Chapter IV: Reference Conditions

4.1 Introduction.

Reconstruction of reference conditions largely depends upon two sources. First, limited records are available giving the impressions of explorers and pioneers as they first saw this region. Although their information was not collected according to the scientific method, it offers valuable firsthand insights into the general distribution of landscape characteristics at the advent of Euro-American settlement. To a large degree, their impressions taken at specific locations can be extrapolated to describe strata within the entire watershed. That is, upland characteristics would be expected to be similar throughout the Tualatin Plain, and likely to be different from riparian characteristics.

The second source is the extrapolation of these impressions based upon geographical, geomorphic, and biological principles. For purposes of this report, the reference conditions are assumed to describe the period immediately prior to European settlement. At that time, geological and climatic influences would be similar to those currently experienced. Given pioneer accounts of the vegetational structure of the watershed, and assumptions of negligible human impact prior to this period we can formulate reasoned deductions related to erosion, hydrology, stream channel, and water quality parameters. Such deductions form a major part in the formulation of the reference conditions described below. They are not to be taken as absolute truth, but rather a reasonable description of assumed watershed condition prior to extensive human impact.

Although these reference conditions may describe conditions prior to human impact, we cannot expect to recreate these conditions. In the next chapter, Synthesis, we will delineate a set of conditions that we consider to be realistic management goals given the current conditions of the watershed.

4.2 Erosion

Prior to human settlement, the vast majority of the Dairy-McKay watershed was heavily forested, with a large proportion of the watershed in old-growth timber. Such conditions would have provided little opportunity for surface erosion. Most surface erosion would occur in episodic pulses for about 20-40 years following stand replacement fire events. In the nearby North Yamhill watershed, such events were estimated as occurring every 200 years (BLM 1997). Thus, it is reasonable to believe that low surface erosion rates characterized the watershed about 80-90% of the time. Additionally, local increases in surface erosion would have been effected at locations where the tree canopy had been disturbed by large storms, wind, or disease.

Mass wasting processes would also have been episodic, being mainly associated with fires and major storm events. The rate of mass wasting (as well as surface erosion) would have been lower than present rates due to the lack of roads. The heavily timbered stands were probably less susceptible to mass-wasting than current clearcuts. However, recent studies by ODF show that mature timber can have landsliding rates similar to those for clearcut stands (Dent et al. 1997).

Streambank erosion would probably have occurred at lower rates than those presently observed. Most evidence from the early 1800s indicate that near-stream areas were heavily vegetated. Although natural stream meandering would have resulted in bank erosion, the increased resistance provided by vegetation, roots, and large wood in streams would have slowed this process.

Where erosion did occur, less sediment would probably have been delivered to streams than is presently the case. Due to high relative humidity and lower fuel temperatures, many riparian zones were more resistant to fire than upland sites (BLM 1997). This effect was strongest in lower watershed elevations. Where riparian vegetation and surface cover remained intact, it would have provided resistance to surface flow and encouraged deposition. Substantial wetland areas and floodplains would also have provided opportunity for sediments to settle outside the active channel.

4.3 Hydrology and water quality

4.3.1 Tualatin Mountains

In the Tualatin Mountains, hydrologic processes would probably have been similar to those occurring now. Forested conditions would have led to high rates of interception. Thick layers of forest duff would readily have allowed infiltration. Evaporation rates were probably quite high, but it is not clear that these rates would have been different than those under present forested conditions.

Peak flows in the mountains were probably lower than current peaks. Due to the absence of roads, fewer opportunities for channeled flow would have been present than under current conditions. Runoff that is now channeled into road ditches and into the stream system would have had greater opportunity to infiltrate. This would have resulted in downstream peak flows lower by an undetermined amount than under present conditions. Additionally, subsurface flows would have been higher than current levels. Stand replacement fires would have altered the surface hydrology. Diminished soil infiltration capacity, along with decreased ground cover would have resulted in increased surface storm runoff. Reductions in evapotranspiration rates could have increased the quantity of water available to streams for up to 40 years (BLM 1997). During this period, increased summer flow could potentially have benefited fish. However, this benefit would have been temporary, as these flows would gradually diminish as the fire-stricken areas revegetated themselves. Where these stands were replaced with phreatophytic hardwoods, evapotranspiration rates may have been above original levels, resulting in decreased streamflow.

Much less of the watershed was probably covered with hardwoods than is presently the case. This probably means that less evapotranspiration took place, resulting in increased water availability for aquatic life.

4.3.2 Tualatin Plain

The hydrology of the valley plain would have been substantially different than that now experienced. Prior to diversions, summer low flow in Dairy Creek would have been considerably higher. The difference was probably substantial, as illustrated by changes in low flow in the Tualatin River. In 1895, the depth of the Tualatin River downstream of Hillsboro always exceeded 3 feet (Cass and Miner 1993). In the years immediately prior to creation of Hagg Lake, the river was known to dry up (water rights seminar, Pacific University, October 3, 1998).

Peak flows would likely have been lower due to retention in floodplains and wetlands. During winter flooding events, water would have been detained for substantial periods of time. In addition to benefits for sediment control and wildlife, these detained waters would have seeped slowly back into the creeks, thus moderating flood peaks and increasing the water available during lower flows. Some of this water would also have become available to replenish subsurface supplies. Additionally, greater in-channel vegetation and large woody debris would have detained flow and dissipated stream energy during high flows.

Although peak flows would have been moderated, flooding would have been a frequent occurrence. Factors contributing to the flooding of Dairy Creek include the low gradient of the stream, and in earlier times would have included the congested nature of the channels.

4.3.2.1 Extent of wetlands in the early Dairy-McKay watershed

Early trapper reports note that most of the Tualatin Valley was wet and swampy (Cass and Miner 1993). Physical factors played the greatest role in creating these wetlands. Flat topography impeded the flow of surface water, while low soil permeability decreased infiltration. Additionally, locally high water tables would rise to the surface in the winter, creating standing pools of surface water (Hart and Newcomb 1965).

Beavers also contributed to construction of ponds and marshy areas in the Tualatin Plain (Cass and Miner 1993). Among other effects, beaver dams "increase hydraulic residence time and flood extensive areas, capture and retain sediment, and facilitate nutrient processing and storage" (Shively 1993).

Analysis of survey maps from 1870 showed that extensive swampy areas occupied the Dairy-McKay watershed. The largest of these areas were in the West Fork Dairy Creek drainage, and included Lousignont swamp, which occupied an estimated 855 acres, and the swamp along Cedar Canyon, which occupied an estimated 560 acres. Three other sites near the West Fork contributed another 265 acres of wetland.

Other tributaries to Dairy Creek also had sizeable wetlands. In the drainage of the East Fork of Dairy Creek, a wetland of about 330 acres extended along the present course of Bledsoe Creek, with another 140-acre wetland along nearby Bausch Creek. East Fork Dairy Creek, itself, had a 150-acre wetland north of Mountaindale. On McKay Creek, the only mapped wetland extended for about 210 acres. It was on the reach between Jackson Creek and Brunswick Canyon.

These wetlands add up to a total of 2,320 acres (3.6 mi^2), about 1.5% of the total watershed area. However, this estimate is probably very conservative as wetlands were inconsistently mapped in the 1870 survey. On a particular quad, adjoining areas would be mapped as wetland, but no such designations were made on the applicable quad. Additionally, known wetlands, such as Jackson Bottom, were not mapped.

4.4 Stream Channel

Stream channel characteristics would have been relatively stable prior to the time of human influence. Large inputs of down wood during large storms were relatively stable over time, and would likely have persisted through the periods between disturbances. Sediment would have been input and transmitted through the system in pulses corresponding to periods of high landslide rates. The routing of water and sediment through the watershed was controlled by the extent and condition of riparian vegetation, especially in the lower watershed where gradients are lower and the floodplain more developed.

Based on historical records, stream channels throughout the Dairy-McKay watershed had abundant vegetation. The trees and their roots tended to restrict channel width (Shively 1993). Additionally they had jams of woody debris, and sediment. The abundance of woody debris likely would have resulted in more diverse instream structure. Pool development, in particular, would have greatly exceeded current levels. It is also likely that these large woody debris elements would have provided better retention of spawning gravels.

Prior to channelization, most stream channels in the Tualatin Plain portion of the watershed would have experienced extensive meandering. The high silt-clay content of channel banks and substrate indicates that then, as now, channels had a low width to depth ratio. Little evidence exists regarding stream dimensions within the watershed in the early days of settlement. However, one survey performed in 1897 gave dimensions at two points on Dairy Creek. At the mouth, creek width was reported as 40 feet. Width was 12 feet at river mile 13. "The banks were from 15 to 25 feet high throughout and the fall about 50 feet in all or 4 feet per mile" (Farnell 1978). Unfortunately, uncertainties about the measurement methodology of the surveyor makes comparison with present stream characteristics difficult.

4.5 Water Quality

Water quality prior to human intervention was partially a function of the condition and extent of riparian vegetation. Water quality characteristics would have varied widely across the landscape and over time as a result of the extent of disturbance of the riparian zone.

Under undisturbed conditions, abundant stream canopy would have provided for stream temperatures cooler than those currently experienced. It is unclear what the temperature regime would have been for wetland areas, nor for water contributed to streams from these wetlands. During periods of major disturbance of riparian vegetation from fire or windthrow, water temperatures were elevated. In the periods between those major disturbances, water quality was good in those areas with adequate riparian vegetation.

Sediment levels were similarly affected by disturbance events. Where the riparian vegetation was intact, it would tend to restrict sediment delivery to streams, both through binding of soil, and detention of sediment-laden runoff. Following disturbance, these factors limiting sediment contributions would be reduced, leading to accelerated sediment contribution to streams.

Phosphorus levels would have been naturally high in the West Fork and East Fork drainages, and in the alluvial sediments of the Tualatin Plain. For the most part, this would have been dissolved phosphorus, as particulate phosphorus inputs would have been restricted by vegetation, other than in burnt and disturbed areas. Additionally, the extensive wetlands prevalent at the time would have helped to remove particulates, including phosphorus.

Contributions of bacteria would have been supplied by wildlife. However, these contributions were probably much lower than those attributable to livestock raising and septic systems.

Levels of nitrate and nitrite, and ammonia nitrogen would have been much lower in the reference period. Limited amounts of nitrogenous compounds would have been available from naturally occurring organic detritus. However, contributions of these substances from fertilizers, livestock, sewage and urban runoff would have been absent.

Dissolved oxygen levels would have been higher. Lower water temperatures would have increased stream capacity for oxygen, while reduced inputs of organic waste and nutrients would have reduced the biochemical demand for oxygen.

4.6 Aquatic Species and Habitat

4.6.1 Fish

Historical fish habitat information is not available at this time. Fish habitat can be interpreted from general vegetation descriptions of the land and estimated human impacts. It can be assumed that prior to extensive timber harvest, road construction and settlement, fish habitat was most likely in better condition. This is probably a result of larger woody material entering the stream channels creating structure and pools desirable for fish production and survival. Fish passage was not impeded by dams or water diversion structures. Water quality was generally better except after major forest stand replacement occurrences such as large fires.

Due to the mature state of most of the riparian timber in the watershed, streams received ample contributions of large woody debris. This would have contributed to higher pool development and greater instream habitat diversity, which would have been beneficial to aquatic life. Additionally, the mature riparian timber provided ample shade for streams. The resulting low water temperatures and high dissolved oxygen levels would have benefited salmonids and many other cool-water aquatic organisms.

Benefits from large woody debris would have extended to streams within the valley plain. Although the extent of spawning substrates would probably have been similar to those currently occurring, the increased incidence of LWD-induced pools, as well as lower temperatures, would have provided more useful salmonid rearing habitat than is now currently available.

Prior to stream clearing and channelization, stream meanders would have provided greater length of total aquatic habitat. Additionally, this habitat would have been more complex. Instream wood would have provided cover elements for fish, as would tree roots in the banks and hanging vegetation.

It is likely that steelhead would have been the only native anadromous salmonid species in the Dairy-McKay watershed during the reference period. The presence of Willamette Falls restricted the distribution of sea-run cutthroat trout. It is unlikely that a substantial population of chinook salmon ever populated the watershed (Ward 1995).

Other streams throughout Western Oregon have documented declining trends for most salmonid species over the last century. This, along with the availability of better habitat, indicates that the Dairy Creeks populations of cutthroat trout and steelhead were larger than those occurring today. However, historical references to fish populations and habitat within the watershed are difficult to find. One anecdotal source notes that trout were abundant in McKay Creek in 1930 (Nelson and Tannock 1998).

4.6.2 Wetland and riparian dependent species

The greater extent of wetland and riparian areas would have provided increased carrying capacity for species dependent on these habitats. This habitat was utilized by greater numbers of waterfowl. In the mid-1800s, for example, anecdotal accounts describe immense flocks of migrating ducks in the Banks area (Fulton 1995). The smaller wetlands created by beavers provided particularly important habitat for pond turtle populations. Trees felled by beavers would have provided habitat for basking, foraging, and refuge (Altman et al. 1997).

These extensive wetland habitats could also have sustained greater numbers of amphibians. Amphibian communities would have consisted of native frog and salamander species. Many of these species, as well as the Western pond turtle, have dwindled since the introduction of the exotic bullfrog.

4.7 Vegetation

4.7.1 General regional characteristics

The watershed area is within the western hemlock zone described by Franklin and Dyrness (1973). Old-growth stands in this zone still retain a major component of the seral species, Douglas-fir. In 1850, nearly 80 percent of the land area in the Oregon Coast Range north of Tillamook was essentially a continuous block of forest over 200 years old (Teensma et al. 1991). These extensive tracts of old-growth forest were broken by patches of 100- to 200-year-old stands and a very small amount of recently burned area. According to Oliver and Larson (1990), the general structural features of these old-growth stands typically include large, live old trees; large, standing dead trees; variation in tree species and sizes; large logs on the forest floor in various stages of decay; and multiple-layered canopies. These stands also have a great deal of horizontal and vertical diversity.

To gain an appreciation of the characteristics of these forests, we can refer to the interim minimum standards for old-growth Douglas-fir described by Franklin et al. (1986). These include:

- Two or more species of live trees with a wide range of sizes and ages.
- Eight or more large (>32 inches diameter at breast height (DBH)) or old (>200 years) Douglas-fir trees per acre; however, most stands have 15 to 45 trees per acre, depending on stand age and history.
- Twelve or more individuals of associated shade-tolerant species per acre, such as western hemlock or western redcedar, that are at least 16 inches DBH.
- More than 15 tons of down logs per acre, including 4 pieces per acre more than 24 inches in diameter and greater than 50 feet long.
- Four or more conifer snags per acre. To qualify for counting, snags must be greater than 20 inches in diameter and more than 15 feet long.

Other features of these old-growth forests include a dense, multiple-layered canopy; decadence in dominant live trees as evidenced by broken or multiple tops and decay; and shade-tolerant climax species, such as western hemlock or western redcedar, in canopy gaps created through the death of the dominant Douglas-fir trees.

Wildfire, wind, and disease appear to be the primary disturbance agents influencing the development of these stands. Wildfire is by far the most significant of these agents. Although fire frequency in the Coast Range has not been determined, it probably occurs at intervals ranging from 150 to 350 years and was associated with east wind events (Teensma et al. 1991). These rather infrequent fires, however, were high-intensity, catastrophic, stand-replacement events. It seems likely that human-caused fires dominated the pattern of fire occurrences in the Coast Range both before and after European settlement. Lightning was probably not a major cause of fires, especially since fire protection and cause determination began in 1908.

Fire results in both the creation and loss of down wood from the system. Large pulses of down wood have been noted following stand-replacement fire events (Spies et al. 1988). Following fire in an old-growth western hemlock/Douglas-fir forest, there was a 10-fold increase in snags. In addition, the total biomass of down wood increased from 244 tons/acre in the old-growth stand to 565 tons/acre in the newly burned stand (Agee and Huff 1987).

Major wind events associated with winter storms also may have influenced the development of these stands. Windthrown trees add down wood to the forest floor, as well as creating various-sized canopy gaps that support species such as western hemlock and western redcedar. In addition, major windthrow events create conditions for population build-up of the Douglas-fir beetle. Subsequent tree killing by these beetles further adds to the snag and down wood component of these forests as well as creating additional canopy gaps.

Laminated root rot, caused by the fungus *Phellinus weirii*, is widespread and probably had an important influence on the structure of many stands in the watershed. *P. weirii* is a native root pathogen that readily attacks and kills Douglas-fir (Thies and Sturrock 1995). Tree killing creates gaps in the canopy where shrubs, hardwoods, or shade- and disease-tolerant conifer species occupy these various-sized openings. Tree killing also creates snags. In addition, infection predisposes trees to windthrow. Live infected trees are susceptible to attack and killing by the Douglas-fir beetle. This disease, therefore, is a major source of down wood and snags.

Prior to European settlement, exotic weed species were not abundant on the landscape. There were, no doubt, a few populations of exotic species introduced through animal migration and Native American travel. Many of the exotic species currently within the watershed were brought into the area as ornamentals, to control erosion processes, or entered as seeds or spores on vehicles or clothing.

4.7.2 Vegetational characteristics of the Tualatin Mountains

Prior to European settlement, vegetation characteristics for the Tualatin Mountains would have been similar to those described in the previous section. The land would have been mostly forested with timber in the mature/old-growth structural stage. Interspersed in this sea of old-growth were stands of younger timber where stand-replacement fires had occurred. Most surveys from the mid-1850s describe the Tualatin Mountains as thickly forested, rough land with little capacity for settlement. However, an area of Dixie Mountain near the present site of Skyline Road was described as open country. This was attributed to burning by Native Americans (Nelson and Tannock 1998).

