1 Executive Summary

1.1 Introduction

The intent of the Executive Summary is to provide ODF managers with a truncated, stand-alone document that summarizes the most important topics from each subject area (i.e., chapter). As such, not all the issues identified in this Watershed Analysis are covered in the Executive Summary. Readers looking for a more in-depth review and discussion, as well as the presentation of other lesser-important issues are encouraged to refer to the expanded chapters in the main (full) document.

1.2 Watershed Overview

The previous OWEB assessment for the Wilson River (E&S Environmental Chemistry 2001) addressed much of the general watershed information. Therefore, only the details considered essential to a general overview of the project area are covered here.

Located in the Coast Range mountains of northwestern Oregon, the Wilson River flows off their western flank eventually emptying into Tillamook Bay, one of five major river systems to do so (refer to section 3.1 Physical Setting). The Wilson River watershed (Wilson) is comprised of eight subwatersheds (6th field HUCs; Map 2 and Table 4; refer to section 3.1.5 Waterboundaries) covering roughly 123,000 acres. The lowland alluvial plains – once forested but containing numerous hydrologically connected sloughs – are currently utilized primarily for dairy farming and rural residential housing while the forested uplands are utilized primarily for timber production and recreation (see section 3.3 Social Context).

The Wilson River watershed, part of the Coast Range Physiographic Province (Franklin and Dyrness 1973; WPN 1999) spans portions of the Coastal Lowlands, Coastal Uplands and Coastal Volcanic Uplands ecoregions (Omernik and Gallant 1986; refer to section 3.1.1 Ecoregion). The Wilson is located in the Tillamook Highlands, a geologic province of the north Coast Range and is typified by long, continuous shorelines punctuated by steep cliffs and the occasional estuarine bay containing rich lowland marshes and deep, alluvial-deposited terraces. Inland, the mountains rise up sharply to elevations greater than 3,500 feet while broad, alluvial, lowland valleys disappear into narrow, steep-sided canyons where high-gradient, cascading streams and landslides predominate (refer to section 3.1.2 Geology, Landforms and Soils).

Prevailing soil types in the Wilson River watershed (see Appendix A – Soils Data) consist of deep, well-drained, highly-productive fluvial and estuarine

deposits in the lowlands with moderately deep soils covering very steep terrain in the uplands (ODF 2003, TBNEP 1998). Although much of the watershed is still forested, most of the lowlands have been cleared for agricultural production (e.g. dairy farming). Situated in the coastal temperate rainforest, the Wilson River (and its climate) is strongly influenced by the Pacific Ocean and its related weather patterns (Taylor and Hatton 1999). Typical of Pacific Northwest climate, the Wilson experiences an extended, mild, winter rainy season (November through February) followed by a moderately warm and relatively dry summer season (refer to section 3.1.3 Climate). Precipitation (generally rainfall) increases with elevation as warm, moisture-laden air rises over higher terrain, causing the air to cool and drop precipitation (orographic effect; refer to Sections 3.4.2 Flooding as an Historic Disturbance and 5.2 Flood History for detailed hydrology discussions). Average high temperatures hover around the mid-fifties (Fahrenheit) in the winter months and the high sixties during the summer months. Average low temperatures dip to the mid-thirties during the winter and the mid- to upper fifties in the summer.

State lands account for the largest proportion by land area at slightly less than 98,000 acres (~80%; Table 3; refer to section 3.1.4 Ownership). Approximately 31,330 acres are administered by the Forest Grove ODF district and the remaining 66,423 acres are administered by the Tillamook ODF district (Map 2). The remaining acreage is split between Private Industrial (~12.3%), Private Non-Industrial (~5.2%), Federally Administered Bureau of Land Management (BLM) lands (2.9%), and Miscellaneous lands administered by the City of Tillamook, Tillamook County, or the State Department of Transportation (~0.5%; Table 3).

The historical characteristics of Tillamook Bay (and the Wilson River watershed) prior to the mid-1800's are not well documented (refer to section 3.2.1 Early European Settlement). Our current understanding of the natural resources during exploration and settlement is limited to a handful of written accounts from early explorers and pioneers and to research into and accounts from Native American culture. What can be gleaned, however, is that the Tillamook Basin was rich in natural resources (e.g., fish, shellfish, crab, berries, roots, big game, etc.) and anthropological and archaeological evidence indicates that the Native Tillamook peoples relied heavily on these plentiful resources (Taylor 1974).

Similar to many of the other Native American tribes of the area, the Tillamook peoples had a custom of "burn(ing) off the whole country" late in the autumn every year to harvest grain and they were also reported to set fires in old growth spruce and fir to clear areas for their ponies and encourage verdant re-growth (Winters 1941; refer to section 3.2.1 Early European Settlement, 3.4.1 Fire as an Historic Disturbance, 3.5.2 The Tillamook Burn and Reforestation). William Clark also noted another disturbance (although not anthropogenic) around the

Tillamook Bay and surrounding coastline in the 1800's; "tremendous" landslides that were "fifty or a hundred acres" across (Bancroft 1886). While his notes pertain mostly to coastline hillslopes, they suggest that landslides were probably common in the area prior to European settlement and may have also been found further inland as hillslope gradients increased. For more detailed discussions on natural and human-influenced disturbances in the Wilson, refer to sections 3.4 (Natural Disturbances), 3.5 (Forest Management), 4.7 (Channel Modifications), 4.8 (Historic Channel Disturbances), 6.7 (Recreational Impacts on Riparian Vegetation – Direct and Indirect Effects), and Chapter 7 (Sediment Sources).

The Wilson River watershed straddles parts of both the Sitka spruce and western hemlock vegetation zones (Franklin and Dyrness 1973), both of which extend from British Columbia south to Northern California, roughly running parallel with the Eastern Pacific coastline (refer to section 3.2.2 Vegetation). Dense stands of timber included Sitka spruce, western hemlock, western red cedar, Douglas fir, grand fir, Pacific yew, red alder, bigleaf maple, black cottonwood, and Oregon ash (TBNEP 1998). Understory vegetation includes a variety of shrubs, ferns and mosses like the western sword fern, bracken fern, thistle, fireweed, wood sorrel, red and green huckleberries, salal, red elderberry, salmonberry, vine maple, Oregon grape and rhododendron (TBNEP 1998).

The structure of the vegetative communities, (i.e., successional stages and species compositions), however, has been heavily influenced by humans. In the late 1800's and early 1900's, large sections of the lowlands and tidal areas were cleared of timber, the wetlands drained, and the rivers diked for agricultural use, often resulting in profound impacts to the vegetative communities. Much of the uplands were heavily logged and/or burned over (both naturally- and human-influenced; refer to section 3.3.1 Historical Land Use, 3.3.2 Current Land Use, 3.4 Natural Disturbances and 3.5 Forest Management) and, with some exceptions, replanted primarily with one species of tree, the Douglas fir. More recently, replanted Douglas fir (many of the seedlings were from an off-site seed source; refer to section 3.5.2 The Tillamook Burn and Reforestation) have been increasingly infected with Swiss needle cast, a foliage disease resulting in defoliation and reduction in growth, which carries with it the potential for very significant forest health issues (e.g., decreased production and disease/insect resistance, increased fire danger and severity, etc.).

The dominant land use in the Wilson River watershed is forestry, accounting for roughly 95% of the watershed's total area (Map 9 and Table 5; refer to section 3.3.2 Current Land Use). The coastal lowland areas in the watershed are dominated by agricultural use, primarily for dairy pastures (~2% of the total watershed area), but development, mostly in and around the City of Tillamook, also accounts for about 2% of the total watershed area (Map 9 and Table 5).

Additionally, recreation has long been an important and valuable output of the Tillamook State Forest and the Wilson River watershed provides the majority of opportunities compared to the rest of the forest. Traditional pursuits like hunting, camping and fishing have continued to draw visitors, while new uses have rapidly increased in intensity and distribution. That trend has been fueled by population growth, change in technology and the development of road access across the forest from salvage and reforestation activities. For more detailed land use discussions, refer to section 3.3 – Social Context, 3.5 – Forest Management, 6.7 – Recreational Impacts on Riparian Vegetation – Direct and Indirect Effects, and 7.5 – Recreation-Related Issues [on sediment]).

