Land Development and Natural Resources in the Upper Deschutes Landscape

Executive Summary

Objectives:

The USDA Forest Service PNW Research Station used landscape models to examine the effects of land development on important resources in the Upper Deschutes area. The analysis focused on providing information for policy issues relating to how conversion of two large tracts of land, the Gilchrist tract near Gilchrist and the Bull Springs tract between Bend and Sisters, from forestry uses to housing development might influence important wildlife habitat, forest conditions, and forest management activities that supply economic goods and services.

Findings:

1. The speed and degree of potential development differ between the two tracts but both are susceptible to development over the next 50 to 100 years. The Gilchrist tract is farther from population centers and, consequently, less likely to experience as rapid and dense development as the Bull Springs tract.
2. The Bull Springs tract contains important habitat for mule deer and is part of a migration corridor that allows mule deer to easily move between summer and winter range. If development occurs as it has since 1970, the Bull Springs tract is likely to become developed to the point that both winter range and migration for mule deer are substantially reduced over the next 50 years.
3. Proposed management of the Bull Springs tract by the Deschutes Land Trust would likely:
    a. Generate sustainable open old forest conditions (trees generally over 150 years old) over time;
    b. Produce modest, continuing levels of forest products;
    c. Provide suitable winter range and migration habitat for mule deer, and
    d. Reduce fuel levels and wildfire hazards. Most wildfires would be relatively easy to control due to low fire intensity and few embedded homes.
4. Development of the Bull Springs tract could move the forests toward:
    a. Accumulating landscape fuels as some or many land owners move away from active fuel treatments.
    b. Forest conditions that are more dense and have greater human presence (houses, roads, pets, etc.), resulting in declining winter range and migration corridor conditions for mule deer. Many of these effects would occur within 50 years.
    c. Replacement of forest products, habitat, and recreation-driven economic services and values by development-driven values and services.
    d. Decreased access to recreation as private land owners restrict access. The Bull Springs tract is heavily used for recreation at present.
5. Proposed management of the Gilchrist tract by the Oregon Department of Forestry would likely move that landscape toward:

a. Sustainable open and mature forest (trees generally less than 150 years old).
b. Economic products that are comparable, on a per acre basis, to those generated by the Sun Pass State Forest. Since the Gilchrist tract is considerably larger than the Sun Pass State Forest, economic benefits could be significant to the local area in future decades.
c. Relatively low levels of landscape fuels, resulting in relatively low and easy-to-control wildfires and few embedded homes.
d. Open, mature forest habitat suitable for a variety of wildlife species and recreation uses.

6. Development of the Gilchrist tract is likely to:
   a. Occur more slowly than in the Bull Springs tract, with lower home densities expected in the future.
   b. Increase wildland fuel concentrations depending on the preferences of private owners (e.g. some may prefer the aesthetics of closed forests). This trend would likely become more pronounced as individual parcels became smaller in the future. Wildfires would likely become more difficult and expensive to control as fuels increased and homes became more abundant.
   c. Reduce wildlife habitat value as human presence increases, along with roads, homes, pets, and other related factors.
   d. Invoke a change in land use values, from substantial forest products-related economic values to development-related values.
   e. Decrease recreation access as private land owners restrict access.

Limitations

As with any model simulation effort, there are limitations to our work. Among these, we think several deserve special note.

1. Land development may not proceed as we project. Historical trends, for example, may not reflect how land use policy affects development rates currently and in the future.
2. The management of private parcels, especially small parcels, is difficult to predict. The proportion of the small parcel owners who will actively treat fuels may be higher or lower than we have assumed.
3. The densities of homes at which mule deer habitat and migration value decline is the subject of considerable debate. More work is needed in this area.
4. Our inventory data for existing, on-the-ground forest conditions on the Gilchrist tract and, to a lesser degree, the Bull Springs tract, suggest that large trees are more abundant than we think is actually the case. Better inventory data would help.
5. We did not include the uncertainties of climate change because we don't know how climate change will impact the local area. Indications are that the forests might become more susceptible to wildfire and insect outbreak disturbances, especially if summers become longer and drier.

Implications

If the Bull Springs and Gilchrist areas were to become developed, it is possible that forest management treatments would cease as more and more development occurs. Of particular concern is a decline in management to reduce wildfire fuels as the diversity of land owners increases. Under the assumption that few land owners would attempt to reduce fuels, the forests would likely to become increasingly dense, with abundant small trees and few openings. Fuel levels and wildfire risks would be high and continue to increase unless land owners took steps to

reduce them. Intermingled areas of high fuels could easily increase rates of wildfire and insect loss in remaining old ponderosa pine forests by providing fire travel corridors and hot-spots for insect outbreaks. These hazards and others would likely make it increasingly challenging to sustain open ponderosa pine forest area in patterns that are useful for wildlife. For example, likely losses in mule winter range in the Bend-Sisters-Redmond triangle would be high if the Bull Springs were to be developed. Furthermore, development would likely include other impacts like higher road densities and vehicle travel that impede deer access and result in road kill and homes with unleashed dogs that harass deer.

On the other hand, if the Bull Springs and Gilchrist tracts were not developed, the possibility for widespread efforts to reduce wildfire fuels and other management would remain, and forest would be likely to remain largely open forest that is less prone to fire and large insect outbreaks than dense forest. Lack of residential development in the tract would also allow the Bull Springs tract to continue to function as an unimpeded migration route between mule deer summer ranges to the south and west, and winter range areas to the north and east. This scenario would also allow more of the Bull Springs area to continue to function as suitable winter range. Because the area is likely to develop largely open forest conditions, habitat for a variety of species would potentially exist for species that prefer open forests (e.g., whiteheaded woodpeckers). However, this relatively stable open forest of old ponderosa pine would be embedded in a matrix of increasingly developed lands.

Finally, neither scenario nor tract can be realistically expected to produce significant amounts of forest products over the first 50 years, primarily because both tracts have been heavily harvested in the recent past. Information from local experts suggests that the trend in the first 50 years is likely to be a slow increase from initially low levels.

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Introduction

The upper Deschutes landscape is an area of about 2 million acres that extends from just north of Redmond, Oregon, to south of Gilchrist in central Oregon (Figure 1). For much of the 20th century, private timberlands in the area were managed for commercial forest products. Over the last several decades, however, many commercial forestry operations in the area have ceased and some private forest lands have been developed for residential dwellings, destination resorts, and similar uses.

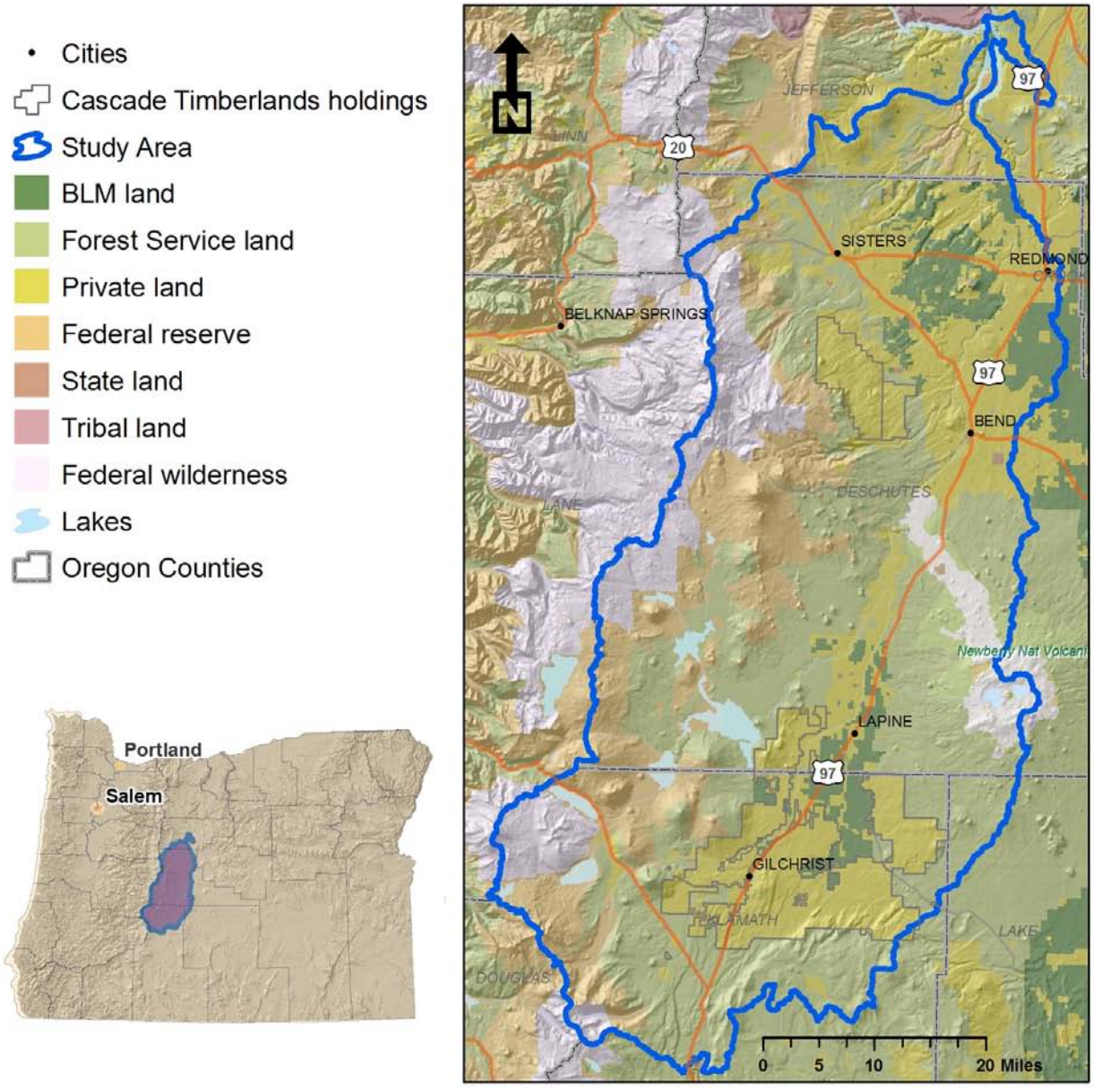


Figure 1. The upper Deschutes landscape in central Oregon.