4.7.3 Vegetational characteristics of the Tualatin Plain

In the mid-1800s, the Tualatin Plain was a forested region interspersed with wetlands and prairies. Letters by early pioneers describe the forests as consisting of fir and oak. Their descriptions of prairie size range from 1 square mile in area, to 2 to 10 miles in linear extent (Buan 1995). These prairies provided valuable grazing and farm land. One such prairie extended south of Banks. Surveyors in 1851 described this area as a level prairie with first rate, clay loam soil (Fulton 1995).

At this same time, the area north of Banks also appeared to be in early successional condition. In the 1851 survey, this area was reported to contain "open fern and hazel, and hills with scattered firs" (Fulton 1995). Fire probably played an important role in creating this open vegetation pattern.

For the most part, the hills at the fringe of the plain were forested. The 1851 survey described one such hilly area in the East Fork Dairy Creek drainage (northeast portion of T2N, R3W) as forested with fir and some cedar, with an understory of maple and fern (Fulton 1995). Soils in these hills were considered to be "second rate".

4.7.4 Wetland vegetation

The characteristics of the Dairy Creek wetlands can be determined from early surveys of nearby wetlands. Just outside of the Dairy Creek drainage, 1852 surveys characterized Tualatin Valley bottomland as thickly forested with fir, ash, maple and vine maple, with many swamps thickly wooded with 10- to 20-foot willow (Shively 1993). Cass and Miner (1993) state that western hemlock, western red cedar, hazel, dogwood, salal, and Oregon grape were also important components of wetland habitats. Based on these assessments, it would be reasonable to assume that the many of the Dairy Creek wetlands were similarly wooded. However, settlers' accounts of lush meadow grasslands, together with the assumption that many of these grasslands were created by flooding, indicates the presence of marshy wetlands as well.

4.7.5 Sensitive plant species

It is difficult to reconstruct the abundance and distribution of sensitive plant species during the reference period. Factors complicating historical information regarding survey and manage species and other sensitive plants are as follows:

- Survey and inventory in the past has predominantly been limited to vascular plants (even vascular plant surveys are very limited);
- Sightings are few and widespread for most plant species, indicating large gaps in range information;

- Only the most rudimentary of ecology data is available for many species; therefore, habitat requirements are essentially unknown for most of these species, historically and presently; and,
- Sighting location information is often general, with little specific information available.

Those species dependent upon old-growth forest habitat, as well as riparian and wetland species, would have had a greater area of available habitat. It is likely, therefore, that these species were more abundant, and more broadly distributed, than is currently the case.

4.7.6 Terrestrial Species and Habitat

Prior to European settlement, the Northern Oregon Coast Range which forms the northern and western portions of the Dairy-McKay watershed was made up of larger blocks of later seral stage forests comprised of a wide range of tree sizes, large amounts of down wood, and abundant large snags. This situation undoubtedly provided habitat for those species dependent upon, or which would utilize larger blocks of interior forest old-growth habitat. Species that are presently of concern within the watershed such as the spotted owl, pileated woodpecker, and red tree vole benefited from the historical habitat condition.

The contiguous nature of the landscape pattern facilitated the free movement of these species throughout the watershed and throughout the region. Old-growth habitat conditions extended down into moist riparian areas and shaded the streams which contained numerous pools as a result of many large logs and debris jams. These riparian areas functioned as corridors for wildlife including amphibians, otter, elk, and cougar.

Abundant habitat suitable for spotted owl would have existed prior to European settlement. The owls would have had the extensive old-growth forest that would provide nesting and roosting habitat.

Abundant habitat for marbled murrelet would have existed in the watershed, as the vast majority of stands would have been in the mature to old-growth stages. The old-growth forest characteristics would also have provided abundant snags for bald eagle nesting.

Due to the limited amount and/or distribution of early-successional stands, forage habitat may have limited deer and elk populations within some portions of the watershed. These species would probably have occupied territories near recent burns, and probably would have had a substantial presence near the prairies of the valley plain.

The Columbian white-tailed deer (*Odocoileus virginianus*) occupied prairie habitat throughout the Willamette Valley, including the Dairy-McKay Creek watershed (Verts and Carraway 1998). Shortly after settlement, these deer were extirpated from most of their range in Oregon. Remnant populations are found in Clatsop, Columbia, and Douglas counties. The Columbian white-tailed deer is currently listed as endangered under the federal Endangered Species Act.

4.8 Human

4.8.1 Historical changes in landscape pattern

Human occupancy in the Dairy-McKay watershed has been a major source of change. The progression of some of the activities leading to changes in watershed conditions is given below.

4.8.1.1 Human uses prior to European settlement

The Tualatin Indians (also known as the Twality, or Atfalati), occupied a number of small villages in the Tualatin Plain. Six winter villages appear to have been located within the Dairy-McKay watershed. Three of these villages were at or near the present site of Forest Grove, with the other three north of Hillsboro. One of the largest of these villages was at the present site of North Plains. Additionally, a number of artifacts have been found near Mountaindale (Cass and Miner 1993, BLM 1979).

In many parts of Oregon, Indians modified the landscape through burning. Fires were set to maintain land in a herbaceous state, which facilitated hunting and travel, and created browse for deer and elk. The Twality Indians, whose diet mainly consisted of large game, do not appear to have utilized agricultural burning to the same extent as some other tribes. They did, however, harvest vegetables, such camas, tarweed, and berries. Fishing was also part of their subsistence base. The Tualatin valley floor was maintained as marsh grassland, but this may have been the result of natural flooding, rather than field burning (Cass and Miner 1993).

4.8.1.2 European settlement and agricultural conversion

European settlement began in the 1820's with Hudson's Bay Company trappers. At this time, their activities centered around beaver trapping. However, by the 1830's declining beaver numbers led some of these trappers to take up farming (Nelson and Tannock 1998). Although Hudson's Bay Company policy was to leave areas where beaver depletion was occurring, numbers continued to decline. By 1846, concerns were voiced that beaver would be eradicated from the Tualatin Basin (Cass and Miner 1993).

In the 1830's, the Hudson Bay Company raised livestock in the meadows of the Dairy-McKay watershed. Cattle were driven from Scappoose over the Tualatin Mountains to summer pasture in the watershed. A dairy was opened in the watershed, leading to the naming of Dairy Creek. The products of these operations were used to supply nearby Fort Vancouver. The Hudson's Bay Company also ran hogs in the watershed. After the company ceased operations in the area, many of these hogs were left to run wild (Cass and Miner 1993, Fulton 1995, Nelson and Tannock 1998).

Prior to 1840, there were very few American settlers in the Tualatin Valley, and these were primarily fur trappers. All of these settlers were located east of Dairy Creek (Buan 1995). Twenty-five donation land claims were listed prior to 1840. Settlement quickly accelerated between 1840 and 1855. The first large migration to the Tualatin Basin occurred in 1843 (Cass and Miner 1993, Fulton 1995).

During European settlement, the pace of change accelerated. Woodlands and prairie in the Tualatin Valley was rapidly converted to agriculture. Settlement and accompanying agricultural conversion occurred first in the natural meadows. Later settlers cleared forested portions of the valley. Agricultural conversion of the Tualatin Valley continued until 1950, when it stabilized (Shively 1993).

Most agriculture in the mid-1850s emphasized production of livestock and wheat. Settlers also planted orchards. By 1890, apples, cherries, pears, plums. onions and potatoes were commonly available.

The settlers also accelerated the pace of vegetation change through fire. In Western Oregon, it was estimated that "approximately seven times as much land was burned from 1845 to 1855 as in any of the three previous decades" (Morris 1934 as cited in BLM and USDA Forest Service 1997).

4.8.1.3 Timber operations

Beginning in the late 1800s, the watershed was extensively logged. Timber extraction started first in the Tualatin Plain. Initially, these operations were designed to clear homesteads. Then timber operations expanded to sites near settled areas. Hillsboro and Cornelius became important milling centers. Expansion continued along waterways, and sawmills were built along all major streams in the watershed (Farnell 1978). Small communities, such as Mountaindale and Snooseville, formed around these sawmills.

Early transport of logs was most efficiently performed by water. Between 1850 and 1910 numerous log drives occurred along streams within the Dairy-McKay watershed. Log driving was primarily concentrated on the Mainstem and West Fork of Dairy Creek (Farnell 1978). Although splash damming was practiced in other parts of the Tualatin Basin, it was uncommon in the Tualatin watershed. West Fork Dairy Creek had one splash dam between 1880 and 1910. No other splash dams are recorded for the watershed (Shively 1993, BLM 1979).

In the early 1900s, railroads opened up much of the mountainous portion of the watershed to logging. Temporary railroad grades were built into logging sites in the mountains, and logs were transported to mill sites in the valley. North Plains and Banks became important sites for distribution of milled timber.
For many years, timber production continued at high rates. However, during the mid-1950's production dropped sharply as the supply of available timber became depleted. At this time Hart and Newcomb (1965) remarked that the only timber left was in the steeper, more inaccessible portions of the watershed.

4.8.1.4 Wetland conversion

In order to reduce flooding, debris jams, beaver dams, and obstructions caused by tree roots were cleared from streams. This practice was common around 1910. Among the streams where the flooding condition, and by assumption, the cleanout occurred was "the Tualatin and its branches". Brush clearing also occurred in the 1930's as part of flood control projects administered by the Works Progress Administration (WPA). These activities were focused on lowland streams, including many in agricultural areas (Shively 1993). It is reasonable to believe that some of these projects may have taken place in the Dairy-McKay watershed.

In the late 19th and early 20th centuries, the wetlands in many parts of the Tualatin Valley were drained for agriculture. Drainage districts were formed to reclaim wetlands and clear out streams. In 1887, one such district is recorded as clearing Dairy Creek and its west fork as far as the Lousignont swamp, near Kansas City in the drainage of West Fork Dairy Creek. By 1914, an irrigation district had been formed to drain the swamp itself. In 1920, two channels were opened up, which reclaimed a sizeable amount of farmland. Apparently, large portions of the swamp remained until 1940 (Shively 1993, Cass and Miner 1993). Current topographic maps only show a small swampy area southeast of Kansas City. Another drainage project occurred in the Jackson Bottom area (Shively 1993).

These drainage projects resulted in an extensive loss of wetland habitat. One study estimated that 61% of Tualatin Valley wetlands had been lost due to conversion and drainage (Gabriel 1993, cited in Shively 1993).

Small wetland areas persist in the Dairy-McKay watershed, particularly in the West Fork Drainage (Map 3-2). Additionally, a large wetland area remains in Jackson Bottom, which lies partially in the watershed. This wetland supplies several benefits, including the removal of nutrients from secondarily treated sewage effluent released by the Hillsboro West Treatment plant. An assessment of functions and values provided by this wetland was conducted on behalf of the Unified Sewerage Agency (USA). The wetland was found to have high social significance due to sediment/toxicant retention and nutrient removal/transformation. Additionally, this wetland was found to perform functions related to groundwater recharge and discharge, flood flow alteration, and sediment stabilization (Van Staveren et al. 1991, as cited in Shively 1993).

Chapter 5: Synthesis

5.1 AQUATIC

5.1.1 Erosion issues

5.1.1.1 Changes in erosion processes following settlement

The current condition for erosion processes varies from the reference condition in the rate and timing of erosion. Under reference conditions there were large increases in erosion rates associated with major disturbances such as fires and large storms, after which erosion rates dropped to relatively low levels. Removal of vegetation and compaction and displacement of soil from logging and road construction have created an increase in erosion rates that has been going on for a much longer time than under natural conditions. In addition, the type of material delivered to stream channels and riparian areas from landslides has changed. Landslides were a major source of large woody debris in historical times, when there were large areas of older timber in the watershed. The large wood supplied through these processes was relatively stable in the stream system, providing structure and altering flow patterns to contribute to pool formation. With the younger timber that dominates the watershed today, there is little or no large wood input to the channels from landslides, and this is reflected in the lack of large wood and structure in the channel. The smaller wood provided by young timber is readily transported during high stream flows, and provides little lasting benefit to habitat structure.

5.1.1.2 Management impacts on erosion, Tualatin Mountains

These changes in watershed process have largely been the result of changes in management practices since Euro-American settlement. In the Tualatin Mountains, these changes were largely the result of timber operations. The greatest impacts in this region would have occurred between 1910, when railroads opened the mountains up to timber operations, and 1954, when most forests in this region were effectively depleted. During this period, timber operations proceeded with little regulation and little regard for watershed condition. Skidding practices common during this period would have resulted in extensive disturbance of the surface soil and litter layer, resulting in greatly accelerated surface erosion. Additionally, unsound logging practices on steep slopes would have resulted in increased incidence of mass wasting. No riparian buffers were utilized during this period, resulting in increased bank erosion and sediment delivery to the channel. Doubtless, this would have resulted in increased instream sedimentation, leading to reduction of pool volume and siltation of spawning gravels.

Since passage of the Oregon Forest Practices Act in 1973, forest practices have substantially improved. Subsequent changes in Forest Practice Rules have mandated practices designed to reduce disturbance of soils and riparian vegetation during forestry operations. For example, current forest practice rules require high-lead yarding on steep slopes and provide for riparian buffer zones where special timber harvest rules apply. Although these changes have resulted in diminished surface erosion, mass wasting, and sediment delivery from forest operations, effects of past practices still persist.

Despite improved forest management practices, steep and geologically unstable lands in the watershed remain susceptible to debris slides and slumping. For example, two large slumps developed in 1995 in the Williams Creek subbasin in association with heavy rainfall events. These slumps may have been associated, either with the old railroad grade near their head, or with timber operations above the railroad grade. The high incidence of such slumping indicates that management activities in steep lands should be scrutinized, and possibly avoided. Such areas may exist anywhere in the mountains, but are particularly abundant along McKay Creek and its tributaries between Jackson and Pottratz creeks, as well as Williams Creek (Map 3-1).

The greatest current management-related erosional impacts in the Tualatin Mountains are caused by roads. Most of the road mileage in the basin consists of roads surfaced with rock. These roads are subject to surface erosion of cutslopes, treads, and fillslopes. In unstable areas, roads exacerbate the risk of slope failure, as road fill increases the burden upon underlying slopes, while road cuts reduce the strength of the slope above the road. Additionally, drainage ditches create channeled flow, resulting in increased erosive power of runoff, and increased sediment delivery to streams. Stream crossings also provide a ready source of road-related sediment contributions to streams.

Based upon the above considerations, it appears that erosion control efforts in the mountainous portions of the Dairy-McKay watershed would best be concentrated in areas of steep slope and subbasins with high densities of roads and stream crossings. Subbasins of greatest concern for slope stability include McKay Creek and its tributaries between Jackson and Pottratz creeks, and Williams Creek. Road related considerations seem greatest along the West Fork of Dairy Creek, where roads and their crossings occur at high density throughout the region north of Banks, as well as the Sadd Creek subbasin. The Murtagh Creek tributary to the East Fork of Dairy Creek also appears to have high potential for road-related erosion and sediment delivery (Map 3-8).

5.1.1.3 Management impacts on erosion, Tualatin Plain

European settlement caused extensive changes to erosional processes within the Dairy-McKay Creek watershed. With settlement came a number of land use activities that exposed land surfaces to rainfall impacts, increased surface runoff, and reduced the strength of streambanks. Most of these new land use practices resulted in accelerated erosion.

An early contributor to erosion in the Tualatin Plain was the extensive conversion of forestland to agricultural purposes during the latter half of the 19th century. Such conversion exposed extensive acreage to raindrop impacts and increased surface erosion. As the conversion has largely been permanent, increased erosion remains to the present.

Between 1850 and 1950, extensive modifications were made to stream channels. Channels were straightened and cleared of brush, and access to floodplains was cut off. The increased peak stream velocity and water depth resulting from these changes have increased the erosive capability of the streams, likely resulting in increased channel entrenchment. Additionally, vegetation clearing has reduced bank resistance to erosion. Some of these changes can be considered irreversible, as the streams in many reaches are likely to remain in the channelized state with continued floodplain disconnection. Due to lack of study, it is unclear whether channel entrenchment is currently occurring.

Prior to 1996, there was little regulation of farming activities in riparian zones. Riparian vegetation was often removed to the edge of the stream, resulting in increased delivery of surface sediments to streams, decreased bank stability and increased bank erosion. Recent changes in the administrative rules administered by the Oregon Department of Agriculture mandate increased ground cover in winter along streams in agricultural lands.

Erosion due to agricultural sources has been reduced by implementation of agricultural Best Management Practices (BMPs). These practices are usually implemented as part of conservation plans administered by the Washington County Soil and Water Conservation District (SWCD). Certain BMPs, including planting of winter cover crops, mulch tillage, and filter strips, are designed to reduce erosion and sediment delivery to streams. Implementation of these practices has been accompanied by improvements in water quality, indicating that these practices are effective. However, the degree of effectiveness of individual practices is unclear, as no systematic methodology has been implemented to monitor effectiveness of the BMPs. Such a methodology, along with systematic data collection, would be valuable for improving the effectiveness of management systems. Despite the lack of this methodology, it seems apparent that further reductions in erosion and sediment delivery would be achieved by bringing a greater percentage of the agricultural community under Voluntary Farm Water Quality Management Plans.

