree species. Oregon White Oak is present in minor amounts, primarily in areas with shallow soils. All are located on north, west or east-facing slopes, with lower moisture stress than flat or southerly slopes. These stands lie on the bottom of hillside slopes, on the edges of the Glenwood Valley.

A. Desired Future Condition

Key management objectives for the Mixed Conifer stands on the Conboy Lake Refuge include

- Protect native habitats and wildlife representative of the natural biological diversity of the Conboy Refuge
- Provide a margin of protection to refuge structures and neighboring residences from future wildfires
- Restore and maintain the health of wildlife habitats, including
 - Mixed conifer forests
 - forest and meadow edge habitats
 - Use Prescribed Fire in restoration efforts where appropriate

Focal species for Conboy Refuge mixed conifer stands are the Townsend's warbler, Varied Thrush, Hermit Thrush, and Olive-sided Flycatcher. These species use large, older mixed conifer stands for breeding, and generally favor mature stands of large trees. The Olive-sided flycatcher also favors the edges of openings.

The Conservation Strategy for landbirds of the eastern Cascades (Altman, 2000) discusses maintaining habitat that is provided by mixed conifer forests. They encourage maintaining existing late-successional mixed conifer forests, but also to avoid actions to minimize further degradation, such as thinning or the use of fire. Managing mixed conifer stands on the Conboy refuge must strike a balance

between preservation of the current habitat and ensuring that large-scale loss does not occur.

Stands that help meet these objectives would be forests dominated by large, well-spaced Douglas-fir and ponderosa pine trees. Small openings would provide in-forest edge, and space for maximum growth of large trees, or provide light for maintenance of Oregon White Oak groups. Scattered areas, representing possibly 20% of the landscape, would consist of more dense forest, with a greater development of understory trees, including grand fir and Douglas-fir, and snags. Near the edges of Conboy Lake and its adjacent grasslands, the forest would provide a valuable ecotone, but disturbances (fire, flooding) would keep the forest from encroaching on the open lands.

B. Species Composition and plant association

Mixed conifer forest stands contain Douglas-fir as an important stand component, a species that only occasionally occurs in ponderosa pine and lodgepole pine stands. In addition, most mixed conifer stands include an understory of grand fir, or a component of grand fir in the overstory. No western larch or western redcedar were noted in exams or walk-throughs, but it would not be surprising to find one. Many of the stands show a gradation of species composition from the valley bottom up the hillside slopes. Adjacent to the valley bottom and lake bed, ponderosa pine dominates on the flatter portions of the stands. As you move up the steeper parts of the slope, Douglas-fir becomes dominant, and ponderosa pine becomes a minor species. Grand fir also becomes more prevalent, including some mature trees.

USFS Stand examinations for these stands made little mention of understory plants. California hazel (*Corylus cornuta*), Snowberry, Prince's pine (*Chimaphila umbellata*), bracken fern (*Pteridium aquilinum*), and wild rose appear in many of the stands.

These forest stands are similar in composition to the Grand fir/Creeping Snowberry/Vanillaleaf and Grand fir/Elk sedge plant associations mentioned in Topik (1989) occurring on the Gifford Pinchot National Forest to the west.

C. Stand development history

Mixed conifer stands on the Conboy Lake Refuge appear to fit in Fire Group 3, or the moist end of Fire Group 2 in "Fire Ecology of the Mid-Columbia (Evers and others). It probably has experienced more infrequent fire than ponderosa pine stands, on the order of every 25-100 years. Semifrequent surface fire maintained stands of ponderosa pine and Douglas-fir on the drier end of this fire group.

In Fire Group 3, grand fir and Douglas-fir can reinvade during prolonged fire-free periods, increasing the destructive potential of subsequent fires. The steeper slopes of Conboy mixed conifer stands would also help to increase fire intensity. These stands probably have seen a greater intensity of fires than did adjacent forests on the valley bottom. Depending on the time between fires, and the resultant change in vegetation, fires could vary from light ground fires to stand-replacing crown fires.