Although a variety of non-salmonid fishes are known to occur within the basin, salmonids are of primary importance to managers as they provide substantial ecological, economic, and cultural benefits for the citizens of Oregon and are often used as indicator species of overall aquatic health (refer to section 3.2.3 Fish and Chapter 9 Fish and Fish Habitat). A variety of anadromous salmonid species are known to occur within the Wilson River watershed, including chum (*Oncorhynchus keta*; Map 5), Chinook (*O. tshawytscha*; Map 6), and coho salmon (*O. kisutch*; Map 7), steelhead trout (*O. mykiss*; Map 8), and both resident and sea-run forms of cutthroat trout (*O. clarki*, no map available). While their life histories and habitat requirements differ, all are freshwater obligate spawners and spend portions of their life in freshwater, estuarine, and marine (except for resident cutthroat trout) environments before completing their life cycle in their natal streams. For a detailed list of non-salmonid species known to occur with in Tillamook Bay and the Wilson River, see the Tillamook Bay National Estuary Project (TBNEP; 1998) and E&S Environmental Chemistry (2001) reports (also summarized in Chapter 9 Fish and Fish Habitat). For a more detailed look at historic and current salmonid abundance and distributions, refer to Chapter 9 Fish and Fish Habitat.

1.3 Stream Channel Modification

The majority of the known channel modifications within the Wilson River watershed are located off of ODF lands, primarily in the lower tidewater portion of the watershed and along the mainstem Wilson River. Log drives ended approximately 100 years ago, and a certain amount of passive recovery is expected to have occurred since then.

Only ten locations of direct channel modifications were found on ODF lands during recent road surveys, and collectively these modifications impact less than one mile of stream. Based on these findings it appears that the legacy road system is having only minor impacts on current channel function.

Current levels of stream channel modification in the Wilson River watershed were compared to the findings from nearby watersheds where ODF has performed watershed analysis. Four ODF Watershed Analyses[1] were reviewed; the Elliot State Forest, the Trask River, Miami River and the Upper Nehalem River.

Results from the Elliott State Forest Analysis were reported as lengths of road within 100 foot of channels, however, road fills within valley bottoms were not identified separately. Similarly, in the Trask Watershed Analysis, the miles of roads in "Valley" topographic positions were reported, but not road fills directly impinging on streams. Consequently, results from these two analyses are not directly comparable with the results from the Wilson River.

A total of three miles of canyon fill and four miles of channel fill were identified within the Miami Watershed Analysis area (Table 1). Canyon fill and channel fill were attributes identified as having been collected in the Upper Nehalem Watershed Analysis, however, none of the summary tables reported any mileage within these two classes. Consequently, they are not included here.

Table 1. Comparison of channel modifications on ODF within the Wilson River and adjacent watersheds. Density of disturbance is the total of canyon fill and channel fill divided by area.

Watershed	Area (mi^2) ODF lands	Canyon Fill (miles)	Channel Fill (miles)	Density of disturbance (mi / mi^2)
Miami River	24.8	3.0	4.0	0.282
Wilson River	152.7	0.3	0.4	0.005

Given these results, current conditions within the Wilson River watershed compare favorably to the Miami watershed. Road building practices have modified channels, to a slight degree, on ODF lands. Management recommendations for ODF lands include:

- Remove the few existing areas of canyon and channel fill that have been identified from the road surveys (This is a long-term strategy. There are other road-related issues that take precedent over this and are discussed later in the document)

[1] http://www.oregon.gov/ODF/STATE_FORESTS/watershed.shtml

- Avoid future road alignments that would result in constrictions to channels and channel migration zones.

For a more detailed review of stream channels and channel modifications in the Wilson River watershed, refer to Chapter 4 Stream Channels and Channel Modification.

1.4 Hydrology and Water Use

1.4.1 Land Use Effects

The Distributed Hydrology Soil Vegetation Model (DHSVM) was used to evaluate the effects of vegetation and road conditions on peak and low flow magnitudes at the outlets of the sixth-field subwatersheds, at the location of the Wilson River stream gage, and at the outlets of ten randomly selected small headwater watersheds.

The initial model was run using only historic vegetation (no roads). The resultant values were used as the baseline against which all other model iterations were compared. The fifteen largest independent peak flow events (12 with an estimated recurrence interval [RI] of ≤ 2 years; 2 with an approximate RI of 2-5 years; and one with an approximate RI of 100 years) were used to evaluate management impacts.

Model results suggest that peak flow conditions due to 1) current vegetation conditions, 2) current road densities, and 3) road drainage conditions are not significantly different than under the baseline condition. Vegetation changes and the addition of roads appear to result in an increase of 1% or less over the baseline peak flow condition. No correlation was seen in the results between percent change in peak flow value and flood size.

In addition, we modeled streamflow for a post-fire scenario that considered the extent of historic wildfires in the Wilson River watershed that occurred in the 1940's and 1950's. Changes relative to historic conditions generally showed less than ten-percent increases in peak flows under post-fire conditions. There were, however, individual storm events that had modeled increases in peak flow magnitude of 40% or more.

Model results indicate that hydrologic response is not constant across all storm events (i.e., percent change varied widely by individual storm). Hydrologic response varies in response to antecedent conditions, within-storm weather patterns, and position of roads and harvest units within the landscape. For example, road location may affect the volume of water intercepted by road ditches, and the extent to which peak flow timing may be changed. LaMarche

and Lettenmaier (1998) theorize that although ridgetop roads may have the greatest potential to change the timing of flows (flow that would have traveled a relatively long distance as slower subsurface flow would now travel as quicker surface flow), the volume of flow intercepted is relatively small because of the small upslope contributing area. Conversely, valley bottom roads have the ability to capture large volumes of flow, but the timing change is small because of the close proximity of these roads to streams. Midslope roads may have the biggest effect on peak streamflows because they capture moderately large volumes of water and the timing change may be significant.

Model results for the low flow period (August) also show only minor differences between the baseline and current conditions. Mean August flows increase slightly over the reference condition, probably in response to lower evapo-transpirative (ET) losses from current vegetation and from roaded areas.

Given these results, management related hydrologic impacts are rated as having a low impact on proper function of aquatic systems throughout the Wilson River watershed. Furthermore, given that future harvest intensity is unlikely to exceed present practices, and that road construction and maintenance standards are likely to reduce hydrologic connectivity, it is likely that planned management activities and restoration projects will have a positive or neutral effect on hydrologic response over time.

Management recommendations for ODF lands include:

- Disconnect those road drainage segments that have been identified as being hydrologically connected to the stream network
- Design future road drainage systems in such a way as to avoid hydrologic connectivity of the road drainage structures to the channel network
- Periodically (on a 5-10 year interval) re-evaluate hydrologic conditions at the sixth-field subwatershed level using DHSVM or similar model.

Confidence in this rating is high given the existence of good road survey information and the extensive modeling exercises undertaken as part of this assessment.

For a more detailed review of land use effects in the Wilson River watershed, refer to section 5.3 Land Use Effects on Peak and Low Flows.

1.4.2 Water Uses

The majority (~70%) of water appropriated in the Wilson River watershed is used for irrigation. The majority of this is diverted in the downstream end of the watershed (below the confluence with the Little North Fork), and is used to irrigate farmland in the Lower Wilson River subwatershed and in the adjacent Trask River watershed. The second largest use for appropriated water (~30%) is for municipal and domestic water supplies, which is also withdrawn primarily in the Lower Wilson River subwatershed.

Consumptive water uses in the Wilson River watershed are relatively low (1-3% of natural flow) as compared to the total water available in any given month. Instream flow rights in the mainstem Wilson and principal tributaries, although they have a late priority date, should be adequate in maintaining ample flows needed by salmonids and other aquatic species, particularly on ODF lands, which are located upstream of the major water withdrawal points. No management changes to address water use concerns are recommended on ODF lands.

For a more detailed review of water uses in the Wilson River watershed, refer to section 5.4 DHSVM Future Modeling.

1.5 Riparian and Wetlands

The riparian analysis area is focused on the stream bank (0 - ~35 ft) and inner riparian zones (~35 – 100 ft) for ODF lands only. The ~35 foot streambank zone presented here is slightly larger than the 25 foot streambank zone buffer, as described in the Forest Management Plan (FMP). This is due to the ground-truth sampling, where variable plot radius occasionally exceeded the 25 feet from the stream edge. For practical considerations, these zones approximate the near-stream outer stream gradations for the riparian zone. Delineations and vegetation classifications followed a species-size-density code (FPS code) that was interpreted from aerial photographs; a subset of the dominant vegetation types were field sampled for this analysis. For more detailed discussions, refer to Chapter 6 Riparian and Wetlands.