Changes in hydrology caused by urban influences result in increased peak flows, potentially accelerating erosion at downstream sites. Additionally, urban runoff leads to increased inputs of hydrocarbons and other pollutants to streams. Such effects will generally be concentrated in lower Dairy Creek, lower McKay Creek, and Council Creek.

Effective erosion control in the valley portion of the watershed will largely concentrate on reduction of source sediments from agricultural operations, and from riparian restoration. The former objective is most efficiently achieved through voluntary efforts spearheaded by the NRCS/SWCD. These agencies have a long history of working together with farmers to reduce soil loss. Additionally, these agencies are able to offer economic incentives and cost-sharing programs to implement BMPs. Although enhanced riparian buffers would be beneficial throughout the watershed, the greatest return on effort would probably occur where the riparian buffers are most severely compromised. Such areas include Council Creek, West Fork Dairy Creek between Williams Creek and the confluence with Dairy Creek, East Fork Dairy Creek between Murtagh Creek and the confluence with Dairy Creek, McKay Creek between East Fork McKay Creek and North Plains, and Jackson Creek near its confluence with McKay Creek (Appendix 6).

Certain agriculturally related conditions that lead to accelerated erosion and sediment delivery to streams are prohibited under the Tualatin River Subbasin Agricultural Water Quality Management Area Plan (Appendix 3). Such "Prohibited Conditions" are discussed in the Water Quality Section (Section 5.1.4.6).

5.1.2 Hydrology and water quantity issues

5.1.2.1 Management effects on hydrology

Stream hydrology has been altered from reference conditions. In general, these changes have tended to increase winter peak flows, decrease summer low flows, and increase surface runoff.

Current changes in the hydrologic regime are likely to be minor in the Tualatin Mountains. At higher elevations, occasional rain on snow (ROS) events in clearcut areas may lead to augmented peak flows. Where road density is high, extension of channel networks and compaction of road surfaces may lead to accelerated surface runoff and increased peak flow. Other hydrologic changes related to current timber harvest practices are usually minor and temporary (Washington State Forest Practices Board 1997). Residual effects of past timber harvest practices on channel morphology may continue to affect hydrology.

The greatest impacts on hydrology have been experienced in valley portions of the watershed. Under reference conditions, the stream channel was hydrologically connected with extensive floodplains and wetlands. These floodplains served to moderate peak flows and flow velocity. Floodwaters were detained. Some of the stored water infiltrated to recharge groundwater supplies, while much of the rest was subsequently released to the stream to augment lower flows. Following Euro-American settlement, stream channelization cut off many portions of the stream channel from the floodplain, thus removing the ability of the floodplain to store and moderate flows. This resulted in higher peak flows, a reduction in low flows, and increased flow velocity. Additionally, channel straightening and brush removal associated with channelization also contributed to increased flow velocity. Channel straightening increased stream gradient, while brush removal removed resistance to flow. The amount of recharge to groundwater was also reduced, resulting in a lower water table, and diminished low flows. These changes are relatively permanent, as these channels are maintained with an artificially straightened configuration and with impaired hydrologic connection to their floodplains. Sites where these hydrologic functions were lost or impaired include traditional wetlands of the West Fork Dairy Creek drainage area such as Lousignont Creek and Cedar Canyon. Portions of the East Fork Dairy Creek near Mountaindale, as well as nearby Bausch and Bledsoe

Creeks, provide other examples. Additionally, limited channel straightening and clearing took place in lower reaches of Dairy and McKay creeks for navigation and flood control purposes. Hydrologic effects from these projects would extend for a considerable distance downstream of these sites.

To a certain degree, storage ponds at traditional wetland sites provide a detention function. However, this stored water does not serve to recharge groundwater storage or augment instream flow, but instead is diverted for agricultural uses. A portion of this water could be expected to return to the aquatic system as return flow. However, such return flow is often degraded, with increased temperature, decreased dissolved oxygen, and often enriched with nutrients and chemicals.

Extensive areas of the urbanized lower portions of the watershed have been covered by impervious surfaces. These surfaces have changed the local hydrology by increasing surface runoff to streams and decreasing groundwater recharge.

Prospects for restoration of the hydrologic functions attributable to floodplains and wetlands appear to be limited. Economic activity in the watershed has adapted to the current channel configuration and disconnection from wetlands. Efforts to restore floodplains and wetlands to their original extent are likely to be expensive. Instead, the most effective policy given current constraints is to protect existing floodplain and wetland resources, prioritize high-potential areas for wetland restoration and/or enhancement, and prevent encroachment of new activities that are incompatible with floodplain and wetland function.

Other major changes to stream hydrology have been effected by instream diversions. The vast majority of these diversions have been for agricultural purposes. Such diversions generally take place in the summer low-flow season, further diminishing these flows below natural conditions. Such effects are felt throughout agricultural portions of the watershed, although demand is greatest in East Fork Dairy Creek below Meacham Corner, and in West Fork Dairy Creek below Manning.

5.1.2.2 Water rights allocations

Water rights appear to be overallocated many parts of the year. Due to lack of gaging, it is difficult to say where the greatest potential deficits occur. As most of the valley streams provide little water contribution in summer, it is reasonable to believe that the greatest cumulative effects of overallocation would occur on lower Dairy Creek. The effects of this overallocation is difficult to predict. Due to climatic factors and use of supplemental water sources, actual demand on surface water from Dairy Creek and its tributaries will vary from year to year.

During formulation of its action plan, the Tualatin River Watershed Council considered the purchase of additional water rights to supplement current instream water rights. The present watershed analysis report did not identify specific reaches where aquatic life would benefit from these water rights. Further field study is necessary to establish a need for enhanced instream water rights and to determine the best location to acquire these rights. Recommendations related to acquisition of these rights are given in Chapter 6.

5.1.3 Stream channel issues

5.1.3.1 Management effects upon stream morphology

Current stream channel conditions have changed from reference conditions. In some stream reaches in the Tualatin Mountains, increased sedimentation and reduced riparian vegetation from past forest practices probably made channels wider and shallower. Along most of the valley reaches, streams have been channelized and confined rather than allowing natural meandering.

The most extensive change in channel process throughout the watershed has been the loss of large woody debris elements from the stream system. Under reference conditions, mature forests along the streams supplied large woody debris to the channel, creating hydraulic characteristics suitable for pool formation and increased hydraulic diversity. Following settlement, timber harvest removed large wood from the riparian zone. Additionally, forest practices prior to the 1980's emphasized clearing of wood from channels. These policies and practices have combined to generate a system severely deficient in large wood and lacking the roughness elements necessary to generate adequate numbers of pools. These circumstances have been major contributing factors to the lack of channel structure that currently characterizes the Dairy-McKay watershed.

Changes in forest practices have improved long-term prospects for restoration of large woody debris recruitment potential in the mountainous portions of the watershed. Forests in Riparian Reserves and (possibly) other riparian buffer zones will gradually attain size characteristics suitable to produce large woody debris. Over the short term, however, prospects for recruitment potential are bleak. Most forest stands do not currently have large trees suitable for production of large woody debris. Additionally, deciduous stands have replaced conifers in many riparian areas. This has diminished the potential effectiveness of large wood contributed to streams. Conifers provide durable wood that is likely to provide beneficial effects over long periods of time. Although deciduous stands will eventually contribute large wood to the stream, the wood decays rapidly, and its effect on instream structure will typically last less than five years.

Future prospects for large woody debris recruitment in the Tualatin Plain are not favorable. Although riparian conifers exist on the lower reaches of McKay and Dairy creeks, most streams in the valley have a canopy of young hardwoods. As there is little available nearby seed stock for natural recruitment of conifers, it is unlikely that the characteristics of these riparian zones will change. Thus, it is unlikely that any substantial natural recruitment of large woody debris will occur in the forseeable future. It may be necessary to supplement long-term development of natural recruitment with interim measures such as artificial placement of large wood. Planting of conifers in riparian areas will also contribute to long-term prospects for contributions of large woody debris.

Channel morphology in the valley plain has been heavily impacted by channelization efforts. Primary effects of channelization have been stream straightening, local increase in gradient, and removal of roughness elements from the channel. These, in turn, lead to secondary effects, such as channel incision and disconnection from floodplain. Current land uses and economic considerations limit prospects for restoration of reference stream functionality in channelized reaches. The most effective channel restoration strategies in the valley plain will focus on preservation of existing channel characteristics at relatively high quality sites.

5.1.4 Water quality issues

5.1.4.1 Management effects on water quality

Management activities have had substantial impacts on water quality. Under reference conditions, riparian forests provided shade to streams. Shading regulated water temperatures, resulting in cooler summer water temperatures and increased stream capacity for dissolved oxygen. Additionally, riparian forests provided stability to streambanks, minimizing erosion and accompanying contributions of fine sediments. Subsequent to settlement, many of these riparian forests were removed. As practices prior to 1980 made no allowance for riparian buffer strips, this removal increased stream exposure to sunlight, leading to higher temperatures and reductions in dissolved oxygen levels. Additionally, forest removal led to increased streambank erosion and reduced filtration of sediments from upland runoff. This resulted in increased turbidity and suspended solids.

Agriculture contributed to many of the changes in water quality in the Tualatin Plain. Conversion of lands from forest to agriculture resulted in increased exposure of soils to energy from precipitation. Cultivated soils were more susceptible to erosion, leading to greater sediment loads in surface runoff. Together with compromised riparian buffers, these factors contributed to higher delivery of sediments, adsorbed nutrients, organic matter, bacteria and pesticides to streams. Fertilization also led to contributions of nutrients to streams, while livestock access to streams increased inputs of bacteria and ammonia nitrogen. Surface and subsurface drains increased peak runoff. Continual improvements in management practices have reduced the impacts of these activities upon water quality.

Other land-use conversion activities affected water quality. Filling of wetlands reduced their ability to filter out pollutants, sediments and nutrients prior to stream entry. This resulted in increased inputs to the active channel. Stream channelization destabilized banks and increased stream velocity, resulting in increased erosion rates and concentrations of suspended sediments.

With increased settlement came an increased need for waste disposal. Many of these waste disposal systems did not possess adequate safeguards against contributions of pollutants to surface water. Septic tanks associated with rural residential development have contributed bacteria and ammonia nitrogen to stream systems.

Urbanization has also contributed to water quality problems. Surface runoff from impervious surfaces often carries large inputs of organic pollutants to aquatic systems. Most of these effects have been centered in the lower portions of Dairy and McKay creeks. However, the prevalence of roads has enabled the distribution of automobile-related pollutants throughout the basin.

Roads are notable contributors of sediment to surface water supplies. Drainage ditches associated with roads produce channeled flow, leading to increased erosion. Where these ditches lead to streams, or where roads are built in riparian zones or cross streams, an effective mechanism is created for accelerated sediment delivery and pollutant loading. This leads to higher levels of instream sediments, total suspended solids, and adsorbed particulates. Generally, water quality within the watershed has been improving in recent years. This improvement seems to be correlated with changes in timber, agricultural, and wastewater management practices. This suggests that expanded implementation of Best Management Practices in forestry and agriculture would lead to a continued improvement in water quality.

5.1.4.2 Factors leading to high aquatic phosphorus levels.

The case of phosphorus is more complex than for other water quality parameters. Most phosphorus occurring in streams in the Dairy-McKay watershed comes from natural sources. Groundwater flowing through regions underlain by sedimentary rock or valley alluvium is naturally high in phosphorus (Wolf 1992, TAC 1997). The Tualatin Basin Technical Advisory Committee Nonpoint Source Subcommittee found that background (natural) stream phosphorus levels in the Tualatin Plain typically ranged from approximately 0.10 to 0.15 mg/L. As these are the levels achieved in the lower portions of the Dairy Creek system (summer median = 0.11 mg/L), it appears that improvements in management practices are unlikely to effect major decreases in dissolved phosphorus levels throughout the watershed during summer low flows.

However, some ODA data indicates that summer phosphorus levels have decreased after implementation of agricultural BMP's in the Christensen Creek watershed. These BMP's involved point source reduction from a container nursery and a confined animal feeding operation. It is likely that point source loads of phosphorus also exist in the Dairy-McKay watershed, for example on Waibel Creek, where phosphorus levels are considerably above baseline levels.

A considerable amount of uncertainty surrounds the magnitude of phosphorus loads attributable to various causes. As previously explained, the amount of winter phosphorus load that affects summer phosphorus concentrations is unknown. Manure from animals grazing in wetlands and riparian areas also provides an unknown phosphorus load to aquatic systems. The effect of the infrequent summer runoff events is also unknown. Additionally, it is unknown to what extent inadequate septic systems add a phosphorus load to streams. This load would logically play a role in both summer and winter. Finally, there is a potential for future saturation of phosphorus sorption capacity on soils receiving large amounts of phosphorus fertilizer and/or manure. This could lead to leaching of phosphorus to tile drains, which flow to streams well into summer months.

Thus, although substantial reductions in phosphorus concentrations appear unlikely, it is still important for farmers and rural landowners to implement BMP's for phosphorus.

5.1.4.3 Temperature

Stream temperatures are above desirable levels throughout the valley portion of the watershed. Most of the streams with high water temperatures are included in current 303(d) listings. Past measures do no appear to be adequately addressing temperature issues, as temperature trends appear to be stable or rising. This suggests that thermal moderation should be a high priority for water quality improvement projects. Canopy restoration and streambank protection (to prevent widening) are potential strategies to promote temperature moderation. Potential reaches for such restoration include the upper portions of the alluvial plain, where potential summer rearing by cold water salmonids would be most likely, and the West Fork of Dairy Creek, where the least amount of riparian cover is found.

5.1.4.4 Streams on the Oregon 303(d) water quality limited list

Management-related factors have largely been responsible for problems leading to stream placement on the 303-d water quality limited list. Although more intensive study would be necessary to determine causality, it appears that the following factors are probable causes for diminishment of water quality.

- Council Creek. Low dissolved oxygen levels are probably due to high nutrient levels and stagnant water. Stagnant, eutrophic ponds lie along much of the course. Other possible causes are high water temperatures, agricultural runoff (USA 1994), and near-stream storage of refuse (USA 1994). Potential corrective strategies include improved waste management, canopy restoration, minimization of runoff to streams, and removal of algae prior to decomposition.

- Dairy Creek. High *E. coli* levels are probably due to livestock operations and/or faulty septic systems. Potential corrective strategies include improved management of animal waste, restriction of livestock access to streams, and improvement of septic systems.
- East Fork Dairy Creek. Low summer pH levels are probably due to decomposition of organic material. Although the sources of this material have not been quantified, they include waste inputs from agricultural sources, septic systems, and decomposition of algae. Lower winter pH values were judged to be associated with natural rainfall, resulting in a non-listing. High water temperature is probably due to diminished canopy levels in alluvial portions of the watershed. Potential corrective strategies include canopy restoration, restriction of livestock access to streams, improvement of septic systems, and minimization of nutrient inputs to streams.
- West Fork Dairy Creek. High bacteria levels are probably due to livestock, with a possible role of septic tanks. High temperature is probably caused by poor canopy cover, related stream widening, and stagnant flow. Low dissolved oxygen levels are probably caused by a combination of high temperature and high oxygen demand created by inputs of waste and fertilizers. Potential corrective strategies include restoration of stream canopy, minimization of riparian zone sedimentation, minimization of inputs of eroded material and fertilizers from upland sources, restriction of livestock access to streams, and improvement of septic systems.
- McKay Creek (downstream of the East Fork of McKay Creek). High year-round bacteria levels are likely caused by livestock operations with possible septic tank influences. However, recent SWCD surveys found few obvious sources of waste to the creek. Temperature problems are probably due to canopy loss. Potential corrective actions include distancing livestock from streams, improvement of septic systems, and restoring riparian vegetation.

5.1.4.5 Effects of water quality on recreation

Current water quality limits the ability of streams in the watershed to support recreation. For example, instream contact recreation is reduced on Dairy Creek and its West Fork, as well as McKay Creek due to high *E. coli* counts. Further, eutrophic conditions on portions of these streams probably diminishes the desirability of contact recreation.

Diminished water quality also has indirect impacts on recreation. Poor water quality is one of the factors contributing to diminished salmonid populations, which in turn leads to diminished cold-water fishing opportunities. Conversely, increased water temperatures may have improved prospects for warm-water fishing opportunities.

Strategies to restore recreation opportunities are similar to those given to obtain other desirable water quality objectives. Implemention of water quality strategies to reduce nutrient loads, sediments, and bacterial inputs will create conditions more desirable for stream-related recreational activities.

5.1.4.6 Prohibited conditions

Agricultural portions of McKay Creek, Dairy Creek, and selected tributaries were surveyed by SWCD personnel to determine the prevalence and location of conditions prohibited under the Tualatin River Subbasin Agricultural Water Quality Management Area Plan (Appendix 3). During this initial survey, problems related to waste management (i.e. placement of wastes or animals where waste has the potential to enter streams), nearstream soil erosion, and riparian condition (i.e., farming operations inside of the 25 foot buffer, as well as active bank erosion) were surveyed. These conditions were not found to be widespread in surveyed portions of McKay Creek and Jackson Creek. Those problems that do exist were generally clustered along a portion of McKay Creek north of its confluence with Jackson Creek, and lower portions of Jackson Creek. Similar studies are now being conducted on East Fork Dairy Creek and West Fork Dairy Creek. Preliminary indications are that a greater incidence of prohibited conditions will be found along this reach than was found along McKay Creek. However, voluntary farm conservation plans are being developed for many of these locations to address issues related to prohibited conditions.

