4 Stream Channels and Channel Modification

4.1 Methods/Background

This stream channel analysis was conducted using NetMap software (Benda et al. 2007). Using NetMap's functions to calculate habitat intrinsic potential (HIP) for coho salmon and steelhead trout (e.g., Burnett et al. 2003), habitat core areas (using HIP for coho and steelhead), and predicted biological hotspots, we can better understand how channel habitat types have been modified. Habitat intrinsic potential is based on a simple empirical model developed for the Oregon Coast Range that ranks habitats according to channel gradient, valley confinement, and flow. Habitat core areas are defined by connected habitat having a defined critical HIP score and size (length). Rankings of biological hotspots is based on biologically relevant physical characteristics such as gradient, confluence effects, and wood accumulation types. For detailed descriptions of the methodology used to complete this section, see Appendix E – Detailed Methodologies. While the results for coho and steelhead HIP, biological hotspots, and channel classification are found below, additional analyses are located in Appendix D – Natural Disturbance Theory and Simulation and Appendix F – Classification of Stream Channel Habitat Types. Additionally, to ensure accuracy, several NetMap watershed parameters were field validated. Results from the field validation analysis are found in Appendix S – Field Validation of Some NetMap Parameters.

4.2 Channel Habitat Types

A classification of stream channel habitat types was performed to lay the foundation for the Habitat Intrinsic Potential (IP), habitat core areas and biological hotspot and channel disturbance analyses. The different types of habitat classification can be used in different ways in the watershed analysis and in forest management. 'Habitat intrinsic potential' for coho and steelhead juvenile rearing (e.g., Burnett et al. 2003) provides a broad brush classification of general habitat potential in a watershed. The addition of large wood accumulation types and confluence effects creates more specificity to HIP values that might be useful in site specific projects or on-the-ground habitat evaluation. 'Habitat core areas' identifies concentrations of the best potential habitats that in effect sews together somewhat disparate pieces of habitat (HIP for coho and steelhead in this case). This information could be used to inform subbasin-scale plans for resource use and even habitat restoration measures. In other words, basins with the most core areas may be of the most concern. Finally, 'Biological hotspots" includes other more site specific habitat attributes known to be important to fish habitat like woody debris accumulation types and confluence environments. This finer scale rendering of habitat potential could be used to plan more site specific

projects, like stream reach scale restoration measures or habitat monitoring projects. Thus the selection of one habitat classification over another is somewhat dependent on the scale of application and interest. Because the channel habitat type classifications were not of primary interest, however, results from the analysis are presented in Appendix F – Classification of Stream Channel Habitat Types.

4.3 Habitat Intrinsic Potential

NetMap's analyses of habitat intrinsic potential (HIP) for coho and steelhead trout are shown in Maps 13 through 15. Generally, a high HIP value is considered to be greater than 0.7 (Burnett et al. 2003). High HIP values for coho would apply to low gradient (<2%) and unconfined channels. In the Wilson watershed, HIP for coho juvenile rearing habitat greater than 0.7 encompasses approximately 10% of the fish-bearing network (ODF fish bearing) and concentrated in the eastern most portion of the basin and in the western most portion nearest the estuary (Map 13). Overall, the Wilson basin appears to provide fair to poor habitat for coho salmon, particularly across the upper steeper portions of the basin, the exception being the lower gradient portions of the Devils Lake Fork. For juvenile steelhead trout, approximately 46% of the fish-bearing network (ODF fish bearing) has a predicted HIP of greater than 0.7 (Map 14). The predicted HIP for coho with the addition of tributary confluence effects and jam-partial jam wood accumulation type is shown in Map 15.[16]

4.4 Habitat Core Areas

NetMap was used to create habitat core areas for coho and steelhead juvenile salmonids. The critical habitat factors for the core areas for both species were a HIP greater than or equal to 0.7 (a threshold recommended in Burnett et al. 2003), a maximum habitat proximity distance of 500 meters, and a minimum habitat core area persistence length of 1,000 meters. The resulting predicted core habitats for coho (Map 16) are limited to the far eastern and far western (estuary) portions of the networks and comprise a total of approximately 12% of the fish-bearing network.