1.5.1 Riparian Composition and Structure

The Wilson River watershed has ~11% land area in the 100 ft riparian buffer zones around the perennial and fish bearing streams, which is a considerable land area for potential management. The major vegetation types on ODF lands included 5,967 acres (61%) in mixed hardwood/conifer types, 2,339 acres (24%) in hardwood dominated sites, and 1,157 acres (12%) dominated by conifers. Stand structure field data were sampled for areas representing 92% of the total riparian land area on ODF lands.

At the landscape scale, stand structure and composition has been most influenced by a set of complete stand replacement events (fires and salvage logging) of the 1950's and earlier. The majority stand age is considered to be approximately 55 years since stand replacement, although recent harvest in upland areas has initiated younger stands. Overall, stands are relatively homogeneous in stand structure, though they have diverse assemblages of species.

For more detailed discussions, refer to section 6.1 Riparian Composition and Structure.

1.5.2 Riparian Vegetation Dynamics: A No Management Scenario

A 100 year growth time series is presented for the sampled riparian types for each of the subwatersheds, assuming a no management and no disturbance scenario. Within this time series, conifers do not appear to become dominant the canopy strata for any of the subwatersheds. The proportion (relative density) of conifers and hardwoods in the system are dependant upon model assumptions, though increased ("forced") regeneration in the closed canopy environment favors the establishment of slow-growing, shade tolerant species (e.g. hemlock), with differentiation allowing for conifer dominance in the second 50-year time frame. Though conifers will eventually gain dominance in numbers and proportional abundances to hardwoods, the functional components of the canopy will favor hardwoods for a period longer than 100 years.

The models suggest that conifers are not recruiting to the canopy through time. Rates of conifer tree recruitment to the ≥14 inch size class decline through time, mostly due to similar and steep declines in conifer regeneration, especially following 2036 (30 year step). This loss of conifer recruitment will potentially cause a lag in conifer recruitment to the canopy strata, which is likely to extend beyond 100 years. These observations are most likely due to the relatively early phase of succession, following the stand-replacement fire events and salvage logging following the Tillamook Burns. The observed lags in conifer recruitment to the canopy (at subwatershed scales, and for the majority of the Wilson watershed as a whole) are characteristic of this early phase of succession and will have direct implications on the *type* of wood to be recruited to the stream system over time. The current projections suggest the majority of the available wood recruiting to the stream channel will be in hardwood material, not conifer. This does not include stochastic factors (landslides, etc), but indicates a relatively low probability for direct riparian recruitment of conifer material through time (beyond 100 years).

Though no shifts in species composition are projected to occur, tree sizes are projected to increase in diameter through time. The stand-level quadratic mean diameter (QMD) of the canopy strata are increasing in size though the 100-year

model run for both hardwoods and conifers. Stands are slowly becoming multi-layered, though recruitment to the canopy classes generally declines with the assumed regeneration component and shade/ competitive factors that favor slow-growing (shade tolerant) conifers. Hence, the stand structure resembles a sparse but large-diameter overstory, with higher proportions of shorter, small-diameter trees (mostly hardwoods in early phases of the run, shifting to conifers in later years) in the lowest forested strata. Mid-canopy trees (≥14 inches DBH) are notably of low density in later model years.

Mortality rates decline through time, resulting in fewer downed trees per acre. Sharp declines in mortality of the ≥14 inch size class begin after 2036. These declines persist for the remainder of the model run, and the projected rates suggest they will continue to decline at a rate of 10-20% per decade for more than 100 years. This has direct implications for large wood (LW) recruitment to the stream channel.

For more detailed discussions, refer to section 6.2 Potential Future Conditions.

1.5.3 Large Wood Recruitment and Wood Recruitment Budget

Large wood recruitment, as compared with ODFW reference reach metrics (i.e., Aquatic Inventories Project reference reaches), appear to be in the lower end of the moderate range (i.e., lower end of the middle 50% of the ODFW reference reach data) for standing conifers >20 and >35 inches DBH after 2016. However, conifer tree recruitment to these size classes sharply declines, and is projected to decline for a period extending beyond 100 years. Though large standing trees are projected to exist, there appears to be a few trees recruited to the larger size classes through time, indicating a long-term lag in large-diameter trees. As such, the standing tree ODFW metrics are not expected to improve over the 100-year timeframe.

The size of wood that can resist fluvial export and serve as a habitat-forming element (e.g., creating forced pools) increases with increasing channel size. Based on modeled tree mortality rates, wood recruitment will provide sufficient functional wood to meet regional benchmarks (e.g., exceeding median abundance values for coastal reference reaches) for small streams, those with active channel widths less than 15 meters (50 ft). Functional wood abundance modeled for larger streams, those greater than 15 m wide, although increasing over time, remains low throughout the 100-year simulation period.

Modeled wood abundances generally follow changing riparian mortality rates, with some lag reflecting the persistence of wood pieces as they decay. Abundances of smaller pieces (e.g., diameter < 24 in) peak around simulation year 2050 and decline over the remainder of the simulation. Abundances of

larger pieces (> 24 in) slowly increase over time. Hardwoods account for more than half of all wood in the channel, although larger pieces (>24 in) come predominantly from conifers.

Landslides and debris flows form an important mechanism for recruitment of wood for many channel reaches in the watershed. The likelihood for landslide or debris-flow deposition varies reach-by-reach (Map 25), depending primarily on the location of tributary, debris-flow-prone headwater channels. Wood from landsliding and debris flow sources plays important geomorphic (e.g., sediment storage) and ecologic roles for all channels where these processes occur, but from a management context, these upslope sources of wood are particularly important for reaches where riparian areas lack functionally sized wood. Stand-growth and wood recruitment modeling suggest that riparian sources of functional and jam-forming wood are and will be lacking primarily along larger channels. Regional surveys indicate that piece abundances exceeding about 20 pieces per 100 m (330 feet) fall in the high range; under unmanaged conditions, riparian recruitment is expected to provide this level only for channels less than about 10 m (33ft) in width. Fewer than 8 pieces per 100 m fall in the low range, a level predicted for nearly all channels greater than about 15 m (~50ft) in width. Channels greater than 10 to 15-meters in width also provide the primary locations for high intrinsic habitat potential and current fish use (Map 37). Upslope sources of wood to these channels (Maps 38 and 39) merit particular consideration for leave areas and headwater management zones to promote future availability of large wood. Likewise, restoration efforts involving wood placement should be focused on reaches lacking potential for debris-flow recruitment.

For more detailed discussions, refer to section 6.2.2 Large Wood Recruitment and section 6.2.3 Stand Modeling of Large Wood Recruitment.

1.5.4 Wetlands, Ponds and Lakes: Condition and Location

A total of 88.8 acres of wetlands, ponds and lakes were identified. Conditions are generally good within ODF lands. Road influence and neighboring harvest may cause increased siltation in some areas, though there appears to be relatively intact riparian buffers available to slow sediment delivery. Though not directly measured, effects of recreational uses, especially OHV uses, have had a diminishing effect on some of the wetland buffer areas observed. Development of Best Management Practices (BMPs) to curtail potential uses in these buffer zones is recommended. Examples include placement of downed wood or other obstructions to discourage use at the wetland edge. A composite GIS layer of wetland, pond and lakes locations is provided in the digital appendix.

For more detailed discussions, refer to section 6.4 Wetlands, Ponds and Lakes – Condition and Location.

1.5.5 Noxious and Non-Native Weed Species

Japanese knotweed is a high priority for removal in the system. Locations near the Idiot Creek Bridge are likely to provide germplasm for infection downstream. Knotweed is well established in the lower reaches of the Wilson River, though not on ODF lands. Constant monitoring is required to track even small infestations of knotweed. Removal and location identification of upstream knotweed populations should be considered a high priority for restoration and enhancement. Other species, including garlic mustard, Scotch broom and Himalayan blackberry are of growing concern in the watershed. Garlic mustard infestations have been recorded in Gales Creek, located immediately outside the watershed boundary and are of concern for entry and establishment in the watershed. Best Management Practices (BMPs) associated with recreational uses, including washdowns of vehicles prior to trail entry, will help to mitigate weed spread. Collaborative development of BMPs with forest users should be considered to minimize the recreational impact on the native community types.