5.1.4.7 Superfund sites

Hazardous wastes in the watershed do not appear to be a major threat to water quality. All former CERCLA sites in the North Plains area were removed from the Superfund list by the Environmental Protection Agency based on a determination that all necessary remedial actions have been taken at these sites.

5.1.5 Aquatic species and habitat issues

5.1.5.1 Fisheries

Winter steelhead trout and cutthroat trout make up the major focus for habitat and water quality issues in the Dairy-McKay watershed. In addition to their intrinsic value, these species are sensitive to changes in water quality, thus functioning as indicator species of the condition of the stream ecosystem. Cutthroat trout are well distributed throughout the watershed and do not appear to be overly threatened. However, pre-emptive action should be taken to maintain good habitat for cutthroat trout. Declining steelhead trout trends in the upper Willamette ESU, of which Dairy Creek is a part, indicate that steelhead trout within the Dairy-McKay Creek watershed are at risk. *Additionally*, the reduced amount and quality of available habitat suggest a steelhead trout population reduced from original numbers. Trends in coho salmon populations since the end of planting efforts are unknown. For all of these salmonid species, habitat quality and quantity are likely to be limiting factors. The best spawning and rearing habitat for these species is found in the Tualatin Mountains and adjacent portions of the Tualatin Plain and is quite limited in extent, particularly for the anadromous species. Due to management practices of the past, the quality of much of this habitat is diminished from reference conditions. Increased sedimentation and decreased large woody debris inputs have created channels with reduced habitat diversity, including reduced pool frequency and diminished instream cover.

Riparian zone conditions also influence prospects for salmonid habitat in the Tualatin Mountains. Although riparian forests in this region have largely recovered their shading function, they are unlikely to provide appreciable amounts of large woody debris during the near future. This indicates that habitat conditions similar to those existing during the reference period will not be produced naturally during the next 50 years. If riparian forests are allowed to develop mature timber stands, they will eventually regain their ability to provide large woody debris to the stream system.

Mainstem sites in the Tualatin Plain are mainly used for migratory corridors with some limited winter rearing (ODFW 1997 data as displayed in TRWC 1998). Substrates in these streams naturally lack spawning gravels. The greater prevalence of large woody debris in the valley during the reference period indicates that there may have been greater numbers of pools and better stream shading than is currently the case. Under such circumstances, more extensive rearing may have taken place in these streams than is currently observed. However, flow in this region would have been naturally slow, making these streams subject to heating and low dissolved oxygen levels, even under reference conditions.

Lamprey species are susceptible to many of the same habitat concerns as salmonids. Increases in water temperature have provided conditions detrimental to lamprey populations. Additionally, Pacific lamprey in their larval stages make extensive use of fine substrate portions of the watershed. Thus, high water temperatures in stream reaches in the Tualatin Plain are likely to have substantial detrimental impacts to lamprey populations.

Migration by anadromous fish has probably been impeded relative to reference conditions. The greatest obstacles may be caused by roads and culverts. Results of the Washington County culvert survey indicated that a high percentage of these structures did not provide adequate passage to salmonids. The degree of impedance due to these culverts is unknown. Additionally, migration may be inhibited by low water due to diversions. As upstream migration occurs prior to the irrigation system, and enhanced instream water rights are in effect during migratory periods, migratory delay due to diversion may be minor. However, unscreened diversions provide a hazard to fish migrating and rearing in the valley channels

Current aquatic conditions in alluvial portions of the watershed tend to favor non-native aquatic species that prefer warm water, and mesotrophic to eutrophic conditions. These conditions may also result in decreased biotic diversity.

5.1.5.2 Wetlands: Management Impacts.

As under reference conditions, most marshes and wetlands are located in the West Fork Dairy Creek drainage. However, drainage projects in the late 1800s and the early 1900s have severely diminished the extent of wetlands from pre-settlement levels. In the same wetlands expressed by the 1870 maps as 2,320 acres, about 60 acres show up on current topographic maps (50 acres on West Fork Dairy Creek, and 10 acres East Fork). As with the historical wetlands, this number is low, as not all wetlands are mapped. Another estimate can be obtained by analysis of the National Wetlands Inventory, which shows about 845 acres of wetland in these same areas. Although differences in methodology preclude the drawing of quantitative conclusions from these numbers, it is qualitatively apparent that the watershed has undergone drastic reductions in wetlands area. Some of these wetlands have been replaced by storage reservoirs with little riparian buffer and few of the habitat values of the original wetlands.

Other activities also reduced the amount of wetland habitat in the watershed. Trapping of beavers severely curtailed the number of small wetlands. These wetlands would likely have been too small to be recorded on survey maps, but would have provided habitat for waterfowl, and aquatic and amphibian species. A few beaver ponds still remain in the watershed, including a significant wetland up Pottratz Creek. Additionally, other isolated ponds exist in mountainous portions of the watershed. These may or may not be related to beaver activity. The habitat functionality of many of the remaining wetlands has been degraded. This degradation is evidenced by the encroachment of non-native noxious species upon the wetland habitats. Reed canarygrass (*Phalaris arundinacea*) is nearly ubiquitous in wetlands. Purple loosestrife (*Lythrum salicaria*), an ODA schedule B noxious weed, is also a common invader of wetland habitats. Programs to restore native plant species would help to improve the ability of wetlands to provide habitat for native animal species.

Livestock grazing in wetlands can destroy native vegetation and add bacterial and phosphorus loads. Most wetlands in the Dairy-McKay watershed contribute water to a stream, providing a conduit of pollutants to surface water.

5.1.5.3 Riparian habitat: Management impacts

Non-wetland riparian habitat is also diminished in extent and quality from reference conditions. During reference conditions, most valley streams had wide riparian forests. Following settlement, timber and agricultural activities often removed these forests up to the stream channel, leaving no buffer. Riparian habitat would have been completely lost during such periods. Current Oregon forest practice rules provide for a riparian buffer strip along streams. Although such a buffer is of value, it has resulted in a tenuous, thin strip of riparian habitat surrounded by habitat adverse to many riparian species. Thus, the current scenario represents a massive loss of riparian habitat relative to reference conditions.

There are no current regulations requiring trees along streams in the agricultural zone, except insofar as logging in the agricultural zone is also under the auspices of the Oregon Forest Practices Act. Clearing of riparian vegetation for farming, however, is not regulated unless logs are sold commercially.

5.1.5.4 Impacts of wetland and riparian changes upon species

Loss of habitat has undoubtedly reduced the abundance of wetland and riparian dependent species in the Dairy-McKay watershed. However, few to no population surveys have been performed to verify this conclusion.

Although population status of many amphibian and aquatic species is unknown, it is assumed that they have declined with declining habitat. It is hoped that stabilization of habitat amounts will result in a stabilization of populations.

Red legged frogs (*Rana aurora*) appear to be relatively abundant in the watershed. Numerous sightings have been recorded in the East Fork Dairy Creek drainage. During field surveys performed in conjunction with this report, many red-legged frogs were observed along McKay Creek above Kay Road.

5.2 TERRESTRIAL

5.2.1 Vegetation issues

5.2.1.1 Post-settlement effects on landscape characteristics.

Due to settlement, the pattern of vegetation has changed extensively from reference conditions. The reference landscape consisted of massive expanses of late-successional forest interspersed with occasional patches of early- and mid-successional vegetation where stand-replacement fires had occurred. In the valleys, there were also patchy prairies where frequent flooding occurred. Following settlement, the scenario changed to the current highly fragmented landscape. The valley portion of the watershed is mostly transformed to agriculture. Urbanization has been instrumental in introducing creating fragmented landscapes in the lower reaches of Dairy and McKay creeks, as well as portions of Council Creek. On valley fringes and foothills, the vegetation pattern is highly fragmented between rural residential uses, agricultural uses, and remaining forest. Although fragmentation persists into the mountains, mean patch size increases, and most vegetation is Douglas-fir ranging between 20 and 80 years of age.

5.2.1.2 Potential vegetation management strategies

Given current ownership and landscape patterns, it is infeasible to manage the watershed for large blocks of late-successional forest. Prospects are better for species dependent on small patches of late-successional forest, or on specific late-successional habitat elements. Suitable habitat for these species can be maintained in the LSRs and Riparian Reserves of federal lands. On private lands, potential to provide habitat for these species will depend upon the management emphases of the land owners. Partnership opportunities with these land owners may be available on a case by case basis.

Given current management emphases, both federal and private lands are anticipated to maintain ample habitat for species dependent on early- and middle-successional habitats, as well as edge habitats.

Both federal and private lands are likely to provide some habitat for riparian-dependent species. Forest practice rules for all types of ownerships emphasize retention of a riparian buffer strip. Assuming current management practices, the width of this buffer on private land is likely to remain narrow, and only minimal habitat will be afforded. Some of these stands will develop mature structural characteristics, providing habitat for riparian species that prefer late-successional habitats or habitat features associated with late-successional habitats.

5.2.1.3 Noxious and exotic plants

Ecosystems appear to be losing native species richness due to the invasion of exotic and noxious plants. Much of this threat to native species is on privately owned lands. In some cases, non-native, exotic weeds on these lands can adversely impact federal lands. Adjacent private lands are often so contaminated with exotic/noxious weeds (especially Himalayan blackberry and Scotch broom) that BLM-administered lands can also become easily infested unless preventative measures are enlisted to curtail it from happening. Also, the spread of exotic/noxious weeds along BLM-administered roadways need to be curtailed now so that future management actions will not have a good share of these species to contend with. Examples of such nuisance species include Canada thistle, bull thistle, reed canarygrass, and tansy ragwort. Interior forests in the watersheds do not have weed problems (Chevron et al. 1998).

5.2.1.3.1 Potential strategies for control of noxious and exotic plants

The checkerboard ownership pattern and differing management goals within the watershed make it difficult to have a coordinated program to promote and preserve native plant populations, and limit the spread of exotic plants and noxious weeds. The diversity of native plants on adjacent private timberlands, especially the industrial lands, is very often negatively impacted by the application of herbicides to control competing vegetation. Himalayan blackberry and Scotch broom are two aggressive exotic plant species that are favored by soil disturbing activities, which include road building and timber harvesting. On industrial private lands, however, these plants are often controlled with herbicide applications as a part of their regular vegetation management programs. Herbicide application often results in net loss of native plant diversity, and may have additional detrimental impacts near aquatic systems. Additionally, exotic plants tend to be more aggressive than natives and reinvade treated areas sooner than many native plants, therefore often requiring multiple herbicide treatments to be effective. Native shrub species that are commonly greatly reduced by the invasion of exotic plants include elderberry, cascara, thimbleberry and salmonberry. Loss of these species has the potential to impact the distribution or abundance of wildlife species such as band-tailed pigeon, Swainson's and varied thrushes and black-tailed deer.

Success of eradication efforts will vary. Some species, such as Himalayan blackberry, are ubiquitous within the watershed, and we can only hope for localized success in eradicating such species.

Preemptive action can be taken to detect potential problem plants and prevent their introduction to the watershed. The giant reed (*Arundo donax*), for example, has created substantial problems in California and is sold as an ornamental here.

Concerns have been voiced that *Arundo* might become a nuisance weed in the Tualatin Valley.

5.2.1.4 [BLM only] Potential management strategies within the Riparian Reserves

Watershed-wide, the amount of habitat available to riparian-dependent species is severely limited. For that reason, any portion of the Riparian Reserves affording habitat for riparian-dependent species should be retained in a condition where they fulfill that function. These areas, and those with potential to provide habitat, should be managed to promote the development of desirable habitat features. Similarly, late-successional habitat is severely deficient in the watershed. Thus any riparian areas that afford such habitat, or are capable of developing such characteristics, should be retained. In some cases, thinning and projects to create snags and down wood may help in development of these important habitat characteristics.

Portions of the Riparian Reserves within the watershed are allocated around areas of steep, unstable terrain. Due to the risk of landsliding and sediment contributions to streams, harvest activities may not be advisable in such areas.

5.2.2 Species and habitat issues

5.2.2.1 Factors affecting the distribution of sensitive species.

Timber operations and their associated roads have had a significant effect upon the character of the stands within the watersheds. Consequently, the landscape of these watersheds is largely made up of fragmented second-growth conifers that are frequently deficient in habitat requirements for sensitive plant species (preliminary plant inventory results from 1978 BLM vascular plant surveys).

BLM-administered lands are found in a checkerboard pattern in the watersheds. Forest fragmentation and loss of native plant diversity is far greater on private lands due mainly to consistent logging and associated road building and the draining of wetlands. Noxious/ exotic weed invasions on these disturbed lands have also increased immensely, thus compounding the loss of natural habitats. Since habitat loss for species of concern is an important factor in this watershed, it is of increased importance that remaining habitats on federal lands be maintained.

Many sensitive species are dependent upon late-successional habitat or specific features associated with late-successional habitat. Such habitat will continue to be limited in the watershed. Most appropriate habitat will eventually be developed in the Big Canyon LSR, and in strips along streams in federal Riparian Reserves. Depending upon management policies, suitable habitats may be developed in riparian areas on private lands. Thus, species dependent on late-successional habitat are likely to be restricted to these lands. The characteristics of these areas will tend to favor species with small home ranges. Habitat for species dependent on mid- and early-successional conditions is expected to remain abundant.

Current levels of snags and down wood are greatly diminished from reference conditions. Due to the lack of mature and old growth forest, few snags and little down wood now exists, and future recruitment potential is limited for a number of years to come. Most such potential is in assorted patches of mature timber on BLM and private lands. In the case of private lands, most stands capable of providing snags and down wood are located on headwater portions of the watershed. Such potential is not expected to increase on private lands, as forest harvest continues. However, Riparian Reserves and other protected riparian buffers are expected to lead to increased levels of down wood in riparian zones. Additionally, leave-tree requirements on federal matrix lands are likely to result in continued supplies of snags and down wood. Active management efforts to increase levels of snags and down wood would benefit many species, including primary cavity nesters such as woodpeckers and secondary cavity nesters such as bats, flying squirrels and saw whet owls.

Due to loss of habitat, the populations of many species of concern have diminished. The spotted owl, for example, is assumed to be eradicated from the watershed due to lack of habitat. The bald eagle and the pileated woodpecker have been diminished. The red tree vole is either extirpated or diminished.

The marbled murrelet is not known to have utilized the watershed. However, there is potential murrelet habitat here. Much less of such habitat exists than under reference conditions.

Appendix J2 of the Northwest Forest Plan and Management Recommendations for Fungi, Version 2.0, September 1997; and present protocols for category 1 and 2 lichens and bryophytes tell what the ecosystem requirements are for species listed in these documents. The influences and relationships of these species and their habitats with other natural or anthropogenic processes are often fragile. The Salem District Record of Decision (ROD) and the Salem District Resource Management Plan (RMP) require certain protection and management procedures be followed for an array of 4 categories of Survey and Manage species. BLM manual 6840 gives details on the protection and management of Bureau Sensitive, Assessment, and Tracking species. Those species potentially found in the Dairy-McKay watershed are listed in Table 1-3 and Sections 3.1.5.1, 3.1.5.2, and 3.2.2.1.2.

The population of game species appears to be stable, with possible minor increases in elk and waterfowl. The major concern at present for some of these species is not depletion, but rather potential conflicts with human land uses. Large elk populations, for example, can create damage to farm and rural residential properties. Although ODFW has found it necessary to implement elk abatement programs near Scappoose, the elk populations in the Dairy-McKay watershed to not appear to be creating a substantial conflict with human interests (Thornton, ODFW, personal communication).

The ownership pattern restricts creation of a uniform habitat management strategy for sensitive species. Habitat management partnerships could potentially be formed with the entities identified in the recommendations related to noxious weeds (Chapter 6).

5.2.3 Forest resources issues [BLM-specific]

5.2.3.1 Management of snags and down wood

Based on stand age, BLM lands in the Dairy-McKay Creek watershed likely have low levels of snags and down wood. In many instances, it will be appropriate to increase the amount of down wood by placement of fresh down Douglas-fir trees. When leaving these trees, the potential impacts to the residual stand from the Douglas-fir beetle should be considered. In westside forests, when there are more than three windthrown Douglas-fir trees per acre greater than 12 inches DBH, infestation and mortality of standing live Douglas-fir trees can be expected (Hostetler and Ross, unpub.). For every two down Douglas-fir trees per acre greater than 12 inches DBH, beetles will likely attack one standing live Douglas-fir tree. Not all beetle attacks will result in tree killing, however. As a general guideline, the number of standing Douglas-fir trees killed in the years following wood placement will be about 60% of the number of fresh down Douglas-fir trees added to the forest floor. However, there is some new information indicating that the number of trees killed may be as low as 25%. Tree vigor is an important factor determining whether a given tree can withstand beetle attack. Trees infected with root disease are especially at risk from beetle-related mortality. It is also important to note that the threat to the surrounding trees is much less when the down trees are exposed to direct sunlight as opposed to being shaded. Beetle attacks and subsequent brood production from exposed down trees are substantially lower than when they are shaded. Wood placed between July and September is also less likely to lead to beetle infestations.

There are sites, particularly in LSRs and Riparian Reserves, where moderate levels of tree mortality due to Douglas-fir beetle activity can be beneficial. Such mortality increases diversity of stand type and structure. These potential benefits should be taken into account on a site-specific basis when placing down wood.