The northerly slopes of these stands allow development of shade-tolerant grand fir to a greater extent than with ponderosa pine and lodgepole pine stands, particularly with fire exclusion during the past century. Currently, mixed conifer stands are relatively dense, and include understories of Douglas-fir and grand fir. In some areas, grand fir is a stand canopy component.

D. Soils

Soil types classified in mixed conifer stands include Bezee Cobbly Loam, Fanal Sandy Loam, Kaiders Stony Loam, Panak Cobbly Loam, and Underwood Loam, soils associated with sideslopes and ridges. Soils are mostly deep and well-drained, in volcanic ash and colluvium from basalt. Small inclusions, usually on convex slopes, have shallower soils, some with soil moisture too limiting for growth of conifers. These areas are occupied by Oregon White Oak.

E. Stand Density

Mixed conifer stands are densely populated, with a few areas of light stocking (dry ridgetops, populated by young ponderosa pine and Oregon White Oak). Although many small grand fir and Douglas-fir saplings inflate the number of stems per acre, stands are fully occupied with larger trees.

Relative Density (RD, Curtis, 1982) is an easily measured variable for Douglas-fir, and was calculated for these stands. A Relative Density of about 55 represent a density above which suppression-related mortality occurs; an RD below 35 represents a density where the site is not fully occupied. See Appendix C for a further explanation of Relative Density.

Most mixed conifer stands showed a high variation in relative densities, as shown in table 5. Most are quite dense, or had areas where density was high. Even when eliminating trees less than 5 inches dbh in calculations (RD>5 inches), most stand densities remain high. In several stands, the presence of Oregon White Oak openings lowers overall stand density, even though conifer patches are densely stocked.

Table 5. Mixed Conifer Stands

Stand	Trees Per Acre	DBH	Basal Area	Relative Density	RD>5 inches	Remarks
Chapman Cr South 2	792.5	7.6	251.6	57	32	Stand contains some DF, GF, and Oak. Largest tree measured was 27 inches dbh
Conifer East 1	734	6.8	185	71	39	Ponderosa pine and Douglas-fir are the main species. Largest tree measured was 25 inches dbh.
Conifer East 2	268	8.9	117	39	26	Douglas-fir, ponderosa pine, and grand fir. Some Oak openings. Largest tree measured was 24 inches dbh
Conifer East 3	1106	7.4	328	121	82	Plots captured dense areas not necessarily indicative of entire stand. Largest tree measured was 22 inches dbh
Conifer SW 1	797	6.2	167	67	39	Douglas-fir with smaller amounts of ponderosa pine. Heavy grand fir understory. Indian paint fungus in grand fir. Largest tree measured 23 inches dbh.
Conifer SW 2	833	7.0	225	85	60	Stand mostly Douglas-fir and grand fir. Largest tree measured was 31 inches dbh
Conifer SW 3	659	6.6	156	61	37	Douglas-fir mistletoe noted in stand. Largest tree measured was 28 inches dbh
Kelley South	671	7.0	180	68	53	Largest tree measured was 39 inches dbh

Stand	Trees Per Acre	DBH	Basal Area	Relative Density	RD>5 inches	Remarks
Lakeside Southwest 1	777	5.3	117	51	37	Very patchy stand with openings populated by Oregon White Oak. Mistletoe in Douglas-fir. Largest tree measured was 29 inches dbh
Laurel	274	11.5	197	58	41	Dense stand with Douglas-fir, grand fir and ponderosa pine. Laminated root rot in western end. Largest tree measured 27 inches dbh.
Oxbow1	317	12.8	284	79	76	Western (lower) portion of stand heavy to ponderosa pine. Eastern section heavier to Douglas-fir. Largest tree measured was 30 inches dbh