For more detailed discussions, refer to section 6.5 Noxious and Non-native Weed Species.

1.5.6 Riparian Restoration and Enhancement Opportunities

Several factors are to be considered in the enhancement and restoration of the riparian zones. The long-term outlook for species composition and structural changes, excluding stochastic factors (landslides, etc) indicate few conifers will recruit to the canopy through time. This has direct implications for wood recruitment in durable conifer material to the stream system from the immediate riparian zone, as measured from standing wood within the 100 foot buffers. In addition, a no-management scenario suggests there will be a substantial lag in canopy recruitment by both conifer and hardwoods through time, which limits the population potentials of all larger-diameter wood material (short lived and durable) in the standing stock, and ultimately for interaction with the stream channel.

This watershed analysis produced several key findings involving the riparian zone and the *ecosystem service* dynamics expected through time. The majority of these findings were based upon a map and subsequent ground-truth sampling based on aerial photography, coarse vegetation types, and relatively large stands. The current riparian vegetation map served as a very refined effort to ascertain the watershed and subwatershed level trends in species composition, structure, large wood recruitment, stream shading, and other intrinsic characteristics of the system. It is important to note that the data do not provide enough resolution to assign site-specific silvicultural treatments, nor are they sufficient to evaluate the potential effects of those treatments on large wood, shade, and other ecosystem

services to the stream system. Despite this level of resolution, however, 1) the data were sufficient for developing "*general*" silvicultural prescriptions based upon the current and projected stand conditions (section 6.3.2.1.1 – Recommended (General) Silvicultural Treatments and Map 63) and 2) the acquisition and use of high resolution LiDAR data (Light Detection and Ranging; also called ALSM, Airborne Laser Swath Mapping) may help resource managers develop "site-specific" silvicultural treatments (and ODF is in process of obtaining LiDAR data for some districts). For riparian zones, LiDAR provides unique opportunities to identify riparian features, characterize, type, highlight "manageable units" to evaluate potential management options and target specific locations for riparian enhancement.

For more detailed discussions, refer to section 6.3 – Riparian Enhancement Opportunities.

1.5.7 Recreational Impacts

Recreational impacts on riparian vegetation were assessed using two different methods; one utilizing ODF's dispersed camping site inventory, the other field assessment of a subsample of ODF's dispersed camping site inventory. Sample sites were chosen to represent sites along tributaries in upper, middle and lower watersheds as well as along the main stem.

Data from ODF's dispersed inventory indicate that 33 sites (17.8%) are within 25 feet of water in the stream bank zone (SBZ). Unfortunately, ODF data were inadequate for determining how many sites are 25-100 feet from water in the inner riparian zone (IRZ). More than 62% of the sites were found to have moderate, high or very high impacts (See Map 42). The impact area in most sites was less than 1,000 square feet but there were a few sites that had very large impact areas of up to 10,000 square feet.

In contrast to ODF findings, results from our follow-up field assessment using a subsample of ODF's inventory indicate that 78% of the sites fell within the SBZ, 22% fell within the IRZ. Overall, the majority of the sites had bare soils with widespread and exposed root systems, or with trees showing visible signs of reduced vigor or mortality. In addition, the field assessment found that disturbance areas were larger than the ODF inventory data indicated. For example, less than 1% of the sites had disturbance areas less than 250 square feet, 33% had between 250-1,000 square feet, 39% had between 1,000-10,000 square feet and 22% had greater 10,000 square feet of disturbed area. The total condition class (i.e., all factors considered) at the sites ranged from 2-10 (low impact to

severe impacts), and averaged 7.4 on this scale[2]. Observations of human impacts included direct erosion to the stream channel or wetlands, severe tree damage or mortality, soil compaction, and multiple user-defined OHV trails leading directly to stream channels.

Key recommendations for reducing the riparian impacts from recreation include; buffer camps from the SBZ, close and upgrade dispersed camps and removal of unrestricted OHV use from IRZ. In addition, we provide an array of potential management actions to recoup costs, collect use data, monitor impacts and modify user behaviors.

For more detailed discussions, including methodologies, results and recommendations, refer to section 6.7 Recreational Impacts on Riparian Vegetation – Direct and Indirect Effects.

1.6 Sediment Sources

1.6.1 Current and Potential Sources and Erosional Areas

Surface erosion of undisturbed soils is not an issue of concern. The soils are sufficiently permeable that surface runoff (and associated surface erosion) occur only where soils have been compacted or where drainage from road surfaces is discharged. Erosion from roads and off-highway vehicle (OHV) tracks is addressed separately, below.

1.6.2 Landslide-Prone Slopes and Debris-Flow-Prone Channels

Landslides formed by the sudden failure of water-saturated soils on steep slopes are a natural process in this watershed and provide a significant source of sediment and wood to stream channels. Steep, landslide-prone slopes are abundant (Map 44), both in headwall areas and along channel-adjacent inner gorges. Shallow-rapid landslides occur on both planar and concave (bedrock hollow) slope forms. Susceptibility to landsliding can be increased by removal of vegetation (timber harvest) and by road or skid trail rerouting and concentration of hillslope drainage. These landslides incorporate both down and standing trees; thus source areas for these landslides also serve as upslope source areas for wood to fish-bearing channels (Map 26).

Many shallow-rapid landslides deposit into small headwater (Type N) channels; these channels then form long-term storage reservoirs for sediment and wood. In some cases, shallow-rapid landslides evolve into debris flows, which can travel long distances through headwater channels, scouring the accumulated material

[2] Adapted from Cole 1989.

for re-deposition in larger, fish-bearing channels downstream. Predominant source areas for these debris flows are identified in Map 27, and the headwater channels most likely to serve as debris-flow corridors to fish-bearing streams are identified in Map 29. Sediment from landsliding is not currently considered a limiting factor for fish productivity in this watershed; however, availability of large wood is and will continue to be limiting for many streams, so that efforts to preserve and promote availability of large wood from these upslope sources can have significant positive effects over time.

In upslope management, it is important to consider the likely effects of downstream debris-flow deposition. As discussed in Section 1.5.3 (Large Wood Recruitment and Wood Recruitment Budget), source areas to channels with high potential for fish use and low potential for riparian sources of large wood merit special consideration for leave areas and riparian management to enhance large-tree abundance. These areas are identified in Maps 38.

Mainstem channels ranging from about 15 – 20 m (50 – 66 ft) width are sufficiently large and steep that storm discharges can entrain debris flows and form debris-laden floods (Map 28). These sediment- and wood-rich floods can severely damage aquatic habitat and riparian vegetation. Unfortunately, many of the channels most susceptible to debris-laden floods are also those with high potential for fish use (Map 37). Although this is a natural process, perhaps enhanced by the lack of large trees along debris-flow corridors and in riparian zones, it is important to recognize the potential for debris-laden floods to destroy habitat gained through conservation and restoration efforts within a sub-basin. The stochastic nature of debris-flow occurrence makes it unlikely that all sub-basins would be equally affected by debris-laden floods during any major storm event. It is important, therefore, that conservation and restoration efforts be dispersed and not concentrated in any single sub-basin.

For more detailed discussions, refer to sections 7.1 – Slope Instability and 7.2 – Debris Flow-Prone Channels.

1.6.3 Deep-seated Landslides

Large, deep-seated landslides (earthflows) are present in the basin, but are generally inactive or only slow moving and are not an important source of sediment to channels. However, valley morphology associated with these landslides does affect channel profiles, with lower channel gradients found adjacent and upstream of these features. Thus large deep-seated slides could contribute to habitat formation in certain areas. For example, one or more large, ancient deep-seated landslides have created low channel gradients and wide valley floors in the lower part of the Devil's Lake Fork, creating highly rated coho habitat.