5.2.3.2 Laminated root rot

Damage caused by *Phellinus weirii* root rot will likely be higher in most managed stands than in natural stands. Most of the harvested lands in the watershed have been reforested with Douglas-fir, which is readily infected and killed by this root disease. Once young Douglas-fir trees reach about 15 years of age, disease centers become apparent and root-to-root spread occurs from the original infection site. On-the-ground surveys in commercial-sized stands in this area are consistent with the findings of Thies and Sturrock (1995), which have shown that Douglas-fir volume production in *P. weirii* root rot centers is less than half of that in healthy stand portions. Disease centers are believed to expand radially at the rate of about one foot per year (Nelson and Hartman 1975) and losses in diseased stands may double every 15 years (Nelson et al. 1981). It is generally not recommended to commercially thin in stands of highly susceptible species, such as Douglas-fir, when disease is present in 20 percent or more of the stand (Thies and Sturrock 1995). High levels of *P. weirii* infection (more than 25 percent of the area in disease centers) are of special concern when considering commercial thinning, especially if the disease centers are not well defined. Specific locations have been identified on photographs, but treatments will be performed on a site-by-site basis.

5.2.3.3 Management of hardwood stands

A sizeable but indeterminate portion of the watershed is in the mixed conifer/hardwood or pure hardwood stand condition. Red alder is by far the most abundant hardwood. Many of these sites once supported western redcedar and other conifers, but because of site disturbance during past timber harvesting activities and inadequate conifer reforestation, alder has become a dominant stand component. Some of these sites are capable of supporting conifers at this time. Others are best left in alder for a while to help relieve soil compaction and increase the site nitrogen level. Some sites, such as wet areas, are probably best left in alder and not intensively managed to restore full conifer stocking. Alder domination of conifer-producing sites represents a potential loss of timber volume production. Over time, the difference in volume production between Douglas-fir and hardwood stands is expected to become increasingly larger.

The proportion of the watershed dominated by red alder has increased in comparison to the reference conditions as a result of ground disturbance from timber harvesting and associated road building activities. Historically, most alder was probably restricted to areas along streams on lower slope positions. Alder currently dominates many upland areas where soils have been disturbed, and is very prevalent along roads. Alder aggressively competes with young conifers for growing space.

5.2.3.4 Achievement of late-successional goals in Big Canyon

Late successional goals in Big Canyon will be determined as part of a Late Successional Reserve Assessment (LSRA). In order to facilitate the management of this LSR, completion of this assessment should be achieved.

5.2.3.5 Management on Connectivity lands

According to the Salem ROD, Connectivity lands are to be managed on a 150-year rotation. Stands on Connectivity blocks in the Dairy-McKay watershed currently range from 60 to 80 years in age. Harvest of some of these stands is necessary for forest regulation and to derive desirable uneven-aged characteristics. Some opportunities might exist for thinning within the Connectivity allocation, provided that such thinning has demonstrable benefits to stand health and/or structural characteristics.

5.3 SOCIAL

5.3.1 Issues related to human uses

5.3.1.1 Agriculture

The amount of farmland is expected to decrease slowly within the watershed. In its comprehensive plan, Washington County recognized the importance of agriculture to the quality of life in the region and designated Exclusive Agricultural Use Zones. These zones protect most of the lands presently in agriculture. Most losses to agricultural land are expected to occur on lands within the Urban Growth boundary, or on the urban fringe.

Agricultural operations impact watershed resources, often creating conflicts with other beneficial uses within the watershed. Most particularly, they are the greatest single use of surface water resources. Operations also can contribute to water quality problems, creating potential conflicts with fishery and recreational resources. With improved practices, negative impacts and conflicts are being reduced. Many of these improvements have been achieved with the assistance of the Farm Service Agency (FSA), the Natural Resources Conservation Service (NRCS), and the Washington County Soil and Water Conservation District (SWCD). Through implementation of farm conservation plans and other programs, farmers in conjunction with these agencies have been able to reduce soil loss, water consumption, and inputs of sediments, nutrients, and other pollutants to streams. Since many farms in the watershed operate without fully utilizing these services, further opportunities for improvement exist within the watershed. However, these agencies and programs lack the funding to fully meet the demand in a timely fashion.

Although total agricultural production is a substantial portion of the watershed economy, the results of the 1992 agricultural census indicate that many farms operate on a slim profit margin. This should be taken into account when implementing new programs to address conflicts with other beneficial uses in the watershed.

5.3.1.2 Timber

Timber operations within the watershed are expected to remain constant or produce more wood in the near term[1]. Many of the forest resources that were depleted in the first half of the century (both through timber harvest and through fire) have regrown to harvestable age, indicating that abundant opportunity exists for increased logging within the watershed. This opportunity has been reflected in the increased timber harvest that has occurred in the watershed since 1990. The large private ownership within the watershed, coupled with diminished output from public lands, indicates that the watershed may be an important supplier of timber in the present and near future.

With increased harvest comes a renewed potential for conflicts with other beneficial uses of the watershed. In the past, timber harvest contributed to significant problems related to erosion and sedimentation, leading to channel changes and diminished fishery resources. Reductions of wildlife populations dependent on late-successional and riparian habitats have also occurred due to the history of disturbance within the watershed. With the improved forest practice rules currently in effect, riparian and stream problems related to timber harvest are expected to be lower than past levels. However, habitat problems for late-successional species are expected to persist.

In order to minimize conflicts with other beneficial uses, future timber operations should consider maintenance of lands in multiple stages of development. As lands within the watershed are seriously deficient in late-successional habitat, enhanced protection of late-successional habitat should be encouraged.

As with private lands, most BLM stands are currently entering harvestable stages. Thus, opportunities for enhanced timber production lie upon such lands. However, because of the differing objectives and practices of federal and private lands, the greatest opportunities for maintenance of sensitive habitats lie upon federal lands.

5.3.1.3 Urban uses

Increasing population is probably the greatest change creating a demand on watershed resources. As population grows, demands for housing space, recreation, and workspace increase, as well as demands on water and contributions of wastewater. Population trends in Washington County indicate that these demands and pressures will consider to persist into the next century. Given current urban growth boundaries, the bulk of these demands will be concentrated along the urban corridor in the southern portion of the watershed. Most construction in response to this demand will consist of infilling within present urban growth boundaries. Within these regions, impervious surfaces will increase. Potential hazards from urban runoff will also increase. As population grows, additional conflicts can be expected between urban and agricultural interests, and pressure to expand the urban growth boundary will be increased.

Rural residential populations can also be expected to increase. Many of these increases will be in alluvial plains near streams, increasing potential hazards to stream resources. Additional concerns as development interests buy rural lands are that these interests will provide pressure to governmental agencies to allow subdivision of these lands.

5.3.1.4 Rural interface

Rural interface problems are hard to gauge. Many BLM parcels are not easily accessible to the public and thus do not pose a problem. However, parcels that are readily accessible by road have experienced dumping problems in the past. Nearness to urban areas many exacerbate this problem. If the magnitude of the problem is serious enough, further action may be necessary to restrict access to BLM lands.

BLM activities could potentially impose conflicts with nearby residential uses. Parcels within 1/4 mile of land zoned for residential parcels less than 5 acres in extent are listed in Appendix 4. Additionally, some BLM parcels are located where they are readily visible from residential lands along East Fork Dairy Creek and McKay Creek. Landowner considerations should be taken into account when planning harvest in these parcels.

5.3.1.5 Recreation

Recreational opportunities in rural portions of the watershed are mostly dispersed. Hiking and hunting take place on public lands and assorted private timberlands in the Tualatin Mountains. Additionally, hiking and bicycling activities exist on the Banks-Vernonia linear trail, and some developed roads. Fishing occurs along streams.

The availability of public lands for these activities is limited by access. Many BLM parcels either do not have public road access or have such access closed by landslides. Performance of recreational activities on such lands are limited to the more ambitious recreationalists. One notable exception is the parcel adjoining Uble Road, which has trails commonly used by the nearby Girl Scout camp for horseback riding.

[1] Based on stand characteristics, and harvest policies on federal lands. No timber economists were consulted.

Several golf courses exist in the watershed. One, the Pumpkin Ridge golf course, is located in a rural section of the watershed north of North Plains. The others are in urbanized portions of the watershed. The primary impact of these recreational sites would be created by inputs of fertilizers to aquatic systems. The actual extent of such effects are unknown.

A model plane flying field is located off of Mountaindale Road near Highway 26. Potential impacts of this recreational activity are unknown.

Recreational opportunities within the urban portions of the watershed are generally more intensive. Many such activities are centered around indoor uses and have watershed impacts similar to those for other urbanized activities. Where concentrated near streams, outdoor activities may contribute to channel degradation and sedimentation. Additionally, maintenance of recreational areas, such as parklands and golf courses, may increase inputs of nutrients and pollutants to streams.

5.3.2 Cultural Resources

Based on the history of Native American occupancy, there is a likelihood that significant cultural resources could exist in the valley portion of the watershed. Tribal specialists were consulted, but did not identify any such resources.

5.3.3 Road-related issues

Road-related concerns are also discussed in sections related to erosion, hydrology, stream channel, and aquatic habitat.

The highest risk for road-related slope failures occur on steep lands in the Tualatin Mountains. Middle portions of McKay Creek, in particular, have had a particularly high incidence of road related slope failures. However, other such failures have been distributed on other roads in the watershed. These failures potentially create opportunities for accelerated sediment inputs to streams. Such seems to have been the case in the McKay Creek slide near the Pacific Rock Products quarry, as well as several smaller slides.

Stream crossings potentially create migratory hazards to anadromous fish. Additionally, insufficiently sized culverts may lead to road washouts, contributing to sedimentation problems. During a recent survey, Washington County found a majority of culverts to be inadequate, either because of migratory or size concerns.

Road surfacing led to a need for rock pits. Two of these are located near McKay Creek: The Pacific Rock Products quarry near the confluence with the East Fork of McKay Creek, and the Washington County quarry near Jackson Creek. The Van Aken quarry, in the Sadd Creek subbasin, is another large rock mining operation. These sites may pose sediment risks to nearby streams. Additional quarries may exist in the watershed.

5.4 DATA GAPS

During preparation of this watershed analysis, several data gaps were identified. Data collection in these areas will provide potential benefits to management, planning, and restoration efforts.

Erosion Processes

- Magnitude and location of mass-wasting processes. This watershed analysis supplied slope-based indicators of high landslide potential and locations of several notable landslides. A comprehensive landslide inventory based on aerial photography and field visits would enhance our knowledge in this area, as well as determining present and potential sediment sources.
- Magnitude and location of sheet, rill, gully, and bank erosion. This watershed analysis identified stream reaches and subwatersheds where such erosion was observed or would be likely. Site-specific field surveys and quantitative modeling would enhance our knowledge of these processes in the watershed.
- Magnitude of erosion reduction effected by implementation of specific BMP's and relative effectiveness of these BMP's.
- Riparian conditions in forested lands and impacts of forestry near streams. Although this watershed analysis noted improvements in Oregon Forest Practice Rules that reduced erosion, it did not address the adequacy of these rules and current enforcement practices to attain erosion-control and water quality objectives.

Hydrology and Water Quantity

- Discharge characteristics at ungaged locations in the watershed. Watershed-wide flow modeling calibrated with field observations would facilitate determination of locations of seasonally inadequate flow.
- Adequacy of current instream water rights to

protect aquatic life and other instream beneficial uses. This report identified existing instream water rights, but did not attempt to determine whether these rights provided adequate protection for aquatic resources. More intensive field study would be necessary to answer this question.

- The best locations for potential purchases of instream water rights.
- The extent of illegal water diversions.

Stream Channel

- Field verification of GWEB channel types. Field study would also provide insights on characteristics not visible from maps and photography, and would aid in restoration planning. Additionally, channel types should be updated to reflect ongoing changes in the GWEB channel typing methodology.
- Ongoing changes in channel characteristics. Field study aimed at detection of current channel migration, widening, and entrenchment would aid in planning efforts.

Water Quality

- Location of inadequate septic systems in the watershed.
- Specific sources of high aquatic phosphorus levels on Waibel Creek.

Aquatic Species and Habitats

- Macroinvertebrate distribution. Comprehensive macroinvertebrate surveys would enhance understanding of water quality and ecological characteristics of the watershed, and would help to delineate potential trouble spots.
- Distribution of fish habitat. In the 1990's, BLM conducted surveys over substantial portions of East Fork Dairy Creek and McKay Creek. More localized surveys have been conducted by ODFW, Pacific University, OGI, and USA. A better understanding of the quantity and quality of habitat for salmonids and other species of interest would be gained if these surveys were supplemented by a comprehensive habitat survey.
- Amount and distribution of salmonid spawning. Redd counts and spawning surveys would be beneficial to determine actual usage patterns by salmonids.
- Population and distribution of amphibian species. Comprehensive amphibian population surveys would help determine the distribution of sensitive species and the potential impacts of habitat loss and exotic species upon native amphibians.
- Population and distribution of sensitive species dependent on riparian and wetland habitats.
- Historic extent of wetlands. This report recorded the extent of wetlands recorded on 1870's era survey maps and noted that this estimate was likely to be low. Another estimate might be developed based on hydric soils.
- Present extent, types, and condition of specific wetlands. Analysis of present wetland extent was based on surveys performed as part of the National Wetlands Inventory (NWI). Additional information could be gained if the NWI delineation were refined using current aerial photographs and field research. Field study would also help to determine the condition of specific wetlands and locate priority sites for restoration.

Vegetation

- Amounts and distribution of sensitive botanical species. These include bryophytes, lichens, and fungi, as well as vascular plants. Comprehensive botanical surveys would facilitate planning efforts for these species.
- Canopy cover and density of riparian stands.

Terrestrial Species and Habitats

- Distribution of snags, large woody debris, and other late-successional habitat characteristics used by species dependent on these characteristics. Based on stand age and size, this report concluded that these habitat characteristics are uncommon in the watershed. Field surveys would be useful to verify this conclusion and find locations of such habitat characteristics.
- Distribution of sensitive species dependent on late-successional habitat characteristics. Population surveys would contribute to management efforts for these species.

Human Uses

- Potential mitigation and funding sources for mitigation of rock pit sites
- Size and condition of culverts in eastern portion of the watershed. Complete bridge inventory, including specifications. Ability of culverts to withstand major floods.
- Specific roads needing repair or closure.
- Extent of dumping on BLM and private lands within the watershed
- Historically, railroads and logging roads were built on sites throughout the Tualatin Mountains. Many of these "legacy roads" may continue to provide erosion and/or sedimentation hazards. However, determination of the locations of these roads, as well as potential mitigation opportunities, was beyond the scope of this report.

Chapter 6: Recommendations

Watershed needs and opportunities are most effectively addressed by a consistent, cooperative effort between landowners and government agencies. In keeping with that principle the following recommendations are intended as general guidelines for cooperative efforts that can be undertaken to achieve watershed objectives. (Recommendations specific to BLM lands are given later in this chapter.) These recommendations are not intended to mandate what private landholders should do with their own land, but instead to identify potential opportunities for improvement of conditions within the Dairy-McKay watershed. Implementation of these recommendations is completely voluntary on the part of the private landowner. Opportunities will be available through cooperation with private landowners to create partnerships to implement these recommendations. As the nexus of many different interests, the Tualatin River Watershed Council plays a vital role in facilitating these partnerships.

The nomenclature for these recommendations was designed with this concept of partnership in mind. Three groups have been identified. The actual implementation of these recommendations and objectives is performed by a large and varied group of individuals, grassroots organizations, and corporations. They voluntarily organize educational activities, donate material, contribute labor and expertise, and manage their lands to achieve desirable watershed objectives. Although the people in this group represent diverse interests, they work toward similar beneficial objectives, and here they are described collectively as **partners**[1]. Another group, that of governmental **agencies**, has specific duties to achieve watershed objectives. Although they are also important partners in the watershed restoration efforts, when performing their official duties they will be referred to as agencies. Finally, the **Tualatin River Watershed Council** acts as facilitator to promote implementation of these recommendations. In this role, the council acts to coordinate efforts between partners to achieve beneficial watershed objectives.

Success of many programs delineated within these recommendations is contingent upon funding. There are several sources of expertise and funding for projects on private lands that could be used for the opportunities identified below. Oregon Department of Fish and Wildlife and state Restoration and Enhancement funds are available for restoration of riparian and stream habitat. The Natural Resources Conservation Service and the Washington County Soil and Water Conservation District have access to federal funds for improvement, particularly of agriculturally related problems in the lower watershed. The U.S. Fish and Wildlife Service, through its Partners for Fish and Wildlife program, also funds wildlife habitat restoration and improvement projects for wetland, riparian, and instream areas on non-federal lands. This availability of state and federal

[1]It should be noted that the Tualatin River Watershed Council is engaged in many types of partnership activities. Involvement in these partnership activities does not obligate a person or corporate entity to become a partner in the sense used in this document, except to the extent that the person or entity chooses to become involved.

Table 6.1. Priority sites for preservation, restoration, and renovation of riparian and wetland sites.