F. Stand Structure and Age

Mixed conifer stands appear to be about 100 years old, similar to or a bit older than other stands on the Refuge. A number of individual trees greater than 100 years old were noted in stand examinations, particularly in Chapman Creek South 1; they may be remnant trees left during logging. Most stands were probably harvested early in the 20th century and possibly re-harvested in the mid-1900s. Mixed conifer stands vary in structure more than ponderosa pine and lodgepole pine stands. There is more vertical structure, with greater development of shade-tolerant, mid-canopy grand fir and Douglas-fir. Stands are also more dense, with greater canopy closure. Oregon White Oak occupies small (often less than an acre) areas where soils are particularly shallow, providing openings amongst the more dense surrounding conifer stands. A couple of mixed conifer stands are similar to ponderosa pine stands, except for a high component of Douglas-fir.

G. Damaging Agents

Mixed conifer stands on the Refuge are fairly healthy. The Laurel stand has a fairly large area (about 20 acres) which has active pockets of laminated root disease (*Phellinus weirii*), and some dwarf mistletoe. Armillaria root disease and annosus root rot (*Heterobasidion annosum*) may also be present, according to entomologist Elizabeth Willhite. These diseases kill trees in small pockets, creating small openings in the forest stand. Phellinus attacks Douglas-fir and grand fir; Armillaria can be present in ponderosa pine, Douglas-fir, and grand fir, particularly weakened, stressed trees. Annosus probably affects grand fir the most, and can become established via wounds to the tree. Dwarf mistletoe occurs throughout the stands, most noticeably in Chapman Creek.

Willhite noted that some Conboy Lake mixed conifer stands are in a condition that makes them susceptible to western spruce budworm (*Choristoneura occidentalis*), an insect that has been present in forests to the north for the last decade. A pattern of missing foliage in Conifer Southwest 1 may be from a light

defoliation. Stands with multiple canopies and with a component of Douglas-fir and grand fir (host species) are particularly susceptible.

H. Fuels

Conby Lake Refuge mixed conifer stands have heavier fuels than other forest types. The Laurel stand contains pockets of root disease, with associated down logs and snags, particularly in the southwestern portion of the stand. Stands on the north-facing slope along the BZ-Glenwood Highway (Conifer East and Conifer SW) have pockets with large amounts of fuel. Those stands also have understories that are more dense than other stands, contributing to ladder-fuel conditions.

Table 6. Mixed Conifer Fuels

STAND	Fuel Type	Est. Fuel Loading	Comments
Chapman Cr South 2	2-PP-4 (varies)	6	Dense stand, some areas of windthrow
Conifer East 1	4-DFHD-4 (varies)	13.7	About ½ of this stand is open ponderosa pine and Oregon White Oak, remainder is Douglas-fir, ponderosa pine, and grand fir
Conifer East 2	2-DFHD-3	10.1	Dense stand in places, some open areas with Oak. Moderately steep
Conifer East 3	2-DFHD-3	10.1	Dense stand, moderately steep.
Conifer SW 1	2-DFHD-3	10.1	Dense stand, moderately steep.
Conifer SW 2	2-DFHD-3 (varies)	10.1	Dense stand, moderately steep.
Conifer SW 3	1-MC-3 (varies)	11.1	Dense stand, moderately steep.
Kelley South	1-DF-4	14.1	North-facing slope, not steep. Slightly heavier slash except for northern part of stand
Lakeside Southwest 1	1-PP-4	.84	Very open stand, patches of conifers interspersed with Oaks.
Laurel	1-MC-3, 2-MC-3	11	Dense stand with higher fuel levels. South end contains patches of down trees (root disease) with much heavier fuels than the remainder of the stand
Oxbow1	1-DF-4	14.1	West-facing slope, heavier slash on east end of stand

I. Recommended Practices

Mixed conifer stands on the Conboy Lake Refuge have a relatively high susceptibility for disturbances, such as spruce budworm defoliation (due to the presence of susceptible species) and fire (due to slope). Stands appear to have less susceptibility to windthrow since they occur on well-drained sites, and trees have good rooting depth. Mixed conifer stands also provide dense forests with multiple canopies, habitat that is uncommon in the greater matrix of surrounding managed forests in the Glenwood area. Management recommendations are aimed at reducing large disturbance probability while maintaining some of the relatively uncommon habitats these stands present. Not all stands are treated the same, however; practices recommended for individual stands are included in the appendix.