Two of the remaining large areas of private forest (the Bull Springs and Gilchrist tracts) are currently for sale and might be developed for non-forestry uses in the future. A political and social debate about the future of important natural resources in the area hinges on the interactions of:

- the conversion of wildlands to developed areas,
- the rate at which development might occur, and
- the interactions of development with a variety of natural resource services and values.

As these two parcels sit on the verge of changing ownerships, the State of Oregon and private non-profit entities have contemplated the tradeoffs: should these organizations invest funds to purchase these tracts to forestall development? The Oregon Department of Forestry and Department of Land Conservation and Development asked the Pacific Northwest Research Station, USDA Forest Service, to examine the consequences of potential future land development, especially regarding these two tracts, and provide information that might help policy makers. We used simulation models to look at many different kinds of effects, but focused on changes in 1) important wildlife habitat (particularly mule deer), 2) forest products, 3) and forest conditions, fuels, and wildfire hazards. This is our initial report of findings.

The Bull Springs tract is about 33,000 acres of forest on the flank of a ridge between Bend and Sisters (Figure 2). In the past, several different timber companies managed the tract for ponderosa pine and related conifer species. The area contains lower elevation forest lands and extends to the interface with developed agricultural and residential lands. The Deschutes Land Trust has proposed purchasing the tract and managing it as a publicly accessible working forest. Alternatively, the tract may be divided into multiple smaller parcels, sold, and, over time, developed in some fashion. Given the location of the area, its proximity to Bend, and relatively easy access, we expect the Bull Springs tract to be attractive for relatively quick development. As we discuss in more detail below, the area is also important for mule deer winter range, migration routes, and other habitat and natural resource features.

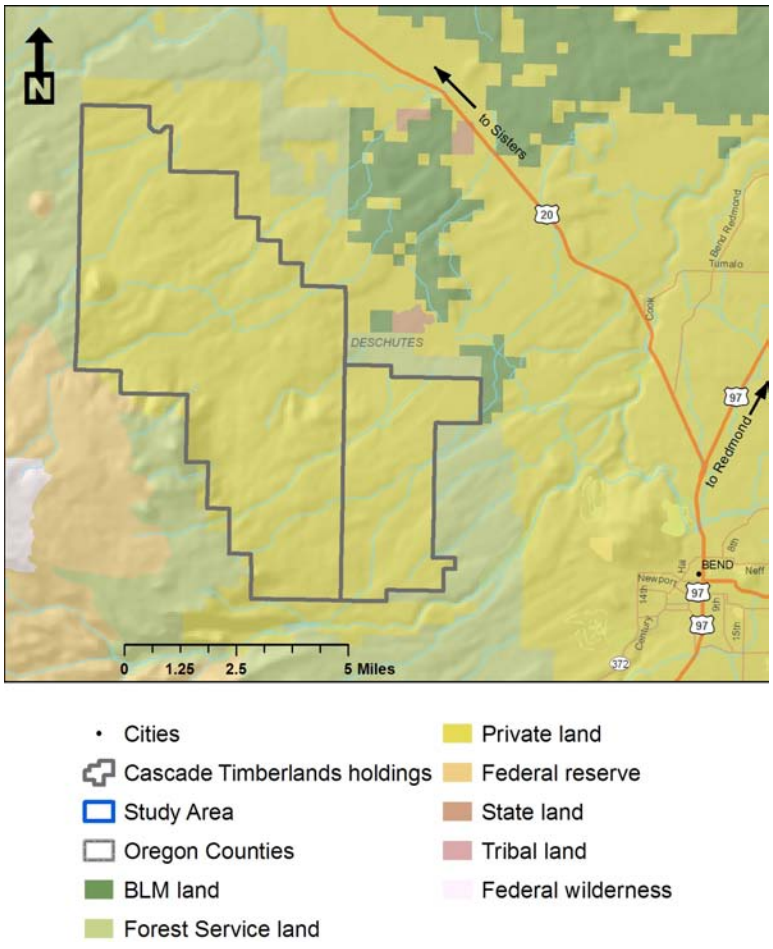
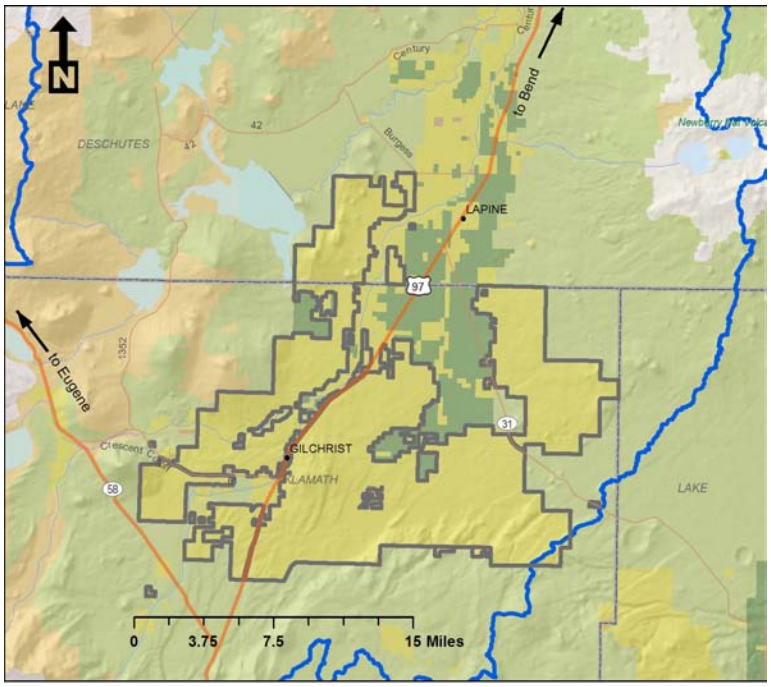


Figure 2 The Bull Springs tract is about 33,000 acres between Bend and Sisters, Oregon.



- Cities
- Cascade Timberlands holdings
- Study Area
- Oregon Counties
- Lakes
- BLM land
- Forest Service land
- Private land
- Federal reserve
- State land
- Tribal land
- Federal wilderness

Figure 3. The Gilchrist tract is about 144,000 acres near Gilchrist, Oregon.

The Gilchrist tract is about 140,000 acres in the area between La Pine and Gilchrist, Oregon, about 30 miles south of Bend (Figure 3). The landscape is generally flat and is relatively cold and snowy in winter. The area has long been managed for ponderosa pine although lodgepole pine is common in flat, frost-prone terrain. For decades, the tract was managed by the Gilchrist Timber Company and provided jobs and forest products to the Bend area. The Oregon Department of Forestry has proposed purchasing portions of the tract and managing it as a working state forest. Alternatively, land development, including destination resorts and residential dwellings, may occur in some parts of the area. While the Gilchrist tract is farther from population centers and, consequently, somewhat less prone to rapid development compared to the Bull Springs tract, there are concerns about the effects of development on forest sector products and jobs, forest conditions, and fuels/wildfire hazards.

Analysis and Data

We projected potential future forest conditions, land development, land management, and natural disturbances (e.g., wildfire and insect outbreaks) to examine the effects future residential land development might have on the Bull Springs and Gilchrist tracts. We used landscape data and models developed through an effort called the Interagency Mapping and Assessment Project (IMAP). IMAP is a collaborative effort between federal and state agencies to collect state-wide data on existing vegetation and other geographic data and build models that allow projecting the effects of natural disturbances, and management on forest and other vegetation. This project involved extending those methods to include the effects of land development.

Our data on existing vegetation conditions come from research done by Janet Ohmann and others at the USDA Forest Service, PNW Research Station laboratory in Corvallis (http://www.fsl.orst.edu/lemma/main.php). Their work uses statistical methods, satellite imagery, and inventory plot data to assign information from inventory plots to 30 meter pixels across the landscape. Since their method relies on inventory plots, their estimates of vegetation are best where there are abundant plot data. Inventory plots falling on recently harvested private lands are not abundant in central Oregon and so data for harvested private land may not be well represented in the vegetation map we used to represent the baseline vegetation conditions. Consequently, our vegetation data

for the Gilchrist and Bull Springs tracts may over or under estimate these and other vegetation conditions. In particular, we think our initial conditions data indicate greater amounts of forest containing medium and large-sized trees (trees over 15" diameter breast height) than actually exist in the two tracts. The result of this bias could be incorrect projections in the first several decades for management that targets larger trees (e.g. commercial timber harvest) and other landscape conditions. After 50 years, our models seem to reach stable conditions and follow reasonable time tracks afterwards. For this reason, we think our estimates of early commercial timber harvest are likely higher than could actually occur. Better inventory information will fix this problem.