Another type of deep-seated failure occurs on relatively steep slopes and may involve tens of acres and occur at depths of 10 meters or more. Driven by highly weathered and weakened bedrock, the deep-seated slides are mostly unpredictable with the exception of mapping old landslide deposits along valley floors. A notable example of this type of deep seated landsliding occurred in the West Fork of the North Fork of the Wilson during the large storm in December 2007. Sediment volumes of tens to hundreds of thousands of cubic meters from deep-seated slides (equivalent to tens to hundreds of debris flows in headwater channels) completely overwhelmed the valley floor morphology for many kilometers downstream of the events. Because of their depth, these types of failures appear to be unrelated to timber harvests.

For more detailed discussions, refer to section 7.3 – Deep-seated Landslides.

1.6.4 Road-Related Issues

This analysis evaluated forest roads in the Wilson River watershed using a survey protocol developed by ODF to rapidly assess the risk roads pose to aquatic resources. The survey, conducted in 2006, found that culverts at stream crossings are one of the most important road features in terms of the need for ongoing inspection and repair. Severe storms in the winter of 2006 and 2007 caused failure at many crossings and illustrated the vulnerable nature of stream crossings. Based on survey data, we found many stream crossings with a high wash-out potential including many on blocked roads that are not routinely inspected. We have identified stream crossings with high washout potential and in need of servicing. These crossings are listed in Table 36 (on blocked roads) and Table 37 (on open roads). Managers need to inspect these crossings to determine if the current structure needs to be removed and replaced. Inspection of critical stream crossings should occur during high flow events. Repairs should include removing debris, constructing dips, and constructing berms in the ditch at the lower spot on the stream crossing fill.

Surveyors also rated fish passage at all stream crossings. We found 28 stream crossings that blocked fish passage. Those stream crossings are listed in Table 38 and are in need of inspection and repair.

Hydrologic connection on both open and blocked roads is relatively low. Open roads have a higher percentage of hydrologically connected segments than blocked roads. Managers should evaluate hydrologic connectivity while upgrading and repairing roads. Significant storms may change the hydrologic connectivity of a road. Therefore, monitoring roads after storms to determine hydrologic connectivity is critical.

Considering hydrologic connectivity alone does not tell the complete story of forest roads and sediment delivery to streams. We found that while hydrologic connection of blocked roads was relatively low, the majority of hydrologically connected blocked roads actively loaded sediment to streams. Segments identified as actively loading sediment to streams are identified in Appendix X – List of Priority Inspection Roads. These roads should be inspected and repaired if needed.

The proportion of open roads in higher resource risk critical locations in the Wilson River watershed is similar to other nearby watersheds. The percentage of blocked road segments determined to have cut and fill slides (i.e., high slope severity) was 10 times greater than the percentage of cut and fill slides for open road segments. Blocked roads were determined to have 3 times more of their total length that contained fill slides than did open roads (Table 30). Table 42 identifies specific road segments that may pose a long-term risk where slope severity intersects with high potential for landslide delivery to fish bearing streams. These road segments should be inspected to determine if maintenance is needed to prevent future delivery to fish-bearing streams.

Open roads in the Wilson River watershed typically have stable prisms. Blocked roads are less stable and pose a greater risk to the aquatic resource. (Table 32). Road segments that are unstable and have a high potential for landslide delivery to fish-bearing streams should be inspected in order to prevent future delivery to fish bearing streams (Section 7.4.9 Long-term Risk Analysis).

In all, the road system has been designed to limit impacts to aquatic resources. Yet, problems persist, especially at stream crossings where wash out potential is high and where fish passage is blocked. The data summarized in this analysis directs managers to road segments that are a high priority for inspection, repair or removal.

For more detailed discussions, refer to section 7.4 – Road-Related Issues (on sediment supply and delivery).

1.6.5 Recreation-Related Issues

Two field-based methods and an analysis of an existing ODF trail inventory database were used to assess the extent to which OHV trails and other recreation activities impact stream sedimentation and water quality, hydrologic connectivity, and erosion conditions, as well as the proportion of OHV trails located next to streams and their associated washout risks. The road/trail survey conducted by Duck Creek Associates in 2006 noted a variety of conditions on approximately 42 miles of trails while an additional follow-up field sample of 13

trails quantified the extent of soil loss and updated the site conditions from ODF's trail inventory database.

Field assessment results indicate that sedimentation is most acute where eroding trails intersect adjacent streams or where trails intersect road drainage systems. ODF estimates that the Wilson River watershed has approximately 150 miles of designated trails but not all undesignated trails have been systematically surveyed except where they intersect roads. Of the trails surveyed (42.7 total miles), 2.1 % had hydrologic connectivity and 2.1 % ran parallel to streams (Map 56). Data were unavailable for determining the percentage of other unsurveyed trails that were connected or parallel to streams. Data from a field assessment of hydrologically connected trails indicate a high likelihood of water quality effect on trail-stream intersections that have had no mitigating trail drainage engineering, bridging, and/or that exhibit trail grade/slope alignment in excess of trail standard maximums. The majority of hydrologically connected trails sampled at trail-road and trail stream intersections violated accepted trail design recommended maximums. An additional field assessment of erosion and site conditions along OHV trails revealed additional highly eroding hydrologically connected trails, suggesting a greater degree of erosion than previously indicated in either the ODF trail inventory database or the Duck Creek Associates road/trail survey. Many trails have steep grades, fall line trail alignment and poor drainage, and, with high use, result in active erosion conditions on most trail surfaces.

Of the designated trails surveyed during the road/trail survey (2006), approximately 3.1 miles were located parallel to streams and hydrologically connected (Map 56). Extrapolated to the entire watershed, 6.3 miles of designated trails are parallel to streams and hydrologically connected. Additionally, 47.3% of trail-stream crossings were found to have a high washout potential. Undesignated trails, however, are more likely to cross streams but no data for this type of trail is available for the Wilson River watershed. Cross sectional area (CSA) measures of soil loss and disturbance area over a combined sample trail length of 3,870 feet revealed an average soil loss of 1,157 cubic yards per mile of trail (all trail types combined). Additionally, 33 dispersed recreation sites were found to be within 25 feet of streams (See Map 43) and 62% exhibited moderate to very high water quality impacts. Sites with complete vegetation loss of greater than 1,000 square feet all occur on the Forest Grove (FG) District (road numbers FG088, FG101, FG060, FG073, FG092, and FG100 in the Duck Creek Associates road database). Two sites had greater than 10,000 square feet of vegetation loss (road numbers FG029 and FG039) and exhibited severe soil exposure and compaction.

Overall, trails in the watershed exhibit conditions that are having impacts on water quality and sedimentation rates. Of the 42 miles assessed during the

road/trail survey (2006), 28% exhibited sedimentation risks. Scaled up to the watershed, this would indicate that as much as 41 miles of the 150 mile designated OHV system pose sedimentation risks. Of the hydrologically connected trail segments assessed during a field survey, extremely high levels of disturbance and erosion were recorded. Nearly half of the trails had moderate to high stream crossing washout potential and exhibited key washout risk indicators. For example, 77% of trail segments ran down the fall line and 84% had trail grades that exceeded 11 degrees. We recommend that several key washout risk indicators be included in future monitoring activities and when determining priority for corrective action on trail segments.

In general, the ODF dispersed camping inventory database provided good baseline data on site conditions but lacked quantifiable measures useful for determining specific site by site priority. We provide a range of acceptable standards and actions to guide recreation managers and recommendations for upgrading the standard ODF recreation inventory form, including the addition of numerical values based on accepted standard campsite monitoring protocols[3]. Finally, the effectiveness of recent (post-1994) upgrades to OHV sites, dispersed camping sites, and other recreational sites has been mixed. The majority of designated campgrounds, OHV sites and trails have been successfully upgraded, while other undesignated trails and dispersed sites are not within the capacity of recreation budgets to upgrade or effectively close. OHV trail upgrade and maintenance capacity is limited by heavy year-round use, too many events, and eroding trails and sites and we provide recommendations for addressing these concerns.

Key recommendations for reducing the sedimentation impacts from recreation include; removal of unrestricted OHV use from the inner riparian zone (IRZ), and relocation of trails from steep slopes and from slope alignments that produce sediment delivery to streams and road drainage systems. In addition an array of management actions to improve inventory of trail system, monitor impacts and modify user behaviors.

For more detailed discussions, refer to section 7.5 – Recreation-Related Issues (to sediment delivery and supply).

[3] Wilderness Campsite Monitoring Methods: A Sourcebook. David N. Cole, GTR-INT-259, April 1989.