Reducing Stand Density

As Willhite notes in her report, reducing stand density would lower susceptibility to spruce budworm in mixed conifer stands. Also valuable would be to reduce the percentage of susceptible species, and to reduce understory canopy layers. Reduction of stand density would help to lessen the chance of large-scale infestations such as spruce budworm. And, reducing stand density would concentrate growth on fewer trees, growing large trees more quickly.

Objectives for focal species emphasize retaining late-successional forest conditions, which these stands are developing, and creating edge. Small openings and thinned areas, combined with areas that remain in their current, relatively dense condition, would help to maintain parts of the stand as dense forest, while creating openings and reducing overall stand density, lessening the chance of large-scale stand loss from disturbance agents such as insects or fire.



Recent thinning on private land adjacent to Conifer SW 3

Stands containing a heavy stocking of Douglas-fir and grand fir should be thinned to a Relative Density of 25-35 over about 50% of the stand area (see Appendix C for a graph and table of trees per acre and tree size, by Relative Density). This equates to about a 17-35 foot spacing. Larger, fire-resistant trees should be retained as much as possible (those over about 20 inches dbh). Since larger trees sometimes occur in groups, thin more lightly in those groups to retain large trees. Pockets of large trees may be a good place in which to create snags, helping to provide large, dead trees and also to provide additional growing space for remaining large trees. Thin heavier amongst smaller trees, and favor fire-resistant Douglas-fir and ponderosa pine

over grand fir. Thinnings that remove small conifers will reduce understory “ladder fuels” and will enhance growth of individual remaining trees.

In the remaining 50% of stands, create small openings (approximately ½ acre in size) over about 10% of the stand, and leave the remaining portions of the stands unthinned. Openings would create edge favored by the Olive-sided flycatcher, and remaining dense forest would favor species such as the Varied Thrush and Hermit Thrush.

An alternative to thinning each mixed conifer stand (and leaving small portions of each unthinned) is to leave some stands unthinned at this time. Due to the small sizes of these forest patches, it may be preferable on a landscape scale to leave one intact, rather than leave small portions of each stand as part of a thinning operation. For example, Conifer SW 1, 2, and 3 are similar stands. An alternative approach may be to thin two of the three, and leave one approximately 30-acre patch intact at this time.

In some stands, Oregon White Oak is present in small patches, usually where soils are shallow. In the vicinity of Oaks, that species should be preferred as trees to leave in thinnings, with adjacent conifers removed to provide light for shade-intolerant Oak.

Select areas with larger trees and healthy conditions to retain unthinned. Given the small size of the Conboy Refuge Mixed conifer stands, it may make more sense to leave an entire stand unthinned, rather than portions of many stands. See individual stand prescriptions.

Thinning operations should strive to retain all snags. If this is not possible due to safety considerations, leave as many as possible, such as shorter snags. Consider using locations that currently have good numbers of snags as untreated patches, if it appears that thinning operations would require cutting hazard trees.

Snag Creation

Conboy Lake Refuge mixed conifer stands do not contain a large number of dead trees. Valuable snags could be created by topping or girdling trees, particularly in areas that are not thinned, where a more dense conifer stand is maintained. As mentioned above, strive to retain all existing snags in treatments. I suggest similar snag numbers as for ponderosa pine stands:

- 2 snags per acre in both thinned and unthinned portions of stands.
- Strive for 25% of snags to be over 20 inches dbh.

4. Oregon White Oak

Oregon White Oak occurs interspersed with conifers, or in small, almost pure groups in the Refuge. The species is very drought-tolerant, and occupies locations with very shallow soils, where conifers have difficulty competing. The species is very shade-intolerant; fire exclusion has resulted in many Oregon White Oaks being overtopped by conifers, decreasing their vigor or killing the hardwoods due to lack of light.