Site	Type of activity	Rationale
East Fork Dairy Creek (north of Greener Road)	Riparian preservation Riparian restoration Channel restoration/enhancement	Historically good fish populations indicate that remaining habitat should be preserved, and that restoration will be effective.
East Fork Dairy Creek (Mountaindale to Greener Road)	Riparian restoration	Adjacent to important fish bearing reach. Has gravel substrate. Indicates good potential for expansion of salmonid rearing.
West Fork Dairy Creek (Williams Creek to mouth)	Riparian restoration	Most extensive depletion of riparian vegetation. Also has extensive bank erosion.
McKay Creek (North Plains to East Fork)	Riparian restoration	Riparian vegetation often constituted by thin, sparse tree layer.
Jackson Creek (near McKay Creek)	Riparian restoration	Virtually no vegetative cover, channelized stream.
Council Creek	Riparian enhancement Wetland enhancement (ponds)	Very little riparian vegetation. Ponds could be enhanced to provide better wetland habitat.
Cedar Canyon	Purchase of land/conservation easements Wetland preservation Wetland enhancement	One of the best remaining examples of wetland habitat in watershed.
West Fork Dairy Creek (Lousignont area)	Wetland enhancement/restoration Purchase of conservation easements	Historically and currently region with greatest amount of wetlands. Current wetlands seriously degraded with *Phalaris*.
McKay Creek near East Fork McKay Creek	Landslide stabilization/ culvert replacement	Provides a sediment hazard to streams.
Jackson Bottom (Portion within Dairy-McKay watershed)	Wetland enhancement	Portion owned by Jackson Bottom Preserve, potentially expediting enhancement efforts.
Waibel and Storey creeks	Riparian enhancement Improvement of waste management	Very high phosphorus levels, and known locations of poor waste management and nearstream soil erosion.

funding should encourage private landowners to join in the effort to improve the Dairy-McKay watershed ecosystem. Furthermore, the Watershed Council and various agencies should pursue additional funding to address the identified needs within the watershed. Through the watershed analysis process, several stream reaches and wetland areas were identified as priorities for preservation and restoration activities priorities were generally based on the degree of degradation and the potential to restore specific beneficial uses (e.g., potential for salmonids to utilize improved habitat). Areas with relatively good habitat were earmarked for preservation.

AQUATIC

Erosion issues

Problem: Soil disturbing activities on steep and unstable forested lands lead to increased hazards for surface erosion, mass wasting, and sediment delivery. Roads are a major contributor to erosion. Stream crossings facilitate sediment delivery.

Solution Strategy: Erosion control efforts in the mountainous portions of the Dairy-McKay watershed would best be concentrated in areas of steep slope and subbasins with high densities of roads and stream crossings. Ideally, total road mileage should be reduced within such areas. Avoidance of soil disturbing activities on steep and unstable lands would also reduce erosion.

Specific Recommendations.

- Land owning partners in the mountains are encouraged to implement the following road-related practices: Avoid building new roads on steep and unstable lands. Evaluate currently existing roads for usefulness to current management activities. Where feasible, decommission or obliterate unnecessary or undesirable roads by pulling back sidecast material, removing culverts, outsloping where needed, subsoiling to restore infiltration, and revegetating the road surface and other disturbed areas with native species. Priority roads for obliteration include those built on midslopes with sidecast construction. Subwatersheds where these recommendations are particularly applicable include **McKay Creek**, **Brunswick Canyon**, **McKay - Neil Creek**, **East Fork McKay Creek**, and **Williams Creek**.

- Drainage-related erosion will be reduced if land owning partners and agencies with road maintenance authority maintain or improve road drainage by cleaning culverts, replacing decaying culverts, and installing downspouts on culverts that have outfalls at a substantial distance above the hillslope. Any culverts that are installed should be designed to withstand the 100-year flood event.

- In order to reduce erosion and sediment contribution to streams, landowning partners and agencies with road maintenance authority should maintain a vegetative cover on drainage ditches.

- Land owning partners and agencies with road maintenance authority can reduce sediment contribution to streams by implementing the following practices where high densities of roads and stream crossings exist: Decommission unnecessary roads. Survey remaining roads for areas with high risk of erosion from cutslopes, fillslopes, and road treads. Minimize such hazards, using methods such as outsloping and endhauling sidecast materials. Locate culverts or drainage dips to avoid excess accumulations of water in ditches or on road surfaces. Minimize connectivity between drainage ditches and streams to minimize sediment delivery potential. These recommendations are particularly applicable to the following subwatersheds: **Williams Creek, Mendenhall Creek, Whitcher Creek, Garrigus Creek, West Fork Dairy - Kuder Creek, Middle West Fork Dairy Creek, Denny Creek, Sadd Creek, and Murtagh Creek**.

Problem: Sheet, rill, and gully erosion from fields and streambank erosion is widespread in the Tualatin Plain. The greatest problem from surface erosion occurs when soil is inadequately protected from rainfall. Bank erosion is greatest in areas of impaired riparian vegetation. Where riparian vegetation is lacking, accelerated sediment delivery to streams also occurs.

Road drainage ditches provide channels that facilitate transport of eroded sediments and associated pollutants from fields, and delivery of these substances to streams.

Systematic methodologies to assess the effectiveness of Voluntary Water Quality Farm Plans and agricultural Best Management Practices (both individually and in combination) are lacking.

Solution Strategy: Effective erosion control in the valley portion of the watershed will emphasize riparian restoration, residue management, cross-slope farming, rotations with sod-building crops, cover crops, filter strips and grassed waterways on agricultural operations. The former objective is most efficiently achieved through voluntary efforts spearheaded by the NRCS/SWCD. These agencies have a long history of working together with farmers to reduce soil loss. Additionally, these agencies are able to offer economic incentives and cost-sharing programs to implement Best Management Practices. When developing conservation plans, erosion predictions should be based on the most erodible slopes rather than average slopes in a field. Implementation of a systematic methodology and database to keep track of specific components of Water Quality Management Plans would assist agency sources in refining future prescriptions.

Specific Recommendations:

- NRCS/SWCD and other agencies should continue to promote implementation of Best Management Practices by agricultural interests. NRCS/SWCD should determine locations in the watershed where BMP's are least often used, and focus efforts on these areas. Together with the Tualatin River Watershed Council and the Farm Bureau, NRCS/SWCD should determine outreach measures to improve land owner interest in implementation of BMP's. These entities should actively seek funding to provide expanded assistance toward these objectives. They should pursue greater funding for cost-share programs and incentives to retain greater widths of riparian vegetation. Local governmental agencies should request a greater role in designing programs such as the Conservation Resource Enhancement Program (CREP), so that these programs best meet local needs.

- Public agencies responsible for road maintenance should maintain a vegetated lining in road ditches. Similarly, land owning partners will benefit from reduced erosion if they incorporate a vegetated design in drainage ditches on their property.

- When designing conservation plans, NRCS and SWCD should keep a database of practices implemented in each plan, and enhance monitoring of farms under such plans to determine the effectiveness of various prescriptions (This will partially fulfill Tualatin River Action Item 6A.). As part of this effort, they should design a standardized format for the database so that information collected by different agencies can be easily interchanged. These recommendations are particularly applicable to **all agricultural subwatersheds.**

- The Tualatin River Watershed Council should continue to coordinate efforts to restore and enhance riparian vegetation. As part of this effort, the Council should continue to coordinate programs with community groups to plant riparian vegetation. The Council, together with the NRCS and SWCD, should assist landowners with restoration efforts. From an erosion standpoint, the areas of highest priority for revegetation include: the **West Fork of Dairy Creek between Williams Creek and the confluence with Dairy Creek, East Fork Dairy Creek between Murtagh Creek and the confluence with Dairy Creek, McKay Creek East Fork McKay Creek and North Plains, McKay Creek between Evergreen Road and Waibel Creek, and Jackson Creek near the confluence with McKay Creek** (see Appendix 6).

- The Tualatin River Watershed Council and its partners should adopt a policy to protect all currently existing riparian vegetation. As part of this policy, they should advertise currently existing incentives and cost-share programs to remove riparian lands from agricultural production. Where these programs provide inadequate incentive for riparian restoration, the Tualatin River Watershed Council and its partners should work with the federal and state government to provide additional incentives.

- The NRCS and SWCD should continue efforts to work with agricultural landowners to remove prohibited conditions under the Tualatin River Subbasin Agricultural Water Quality Management Area Plan (OAR 603-95, listed in Appendix 3).

Problem: In urban areas, increased surface runoff from impervious surfaces leads to contributions of pollutant-laden sediments to stream systems. Construction activities contribute to erosion and potential sediment delivery. Increased peak runoff potentially causes increased downstream erosion.

Solution Strategy: Management strategies should focus on reduction of surface runoff, control of sediment sources, and settling of suspended sediments.

Specific Recommendations:

- Partners and agencies responsible for urban portions of the watershed should continue to promote use of urban Best Management Practices. Use of these practices should not be limited to areas within the urban growth boundary, but should extend to all areas with urban characteristics. These partners should conduct educational efforts that inform the public on BMP's and also stimulate public interest in implementation of these BMP's by outlining desirable, achievable environmental goals. A methodology should be formulated to measure progress toward achievement of these goals, and the public should receive regular progress reports. Partners should promote landscape design that reduces direct urban runoff to streams. Agencies should maintain current restrictions on construction near streams, and currently mandated buffer zones. These recommendations are particularly applicable to **Dairy Creek, North Hillsboro, Lower McKay Creek, Middle McKay Creek, Council Creek and Waibel Creek** subwatersheds.

Hydrology and water quantity issues

Problem: Wetland and floodplain area is greatly diminished from historical levels. This has resulted in loss of hydrologic regulation of flows.

Solution Strategy: The most effective policy given current constraints is to protect existing floodplain and wetland resources, and to prevent encroachment of activities that are incompatible with floodplain and wetland function. Where incompatible uses do not exist, there may be opportunity to restore the functionality of degraded wetlands. Opportunities for wetland enhancement may be available on lands recently acquired by the Jackson Bottom Wetlands Preserve. Additionally, there may be partnership opportunities with sympathetic landowners to create or re-establish wetlands where they do not currently exist.

Specific Recommendations:

- Planning agencies should restrict further residential and industrial development within the 100-year floodplain.

- The Tualatin River Watershed Council, partners and NRCS/SWCD should sponsor a study to determine priority sites for preservation or restoration of historic floodplain and wetland function. For each site, appropriate protection, restoration, or enhancement strategies should be identified. Information gained in this study should be systematically maintained in a database, where it can be referenced for future funding opportunities.

- Partners and appropriate agencies should acquire property or habitat conservation easements to protect or expand existing wetlands. They should also evaluate opportunities for land acquisition with which to create new wetlands. If wetland creation appears to be a viable option, they should purchase lands for this purpose. The greatest potential for restoration of historic wetland function lies in traditional wetland sites in the **Lousignont Canal, West Fork Dairy - Cedar Canyon, Lower West Fork Dairy Creek, Bledsoe Creek, and East Fork Dairy Creek** subwatersheds.

- The Tualatin River Watershed Council and its partners should institute programs to restore functionality to degraded wetlands. This should include replacement of reed canarygrass and other exotics with native vegetation. The subwatersheds with the greatest amount of eligible wetlands include **Lower West Fork Dairy Creek, Lousignont Canal, West Fork Dairy - Cedar Canyon, and McKay-Tualatin confluence.**

- Agencies and partners should conduct post-project monitoring to determine the success of wetland restoration efforts.

Problem: Diversions of streamflow have diminished summer flows far below reference levels. Over much of the year, surface flow appears to be insufficient to support all beneficial uses. Current instream water rights may be inadequate to protect resources.

Solution Strategy: Water conservation is a necessary part of any strategy designed to optimize water supply for all beneficial uses. As irrigation is the largest use of surface water within the watershed, conservation efforts would benefit greatly if agriculture employs technological solutions to minimize waste during irrigation.

During formulation of its action plan, the Tualatin River Watershed Council considered the acquisition of additional water rights to supplement current instream water rights. If the decision is made to acquire supplementary instream water rights, consideration should be given to the OWRD instream leasing program. Several considerations should go into any decision to acquire instream water rights. Seniority, of course, is a prime consideration. However, location of these water rights is also important. In order to protect cold-water fishery resources, any additional water rights purchases should protect instream flows in the Tualatin Mountains and the upper portion of the plain, where most summer rearing is likely to occur. Downstream of these locations, enhanced flow will have some value for thermal moderation of streams, but is unlikely to provide direct benefit to salmonids outside of migration periods. Other native fish species, such as lampreys, would benefit from resulting improvements in water quality.

Specific Recommendations:

- TRWC, partners, and agencies should encourage irrigation water management, including the use of technological soil moisture sensing devices and the conversion of sprinkler to drip systems on appropriate crops.

- TRWC, partners, and agencies should conduct a study to determine the adequacy of current instream water rights to provide adequate conditions for fish and other aquatic life. If current instream water rights are found to be inadequate, locations of greatest need for supplementary water rights should be noted. Priority for water rights acquisition should be given to the most senior rights available at these locations. When acquiring water rights, strong consideration should be given to use of the OWRD instream leasing program.

Stream channel issues

Problem: Stream channels are severely deficient in large wood. This has limited the development of pools, which provide essential habitat for fish and other aquatic life. Little potential exists for recruitment of large wood to streams.

Solution Strategy: Long-term development of large woody debris recruitment potential should be supplemented by short-term tactics. Potential elements of this strategy include re-introduction of conifers to hardwood stands, thinning within riparian zones to promote development of tree mass, and artificial placement of instream structures. Location of these restoration activities will depend on management objectives. Channel structure throughout the watershed would benefit from placement of large wood. However, wood placement to improve habitat for salmonids would be more effective in the mountains and nearby areas than in lower reaches in the Tualatin Plain. Effective channel restoration strategy throughout the watershed will focus on preservation of existing channel characteristics at relatively high quality sites.

Specific Recommendations:

- As an interim measure, partners performing stream restoration should place large wood in channels, and construct instream structures to create pools in degraded habitat with high fisheries potential. Restoration projects should include substantial post-project monitoring to determine the effectiveness of restoration techniques. Channel structure throughout the watershed would benefit from this recommendation. Sub-basins where placement of large wood would have the greatest benefit for salmonids are listed in the aquatic species and habitat section.

- Landholding partners should manage riparian areas to develop late-successional characteristics so that they can eventually develop large wood for potential delivery to streams. This can include re-introduction of conifers to hardwood stands and some thinning within riparian zones.

Water quality issues

Problem: In many portions of the watershed, sediments are delivered to streams at levels well above reference conditions. These sediments often carry adsorbed pollutants.

Solution Strategy: Strategies to combat sedimentation are described under the erosion section.

Specific Recommendations:

- NRCS/SWCD should continue efforts to expand implementation of agricultural Best Management Practices to reduce sediment discharge to streams (see under Erosion).

- Agencies, partners, and TRWC should work together to restore riparian buffers (see under Erosion).

- Landowning partners and agencies with road maintenance responsibility should minimize connectivity of road drainage ditches to stream channels (see under Erosion). Where necessary, they should build a sediment settling system to detain runoff prior to stream entry.

Problem: High levels of bacteria and ammonia have adversely impacted streams within the watershed. In some cases, inputs of these constituents have caused streams to be listed under section 303(d) of the Clean Water Act.

Solution Strategy: The management strategy for problems related to bacteria and ammonia nitrogen should focus on keeping animal and human waste away from aquatic systems. Successful nitrogen management also relies on effective fertilizer management.

Specific Recommendations:

Agencies should intensify efforts to identify and improve faulty septic systems near streams. In order to facilitate improvement of these systems, homeowners should be offered incentives such as cost-share opportunities. In order to remove streams from the 303(d) list, these efforts should be concentrated in the **Council Creek, Dairy Creek, East Fork Dairy Creek, East Fork Dairy – Gumm Creek, Lower McKay Creek, and Middle McKay Creek** subwatersheds, along with subwatersheds along the extent of **West Fork Dairy Creek**.

Agencies and animal-owning partners should intensify efforts to keep sources of animal waste from entering streams. NRCS/SWCD should continue efforts to identify sources of animal waste to aquatic systems and to work with land owners to eliminate these sources. Together, they should implement appropriate measures, potentially including livestock exclusion, vegetation buffers, and proper storage and application of waste. NRCS/SWCD should continue efforts to publicize available cost-share programs to implement these measures. In order to remove streams from the 303(d) list, these efforts should be concentrated in the **Council Creek, Dairy Creek, East Fork Dairy Creek, East Fork Dairy – Gumm Creek, Lower McKay Creek, and Middle McKay Creek** subwatersheds, along with subwatersheds along the extent of **West Fork Dairy Creek**.
Agencies and partners should work together to improve fertilizer management for agricultural, forestry, and urban applications. NRCS/SWCD, other appropriate agencies, and educational institutions should seek funding to continue studies to determine optimal fertilizer application levels. As funding becomes available, they should conduct these studies expeditiously. They should distribute findings of these studies to applicable agency personnel and private agriculture, forestry, and landscaping businesses. Additionally, they should update publicly accessible literature to include the most current findings and create a distribution system to ensure that the literature makes its way to applicable personnel.

NRCS/SWCD should continue to work with land owners to implement Agricultural BMP's that reduce nutrient laden runoff to streams.

Problem: Phosphorus levels in much of the watershed are well above TMDL levels.

Solution Strategy: Due to high natural groundwater levels of phosphorus, massive declines in summertime phosphorus loads are unlikely (except on Waibel Creek). However, continuing efforts will be essential to retaining instream phosphorus at or slightly below current levels. Measures taken to minimize sediment delivery to streams, as well as effective nutrient and animal waste management will limit inputs of adsorbed phosphorus. Reductions in readily decomposable organic matter will reduce anaerobic streambed conditions that release phosphorus from sediments.