We use models that show vegetation conditions as boxes of cover types (e.g. ponderosa pine in dry environments) and structure (e.g. dense, multi-story forests of large trees) connected by arrows representing growth, management activities, or disturbance (Figure 4). We can easily adjust rates and kinds of management activities to reflect how different land owners might manage their lands or turn any activity on or off. For this project, we added land development as a new kind of disturbance that could change wildland forests into several density classes of developed land.

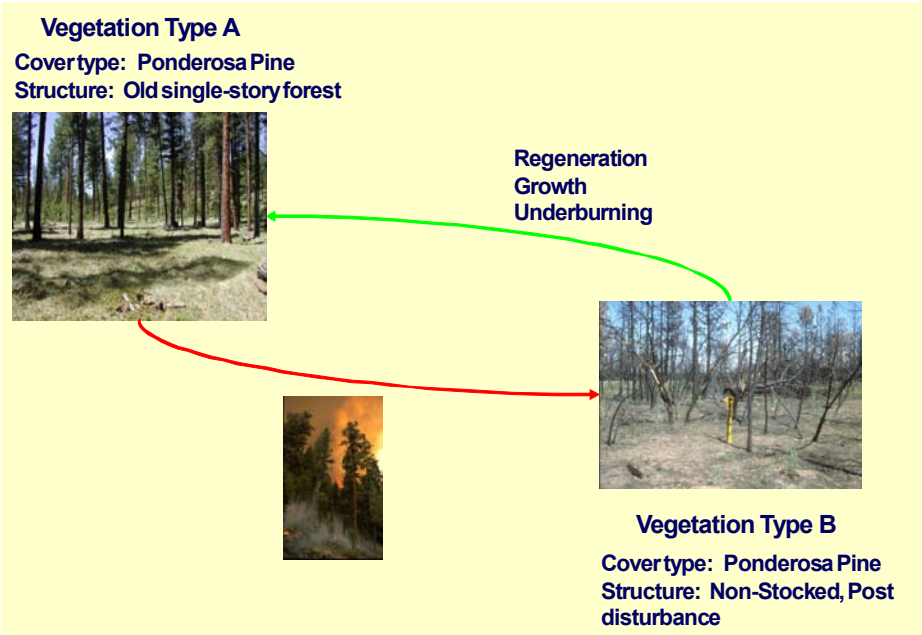


Figure 4. Model design—boxes and arrows.

We then developed different "scenarios" that include how managers might treat lands, whether or not development happens, and the rate of development when it does happen. This is important because potential future development rates differ across the landscape according to proximity to cities, travel access, topography, and other factors. We examined interactions at the scale of ownerships and land allocations within individual watersheds or across larger areas. We also developed a fine-scale model for part of the upper Deschutes landscape, focused on the Bull Springs tract, which projects individual stands down to about 4 acres in size.

Scenarios

We designed two scenarios to examine the effects of land development compared to proposed management of the Gilchrist tract as state forest and the Bull Springs tract for restoration by the Deschutes land trust. These are only two of many possible potential futures that could be examined. We selected these two scenarios because we think they address key issues associated with current public and political topics regarding the two tracts.

Scenario 1 - What might happen if the Bull Springs and Gilchrist tracts (and other private lands) become developed over the next 50 years?

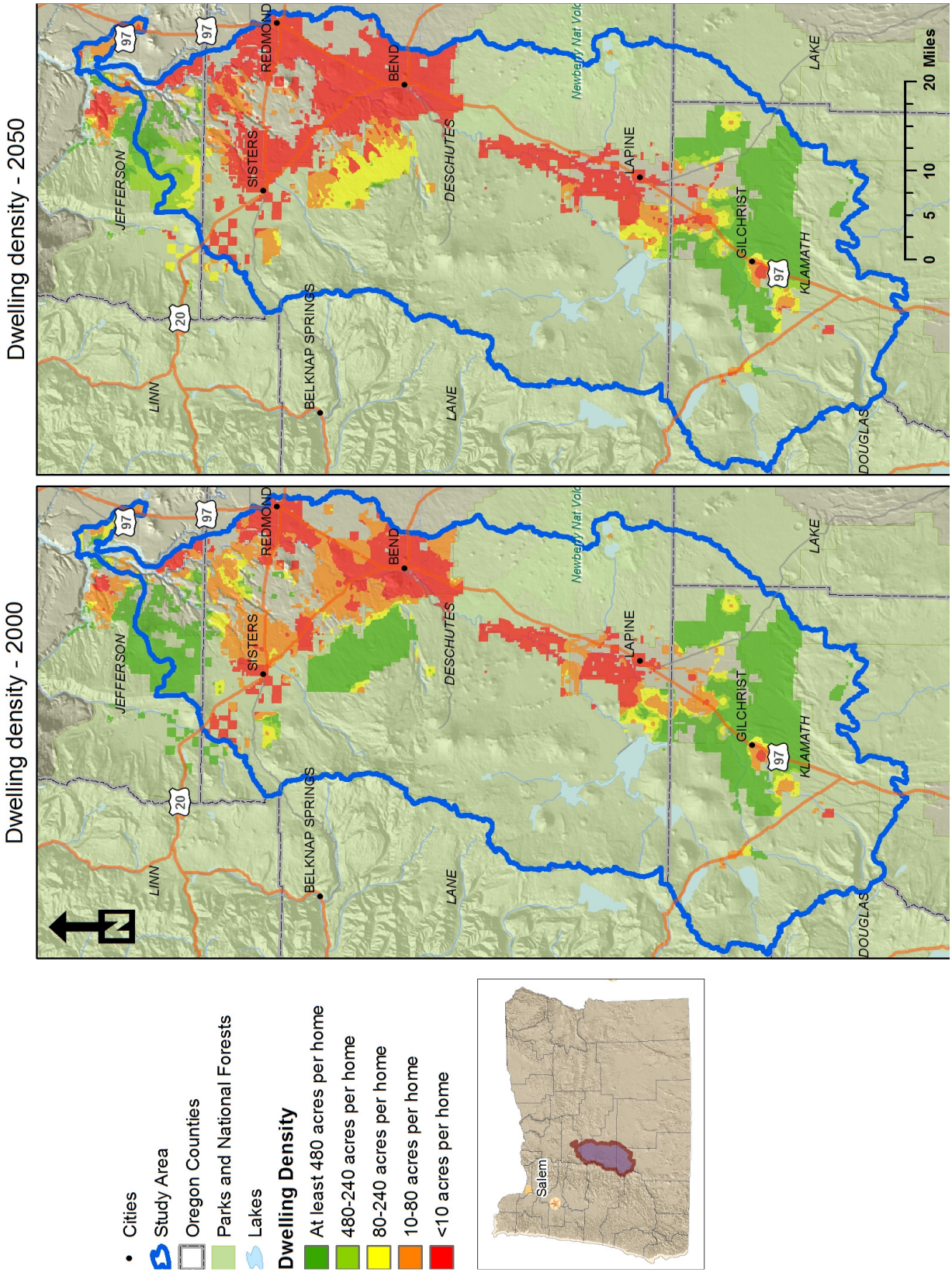


Figure 5. Dwelling densities in the upper Deschutes landscape in the year 2000 and 2050. Projections and data were provided by Jeff Kline (USDA Forest Service, PNW Research Station, Corvallis) and Gary Lettman (Oregon Department of Forestry, Salem).

Scenario 2 - What might happen if the Bull Springs tract was managed as working, publicly accessible forest by the Deschutes Land Trust, and the Gilchrist tract was managed as working forest like the Sun Pass State Forest near Klamath Falls? In this scenario, private lands outside the Gilchrist and Bull Springs tracts were assumed to become developed following recent historical trends.

In both scenarios, public lands (primarily managed by the USDI Bureau of Land Management and USDA Forest Service) were modeled with active restoration and fuel treatments. Private land outside the two tracts was assumed to become developed following patterns from recent historical trends (data and development projections provided by Jeff Kline, PNW Research Station, Corvallis and Gary Lettman, Oregon Department of Forestry, Salem; Figure 5). A variety of factors appear to be related to the conversion of private land from undeveloped to developed conditions between the mid-1970s to the year 2000, including: land use zoning regulations, distance from population centers, travel access, topography, and others. Land use zoning regulations influenced, but did not dictate, where development occurred from the mid-1970s to 2000 (see http://www.fs.fed.us/pnw/sciencef/scifi68.pdf for more detail). Rather, zoning was one factor among several that was related to private land development. Economic and other pressures combined with case-by-case local exceptions to zoning regulations, resulted in development in a variety of land uses. When a combination of factors are used to project development, it appears that privately owned land such as the Bull Springs tract may, under evolving land use policy and regulation, become developed over the next 50 years even though today it is zoned for forestry uses.
There are concerns that the land development projections we used do not adequately reflect changes in zoning regulations since the mid-1990s. Changes since the mid-1990s likely have reduced the rate of conversion of wildlands into developed lands. Consequently, our estimates of development conversion may be higher than they should be. Future work to separate development rates before and after the mid-1990s will help resolve this issue. In any case, future development is likely to be higher in both tracts than it is at present. We also did not include variation in actual development rates over time as a result of economic forces. The current economic depression has likely reduced land development substantially, at least for a time.

Forest Conditions

We made two assumptions that strongly influence our projections of future forest conditions. These could be changed relatively easily to generate different scenarios and projected future conditions.

- Forest management essentially ceases when residential development exceeds one dwelling per 240 acres. We recognize that some land owners will treat fuels, but do not have information on how much fuels might be treated on private, residential land.
- Forest management would continue in undeveloped areas until residential dwellings exceed one per 240 acres. It's possible that very different forest management would be practiced in undeveloped areas under Scenario 1, depending on who owns the forest land and their management emphases.