Oregon White Oak provides important wildlife habitat. Oak snags and dead portions of live trees harbor insect populations and provide nesting cavities and perches for birds and mammals. Acorns (mast) as well as leaves, fungi, and insects provide food. Oak/conifer associations provide contiguous aerial pathways for squirrels and other animals (Larson and Morgan, 1998). Many invertebrates are found exclusively in association with Oregon White Oak. In Klickitat County, Oregon White Oak provide important habitat for western gray squirrels. Western gray squirrels are located south of the Conboy Refuge, but could potentially exist here, and are considered a focal species for Oregon White Oak management on the Refuge.

On the Conboy Refuge, most Oregon White Oak are located in mixed conifer stands and ponderosa pine stands along the Glenwood – BZ Highway. In mixed conifer stands, the species occupies convex slope positions, where soils are shallow. Conifer East 1, Lakeside Southwest 1, and Lakeside Southeast have significant amounts of Oregon White Oak.

Recommended Practices

Due to its importance as habitat, the primary strategy for managing Oregon White Oak on the Conboy National Wildlife Refuge should be to protect and maintain the vigor and growth of existing trees. A recommended practice for Oregon White Oak is to thin adjacent conifers that are overtopping the hardwood, in order to maintain Oak vigor and growth (Larson and Morgan, 1998). Locally, a practice used has been to thin conifers from the south side of Oak trees, leaving some connectivity on the north side for arboreal rodents such as the western gray squirrel. Connectivity is important since gray squirrels nest in conifers (Larson and Morgan, 1998).

5. Quaking Aspen

Quaking aspen is another valuable hardwood tree species on the Conboy National Wildlife Refuge. Aspen is found on the valley floor, adjacent to wetlands. Quaking Aspen grows in clones, with many stems that originate from the same genotype. The species sprouts prolifically from the root suckers, produced on the shallow lateral roots (USDA Forest Service, 1968). The resulting young trees need abundant light in order to develop; thus, new suckers that survive and develop are on the edges of the clone. Individual quaking aspen trees are not long-lived (maximum age of about 150 years in the western US), although clones are much older. Many clones in the Rockies and Great Basin are over 8,000 years old (USDA Forest Service, Fire Effects Information System). The thin, soft bark of quaking aspen makes it susceptible to many insects, diseases and mechanical damage. The wood rots easily, and scars often harbor wood-rotting fungi.

Quaking aspen can provide valuable habitat for cavity nesting birds and mammals, browse, and cambium favored by beavers (Allbritten and Bottorff, 2004). Buds are favored by ruffed grouse. The hardwood stands provide valuable structural diversity amongst conifer forests. The red-naped sapsucker is identified as a focal species for large aspen trees and snags in the Eastern Washington conservation strategy for landbirds (Altman, 2000).

Recommended Practices

Habitat recommendations for quaking aspen in Altman (2000) include maintaining >10% cover of saplings in the understory to provide younger seral stages, >1.5 snags per acre that are 10 inches dbh, and mean canopy cover of 40-80%. Based on visual observation, Conboy National Wildlife Refuge stands of quaking aspen provide canopy cover, and probably sufficient dead trees. Saplings and new trees may be in relatively short supply due to heavy browsing observed on the edges of many clones, caused by elk, deer, and cattle. That situation may be improved by increased levels of fence maintenance on the refuge in 2009, removing stray cattle from the refuge.

Quaking aspen clones are in good shape on the Conboy National Wildlife Refuge, for the most part. Some recommendations (also see individual stand prescriptions):

- Maintain Refuge fences, to keep cattle from browsing young quaking aspen
- Consider removal of lodgepole pine that is overtopping aspen, particularly in the southern part of the Troh stand. See the individual stand prescription for Troh LP.