The predicted area of core habitats for steelhead is distributed throughout the Wilson watershed (Map 17) and comprises approximately 45% of the fish-bearing network. Thus, based on habitat intrinsic potential predictions (e.g., Maps 15 and 16) and estimated core habitat areas (e.g., Maps 18 and 19), the

[16] For definitions, refer to Appendix D – Natural Disturbance Theory and Simulation, Appendix E – Detailed Methodologies, Appendix R – NetMap Analysis of Critical Road Locations and Appendix T – Slope Stability Assessment.

Wilson watershed is dominantly a steelhead fishery system. However, there are patchy but significant areas of coho habitat, particularly in the far eastern and western portions of the basin.

4.5 Biological Hotspots

The map of potential biological hotspots for the Wilson watershed is shown in Map 18 (refer to section 4.2, above, for a definition). Approximately 14% of the fish-bearing network was classified as having a biological hotspot index of > 0.7 and only about 5% of the network was classified as having a biological hotspot index of> 0.8. The parameter used to create biological hotspots includes 1) tributary confluence effects, 2) channel gradient, and 3) valley confinement.[17]

4.6 Sensitive Areas

Channel sensitive areas are those that are most likely to have a change in morphology given the addition or removal of sediment from natural watershed processes (landslides and floods) or from land use related events, including landslides, etc.

4.6.1 Background/Methods

A habitat sensitivity index was created using the parameters of 1) gradient, 2) confinement, and 3) local channel segment-scale sediment supply (t/km^2/yr). The most sensitive channel segments are those classified as meandering in gravel beds and typically have a gradient less than 2%. In addition, unconfined channels are generally those with a valley width to channel width ratio of greater than 5. Local sediment supply was calculated in NetMap using an average basin erosion rate of 100 t/ km^2/yr. Based on that average, a channel-segment-scale threshold erosion rate of 130 t/ km^2/yr was used (e.g., 30 t/ km^2/yr > than the average) based on NetMap's predicted sediment supply associated with high landslide and debris flow terrain in the Wilson River watershed.

4.6.2 Results

The resultant "habitat sensitivity index" map created by the "Habitat Index" tool in NetMap differentiates the fish-bearing channel network into classes of habitat sensitivity that varies from 0 to 1 (Map 19). For example, approximately 15% of the fish-bearing network is classified as having a relatively high sensitivity (> 0.7). The highest sensitivity channels (> 0.7) are scattered across the Wilson River basin with the highest concentrations located in upper subwatersheds that

[17] For details of the model parameterization using NetMap's habitat creator tool, see the NetMap datafile "Wilson_hot".

have combinations of lower gradient habitats and high erosion potential. The Little North Fork Wilson river subwatershed exhibits the highest overall sensitivity and the Devils Lake Fork, Lower Wilson and Middle Wilson subwatersheds exhibit the lowest overall channel sensitivity.

4.7 Channel Modifications

4.7.1 Methods

We reviewed existing material relevant to the locations and significance of channel modifications and disturbances within the Wilson River watershed, and compared these to channel sensitivities. Materials reviewed included:

- ODFW aquatic habitat inventory GIS data and survey reports (supplied for this assessment by ODF)
- Wilson River Watershed Assessment (E&S Environmental Chemistry 2001)
- Development of an Integrated River Management Strategy, Final Report (Philip Williams & Associates et al. 2002).
- 2006 road survey data collected by DCA
- 2005 color digital orthoquads of the Wilson River watershed
- Additional ODF watershed analyses from adjacent basins[18]
- GIS coverages showing State Highways and Railroads[19]
- Federal Emergency Management Agency (FEMA), National Flood Insurance Program's floodplain maps[20].

The ODFW aquatic habitat inventory GIS data and survey reports reviewed for this assessment identified no areas of channel modification along any of the streams surveyed[21]. Channel modifications were mapped in GIS to the extent possible given available information. Materials from this and other sections of the assessment were synthesized to evaluate:

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[18] http://www.oregon.gov/ODF/STATE_FORESTS/watershed.shtml
[19] http://www.oregon.gov/DAS/EISPD/GEO/alphalist.shtml
[20] http://libweb.uoregon.edu/map/gis_data/fema.html
[21] As part of the RFP for this assessment, ODF specifically asked about modifications in the vicinity of South Fork Camp. Although ODFW surveys covered this area, no significant modifications were identified.