Both the Bull Springs and Gilchrist tracts have seen substantial commercial timber harvest in the last 30 years and very few large trees remain. Because it takes many decades or centuries to grow ponderosa pine 30" or more in diameter, neither of our scenarios produced many stands of large trees. Since we assumed that the Bull Springs tract would be managed differently than the Gilchrist tract in the future, our analysis shows the effects of different forest management emphases as well as differing development potential. We looked at (i) the effects that intended forest management might have on future forests and (ii) how development might change overall landscape conditions.

Bull Springs

The Bull Springs tract has seen substantial commercial timber harvest in the last 30 years and very few large trees remain. Over the next 50 years, both scenarios 1 and 2 produce very few large trees because it takes many decades to grow big ponderosa pine, 30" or more in diameter in these kinds of sites.

Scenario 1 (development) - Over the longer term, continuing residential development may reduce forest wildland area to about 60% of its current extent in the Bull Springs tract (Figure 6a). We assumed that private land owners would continue to manage for ponderosa pine forest restoration until development density exceeds one dwelling per 240 acres. Given this assumption, open forests of large ponderosa pine eventually dominate in undeveloped forest land. After about 100 to 150 years, the proportions of open, park-like ponderosa pine forests begin to resemble historical conditions. Development, however, takes an increasing bite out of undeveloped forest land, reducing wildland forests to about 60% of their current area after 300 years.

Figure 6a. Scenario 1 (development).

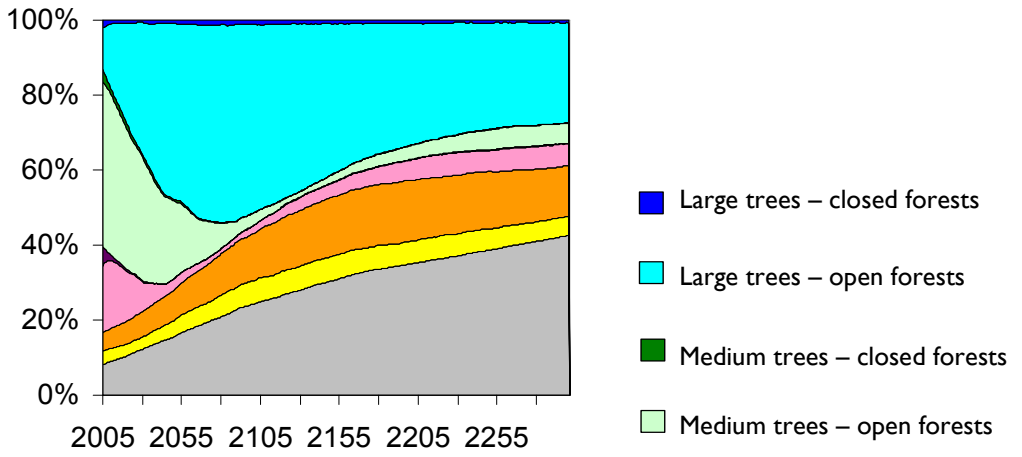
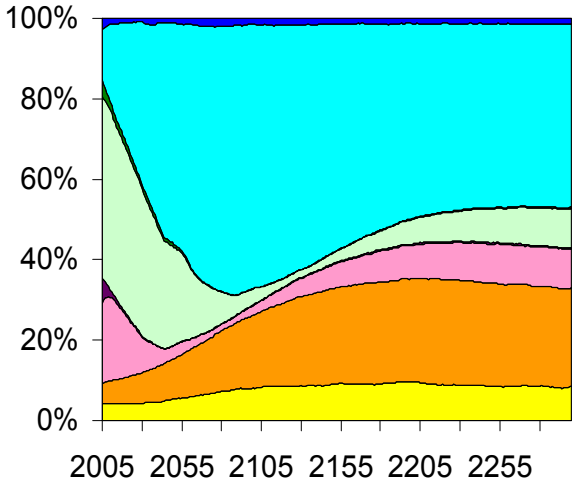


Figure 6b. Scenario 2 (no development).



We assumed that half of the area that becomes developed will not receive thinnings or fuel treatments once development density exceeds one residence per 240 acres. Without treatment, forests in developed areas will likely become mostly dense, with abundant small trees and few openings. Fuel levels and wildfire risks would be high and increasing unless land owners take steps to reduce them. These intermingled areas of high fuels could easily increase rates of wildfire and insect loss to the remaining old ponderosa pine forests by providing fire travel corridors and hot-spots for insect outbreaks. It could become difficult to sustain the declining area of open ponderosa pine forest in the face of a variety of wildfire, insect, and other hazards.

Our supposition that private land owners would manage their holdings in the Bull Springs tract with a forest restoration emphasis is debatable. We don't know how land owners would manage private lands in the area, especially as individual tracts become smaller over time. It's quite possible that owners would adopt some other emphasis, manage only to reduce fuel hazards around home sites, or not manage their forests at all. These alternative approaches would produce substantially different conditions on developed lands, most likely in the direction of increasing forest density, fuel hazards, and risks from fire and insects. Research into how owners of smaller private forest lands manage their lands may provide better information that could be used to refine our projections.

Figure 7a. Scenario 1 (development)

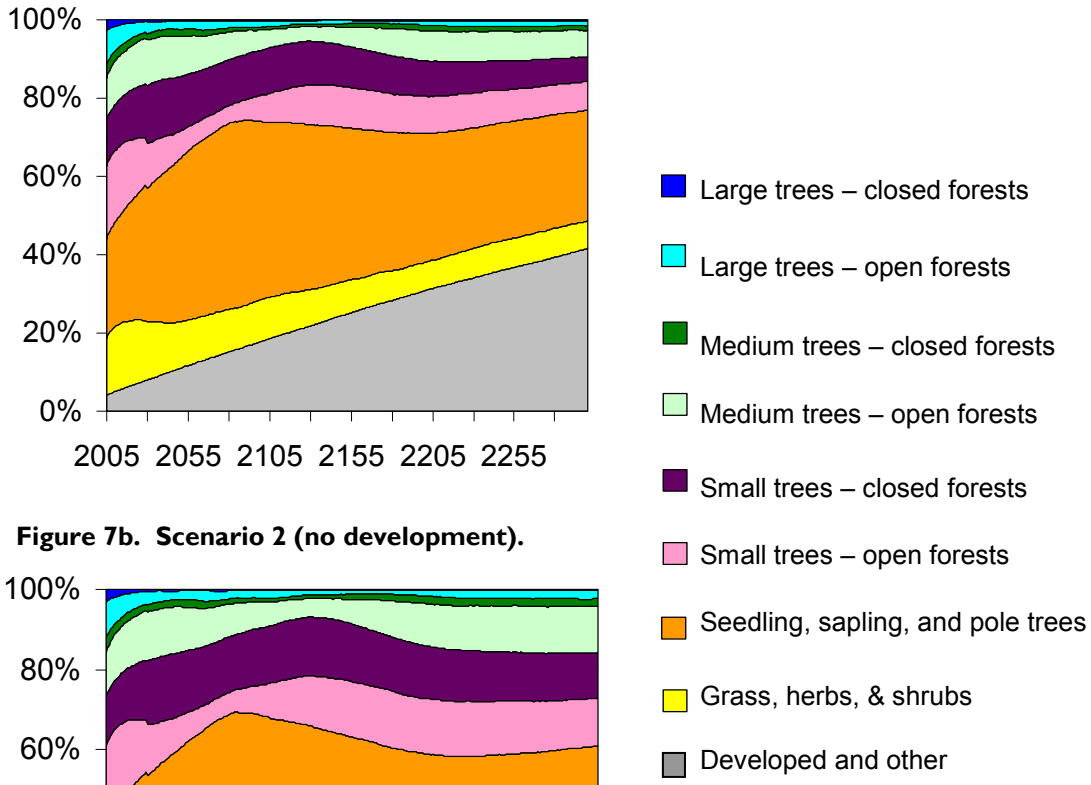
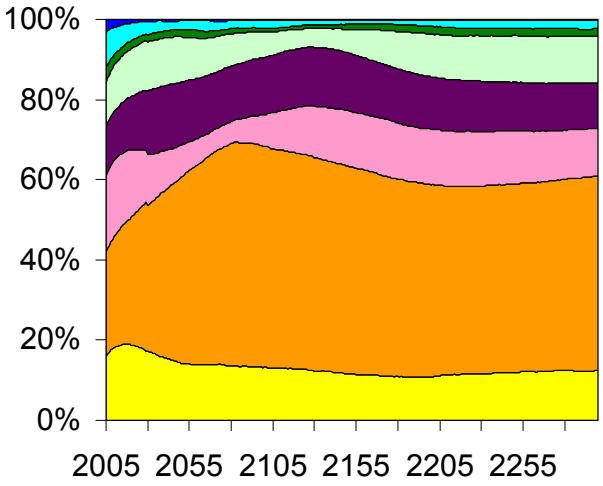


Figure 7b. Scenario 2 (no development).



Figures 7a and 7b. Projected forest conditions in the Gilchrist tract under Scenario 1 (development) and Scenario 2 (no development). Developed land occupies more than 40% of the tract at the end of 300 years, but development happens more slowly and is less dense than in the Bull Springs tract.