1.7 Water Quality

1.7.1 Water Quality Criteria, Limited Sections and Status

Beneficial water uses in the Wilson River watershed include maintenance of estuarine waters, support of cold-water aquatic life, and support of salmon and steelhead spawning. Current water quality limitations identified by the Oregon Department of Environmental Quality (ODEQ) in the Wilson River are due to low dissolved oxygen, probably related to high water temperatures, for the period September 1 - June 15 in the Wilson River mainstem from river mile 5.8 to 27.2 (approximately 4 miles downstream of the confluence with Little North Fork to Lee's Camp).

For more discussions, refer to section 8.2 Water Quality Criteria, Limited Sections, and Status.

1.7.2 Current and Potential Shade Levels

Stream shading was estimated as the combined function of riparian vegetation, topography, and active channel widths (i.e. effective shade) for current conditions (year 2006) and two future time periods (2056 and 2106) along the 12 principal streams within the Wilson River watershed. Future shade levels were based on riparian stand modeling, assuming no active management of riparian stands. Shade levels for all stands generally increase along the principal streams for the 0-50 year time horizon, but decrease over the 0-100 year time horizon as stands mature and canopy conditions begin to break up. Management recommendations for ODF lands include:

- Protect and allow for further passive restoration of those riparian areas currently offering high shade levels
- Evaluate areas where current shade levels are low and determine if active restoration (e.g., removal of riparian roads; planting of low-stocked stands) is warranted
- Consider more aggressive stand treatments for those riparian stands where long-term shade levels are predicted to <u>decrease</u> in the absence of active management.

For more detailed discussions, refer to section 8.3 Stream Shading.

1.7.3 Stream Temperatures, Reasonable Achievable and Compared to Potential Levels

Regression analysis was used to determine the relationship between the annual maximum seven-day moving average of the daily maximum water temperature (**T_{max}**) and the environmental variables most likely to affect water temperatures. Regression results were robust, explaining 81% of the observed variation. Effective shade (a combination of topographic and riparian shade) showed the strongest correlation with T_{max}.

Effective shade values for the 2056 and 2106 modeled time periods were used in the Wilson River regression model to evaluate likely future stream temperature levels along the principal streams in the Wilson River watershed. Results indicate that in the mid-term (i.e., 50-year time horizon) shade conditions, and associated stream temperatures, will experience an improving trend, as current stands mature, and riparian shade generally increases. However, over the longer term (0-100 years) we can expect to see shade conditions deteriorate, and temperatures increase, as stands break up and shade conditions decrease.

For more detailed discussions, refer to section 8.4 – Stream Temperatures, Reasonable Achievable and Compared to Potential Levels.

1.7.4 Stream Temperature Comparison with Adjacent Basins

We evaluated how water temperatures at sites in the Wilson River watershed compared to other nearby basins with similar environmental conditions. The adjacent Trask River watershed was most similar to the Wilson in terms of principal lithologies, size, and (given its adjacency to the Wilson) climate. Results of the assessment suggest that stream temperatures in the Trask are lower (by about 2 degrees Fahrenheit) than in the Wilson, at least up to ~20 miles from the drainage divide. Possible explanations for relatively lower temperatures in the Trask as compared to the Wilson include differences in riparian shading, due to more aggressive riparian harvest and/or greater riparian disturbance (e.g., flood damage); and cool-water reservoir releases (i.e., Barney Reservoir on the Middle Fork of the North Fork Trask River).

For more detailed discussions, refer to section 8.5 – Stream Temperature Comparison with Adjacent Basins.

1.7.5 Limiting Factors

We used the ODEQ "core cold water habitat use" criterion of T_{max} less than or equal to 60.8 degrees Fahrenheit (16.0 degrees Celsius)[4] as the metric to evaluate to what extent stream temperatures and/or shade conditions are limiting the achievement of properly functioning condition in the Wilson River watershed. All of the principal streams within the Wilson River watershed are designated as core cold water habitat[5]. Many of the principal streams are also designated as salmon and steelhead spawning use[6] as well, however, the seasons that this designation apply to are outside of the July and August time period considered for this analysis.

Results, presented for two time periods (0-50 years in the future, and 0-100 years), indicate that in the mid-term (i.e., 50-year time horizon) shade conditions, and associated stream temperatures, will experience an improving trend, as current stands mature, and riparian shade generally increases. However, over the longer term (0-100 years) we can expect to see shade conditions deteriorate, and temperatures increase, as stands break up and shade conditions decrease (see the discussion on lack of canopy recruitment in Chapter 6 – Riparian and Wetlands, section 6.2 – Potential Future Conditions).

For more detailed discussions, refer to section 8.6 – Limiting Factors (to water quality).

1.8 Fish and Fish Habitat

1.8.1 Species Information

As of December 2007, none of the anadromous salmonid species inhabiting the Wilson River watershed are currently listed as *Threatened* or *Endangered* under the federal Endangered Species Act (ESA; refer to Table 63 in section 9.3 Native and Introduced Salmonids). Oregon coastal coho, however, are likely to be re-listed by NOAA Fisheries in early 2008 as *Threatened*. Numerous species/stocks, however, including several non-salmonids, are listed by the State as *Sensitive/Vulnerable* or *Sensitive/Critical* (Table 63). While no introduced salmonids, except the summer steelhead stock/race, are known to occur in the Wilson River, information pertaining to the introduction and establishment of non-salmonid species is severely lacking. Additionally, information pertaining to native non-salmonid abundance and distribution is non-existent.

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[4] http://arcweb.sos.state.or.us/rules/OARs_300/OAR_340/340_041.html
[5] http://www.deq.state.or.us/wq/rules/div041/fufigures/figure230a.pdf
[6] http://www.deq.state.or.us/wq/rules/div041/fufigures/figure230b.pdf

According to a recent study by the ODFW (Kavanagh et al. 2005), historic salmonid distributions (although somewhat speculative in nature) are likely very similar to their current distributions. Additionally, current abundances, with the exception of fall Chinook salmon, are likely severely depressed compared to their historic (pre-European settlement) abundances. Indeed, resting hole and spawning counts from the past 50+ years, with few exceptions, generally indicate decreasing abundances coupled with high variability, underscoring the tenuous nature of many of these stocks/runs. Recent data (e.g., <15 years), however, may indicate that coho and Spring Chinook salmon populations are on the rebound but inter-annual variation and the short duration of the recent trend makes interpretation and conclusion problematic (refer to sections 9.7 – Historic Salmonid Abundance and 9.8 – Current Salmonid Abundance).

1.8.2 Instream Large Wood

Since European settlement, fish habitats in the Wilson River watershed have been significantly influenced by both natural and human-caused disturbances. The Tillamook Burn fires and subsequent timber harvest and road-building activities significantly altered the types and availability of high-quality aquatic habitats present in the Wilson. Perhaps the most significant effect was the removal of large wood from the system, both from the streams ("stream-cleaning") and from the riparian (fires and subsequent harvest). The lack of instream large wood pieces (see section 9.10 Fish Habitat Condition) is likely having a detrimental effect on the overwintering abilities of juvenile salmonids and on the accumulation of gravels, especially in the Jordan Creek subwatershed where 80% of the surveyed stream reaches exhibited LOW (relative to ODFW "reference/benchmark" reach data) percent gravel, HIGH percent bedrock and LOW percent pools (Table 73 and section 9.11 – Instream Large Wood; although this may also be a relic of historic log drives).

1.8.3 Aquatic Habitat Conditions

Data for several key habitat attributes from reaches throughout the various Wilson River subwatershed often are not apportioned according to ODFW's Aquatic Inventories Project (AIP) reference reach data. When considered collectively, however, the data may suggest that aquatic habitat conditions in the Wilson River are still exhibiting some level of functionality. For example, data for conditions within the Little North Fork of the Wilson subwatershed are fairly evenly distributed among the LOW, MODERATE and HIGH categories (28.7%, 50%, and 21.3%, respectively; see Table 73 in section 9.10.2 –Results [of Fish Habitat Condition]), indicating that aquatic habitat conditions within this subwatershed are likely functioning in a manner similar to other coastal watersheds that have experienced relatively little human disturbance (refer to section 9.10 – Fish Habitat Condition).