Specific Recommendations:

- NRCS/SWCD should continue implementation of rural Best Management Practices and educational programs, especially with respect to nutrient management, animal waste management, livestock grazing, and erosion control.

- An agency or educational institution should conduct a study to determine sources of high phosphorus levels on Waibel Creek.

- Partners and agencies should implement measures to reduce inputs of sediment, manure, grass clippings and other non-woody organic matter to streams.

- Agencies and partners should avoid practices that resuspend stream bottom sediments.

- ODEQ or another agency source should conduct a study to investigate the role of inadequate septic systems in contributing to phosphorus loads. In stream reaches inadequate septic systems are found to be a significant contributor of phosphorus, the source should be identified, and a cost-share program should be implemented to upgrade the septic system to adequate standards.

Problem: Many streams in the Tualatin Plain have temperatures detrimental to salmonids and other aquatic life preferring cool water conditions.

Solution Strategy: Strategies for temperature moderation should focus on protection and restoration of the riparian canopy. Some stream reaches would also receive local reduction of water temperature through leasing of additional instream water rights.

Specific Recommendations:

The Tualatin River Watershed Council, partners, and agencies should work together to implement programs to restore canopy cover through revegetation of the riparian zone with appropriate species. (See under Erosion).

The Tualatin River Watershed Council should explore leasing options for additional instream water rights (See under Hydrology/Water quantity)

*Problem: Dissolved oxygen levels are low in some streams within the watershed. Streams with known dissolved oxygen problems include **Council Creek and the West Fork of Dairy Creek.***

Solution Strategy: Temperature reduction is an important strategy for increasing dissolved oxygen levels. Additionally, strategies should focus on reduction of total chemical oxygen demand.

Specific Recommendations:

- TRWC, partners, and agencies should work together to implement recommendations designed to reduce temperature.
- TRWC, partners, and agencies should work together to limit disposal of organic debris near streams. Agency sources should review current information dissemination methods to determine whether they are adequately informing landowners on proper waste disposal methods and current regulations restricting near-stream waste disposal. They should revise educational methods as necessary.
- NRCS/SWCD should continue to work with animal owners to implement waste management recommendations designed to reduce nutrient inputs to streams (listed earlier).

*Problem: Low summer pH levels potentially create a hazard to aquatic life. This problem limits water quality on **East Fork Dairy Creek.***

Solution Strategy: Low summer pH levels are often due to decomposition of organic material. Strategies should focus on waste management from agricultural and domestic sources, and reduction of algal growth.

Specific Recommendations:

- NRCS/SWCD should work with land and animal owners to implement measures for management of waste and organic debris that have been recommended to address dissolved oxygen and nutrient issues.

Aquatic species and habitat issues

Problem: Salmonid populations are declining. A large proportion of this decline can be attributed to degradation of habitat and water quality.

Solution Strategy: Attempts to restore salmonid populations should focus on habitat preservation and restoration. Tributary preservation is particularly important for cutthroat, while preservation and restoration of mainstem habitats will aid anadromous steelhead trout and coho salmon, as well as the resident cutthroat trout. Habitat preservation should mainly concentrate in the mountains and adjacent narrow valleys, where most existing habitat is located.

Habitat restoration can also provide an important role in the watershed. However, restoration should not substitute for preservation of currently suitable habitats. A likely restoration site is the East Fork Dairy Creek above Greener Road. As late as 1995 this was one of the best salmonid rearing and spawning sites in the Tualatin Basin, which indicates high potential for fish use if habitat is restored. Other restoration efforts should focus on other degraded sites within the Tualatin Mountains, as well as valley sites near to the mountains. If restoration efforts are performed well, these sites have good recolonization potential.

Compared to the mountains, habitat restoration of most streams in the Tualatin Plain has less potential for direct benefit to salmonids. In these reaches, the substrate is generally unsuitable for spawning and salmonid rearing is very limited. However, other native fish and amphibian species could derive benefit from restoration at these sites. Appropriate restoration strategies for valley plain sites should focus on development of appropriate habitat characteristics for these native non-salmonid fish and amphibian species, as well as minimization of obstacles to migration of anadromous fish.

Restoration strategies should focus on restoring channel structure, roughness elements, and habitat diversity. Lack of large woody debris (LWD) seems to be the most important factor impacting channel structure. Current LWD recruitment potential is poor. LWD placement is a viable short-term option, but should not replace riparian protection and other measures that will provide for long-term recruitment potential. Other measures, such as restoration of stream canopy and improvement of water quality, coincide with objectives of other modules. If efforts are taken to address concerns related to erosion, hydrology, water quality, and stream channel characteristics, benefits to fish will accrue.

Specific Recommendations:

- TRWC, partners, and agencies should work together to preserve existing salmonid spawning and rearing habitat. They should conduct surveys to determine the location and condition of such habitat. During these surveys, appropriate restoration sites should be noted. For optimal results, surveys for steelhead trout habitat should be concentrated within the **Upper West Fork Dairy Creek, Burgholzer Creek, Upper East Fork Dairy Creek, East Fork Dairy – Plentywater Creek, Denny Creek, Upper McKay Creek, and McKay – Neil Creek** subwatersheds. Additional habitats for resident cutthroat trout may be found in other tributaries. Murtagh et al. (1992) identified Poliwaski Canyon and Strassel and Lousignont creeks as sites in particular need of stream surveys.

- TRWC, partners, and agencies should work together to restore instream habitats for salmonids. Such restoration may include placement of large woody debris and/or instream channel structures. Restoration projects should be accompanied by monitoring to determine the most effective techniques. A recommended site for restoration is the East Fork Dairy Creek in the lower reaches of the **Upper East Fork Dairy Creek** subwatershed. Additionally, East Fork Dairy Creek between Roy Road and Highway 26 (**East Fork Dairy – Gumm Creek** subwatershed) was identified by USA (1995) as likely reach for restoration. Most other potential restoration sites may be found in degraded reaches within the subwatersheds listed under "preservation".

- TRWC, partners, and agencies should work together to restore riparian vegetation. Partners should plant appropriate native tree species where the natural riparian canopy has been removed. Where non-native shrub and herb species such as Himalayan blackberry and reed canarygrass have invaded riparian habitats, partners should replace these species with appropriate native trees and shrubs. This recommendation applies throughout the watershed. Areas where riparian restoration would provide the greatest potential benefit for fisheries includes the **East Fork of Dairy Creek** between Mountaindale and Murtagh Creek, and **McKay Creek** between its East Fork and Jackson Creek. For other areas with very poor riparian cover, see recommendations in the Erosion section.

- Landowning partners and appropriate agencies should remove obstructions to fish migration. They should replace culverts and other stream crossing structures that do not provide adequate passage. In some cases, road decommissioning[1] and culvert removal may be a desirable option.

- The Tualatin River Watershed Council should provide input to ODFW to formulate an aquatic habitat plan. The Council should also act as facilitator to help resolve differences between competing social and biological interests.

- Conservation organizations, other partners, or agencies should acquire land or conservation easements in crucial riparian habitats. Agencies should promote incentives for private land owners to implement BMP's designed to protect aquatic habitat. The TRWC, partners, and agencies should strive to form cooperative fisheries enhancement projects across ownership boundaries that maximize habitat improvement.

Problem: Emergency measures taken to preserve roads and other public works during flooding events have resulted in destruction of salmonid habitat.

Solution Strategy: Cooperative planning between wildlife agencies and public works agencies is necessary to prevent future occurrences of habitat destruction. This planning should take place prior to the next emergency event, and should incorporate a streamlined process for handling emergencies.

Specific Recommendations:

- Public works agencies, USFWS, ODFW, and other agencies entrusted with protection of wildlife and aquatic resources should prepare a coordinated, cooperative emergency plan. This

[1] FEMAT (1993) defines road decommissioning as removing "those elements of a road that reroute hillslope drainage and present slope stability hazards. Most of the road bed is left in place". This contrasts with "full site restoration", where the complete roadbed is obliterated and the hillslope is restored to its original contours.

plan should include a streamlined notification process to all pertinent agency personnel when emergency measures requiring channel or habitat alteration are considered necessary. Agency personnel should be prepared to respond promptly to such notification and provide input on correct design and implementation of emergency measures. In anticipation of events when prompt response is infeasible, a set of standard guidelines for handling emergency measures requiring channel or habitat alteration.

Problem: Reductions in wetland area have led to depletion of habitat for wetland and riparian species. This has adversely impacted populations of these species, especially amphibians.

Solution Strategy (Wetlands): The most effective policy given current constraints is to protect existing wetland resources, and to prevent encroachment of activities that are incompatible with wetland function. As financing becomes available, procurement of additional lands and conservation easements will also assist in providing wetland habitat. Where incompatible uses do not already exist, there may be opportunity to restore the functionality of degraded wetlands. For example, eradication of reed canarygrass and restoration with native vegetation may enhance the habitat values of these wetlands. Opportunities for wetland enhancement may be available on lands recently acquired by the Jackson Bottom Wetlands Preserve. Additionally, opportunities may exist to enhance habitat values within storage ponds. Many of these ponds already provide open water habitat for waterfowl. Emergent species could be planted along pond margins to increase habitat values for amphibians and other species dependent on shallow water habitat. However, this approach may cause conflicts with other interests using the ponds.

Where feasible, wetland creation could be encouraged by promoting beaver activity. It is anticipated that this approach would work best in the Tualatin Mountains, where fewer conflicts between beavers and management activities exist.

Solution Strategy (Riparian habitats): Strategies for riparian dependent species should emphasize increasing the amount of riparian habitat. Programs are currently underway to meet this objective. One such program is the Conservation Resource Enhancement Program (CREP). Administered by the NRCS, this program provides financial incentives for farmers to establish buffer strips along streams. It is hoped that this and similar programs will increase the amount and quality of habitat available to riparian dependent species.

Specific Recommendations:

- The TRWC should coordinate with partners and agencies to perform population surveys to determine the extent of amphibian species, as well as other riparian and wetland-dependent species.
- The TRWC, partners, and agencies should evaluate and implement programs to restore wetland functionality. These are discussed in the section titled "Hydrology and Water Quantity".
- Conservation organizations, other partners, or agencies should acquire habitat conservation easements in riparian areas.
- The TRWC should facilitate a forum to explore opportunities for beaver production of wetland habitats, as well as means of resolving potential conflicts between beavers and socio-economic interests.

TERRESTRIAL

Vegetation issues

Problem: Management practices have resulted in a change in vegetational characteristics. Amounts of vegetation in late-successional stages has been severely reduced from reference levels. Hardwoods have invaded areas formerly dominated by conifers.

Solution Strategy: The ability to resolve these problems will depend on the management emphases of different landowners. Portions of federal lands are managed under a specific directive to manage for old-growth characteristics. Generally, private lands are not managed under such a directive. Often, restoration of conifers to hardwood areas is in the management interests of both federal and private landowners.

Specific Recommendations:

- Where feasible, landowners should reestablish conifers on sites where hardwoods have invaded.

- Large landowning partners are encouraged to manage currently mature stands of private forests to develop late-successional characteristics.

Noxious/Exotic Plants

Problem: Native species richness within most of the watershed has been compromised by invasive exotic and noxious weeds.

Solution Strategy: Solutions are best achieved by creation of partnerships between the BLM and other land owners. Given the fragmentation of ownerships, the best opportunities for partnerships to reduce the spread of noxious weeds would lie with large landowners, and with organizations representing large amounts of land ownership. Such opportunities could include a cooperative agreement between:

- The Bureau of Land Management;
- Oregon Department of Agriculture, which is contracted by BLM for weed eradication work;
- Industrial owners, of which Longview Fibre is the largest. These measures would probably work best in the East Fork drainage, as the largest blocks of BLM and Longview Fibre lands are located there;
- Washington County, which could assist with roadside weed eradication. However, many owners prefer to retain a no-spray zone beside their properties;
- The Farm Bureau. Cooperation of this entity would be essential in the valley plain. However, with some weed species, farmers may need an economic incentive to pursue eradication.

Small residential landowners may be difficult to enlist toward any organized eradication effort. The best strategy to pursue with such landowners is an educational approach. Prospects for eradication in areas of such ownership are dim.

Success of eradication efforts will vary. Some species, such as Himalayan blackberry, are ubiquitous within the watershed, and we can only hope for localized success in eradicating such species. To prevent recolonization by weed species, planting and cultivation of desirable species should accompany weed eradication.

Specific Recommendations:

- The watershed council should facilitate contact between the BLM, Farm Bureau, ODA, NRCS, SWCD, private industrial landholders, and other entities representing landholders to form partnerships to combat noxious weeds. The Council should coordinate efforts by other groups with current efforts being conducted by the Oregon Department of Agriculture. If feasible, eradication efforts should emphasize non-chemical methods near aquatic systems. Non-chemical methods should also be considered for other areas.
- NRCS, SWCD, and other applicable agencies should advertise the availability of educational pamphlets encouraging eradication of noxious weeds. These pamphlets should be updated as necessary to address problems specific to the Tualatin Valley.
- TRWC, ODA, SWCD, and concerned partners should form a committee to determine which plants have the capability to become noxious weeds within the Tualatin Basin. The committee should work with the appropriate agencies, nurseries, and consumer groups to restrict the ability of these plants to become naturalized within the basin. In particular, scrutiny should be given to giant reed (*Arundo donax*) and Pampas grass (*Cortaderia selloana*).

Species and habitat issues

Problem: Many plant and animal species in the watershed are sensitive to management-induced habitat changes. The Bureau of Land Management has included many of these species on its list of sensitive species. Habitat for many of these species has been reduced from former levels.

Solution Strategy: Proper management strategies for sensitive species will vary by the species. The Bureau of Land Management has identified management strategies for species considered by the Bureau to be sensitive[2].

Knowledge of species distribution is an important prerequisite for successful management for sensitive species. In order to gain this knowledge, systematic surveys should be conducted where habitats are suitable for these species.

Specific Recommendations:

- The watershed council should act as a facilitator to formulate uniform habitat management policies.
- Government policy makers should consider providing incentives for landowners to manage forests for recruitment of snags and down wood.
- The watershed council should seek funding and facilitate partnerships to conduct systematic surveys for sensitive species.

SOCIAL

Issues related to human uses

Problem: Timber, agricultural, domestic, industrial, and wildlife interests often come into conflict for limited resources. As population increases, this competition will intensify.

Solution Strategy: A cooperative approach between various interests is necessary to resolve competing watershed demands. The Tualatin River Watershed Council plays a major role in facilitating this cooperation.

Specific Recommendations:

- In order to achieve Oregon's environmental policy objectives, the Governor's Watershed Enhancement Board should continue funding for the Tualatin River Watershed Council.
- Urban growth should be restricted to the current UGB. Additional extensions of the UGB are detrimental to the watershed. Any new growth should implement technologies that decrease urban runoff and increase infiltration, such as porous pavements and artificial wetlands.

Recreation

Problem: Nearstream recreational activities can lead to disturbance of the riparian zone. Support activities associated with recreational facilities can contribute pollutants to streams.

[2] These are given in BLM Manual 6840, Appendix J2 of the NFP, and in the Salem District RMP.

Solution Strategy: Measures should be taken to minimize the effects of recreational activities upon streams. These include regulation of stream access, maintenance of vegetated buffer strips between streams and activities detrimental to the aquatic system, and monitoring to determine the location, nature, and magnitude of recreation-associated impacts on streams.

Specific Recommendations:

- TRWC, agencies, and partners should work together to conduct a survey to determine specific sites of impacts due to recreational access to streams. Determine whether recreational benefits outweigh impacts at these sites. Where continued access is considered beneficial, consider armoring the streambank or otherwise constructing facilities to minimize impacts.
- Agencies should monitor golf courses and parks to ensure that they do not contribute appreciable inputs of fertilizers, pesticides, and herbicides to stream systems. Managers of these facilities should be encouraged to develop conservation plans through NRCS/SWCD.

Cultural resources

At present, neither problems nor recommendations for cultural resources have been identified.

Road Related Issues

Problem: Roads are significant contributors to problems related to erosion, water quality, stream channels, and aquatic life (see respective sections).

Solution Strategy: A diversified strategy is necessary to deal with road-related problems. This strategy will consist of a combination of road closures, road upgrades, and measures to restrict road-related impacts upon streams.

Specific Recommendations:

- Landowning partners should avoid building new roads on steep terrain (e.g. steep portions of McKay Creek and Williams Creek drainages). Where feasible, roads in these areas should be decommissioned. (See Erosion). Potential criteria for road closure are given on page 32.
- Surveys should be conducted to locate "legacy roads" and abandoned railroad grades that may be posing problems to watershed resources. Additionally, funding should be sought to reduce impacts from these roads.

Recommendations on BLM lands

The following recommendations were specifically designed to fulfill management objectives on BLM lands. Many of these recommendations may be potentially useful on other ownerships, as well.

AQUATIC

Erosion issues

- Where appropriate, reduce existing soil compaction levels by obliterating roads that are not needed for future management and by treating old compacted areas such as dirt roads and cat trails with a winged subsoiler.

- Identify road-related sediment problems, such as old railroad grades with inadequate or failing water crossing structures and roads with failing sidecast. Evaluate the potential for sediment delivery from these sources to determine whether it is appropriate to fix the problems.