Scenario 2 (no development) - If the Deschutes Land Trust takes over management of the Bull Springs tract, it intends to manage Bull Springs much like it manages a similar tract along the Metolius River (Figure 1, Figure 6b). The emphasis would be on restoring the forest's historical conditions and reducing fuels and wildfire risk. Using this as our basis for this Scenario 2, we found that at the end of 50 years, the Bull Springs tract would likely contain abundant open forests, mostly of ponderosa pine. Over the following 100 years, most of the open ponderosa pine forests might begin to resemble historical conditions. By the end of 300 years, at least 50% of the landscape could be occupied by old ponderosa pine trees, with considerable area in openings and small trees. Habitat for a variety of species would exist under such conditions, but open conditions tend to favor species that prefer open forests (e.g., whiteheaded woodpeckers). This relatively stable open forest of old ponderosa pine would be embedded in a matrix of much more developed lands.

Gilchrist

Scenario 1 (development) - According to our base vegetation map, most of land in the Gilchrist tract is currently in openings, shrubs, and small trees, primarily lodgepole pine.* Over the next 50 years, forest management with a multiple use emphasis would produce open stands of larger trees and shift dominance toward ponderosa pine (Figure 7a) as well as produce multiple age classes of open ponderosa pine forests up to about 150 years in age rather than old forest conditions. In addition, regular thinnings and selection harvest of large trees will keep much of the area in seedling, sapling, and small trees. Due to soils, environment, and prolific local seed sources, lodgepole pine will be a substantial component of the forests. A note of caution: based on informal field visits and information from local experts, we think our data may show higher abundance of medium sized tress than actually exists. Better inventory information would clarify the current condition.

Development would take a continually increasing bite out of wildland forests in the Gilchrist tract. Over the next 50 years, development might move 10% or less undeveloped forest land to developed conditions. However, if the same development trend continues for 300 years, as much as 40% of the area could become developed to densities of more than one dwelling per 240 acres. Our assumption is that much of the developed area will not receive thinnings or fuel treatments and forests on them will become denser over time. We recognize that some land owners will treat fuels, but do not have information on how prevalent treatment might be on private, residential land. In the absence of fuel treatments, developed lands in the Gilchrist tract will likely be mostly dense lodgepole pine with abundant small trees and few openings. Fuel levels and wildfire risks would likely be high and increasing unless land owners take steps to reduce them. Wildlife habitat for species that need larger trees and open areas would be limited.

Figure 8. Expected future stand conditions in the Gilchrist tract.

* More recent inventories suggest that ponderosa pine is the most abundant and dominant species. Please see page 5 for additional explanation.

Figure 9. Expected future stand conditions in the Bull Springs tract.

Scenario 2 (no development) - We assumed that management of the Gilchrist tract would be to produce forest products, wildlife habitats, and other values while reducing wildfire and insect outbreak risks. The emphasis would be on small group selection harvesting with an upper stand age limit of about 150 years. Stands would be regularly thinned to maintain open conditions and fuel treatments done during the course of other stand management activities. At the end of 50 years, the Gilchrist tract will likely contain abundant young open forests, mostly of mixed ponderosa pine and lodgepole pine (Figure 7b). Over the longer term selective harvest should produce open forests of medium sized ponderosa pine and lodgepole pine with a variety of age classes up to about 150 years, many scattered openings of a few acres, and minor areas of dense forest. Habitat conditions will likely favor open forest wildlife species, especially those that use trees less than 20 inches diameter. Larger trees, snags, and down wood would likely be present but not abundant.

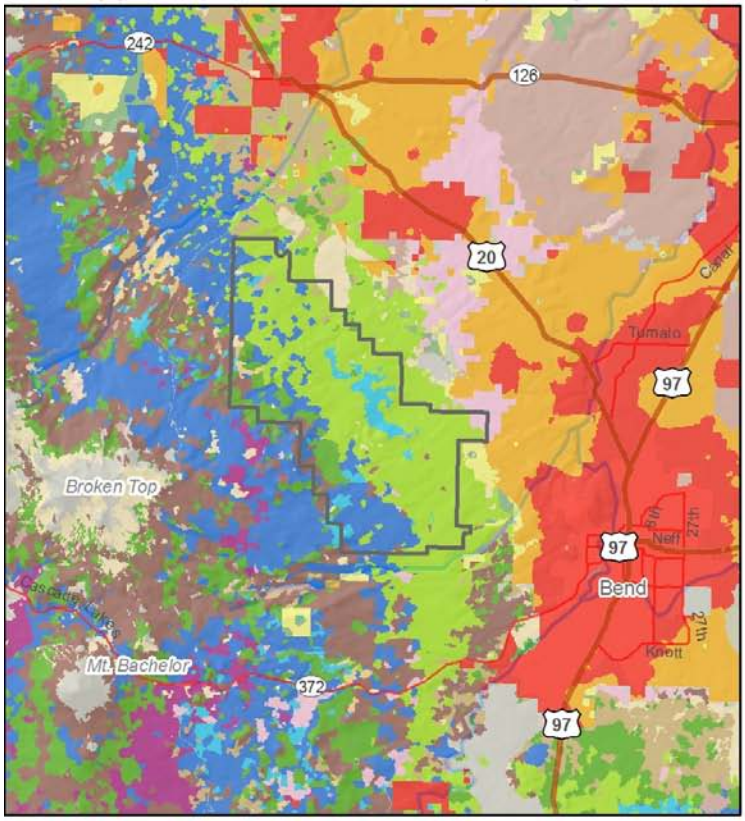
Proposed management in the Gilchrist tract by the Oregon Department of Forestry is likely to produce some large, old trees and mostly open stand conditions. Most trees would be harvested soon after reaching 20" DBH and nearly all stands would be thinned to maintain open forests. Wildlife habitat conditions might favor open forest species and generalists rather than species related to older forest conditions (Figure 8).

Proposed management in the Bull Springs tract by the Deschutes Land Trust could produce abundant large, old ponderosa pine in open forests and small areas of denser conditions. Wildlife habitat may be varied and support species that require older forests, particularly open older forests (Figure 9).

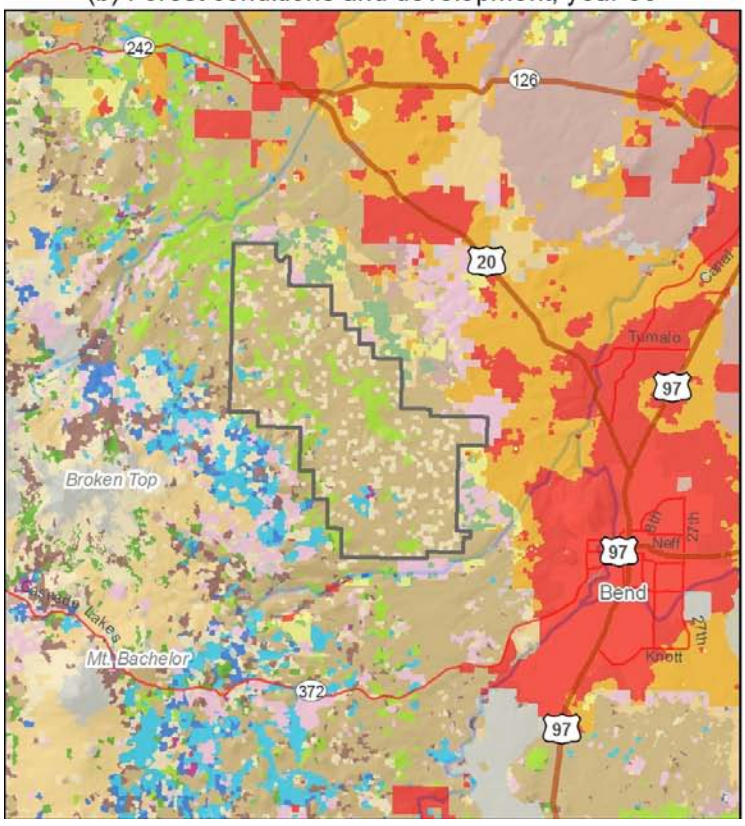
Stand-Scale Forest Conditions – Bull Springs

We examined the Bull Springs area in more detail to better understand stand patterns, mule deer habitat, and other forest conditions that might occur with the restoration management approach proposed by the Deschutes Land Trust and in the absence of development (Figure 10). Much of the area currently occupied by pole and small sized trees at present should become open forests of medium to large sized trees in 50 years. Because the proposed restoration management uses group selection harvests with harvested areas averaging a few acres or less, the forests may eventually become an uneven aged mosaic of old forests. Small patches, generally a few acres in size, of openings and small trees would be scattered through older forest. This is in contrast to the current conditions dominated by larger patches (tens to hundreds of acres) of even-aged forest, all generally less than 50 years old.

(a) Forest conditions and development, year 0



(b) Forest conditions and development, year 50



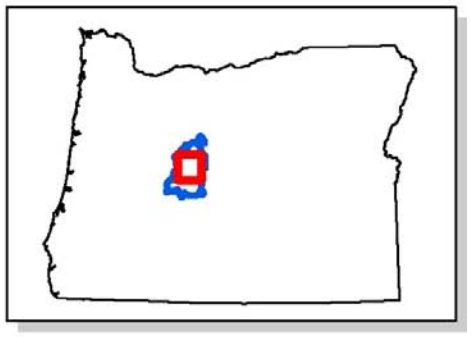


Figure 10. (a) Projected future conditions in the Bull Springs tract under Scenario 2 (no development). Much of the tract has become open forests of medium and large sized trees after 50 years (b) of sustained restoration management proposed by the Deschutes Land Trust. Numerous small openings and patches of small trees result from group selection harvest as part of restoration management.