Key habitat attribute data from the Jordan Creek subwatershed, on the other hand, are skewed relatively heavily toward LOW categories (48% LOW, 37% moderate, 15% HIGH; see Table 73 in section 9.10.2 Results), indicating that aquatic habitat conditions in this subwatershed may be compromised compared to reference conditions (i.e., other coastal watershed that have experienced relatively little human disturbance). Indeed, three other subwatersheds exhibit similar patterns (Devils Lake Fork, Middle Wilson, and North Fork Wilson). In contrast, key habitat attribute data for the Upper Wilson/Cedar Creek and South Fork Wilson subwatersheds indicate only a moderate distributional skew away from reference conditions while still roughly approximating data from reference reaches (refer to section 9.10 – Fish Habitat Condition).

1.8.4 Fish Barriers

In order to document culvert/road barriers to fish movement, Duck Creek Associates conducted an extensive and exhaustive survey in the Wilson in 2006. Surveyors identified 926 road/stream crossings, of which 144, or 16%, were considered (likely or observed) barriers to fish-passage (see Table 77 in section 9.13 – Fish Passage Barriers; Map 58). Blockage types described by surveyors ranged from collapsed and sediment-filled culverts to blocked inlets and outlets and well as perched culverts. There are an estimated 24.6 miles (or 7.8% of the total miles [313] of designated fish habitat in the Wilson) of *potential* fish habitat that are blocked by impassable culverts (see Table 78 in section 9.13 – Fish Passage Barriers). Of the total percent blocked by culverts(7.8%), 4.6% are effective adult salmonid barriers and 3.3% are only barriers to juvenile salmonid movement. For a detailed list of the road location of these barriers, refer to Appendix Q – Fish Barriers.

1.8.5 Recommendations and Priority Stream Reaches

Although the Tillamook Bay estuary may well be the conduit for potential introduced species invasions, introductions may also occur on ODF lands. Because some invasions can have far-reaching and catastrophic effects on local, native populations, we recommend that ODF maintain a close working relationship with the ODFW and Tillamook Estuaries Partnership to identify (early) potential outbreaks of invasive species.

Due to the sensitive and precarious nature (e.g., low abundances and high variability in peak counts) of many of the watershed's fish species, extra precaution should be employed when considering whether a species will be impacted by management actions. Additional caution is urged when considering the effects of multiple actions within relatively discrete geographic areas (e.g., individual streams).

Furthermore, because the spawning survey data indicate such a high variability in peak abundance over the last 50+ years (see sections 9.7 – Historic Salmonid Abundance and 9.8 – Current Salmonid Abundance), we recommend extreme caution when interpreting the effectiveness of restoration activities, especially over the short-term. Additionally, the effectiveness of restoration projects should be repeatedly assessed over the course of several years and even decades and the costs of long-term monitoring activities should be included when calculating future projects' costs.

Fish production is intricately tied to the availability of quality habitat and the current aquatic habitat data in the Wilson are often negatively skewed compared to ODFW's Aquatic Inventories Project (AIP) reference reach data. Furthermore, aquatic habitat complexity is intricately linked with the abundance of instream large wood. The lack of large instream wood pieces in the Wilson is having a substantial and persistent detrimental effect on the overwintering abilities of juvenile salmonids and on the accumulation of gravels and the overall number of pools present in the system. Therefore, silvicultural treatments that encourage the production and recruitment of large instream wood may well have a substantially positive impact on 1) long-term aquatic habitat conditions and 2) increased production of fish species.

Two actions that would arguably have the largest beneficial impact on aquatic wildlife and their associated habitats would be:

1. encouragement of instream large wood recruitment in both riparian and upslope areas that coincide with landslide- and debris-flow prone areas that are predicted to deliver to fish-bearing streams, and

2. placement of instream large wood in and upstream of high priority aquatic areas for the development of instream pieces of large wood.

As key pieces of large wood begin to recruit to (or are placed in) the streams, we would expect to see an increase in pool frequency, decreases in the number of habitats where bedrock dominates, increases in gravels, and increases in aquatic cover associated with wood accumulations. It is important to note, however, that the effectiveness of instream large wood depends on size of the receiving channel, size of the piece(s) of wood and the probability that large wood additions will accumulate (related to channel roughness, meander, riparian vegetation, wood size/length, etc.). Our modeling results indicate that riparian stands will be unable to provide adequate functional wood throughout the next century for streams of about 30 feet in width and greater. Streams of this width are at the upper end (and beyond) the size range generally recommended for large wood placement (e.g., ODF & ODFW 1995). Nevertheless, these are the streams with highest value for fish and the lowest potential for large wood

recruitment (see Maps 31, 32, 33, and 37). It will be worthwhile, therefore, to look for opportunities for large wood placement within these general areas. The models used an estimate of average channel width, and do not capture details of spatial variability in channel configuration: some reaches within the channels identified as high priority for fish, and low potential for riparian recruitment of functional wood, will fall within the range of channel widths and slopes recommended for wood placement (page 5 in ODF & ODFW 1995). Managers ought to identify and evaluate these narrower, lower-gradient reaches as potential reaches for large wood placement.

A stream reach prioritization scheme was developed and the resulting list (detailed in section 9.14 – Priority Streams) can be used as a screening tool – when overlayed in a GIS – to identify streams and stream reaches that are of particular importance. These streams/reaches, if protected and/or restored, would provide the greatest overall beneficial impacts to aquatic resources. Priority streams/reaches were identified in every subwatershed (see Table 79 in section 9.14 – Priority Streams) and ranged in length from less than 0.1 miles to more than 60 miles with most of the reaches occurring in large, contiguous segments (as opposed to fragmented). Because of the presence of Salmon Anchor Habitats, the subwatersheds with the highest priority streams all occur in the Little North Fork Wilson, Upper Wilson/Cedar Creek (including Ben Smith Creek), and Devils Lake Fork subwatersheds. Not surprisingly, this result also corresponds with subwatersheds where aquatic habitat conditions were in MODERATE to GOOD shape (i.e., where conditions were most similar to ODFW "reference/benchmark" streams).

Aquatic habitat conditions in the Little North Fork Wilson subwatershed are in GOOD shape (relative to ODFW "benchmark/reference" reaches), indicating that aquatic habitat conditions within this subwatershed are likely functioning in a manner similar to other coastal watersheds that have experienced relatively little human disturbance. Indeed, fish numbers in this subwatershed generally reflect this. Therefore, we recommend that ODF take actions that maintain the current conditions in this subwatershed.

Key habitat attribute data from the Jordan Creek subwatershed, on the other hand, are skewed relatively heavily toward LOW categories (48% LOW, 37% moderate, 15% HIGH), indicating that aquatic habitat conditions in this subwatershed may be compromised (the aquatic habitat condition received a VERY POOR rating). Indeed, steelhead and coho numbers generally reflect this. Because this subwatershed contains high habitat intrinsic potential but low numbers of fish, ODF could consider restoration actions in this subwatershed that are geared toward steelhead and coho recovery and improvement of overall

aquatic habitat complexity (e.g., increase the number of pools, percent gravel, and instream large wood).

Aquatic habitat conditions in the Upper Wilson/Cedar Creek and the Little North Fork Wilson, on the other hand were rated as being in MODERATE and GOOD condition (respectively), the subwatersheds contain high IP for coho and steelhead, areas of high core habitat for coho and steelhead, and contribute large numbers of coho, steelhead and cutthroat trout. Few restoration efforts, therefore, may be needed here and ODF should take actions that maintain the current conditions. Conversely, aquatic habitat conditions in the Devils Lake Fork and the South Fork Wilson were rated as being in POOR and MODERATE condition (respectively), yet the subwatersheds contain areas of high IP and core habitats for coho and steelhead, contribute large numbers of coho salmon and cutthroat trout but do not produce many steelhead. Therefore, restoration efforts in these subwatersheds could be focused on improving aquatic habitat conditions (e.g., increasing the number of pools, percent gravel, and large wood) for steelhead (low fish numbers) and coho (listed species).