- The extent to which historic modifications and disturbances are impacting current conditions,
- The distribution of modifications and disturbances by channel sensitivity,
- The relative magnitude of modifications and disturbances among the sixth-field subwatersheds within the Wilson River, and between the Wilson River and adjacent similar watersheds that have available data on channel modification and disturbance.

4.7.2 Results

Known channel modifications within the Wilson River watershed are shown on Map 20. Six types of channel modifications were identified in this assessment, and are discussed in the following paragraphs. Dredging and gravel extraction within the lower river are additional modifications that historically occurred but current operations are extremely limited in scope and volume of material extracted and are not discussed in this section. The majority of channel modifications occurred on non-ODF lands (only "Canyon Fill" and "Channel Fill" occurred on ODF lands), and are beyond ODF's power to change.

Dikes occur exclusively within the Lower Wilson River subwatershed (Map 20) where there are approximately 2.5 miles of them (Table 7). Dikes within the Lower Wilson River were likely constructed to reduce saltwater intrusion in farm fields, as well as to constrain the location of the river in its existing location.

Table 7. Summary of channel modifications. Miles of each feature are summarized by subwatershed.

Subwatershed	Dikes	Highway fill	Railroad fill	Canyon Fill	Channel Fill	Log drives
Devils Lake Fork	-	2.5	-	-	-	-
Jordan Creek	-	-	-	-	0.1	-
Little North Fork Wilson River	-	-	-	0.2	-	-
Lower Wilson River	2.5	2.6	0.5	-	0.1	17.3
Middle Wilson River	-	-	-	-	-	8.5
North Fork Wilson River	-	-	-	0.0	0.1	-
South Fork Of Wilson River	-	-	-	-	-	-
Upper Wilson River / Cedar Creek	-	3.0	-	0.1	0.0	5.3
Grand Total	**2.5**	**8.1**	**0.5**	**0.3**	**0.4**	**31.1**

Over eight miles of highway fill have been identified as limiting channel migration and flood flows along the Wilson River (Map 20; Table 7). Sections of highway fill along US Route 101 north of Tillamook are located within the floodplain of the Wilson River (Map 20). State Highway 6 follows the mainstem of the Wilson River from Tillamook to the crest of the coast range in the Devils Lake Fork subwatershed. Portions of Highway 6 impinge on the river in the Lower Wilson and Upper Wilson/Cedar Creek subwatersheds. In the Devils Lake Fork subwatershed, several sections of fill slope impinge on the river as the highway climbs in elevation towards the pass (Table 7; Map 20).

The Port of Tillamook Bay Railroad crosses the Wilson River floodplain east of US Route 101 (Map 20). Approximately one half mile of fill associated with the railroad is located within the 100 year floodplain (Table 7).

The 2006 road survey conducted by Duck Creek Associates identified two types of channel modifications associated with roads on ODF land. Segments identified as "canyon fill" consist of roads in steep, narrow canyons, with high cuts and fills crowding the stream in places. Segments identified as "channel fill" consist of roads next to and sometimes crowding stream, though in a generally stable location. Very few road segments were identified as either canyon or channel fill (Table 7; Map 20). The five segments identified as canyon fill total 0.3 miles, and the five channel fill segments total 0.4 miles.

4.8 Historic Channel Disturbances

4.8.1 Methods

We reviewed existing materials relevant to the locations and significance of channel modifications and disturbances within the Wilson River watershed, and compared these to channel sensitivities. Materials reviewed included:

- Wilson River Watershed Assessment (E&S Environmental Chemistry 2001)
- Environmental History of the Tillamook Bay Estuary and Watershed (Coulton et al. 1996)
- Development of an Integrated River Management Strategy, Final Report (Philip Williams & Associates et al. 2002).
- Additional ODF watershed analyses from adjacent basins[22]

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

- Federal Emergency Management Agency (FEMA), National Flood Insurance Program's floodplain maps[23].
- Regional- and local-scale assessments of splash-damming and log drives (Sedell and Duval 1985, Coulton et al. 1996).
- Historic ODF stream survey and cleaning reports from the 1940's to 1970's.

Channel modifications were mapped in a GIS to the extent possible given available information. Materials from this and other sections of the assessment were synthesized to evaluate:

- The extent to which historic modifications and disturbances are impacting current conditions,
- The distribution of modifications and disturbances by channel sensitivity,
- The relative magnitude of modifications and disturbances among the sixth-field subwatersheds within the Wilson River, and between the Wilson River and adjacent similar watersheds that have available data on channel modification and disturbance.