Effects on Mule Deer Winter Range

We consulted with Oregon Department of Fish and Wildlife and USDA Forest Service biologists to refine the efforts to model winter range, migration routes, and other habitat conditions for mule deer. There are different opinions about what constitutes optimal winter range and we will hold a round table discussion in 2009 to refine our definitions. Mule deer winter range is restricted by snow and cold winter temperatures to the lower elevation areas mostly between Bend, Sisters, and Redmond. Much of what is potentially winter range has been developed over the last century or more and additional loss of winter range is likely by 2050.

Scenario 1 (development) - Landscape change in and near to the Bull Springs tract would most affect mule deer winter range. Private forest lands in the three Bull Springs watersheds (blue outline) are likely to see substantial change, especially in the lands currently owned by Fidelity National Timberlands (gray outline). Our analysis indicates that, given projected land development, very little of the currently available mule deer winter range (Figure11) would likely remain winter range by 2050. In addition, the existing mule deer migration connection between mule deer habitat south of Bend and the largest area of existing winter range in the Bend-Sisters-Redmond triangle might be lost to development. In addition to changes in habitat conditions, development would likely include other impacts like higher road densities and vehicle travel that impede deer access and result in road kill and homes with unleashed dogs that harass deer. We did not specifically evaluate these impacts.

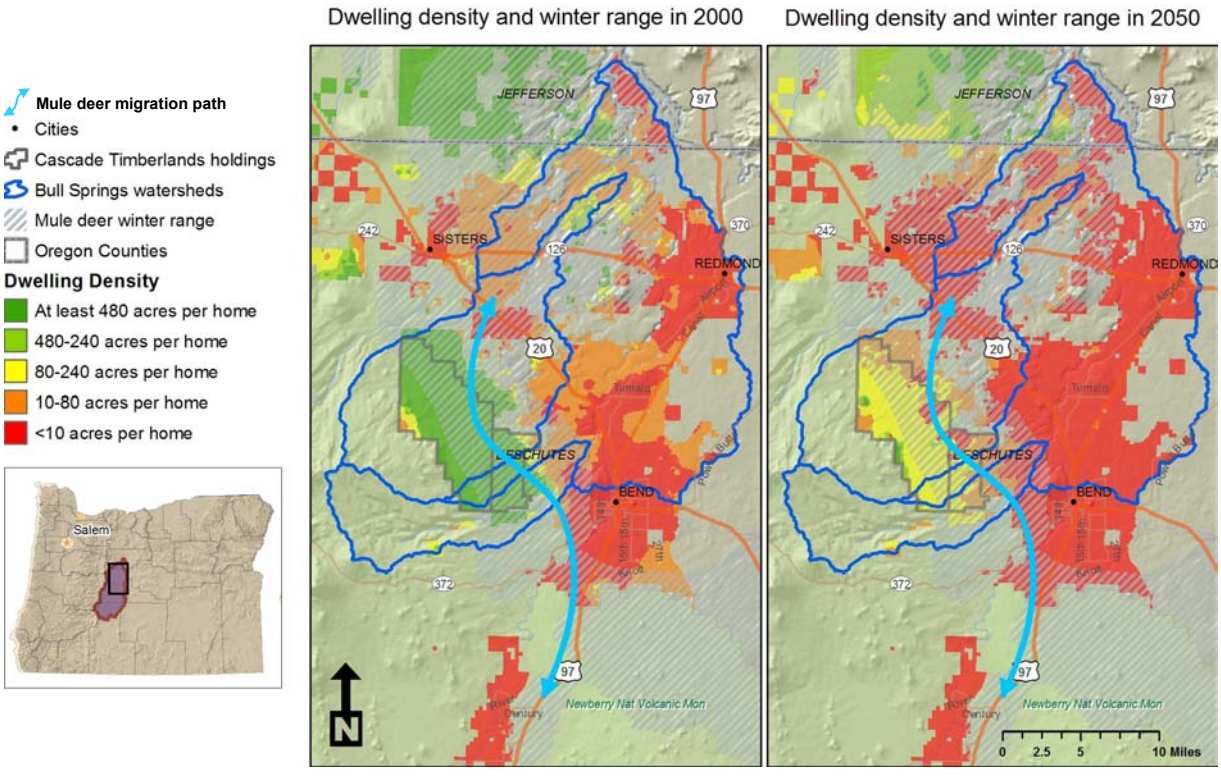


Figure 11. Dwelling Density and Winter Range in 2000 and 2050. Potential mule deer winter range habitat currently lies in mostly un-developed lands at lower elevations within and north of the Bull Springs tract. Migration between winter and summer range occurs along and through portions of the Bull Springs tract. By 2050, much of the existing mule deer winter range habitat has been converted to developed land. Migration between summer range and winter range through the Bull Springs tract has also been altered by development.

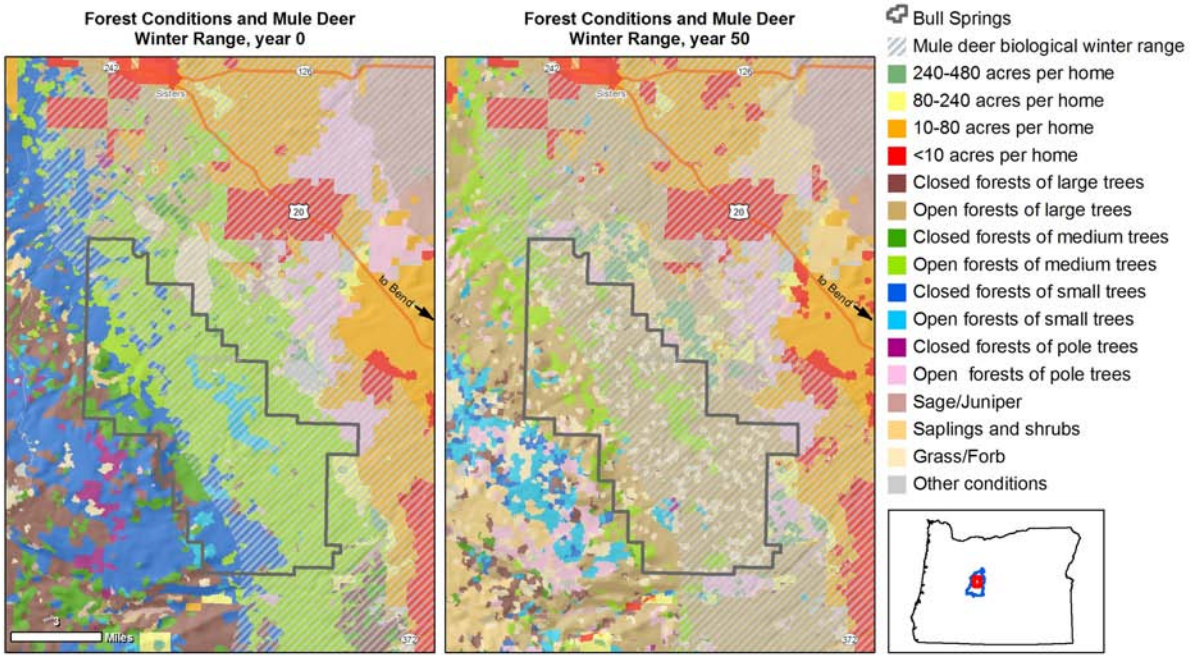


Figure 12. Under the no development scenario, it is likely that dramatic changes in forest structure will arise. In particular, we can expect to see an increase in the amount of mature, open forests.

Scenario 2 (no development) – Considerable changes in forest conditions from present day to the future are possible in and around the Bull Springs tract even without development inside the tract (Figure 12). The proposed management of the tract by the Deschutes Land Trust over the next 50 years would move most forests from current conditions, dominated by extensive stands of small trees, to increasing areas of mature, open forests. In addition, the area would have fewer highly used roads and human presence in general and many fewer homes. Lack of residential development in the tract would allow the tract to continue to function as an unimpeded migration route between mule deer summer ranges to the south and west and winter range areas to the north and east. It would also allow more of the area to continue to function as suitable winter range.

Forest Products

Predicting potential impacts of land development on forest products is challenging. We assumed the rate of development based on historical trends, but we don't know what private land owners might do with undeveloped forests under Scenario 1. If private land owners manage forest lands for sustainable timber production until development density exceeds one dwelling per 240 acres, forest product generation would slowly decline with increasing development. We assumed this would be the case, as our estimated acres treated to produce forest products and reduce fuels reflect. If, on the other hand, private forest land owners can not afford or do not wish to manage their lands for forest products, the decline in forest product generation could be sharp and immediate following development. In either case and over the long term, if the tracts are available for development all forest management treatments could cease as development proceeds.

Realistically, neither scenario would produce much in the way of forest products over the first 50 years in either tract, primarily because both have been heavily harvested recently. Since it takes many decades to grow trees

large enough for commercial harvest in these types of forests, it will be 50 to 100 years before substantial commercial harvest could begin.

The initial spikes in forest management activities under both scenarios result from an over-estimate of current large tree abundance for both tracts. Both tracts have been heavily harvested in recent years, resulting in mostly small tree dominated forest conditions. Information from local experts suggests that the trend in the first 50 years is likely to be a slow increase from initially low levels rather than a decline from initially high levels. Our models reach long term equilibrium conditions after the first 3-6 decades when trees have grown large enough for sustainable commercial harvest to begin.