VI. Monitoring

Little information exists regarding Conboy National Wildlife Refuge forest stands, other than data gathered by the USFS and during development of this report. Monitoring of rare plant species has occurred, but little information about forest vegetation exists. As FWS considers management of forest stands, it will be important to gather baseline information and follow the results of projects, in order to document vegetation and wildlife changes, and to learn from results. I suggest that the Refuge develop a baseline and a project monitoring plan for Refuge forests.

VII. Priorities

With limited budgets and capabilities, a sense of treatments that are of high priority is valuable. Based on my review of Refuge stands, following are suggestions regarding both types of treatments and treatment of particular stands.

High Priority Treatments

1. Reducing tree colonization of meadows

Lodgepole pine, and to some extent ponderosa pine, have been colonizing meadows on the Refuge for some time. Controlling this colonization is a top priority, and has been recognized as such by the USFWS, with work ongoing in this area.

Of particular importance is to remove young trees when they are very small. This minimizes cost, and reduces the amount of slash that is created in the process.

Particular stands where this work is useful include Bird Creek West, Frazier Meadow, Troh and West Oxbow.

2. Reducing Stand Density in Mixed Conifer stands. These stands are probably at the edge of their ecological range of variability, and could be subject to spruce budworm defoliation, or stand-replacing fire. They are also quite valuable habitats, developing many older-forest conditions. Thinning over parts of these stands will help to break up the continuity of dense forest while retaining portions of the stands for those values. Particular stands where this work is useful include Conifer East 2 and 3, Conifer SW 1, 2, and 3, and Laurel.

3. Increasing the amount of snag habitat on the Refuge. Since Refuge stands are mostly not very old, there are not large numbers of large, dead trees. Cavity-using wildlife would benefit from an increase in snags. A snag-specific survey would be helpful, due to the high variability in snag occurrence. I captured very few in my plots, but my sample was small for this variable. Particular stands where this work would be most useful include Headquarters 1 and 2, Arena PP, Kelly South and Oxbow. Generally, lodgepole pine and mixed conifer stands are in better shape, but all appear to be somewhat deficient in snags.

4. Introducing some density reduction in lodgepole pine/ponderosa pine forests, particularly in locations containing quaking aspen. Stands with lodgepole pine may be the most susceptible to insect-related mortality. Beginning some density reduction in these stands may provide some valuable information related to how the stands respond, and if windthrow of trees is a major problem. Trying a small amount of density reduction may show benefits and problems with this practice.

5. Density reduction and prescribed fire in ponderosa pine forests. Stands are healthy at this time, and have relatively low ground fuel levels. Headquarters stands are flat, and appear well-suited to use of prescribed fire. The practice worked well when used in the 1980s. The near future would be a good time to initiate some density reduction and prescribed fire treatments, and monitor to see effectiveness.

6. Create small openings in lodgepole pine, particularly in locations where quaking aspen have been overtopped (example: Arena, Troh). A small project involving this practice would provide valuable information regarding its effectiveness. Removal of conifers from overtopped aspen will help increase the amount of this valuable hardwood.

7. Monitor treatments, including some pre-treatment baseline information, and follow-up results.

VIII. Conclusions The Conboy Lake National Wildlife Refuge contains a rich variety of forest stands, most of which are currently in fairly good health. These stands provide valuable habitats and ecotones that complement the Refuge's important wetlands.

However these stands are dynamic, and are changing over time. As with many western forests, a lack of fire in these forest stands over time makes them prone to more destructive disturbances, such as stand-replacement wildfire or a spruce budworm outbreak. Some active stand density control, applied strategically to stands on the Refuge, can minimize the chance of future large-scale disturbance, and still maintain the wildlife habitat values of the Refuge. Initiating some forest stand management practices in the near future will provide opportunities to test practices and determine how forest stands and associated wildlife respond.

Appendices

- A. Individual Stand Prescriptions
- B. Insect and Disease Report
- C. Stand Density and Stocking Levels
- D. Data Summaries and raw data
- E. References