Additionally, while apparently not a large issue in the Wilson, historic road-building activities have reduced the connectivity of stream reaches to each other, blocking the movements of fish. Although some fish blockages still exist (e.g., improperly sized culverts, steep gradients, too high steps at the mouth, etc.), current road-building and road-restoration practices have largely eliminated fish passage issues. Yet, the stream crossing washout potential and sedimentation issues identified in this assessment still have the ability to negatively impact aquatic habitats and, given the recent frequency of large storm events, should be immediately repaired or replaced. Furthermore, this assessment identified numerous recreational trails and dispersed recreation sites that were 1) hydrologically connected, 2) actively eroding, and 3) damaging riparian vegetation. To reduce sedimentation and increase riparian shade at these sites, ODF should 1) restrict their recreational use or close them altogether, 2) repair damaged areas, and 3) work to educate recreational users about the negative ecological, biological, and socio-economic effects from improper use.

In general, the Wilson River watershed's basic biological and ecological requirements are largely being met by the current conditions in the Wilson, but the lack of large wood (upslope, riparian and aquatic) is arguably having the largest impact on aquatic habitat complexity (e.g., lack of pools, deep pools, large wood accumulations, cover, low gravels, etc.) and large wood recruitment is projected to remain below target levels well into the next century. Tailoring riparian and upland silvicultural treatments for the enhancement/recruitment of large wood may help the aquatic habitat conditions recover at a faster rate.

Adhering to the management recommendations mentioned above will help to 1) ensure adequate funding for long-term monitoring activities, 2) reduce the likelihood that an exotic species invasion will go unnoticed for some time, 3) reduce sedimentation and erosion and increase riparian shade (in some areas), 4) restore fish passage to useable habitat, 5) enhance the recruitment of large wood to streams thereby improving aquatic habitat complexity, and 6) maintain (or enhance) aquatic habitat conditions throughout the Wilson.

1.9 Synthesis

1.9.1 Watershed Condition

Since European settlement, the Wilson River watershed has experienced widespread natural and human-influenced disturbance. Although current timber harvest and riparian management practices adhere to widely-accepted standards (e.g., Forest Management Practices), much of the watershed has been heavily impacted by past management practices (e.g., timber harvesting, wildland fire activities, road building, conversion of lowlands to agricultural production, stream cleaning, etc.). While the Wilson is currently in a state of intermediate recovery, the combined effects of legacy and current practices are largely evident in:

- the young, even-aged riparian forest stands,
- the low potential for near- and long-term large wood recruitment to streams
- the low amounts of instream large wood,
- the low number of pools (including deep pools),
- the lack of instream diversity,
- the relatively high number of stream crossings that
    - exhibit a high washout potential and
    - are potentially blocking fish passage,
- and the quantity of road segments, trails, and dispersed recreation sites that are actively eroding to streams.

Although recovering, these legacy effects – particularly from the Tillamook Burns and subsequent road-building and logging activities – are still having a moderate to high impact on the Wilson. Furthermore, riparian and large wood

recruitment modeling exercises indicate the legacy effects will continue to impact the Wilson into the foreseeable future (e.g., >100 years). Because there are no examples on which to base the recovery of a watershed after these kinds of large-scale disturbance events, it is difficult to determine exactly how far along in the recovery process the Wilson River watershed is.

The effects from current management practices, however, range from low (e.g., hydrology) to high (e.g., recreation). Limiting recreational use and focusing restoration efforts on streamside areas will likely have a beneficial impact on the recovery of riparian areas. Fixing stream crossing with high washout potential and removing fish blockages will reduce sedimentation and open up additional areas for fish spawning, migration and rearing (although the degree to which this will aid in the recovery of a species is unclear). Additionally, tailoring riparian and upland silvicultural treatments for the enhancement/recruitment of large wood may help the aquatic habitat conditions recover at a faster rate.

Overall, while the Wilson River watershed is still largely being impacted by the legacy effects of previous land use practices, negative effects from current management practice are at relatively low level and are generally improving conditions throughout the watershed (see recreation-related topics in the text for some exceptions). In general, the Wilson River watershed appears to be in an intermediate state of recovery, given the high degree of disturbance it has experienced in the last 100+ years. While many basic biological and ecological requirements are largely being met by the current conditions in the Wilson, the lack of large wood (riparian and aquatic) is arguably having the largest impact on aquatic habitat complexity (e.g., lack of pools, deep pools, large wood accumulations, cover, low gravels, etc.) and large wood recruitment is projected to remain below target levels well into the next century.

1.9.2 Management Considerations

The Wilson River watershed is prone to periodic, large-scale disturbances. Large storm events lead to flooding and landsliding, resulting in debris-flows and torrents. Historic catastrophic fires with long fire-return intervals, combined with periodic storm events, historically recruited large wood and sediments to the system creating a rich, diverse freshwater habitat. Since European settlement, the watershed has been exposed to a variety of human-influenced events including frequent forest fires, creation of a dense network of forest roads, increasing forest recreation use and intense timber harvest.

It is important to consider that the riparian ecosystem has essentially been reset to an early-successional, even-aged, hardwood-dominated forest which modeling exercises predict, in the absence of management, is likely to persist for 100+ years. Furthermore, the Wilson has abundant steep, landslide-prone slopes and

steep, mainstem channels that often confined and highly sensitive to management activities. For example, road building on steep slopes may lead to road failure and increased sedimentation to fish-bearing streams. Additionally, dispersed recreational trails on erosion-prone steep slopes that are hydrologically connected can dramatically increase sediment loading. While landsliding and debris-flows deliver sediments and large wood that is beneficial as aquatic habitat, increased fine sediments can inhibit survival of salmonid eggs and decrease the amount of available spawning gravel. Given that salmonid populations are depressed compared to historic levels and recent return rates are highly variable, it is advisable to carefully consider how management actions might influencing these areas.

While the road system in the Wilson is dense and some human-influenced barriers to fish movement exist, improvements to the existing infrastructure and well-designed new roads have largely eliminated sedimentation and fish passage issues. ODF-managed lands in the Wilson are currently being (or are attempting to be) managed to effectively address key issues influencing water quality and aquatic life. Additionally, continuation of current projects that address sedimentation and fish passage issues will help the watershed (e.g., speed up) continue its process of recovery.

Hydrologically, the Wilson has recovered from the Tillamook Burns evidenced by modeled low and peak flows that are ≤3% of baseline flows. Water quality issues (e.g., low dissolved oxygen, high stream temperatures, localized sedimentation), however, are still present during some portions of the year and streamside roads, chronic recreation-related impacts, and projected decreases in shade (under a "no management" scenario) are likely to continue to degrade water quality.

Sedimentation in the Wilson has been of considerable concern, especially after the Tillamook Burns and subsequent logging and road-building activities. However, current sediment sources from landsliding and debris flows should be considered at or near (e.g., slightly elevated) background levels as aerial and field surveys indicate that these types of disturbances were occurring in the Wilson prior to European settlement. This watershed analysis, however, has identified road segments that are actively eroding to streams that might increase sedimentation above background levels.

Riparian areas in the Wilson were essentially "reset" during the Tillamook Burns and are in an early seral stage (early recovery). This is evidenced by a general lack of large diameter trees and a relatively uniform age structure. Additionally, modeling results indicate that in the absence of active management, current riparian conditions are likely to persist into the foreseeable future (e.g., >100 years). Furthermore, few trees are projected to recruit to the larger diameter size

classes, resulting in a lack of large wood recruiting to streams. Silvicultural prescriptions designed to encourage the production and recruitment of large conifers may help speed the recovery of both riparian and aquatic habitat condition.

Recreational activities in the Wilson have been occurring since settlement but large-scale activities (e.g., OHV riding and camping) are relatively recent and increasing at a rapid rate. Sedimentation and streamside shading impacts are of the greatest concern and, although relatively localized, are severe in some areas. The extent to which these activities are occurring throughout the watershed is not fully known but year-round use levels are considered chronic (as opposed to episodic) and will likely remain high.

From an aquatic habitat standpoint, the Wilson is still largely experiencing the legacy effects of past management practices evidenced by the lack of instream large wood, pools (including deep pools) and relatively low channel habitat complexity. While aquatic habitat conditions in the Wilson are recovering, three of the eight subwatersheds received a MODERATE to GOOD proper functioning condition rating, but four of the subwatersheds are in POOR to VERY POOR condition. Even though modeling exercises predict large wood will recruitment to the streams at very low levels over the next 100+ years, accumulations of wood (and gravels) from natural landsliding and debris flows may help the system recover aquatic habitat complexity faster than predicted.

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