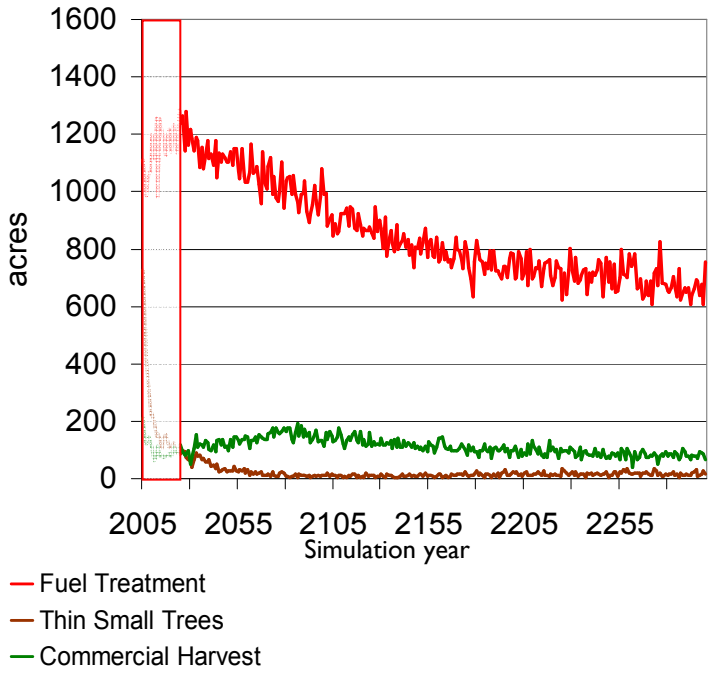


Figure 13. Trend in management treatments for the Bull Springs tract under Scenario 1 (development). Treatments declined as development took an increasing bite from managed forest land base. Treatments continued downward to less than 100 acres per year as development increased over time. Our estimates of forest management activity rates in the first two decades (red box) are likely too high due to poor inventory data.

Forest Products – Bull Springs

Forest products and fuel treatments from management of the Bull Springs tract reflect an emphasis on restoration. Fuel treatments, an important factor in restoration efforts, would be frequent and extensive to keep the ponderosa pine dominated stands moving toward open conditions with large, old trees. Small group selection harvests, another important tool for restoration, would occur on 100-200 acres per year, beginning 50 to 100 years in the future, and would leave most or all the accumulating large, old ponderosa pine. Ultimately, the forests would consist of large, old, ponderosa pine and smaller ponderosa pine, Douglas-fir, white fir, and lodgepole pine.

Scenario 1 (development) – Much of Bull Springs exceeded one dwelling per 240 acres over the long term in our simulations, substantially reducing management treatments (Figure 13). Commercial forest harvest reached a high of almost 200 acres treated per year in the 7th decade, then tapered to a low of less than 100 acres treated at 300 years. We think our estimates of managed area for the first 3 decades are too high due to poor inventory of current conditions.

Scenario 2 (no development) – Levels of forest management treatment were higher than those in Scenario 1 over the long term (Figure 14). Commercial harvest of large trees, mostly Douglas-fir and white fir thinned from around large ponderosa pine, gradually increased to between 100 and 200 acres per year after the first 6 decades. Thinnings of small trees were common in the first 50 years, but declined to less than 100 acres per year over the

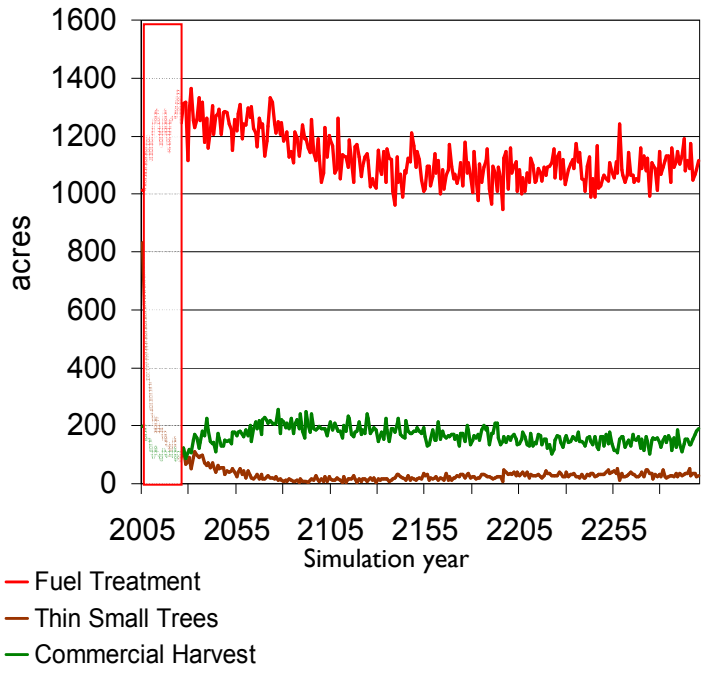


Figure 14. Trend in forest management treatments in the Bull Springs tract under Scenario 2 (no development). Commercial timber harvest reached a sustained level of between 100 and 200 acres per year after the first 6 decades. Thinning treatments tapered off to lower levels as the forests became open and prescribed fire was used to maintain open forests and reduce fuels. Our estimates of forest management activity rates in the first two decades (red box) are likely too high due to poor inventory data.

long term. This trend reflected the transition from current conditions (most of the area in sapling, pole, and small trees) to a future condition of open stands dominated by larger ponderosa pine. Fuel treatments were common, averaging between 1000 and 1200 acres per year over the long term. We think our projections of management levels for Bull Springs under Scenario 2 are too high during the first 2 or 3 decades due to an over-estimate of the current abundance of large trees.

Forest Products – Gilchrist

We assumed that the Gilchrist tract would be managed for a combination of forest products, wildlife habitats, and other values: an emphasis that could generate higher outputs of forest products than the restoration management strategy assumed for Bull Springs. Conversely, the soils and environment in the Gilchrist tract are not as productive as those in the Bull Springs tract. Also, lodgepole pine (a less economically valuable species) is abundant and ponderosa pine is somewhat less abundant in the Gilchrist tract . In balance, the Gilchrist tract produced somewhat higher levels of commercial management on a per acre basis than the Bull Springs tract.

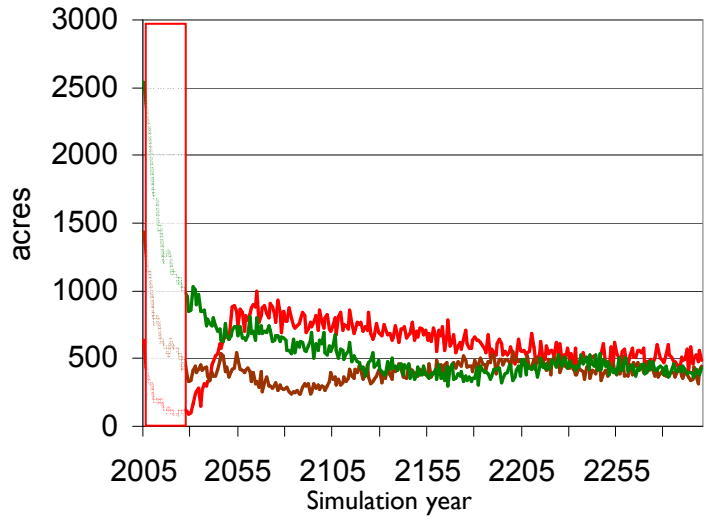
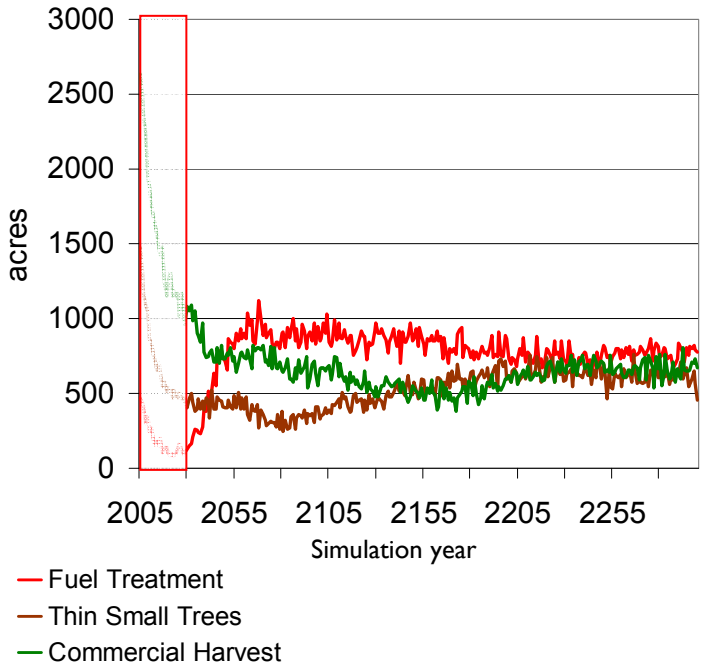


Figure 15. Trend in forest management treatments in the Gilchrist tract under Scenario 1 (development). Commercial timber harvest began a continued downward trend to less than 500 acres per year. Fuel treatments and thinning of small trees likewise declined as development took an increasing area from managed forest land. Our estimates of forest management activity rates in the first four decades (red box) are likely too high due to poor inventory data.