Stream channel issues

- Conduct surveys to determine appropriate sites for enhancement projects to increase the amount and size of large woody debris in stream channels, floodplains, and riparian areas. The highest priority areas for enhancement projects are those streamside areas that are dominated by hardwoods or overstocked conifer stands that would benefit from thinning or underplanting.

Water quality issues

- When doing enhancement projects in Riparian Reserves, avoid removal of vegetation along perennial streams that will significantly decrease stream shading during the summer months.

- When conducting forest density management projects inside Riparian Reserves, leave a no-cut vegetation buffer along all intermittent and perennial stream channels, lakes, ponds, and wetlands. The width of this buffer should be determined on a site-specific basis. Additionally, the buffer should include stream-adjacent slopes with a high potential for landsliding. The purpose of this is to protect the streams and riparian zones from any direct or indirect disturbance from project activities, and to ensure that existing shading is not reduced.

- Where a few scattered understory conifers are growing within riparian areas strongly dominated by alder, consider treatments to increase conifer growth, vigor, and exposure to sunlight.

- Consider possible conversion or pocket planting of conifers along stream segments that are dominated by hardwoods.

- Where feasible, avoid road-building activities within Riparian Reserves. Where these activities are necessary, use practices that minimize hazards to aquatic systems.

- When yarding through Riparian Reserves, yard away from or require full log suspension over all stream channels, lakes, ponds, and wetlands. Limit soil disturbance by selecting appropriate yarding systems and restrictions based on site analysis.

Aquatic species and habitat issues

- Maintain active participation in the Tualatin River Watershed Council. Designate a BLM employee to act as liaison with the council. Participate and cooperate in projects when possible and requested to do so by the council.

- Evaluate all stream segments capable, or potentially capable, of supporting salmonid spawning and rearing for potential stream habitat improvement projects. These areas include, but are not limited to East Fork Dairy Creek upstream of Greener Road.

- Explore partnership opportunities with other land owners to evaluate best areas for stream enhancement and to implement enhancement projects.

- Expand efforts to identify fish migration barriers and prioritize barriers for corrective action.

- Take an active role in fisheries information collection and cooperatively distribute information to other land or resource managers. Develop a system to conduct follow-up stream habitat inventories to assess habitat trends over time.

- During the planning stages of timber sales involving Riparian Reserves, consider integrating the use of on site equipment with instream habitat improvement projects.

TERRESTRIAL

Vegetation issues

Noxious/Exotic Plants

- Where appropriate, develop "Memoranda of Understanding" (MOU's) with adjacent landowners and state and county agencies in order to expedite weed control goals.
- Where consistent with safety and management considerations, protect existing native vegetation along roads.
- Consider cleaning heavy equipment that will be used in Riparian Reserves and LSR's, and that will conduct soil disturbing activities, of soil and vegetation from outside sources.
- Consider information from the Oregon State University Weed Survey Report, Spring 1998, to control and prevent exotic/noxious weeds (and invasions of such weeds) on BLM administered lands in the watershed.
- Where feasible, control small weed infestations through manual labor and biological controls.
- Where appropriate to meet management objectives for control of noxious weeds, consider the use of prescribed fire.

Species and habitat issues

- Where appropriate, as opportunities permit, develop MOU's with adjacent landowners (especially industrial owners) to ensure cooperation toward attainment of management objectives for species and habitats.

- Follow enhancement and monitoring guidance in the Conservation Strategy for *Cimicifuga elata*, June 1996.

- Where appropriate to achieve desired wetland characteristics, consider the use of prescribed fire.

- Prepare a Late Successional Reserve Assessment (LSRA) for Big Canyon to determine appropriate management strategies for development of late-successional characteristics within this LSR.

- Maximize the current and future benefits derived from Riparian Reserves, LSRs and administratively withdrawn lands for cavity dwellers and other species dependent upon late-seral stage habitat features. Evaluate LSR stands under 80 years old and Riparian Reserve acres and consider the application of silvicultural prescriptions to benefit the development of late-seral stage habitat. Potentially beneficial treatments include thinning to encourage rapid growth and enhance the development of late seral stage habitat, creating snags (eventual down woody debris), and underplanting with long lived coniferous species in areas where they are largely absent.

- Consider retention of quantities of snags and down wood and wildlife trees in harvest areas commensurate with the availability of such habitat in adjacent areas. Evaluate adjacent sites for current and near-term potential to supply snags and down wood. In young forests and other areas where potential supply is low, retain relatively high levels of snags and down wood and wildlife trees. (As a general guideline, 8-12 wildlife trees may be appropriate). Where sites adjacent to the harvest area have a large proportion of mature timber, less retention of snags, down wood, and wildlife trees will be needed. (For example, 6 wildlife trees may be appropriate).

- Consistent with project objectives, consider the use of logging systems and site preparation methods that would reduce disturbance to reserve trees, existing snags and down wood, especially when operating in Riparian Reserves.

- When implementing silvicultural prescriptions in Riparian Reserves, consider use of logging systems and site preparation methods that would reduce site disturbance, and maintain a "no-cut buffer" appropriate to site specific conditions along stream channels.

- Consider enhancing the recreational hunting experience for some hunters and improve habitat for big game and other wildlife by closing roads where they are no longer needed for management. In particular, this action will be beneficial to late-successional species that are sensitive to disturbance.

- Depending upon site specific conditions, consider providing "visual buffers" adjacent to new regeneration harvest units to limit disturbances to wildlife as well as help with limiting the spread of noxious weeds. Where feasible, maintain an uncut strip of dense native vegetation along roadsides which may include existing young conifers, salmonberry, thimbleberry or other native shrubs.

Forest resources issues [BLM only]

Recommendations for silvicultural treatments in alder-dominated riparian stands[3]:

- Release existing young conifers in riparian areas as the first priority for re-establishing large conifers in alder-dominated riparian areas.

- In Riparian Reserves adjacent to stream channels where conifers are absent or are in very low abundance, consider clearing selected areas in existing alder canopies to plant and maintain young conifers. Openings should probably be 0.5-acre or less and should be well distributed along a given stream reach. Additional areas along the stream reach could be treated when the trees in the first sequence attain sufficient size, perhaps in 10 years or so. Target conifer stocking should be about 50 conifers per acre.

Recommendations for density management thinning in Riparian Reserves:

- Consider thinning well-stocked and over-stocked mid-aged conifer stands in Riparian Reserves to accelerate size development and promote windfirmness in remaining conifers. Variable-density thinnings could also be used to enhance structural complexity of relatively dense conifer stands.

- In young (non-commercial) conifer stands, consider maintaining appropriate conifer stocking adjacent to stream channels or other areas with water to encourage conifer domination of these sites.

- In all management operations, consider maintaining a buffer of trees and brush along stream channels (both intermittent and perennial) sufficient to provide adequate shade to the stream and protect the stream banks and channel.

Recommendations to reduce the potential for excessive damage caused by the Douglas-fir beetle when managing for snags and down wood:

Consider the following:

- Do not leave more than three fresh down Douglas-fir trees per acre greater than 12 inches

[3] These treatments are generally applicable where the natural riparian forest is considered to have been dominated by conifers.

DBH, especially where the down trees are shaded and where tree vigor of the remaining trees is reduced because of root disease or other causes. Where down trees are exposed to full sunlight, the number of trees left for snags and down wood could probably be doubled without posing an undue risk to the surrounding trees.

- When there is a need to add large amounts of fresh down Douglas-fir trees or logs to increase the amount of snags and down wood, add them in a *series* of events spaced three to four years apart.

- To reduce the amount of subsequent killing by Douglas-fir beetles, fell Douglas-fir trees to create snags and down wood no earlier than July and no later than the end of September to avoid beetle breeding and dispersal periods. There may be cases, however, where subsequent beetle killing is desirable for snag creation, such as in Riparian Reserves or LSR's. In these circumstances, adhering to the July to September time period may not always be appropriate.

Recommendations for alder dominated sites:

Consider the following:

- Inventory alder-dominated stands to determine whether to convert particular alder-dominated sites to conifers.

- Those alder-dominated sites capable of supporting conifers at this time, and that are reaching their peak volume production, should be considered for harvesting and conversion to conifer stands to increase timber production in the Matrix. Consider including those alder areas currently suitable for harvest in timber sale plans for the Matrix.

- Alder-dominated sites with compacted soil and/or nitrogen deficiency problems are best left in alder until those problems are alleviated. Sites that are naturally suited to alder production, such as wet areas, are best left in alder and not intensively managed to attain full conifer stocking.

Recommendations for stands infested with *Phellinus weirii* root rot:

Consider the following:

- In regeneration harvests, survey for areas of *P. weirii* infection. Once these areas are located, mark them for subsequent reforestation with disease-resistant or disease-tolerant species.

- Avoid commercially thinning stands of highly susceptible species, such as Douglas-fir, when disease levels are high (present in 20 percent or more of the stand). High levels of *P. weirii* infection are of increased concern when considering commercial thinning, if the disease centers are not well defined.

- Consider early regeneration harvest in pure Douglas-fir stands with disease levels exceeding 25 percent when the disease pattern is dispersed rather than occurring in distinct centers. These stands should be considered relatively high in priority for offering as tracts of timber for sale in the Matrix.

- In disease centers, trees left for wildlife should be species other than Douglas-fir or grand fir if the intent is to have them remain standing.

- In sapling-sized stands of highly susceptible species during pre-commercial thinning, leave disease-resistant or disease-tolerant species in obvious disease centers in a two-tree spacing around the centers.

- In commercial thinning-sized stands of highly susceptible species where infection levels are under 20 percent and infection centers are well-defined (as opposed to dispersed), thin healthy portions of the stand and consider removing all highly susceptible species in the disease centers and within 50 feet of visibly infected trees. In the GFMA, regeneration of the openings created with species that are immune to *P. weirii* should be strongly considered. Red alder is a good choice for an immune species. In the other land-use allocations, regenerate these areas with disease-resistant or disease-tolerant conifer species to increase species diversity, begin the establishment of another canopy layer, and reduce the disease spread.

Recommendations to increase tree growth and value:

Consider the following as funding permits:

- Precommercially thin young conifer stands in all land-use allocations.

- Prune about 100 trees per acre up to 18 feet after precommercial thinning once the average stand DBH reaches four to six inches. Prune the best trees in the stand and do not reduce the crown ratio below 50 percent, which may require pruning to be done in two stages to reach the desired 18-foot height. Pruning is most appropriate in the Matrix land use allocations, especially the GFMA portion of the Matrix.

- Consider fertilization with nitrogen following precommercial and commercial thinning in the Matrix, especially the GFMA portion of the Matrix. Such fertilization should be performed at levels consistent with water quality considerations.

- Promptly reforest regeneration-harvested areas and aggressively manage competing vegetation.

- Where appropriate to achieve management objectives, consider the use of prescribed fire.

- Overstocked Douglas-fir stands that are developing late-seral forest conditions and progress toward achieving late-seral forest conditions should be accelerated by applying density management in the Connectivity portions of the Matrix.

Recommendations regarding relief of compaction using a winged subsoiler:

- Carefully evaluate the trade-off between relieving soil compaction and root damage to residual trees before recommending subsoiling in commercially thinned stands.

General priorities for selecting stands for regeneration harvest in Matrix allocations

1. Pure Douglas-fir stands where more than 25 percent of the area is in *P. weirii* disease centers.
2. Hardwood stands growing on conifer sites where soil compaction is no longer a threat to conifer growth.
3. Mixed hardwood-conifer stands growing on conifer sites where soil compaction is no longer a threat to conifer growth. This priority is particularly applicable to the GFMA portion of the Matrix.
4. Overstocked conifer stands that are no longer suitable for commercial thinning.
5. Conifer stands that have reached or are beyond their peak volume production (culmination of mean annual increment). This priority is particularly applicable to the GFMA portion of the Matrix.

General criteria for selecting stands for commercial thinning in the GFMA

Top priority for commercial thinning should go to Douglas-fir stands that are 30 to 60 years old which have the following characteristics:

- Curtis Relative Density levels in the general range of 55 to 70.

- Live-crown ratios on residual trees of 30 percent or more.

- Less than 20 percent of the stand is in *P. weirii* root rot centers, with the centers being well-defined (as opposed to dispersed).

SOCIAL

Issues related to human uses

Rural interface

To the extent possible:

- Consult community groups and affected landowners during the scoping phase of the environmental assessment process for BLM projects. Increasing our sensitivity to the concerns and desires of the residents of the watershed may decrease conflict on rural interface issues. Participation in watershed councils would provide BLM managers additional information concerning activities occurring or planned within the watershed as well as keeping local publics apprised of BLM activities.

- Reduce vandalism, dumping and resource theft by increasing law enforcement presence through BLM ranger patrols and cooperative agreements with local law enforcement agencies or BLM personnel along with aggressive prosecution of offenders. Public outreach and education programs should also be used to educate the public about the proper use of public lands.

- Where BLM lands lie along publicly accessible roads, post signs on roads indicating boundaries of public lands. At heavily used sites, information signs written to create pride in public ownership, recreational and permit information and asking public assistance in reporting infractions should be erected.

- Produce a pamphlet on BLM management policies in the watershed. Ask realtors to distribute these pamphlets to prospective purchasers of parcels near BLM lands. Make these pamphlets available through other avenues as opportunities arise.

Recreation

- Continue to manage for dispersed recreation opportunities such as hunting, fishing, hiking, and horseback riding. These activities should be allowed to continue on all BLM lands where damage to resource values would be minimal.

- Develop literature for the wise use of the public lands. This literature could provide useful information on what products are available from the public lands and procedures for obtaining a permit. The literature should make the public aware of how their activities impact the resources on forest landscapes and how they could reduce the impacts of their activities.

Road-related issues

Potential strategies to address road-related concerns on BLM land

Road strategy will depend upon BLM objectives within the watershed. To prevent high maintenance costs in the long term, roads should be designed to accommodate the needs of resource management and to accommodate the needs of the resource itself. When constructing new roads, the road network system should be analyzed for future harvest prescriptions, access, and possible obliteration and/or subsoiling of existing roads.

Under certain circumstances, road-related problems may make upgrading or closure desirable. To determine whether these problems warrant closure, the following criteria should be considered:

- Nearness to stream

- Inordinate number of stream crossings

- Large proportion on unstable lands

- High failure history

- Not needed for stand management, fire protection, or other administrative needs.

- High incidence of dumping and vandalism.

- Substantial conflicts with natural hydrologic processes.

Road closure methodology will depend upon the reasons for closure. Such roads as are closed due to dumping or vandalism concerns, but still are potentially useful to BLM operations, should be gated or blocked with debris piles double tank traps. In most other cases, decommissioning would be the preferred option as costs are much lower than for complete obliteration (FEMAT 1993).

The following roads are candidates for closure, obliteration, or subsoiling. These should be reviewed during the final stages of establishment of transportation management objectives (TMO's).

T	R	S	Road number	Description
4N	3W	21	4N-3-21.2 4N-3-21.3	
4N	3W	33	4N-3-33.2 3N-3-3.1	The portion in S33, SE1/4, SE1/4
3N	3W	29	3N-3-29 none	Located in S29, NW1/4, NE1/4
2N	3W	5	2N-3-7 none	Portion in S5, SW1/4, NW1/4 Leaves Road #2N-3-7 in Section 6, SE1/4, SE1/4 and enters S5, SW1/4, SW1/4

The following roads are candidates for easement acquisition:

T	R	S	Road name/no.	Description
3N	2W	9		Needed to access BLM land within S9, N1/2, SE1/4
3N	2W	S18	1050 Layton Road	Both roads are gated.
3N	2W	33	539	
2N	2W	3		Needed to access existing road network
2N	2W	9		Needed to access BLM land in Section 9, NW1/4, S1/2; and SW1/4, N1/2
2N	2W	29		Needed to access BLM land in S29, NE1/4, SW1/4

Consider the need for access to the following parcels. If access is sufficiently beneficial or necessary for management operations, the necessary actions should be taken to provide access.

T	R	S	subsec	Description
3N	3W	29	NE 1/4	No present road access
3N	3W	9	NE 1/4	No present road access
3N	3W	3		Most convenient road access points are closed by landslides.
3N	3W	25	SW1/4	Access closed by landslide
3N	3W	31		Access closed by landslide
3N	3W	35		Access closed by landslide
3N	3W	19		Needs legal access
3N	2W	7		Access closed by landslide
3N	2W	21		Needs legal access
2N	3W	1		Access closed by landslide
2N	3W	11, 12		Needs legal access
2N	3W	21		Needs legal access
2N	2W	7		Access closed by landslide
2N	2W	27		Needs legal access

Culverts

- Culvert spacing should be evaluated. On steep road grades or erodible soils, culvert distance should be more frequent than the standard of every 500 feet. A guideline for placement is:
  - silt and silty sands
    - not more than 150 feet apart on 10% grade,
    - not more than 80 feet apart on 18% grade
  - silt
    - not more than 350 feet apart on 10% grade
    - not more than 150 feet apart on 18% grade
  - rocks, cobbles, gravel
    - not more than 500 feet apart on 10% grade
    - not more than 300 feet apart on 18% grade

- Calculations to determine culvert size should include the volume of water attributed to runoff from insloped roads that flows in the ditch and out of the culvert.

Sediment and Erosion (Preventative Measures)

- Incorporate considerations related to slope, soils, habitat objectives, and hydrologic function into the decision-making process when placing roads near Riparian Reserves.

- Consider obliteration of disused roads with extensive lengths of cut and fill. Obliteration should entail reshaping of the land base to its original characteristics.