4.8.2 Results

Information on historic log drives and splash damming was taken from Sedell and Duval (1985) and Coulton and others (1996). Coulton and others (1996) summarize information from a navigability study of the rivers of Tillamook Bay (Farnell 1980) that suggest that log drives occurred along the mainstem Wilson River from the mouth upstream to river mile 22.5. Sedell and Duval (1985) indicated that the log drives extended upstream of Lee's Camp to approximately river mile 31 (Map 20; Table 7). Log drives on the Wilson River ended by 1908. No splash dams were identified to have occurred within the Wilson River watershed, although there are records of dams on other Tillamook Bay tributaries.

No information is available on persistent impacts from splash damming within the Wilson River watershed. However, given that approximately 100 years have passed since the end of log drives it is likely that impacts to stream banks and riparian vegetation have recovered to a large extent. Impacts due to removal and loss of large wood accumulations/jams likely persist to the present day.

[23] http://libweb.uoregon.edu/map/gis_data/fema.html

ODF supplied over 200 pages of historic stream survey reports for the Wilson River watershed conducted primarily in the 1950's, but spanning the period from the late 1940's to the early 1970's. These reports described observations made by aquatic biologists during field reconnaissance of the mainstem Wilson River and tributaries. These surveys were extensive, appearing to have covered at least portions of most major streams and tributaries. The primary focus of these surveys was observations of spawning gravel size and quality, observations of fish and fish carcasses, notes on possible stock-supplementation sites, and identification of potential barriers to fish passage. Areas of recent stream cleaning were also noted. Numerous large log jams were noted as part of these surveys, and most were rated as being barriers to fish migration. It is assumed that many of these jams were targeted for subsequent removal. Given that these surveys occurred following the major fires in the area it is not surprising that many large jams were identified; most likely as a result of fire-killed instream large wood (LW) recruitment. Although no quantitative conclusions can be derived from these records, it is clear that extensive stream cleaning occurred throughout the watershed (heaviest in the areas of greatest fire impacts), which most likely resulted in habitat simplification and release of large quantities of stored sediments that may have otherwise been stored in stream banks and streamside terraces.

4.9 Channel Habitat Types Impacted By Channel Modification

4.9.1 Methods

As discussed in section 4.1 Methods/Background and Appendix F – Classification of Stream Channel Habitat Types, a channel classification system was developed for the Wilson River watershed based on channel gradient and channel confinement. Channel confinement consisted of two categories; streams whose ratio of valley width (Vw) to channel width (Cw) was less then or greater than five. Channel sensitivity to modifications generally decreases with increasing gradient and confinement.

4.9.2 Results

Channel modifications are summarized by channel class in Table 8. The majority of modifications are located off of ODF lands and are beyond the control of ODF managers. Disturbances on ODF lands (i.e., channel fill and canyon fill segments) occur primarily in less responsive steep and/or confined segments (Table 8). The three areas of channel fill that are identified along channel type 1A occur along the North Fork Wilson River in the North Fork Wilson subwatershed and along two distinct sections of Jordan Creek in the Jordan Creek subwatershed. These three segments should be the highest priority areas for remediation on ODF lands.

Table 8. Summary of channel modifications by channel class. Miles of each feature are summarized by channel class. Channel sensitivity generally decreases with increasing gradient and confinement (i.e., from left to right across the table).

	Gradient <2%		Gradient 2-4%		Gradient 4-8%	Gradient >8%	Unknown gradient and Confine-ment
	Vw/Cw <5	Vw/Cw >5	Vw/Cw <5	Vw/Cw >5	Vw/Cw <5	Vw/Cw >5	
Channel modification	**1A**	**1B**	**2A**	**2B**	**3A**	**4B**	**n/a**
Canyon Fill	-	-	-	-	0.1	-	0.2
Channel Fill	0.2	-	-	-	0.0	0.1	-
Dikes	-	2.5	-	-	-	-	-
Highway fill	4.8	1.8	1.3	0.1	0.1	-	-
Log drives	19.7	10.6	0.3	-	0.5	-	-
Railroad fill	-	0.5	-	-	-	-	-
Grand Total	**24.8**	**15.3**	**1.6**	**0.1**	**0.7**	**0.1**	**0.2**

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