Scenario 1 (development) - Commercial harvest of large trees averaged about 600 acres per year after 50 to 75 years (Figure 15). Given current conditions, most of the management activity in early decades was pre-commercial thinning, fuel treatments, and thinning dense stands of small trees. Forest management activities declined over the long term as land development reduced the available timber base. This assumed that private land owners would manage undeveloped forest lands in the Gilchrist tract much like a state forest. It is entirely possible that private owners could adopt much different management emphases or decide not to invest in forest management other than fuel treatment. In the latter case, forest products generation might quickly decline to near zero. Because the Gilchrist tract is farther from major population centers than the Bull Springs tract development was slower and to lower density levels compared to the Bull Springs tract. Consequently, development had less impact on forest management in the Gilchrist tract than it did in the Bull Springs tract.

Figure 16. Trend in forest products and fuel treatments in the Gilchrist tract under Scenario 2 (no development). Commercial timber harvest reached a sustained level of between 600 and 700 acres per year. Our estimates of forest management activity rates in the first three decades (red box) are likely too high due to poor inventory data.



Scenario 2 (no development) – Our projections indicated long-term commercial harvest on an average of about 600 acres per year (Figure 16). Forest management in this scenario emphasized thinning dense stands of small trees to increase tree growth and reduce fuels for the first several decades. Thinnings in stands of trees between 10 and 20 inches in diameter averaged about 600 to 700 acres per year over the long term. These would produce lots of small diameter lodgepole pine and some ponderosa pine, Douglas-fir, and white fir. Fuel treatments, done during the course of thinning small trees and commercial harvests, also averaged about 600 acres per year.

Implications

If the Bull Springs and Gilchrist areas were to become developed, it is possible that forest management treatments would cease as more and more development occurs. Of particular concern is a decline in management to reduce wildfire fuels as the diversity of land owners increases. Under the assumption that few land owners would attempt to reduce fuels, the forests would likely to become increasingly dense, with abundant small trees and few openings. Fuel levels and wildfire risks would be high and continue to increase unless land owners took steps to

reduce them. Intermingled areas of high fuels could easily increase rates of wildfire and insect loss in remaining old ponderosa pine forests by providing fire travel corridors and hot-spots for insect outbreaks. These hazards and others would likely make it increasingly challenging to sustain open ponderosa pine forest area in patterns that are useful for wildlife. For example, likely losses in mule winter range in the Bend-Sisters-Redmond triangle would be high if the Bull Springs were to be developed. Furthermore, development would likely include other impacts like higher road densities and vehicle travel that impede deer access and result in road kill and homes with unleashed dogs that harass deer.

On the other hand, if the Bull Springs and Gilchrist tracts were not developed, the possibility for widespread efforts to reduce wildfire fuels and other management would remain, and forest would be likely to remain largely open forest that is less prone to fire and large insect outbreaks than dense forest. Lack of residential development in the tract would also allow the Bull Springs tract to continue to function as an unimpeded migration route between mule deer summer ranges to the south and west, and winter range areas to the north and east. This scenario would also allow more of the Bull Springs area to continue to function as suitable winter range. Because the area is likely to develop largely open forest conditions, habitat for a variety of species would potentially exist for species that prefer open forests (e.g., whiteheaded woodpeckers). However, this relatively stable open forest of old ponderosa pine would be embedded in a matrix of increasingly developed lands.

Finally, neither scenario nor tract can be realistically expected to produce significant amounts of forest products over the first 50 years, primarily because both tracts have been heavily harvested in the recent past. Information from local experts suggests that the trend in the first 50 years is likely to be a slow increase from initially low levels.

Summary

The Gilchrist and Bull Springs tracts have similarities and differences that drive the effects of residential development:

Similarities:

- Both have been private commercial forests and both are on the market for sale. Their future condition and management are uncertain. Both could be sold and, over time, experience substantial conversion from wildlands to developed lands.
- Both have been heavily managed for commercial timber in the last 30 years. Consequently, neither one will produce many large trees nor the associated values (habitat, forest products, aesthetics, and others) for many decades. However, both also have the capability to grow large trees and both could be managed for sustainable forests of ponderosa pine and other species.
- Both occur in environments where fire suppression and lack of stand management could produce dense and, ultimately, unsustainable forest conditions with high fuel accumulations, wildfire risks, and risks of insect outbreaks. Costs of wildfire suppression in situations where fuels are not treated could be high and suppression of intense fires under those conditions could be difficult.

Differences:

- Bull Springs is a smaller area and is located in a rapidly developing area, so that future land development could be faster and more complete than is likely in the Gilchrist tract.
- Bull Springs is located in an area important for mule deer winter range and migration to and from winter range. Given the potential for conversion to developed land, this habitat may be jeopardized.
- The Gilchrist tract is in a colder, snowier environment and is not important mule deer winter range. It is also less subject to development pressure, so mule deer habitat issues are not as pressing.
- Because Gilchrist is in a colder environment and dominated by ash-derived soils, lodgepole pine is more important there now and over the long term. Management activities may move forests toward ponderosa pine, but lodgepole pine will likely always be abundant. Ponderosa pine is more dominant in Bull Springs and, given the intended management by the Deschutes Land Trust, open stands of large ponderosa pine will likely dominate there.
- The Gilchrist tract is large enough that management for forest products could generate significant economic and employment opportunities, especially given the proposed State Forest management strategy. This would only occur after about 50-75 years, during which time the forest would have time to recover larger, commercially valuable trees. After this time, the tract is likely to produce about 600 acres of commercial harvest per year. Thinning and fuel treatments are likely to be similarly paced. However as development increases, there is some chance that private land owners might have other objectives and produce considerably less timber.
- The Bull Springs tract is smaller and proposed management is less likely to generate abundant forest products. After 50-75 years, this area may be able to support about 100-200 acres of commercial harvest per year, and similar amounts of thinning. However, with development both commercial harvest and thinnings are likely to decrease.
- Lower landscape rates of fuel treatment and higher dwelling densities in the Bull Springs tract would increase wildfire hazards, property values at risk, and suppression costs compared to Gilchrist.

Findings:

- The speed and degree of potential development differ between the two tracts but both are susceptible to development over the next 50 years. The Gilchrist tract is farther from population centers and, consequently, less likely to experience as rapid and less dense development compared to the Bull Springs tract.
- The Bull Springs tract contains important habitat for mule deer and is part of a migration corridor that allows mule deer to easily move between summer and winter range. If development occurs as it has since 1970, the Bull Springs tract is likely to become developed to the point that both winter range and migration for mule deer are substantially reduced over the next 50 years and even more over the longer term.
- Proposed management of the Bull Springs tract by the Deschutes Land Trust would likely:
    - ⇒ Generate sustainable open old forest conditions (trees generally over 150 years old) over time;
    - ⇒ Produce modest, continuing levels of forest products;
    - ⇒ Provide suitable winter range and migration habitat for mule deer, and
    - ⇒ Reduce fuel levels and wildfire hazards. Most wildfires would be relatively easy to control due to low fire intensity and few embedded homes.
- Development of the Bull Springs tract could move the forests toward:
    - ⇒ Accumulating landscape fuels as some or many land owners move away from active fuel treatments. Wildfires would become more difficult and expensive to control as fuels increased and homes became more abundant.
    - ⇒ Forest conditions that are more dense and have greater human presence (houses, roads, pets, etc.), resulting in declining winter range and migration corridor conditions for mule deer. Many of these effects would occur within 50 years.
    - ⇒ Replacement of forest products, habitat, and recreation driven economic values with values driven by development.
    - ⇒ Declining access to recreation as private land owners restricted access. The Bull Springs tract is heavily used for recreation at present. We did not specifically analyze this attribute, but restricted public use often accompanies development.
- Proposed management of the Gilchrist tract by the Oregon Department of Forestry would likely move that landscape toward:
    - ⇒ Sustainable open mature forest (trees generally less than 150 years old).
    - ⇒ Economic products that are comparable, on a per acre basis, to those generated by the Sun Pass State Forest. Since the Gilchrist tract is considerably larger than the Sun Pass State Forest, economic benefits could be significant to the local area.
    - ⇒ Relatively low levels of landscape fuels, resulting in relatively lower wildfire intensity and few embedded homes; fire fighting costs would likely be lower than if the tract became developed.
    - ⇒ Open mature forest habitat suitable for a variety of wildlife species and recreation uses.
- Development of the Gilchrist tract is likely to:
    - ⇒ Occur more slowly than in the Bull Springs tract, with lower home densities expected in the future.
    - ⇒ Increase wildland fuel concentrations depending on the preferences of private owners (e.g. some may prefer the aesthetics of closed forests). This trend would likely become more pronounced as individual parcels became smaller in the future. Wildfires could become more in-

tense and difficult to control.

⇒ Reduce wildlife habitat value as human presence increases, along with roads, homes, pets, and other related factors.

⇒ Invoke a change in land use values, from substantial forest products-related economic values to development-related values.

⇒ Decrease recreation access as private land owners restrict access.

Limitations

As with any model simulation effort, there are limitations to our work. Among these, we think several deserve special note:

- Land development may not proceed as we project. Historical trends, for example, may not reflect how land use policy affects development rates currently and in the future.
- The management of private parcels, especially small parcels, is difficult to predict. The proportion of the small parcel owners who will actively treat fuels may be higher or lower than we have assumed.
- The densities of homes at which mule deer habitat and migration value decline is the subject of considerable debate. More work is needed in this area.
- Our inventory data for existing, on-the-ground forest conditions on the Gilchrist tract and, to a lesser degree, the Bull Springs tract, suggest that large trees are more abundant than we think is actually the case. Better inventory data would help.
- We did not include the uncertainties of climate change because we don't know how climate change will impact the local area. Indications are that the forests might become more susceptible to wildfire and insect outbreak disturbances, especially if summers become longer and drier.

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