Lower Mainstem Coquille River

And Tributaries

Riparian Shade Assessment

Technical Data for
Water Quality Management Plan

Prepared for
Coquille Watershed Association

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1. Introduction

The Lower Mainstem of the Coquille River and tributaries were assessed for channel shading and riparian condition during the summer of 2005. The Lower Mainstem is defined as extending from the confluence of the Middle and South Forks to the mouth. This report presents the procedures used in data collection, SHADOW model data inputs, methods used to fill in data gaps between field data collection plots, and the results of running the SHADOW Model.

The Lower Mainstem Coquille is listed as water quality limited for stream temperature and dissolved oxygen. Bear and and Cunningham Creeks are also listed for dissolved oxygen (DEQ 303d list). Shade and channel form have strong effects on the temperature of a stream through controlling how much sun can heat the water, and water temperature has a strong effect on dissolved oxygen. The SHADOW model uses trigonometry to project the amount of sunlight striking a channel using data on sun angle, which is calculated using an index day of August 1st and the latitude of the site. Data loaded into the model is described in Section 2 below. The model output is the percentage of the channel that is currently unshaded. Running the model a second time using data on the potential natural vegetation for the channel gives the potential shade for the system. This allows an analysis of current versus potential shade for each reach of the channel system. This analysis helps indicate where a channel is heating and where adding riparian vegetation can reduce that heating. It will be a very useful tool for the Coquille Watershed Association (CWA) to prioritize riparian projects designed to address water temperature by determining the potential for shade improvement.

The ownership of the Lower Mainstem and tributaries is divided between private commercial forest, agricultural ownership, small timber owners, rural residential and Coos County Forest lands. Partners in the assessment include CWA, the Department of Environmental Quality (DEQ) and Coos County.

The CWA Executive Board discussed the issue of the Lower Mainstem Coquille temperature listing and voted to pursue this shade assessment project. DEQ consulted with CWA staff to decide which streams were to be included in the shade assessment. The entire Lower Mainstem Coquille River and its major tributaries were included in the assessment. Minor tributary streams were included if they were fish bearing.

CWA staff performed a preliminary division on the Lower Mainstem Coquille and tributaries into approximately 240 reaches. Criteria for establishing reach breaks included: perennial confluences, change in channel aspect, change in riparian vegetation class, change in land ownership, or change in channel size. During the course of the aerial photo assessment, a number of reach breaks were added and several were dropped resulting in a total of 245 reaches. Fourteen reaches had the vegetation divided into separate banks because the vegetation was significantly different between the two banks.

Coos County contributed material support to the project including access to the 2002 aerial photo set, access to a stereoscope for aerial photo interpretation, and a desk for the aerial photo work.

The CWA provided material support including a computer for running the model, spreadsheet management and word processing, a Solar Pathfinder (shade measuring instrument), GIS stream, road and topographic layers and grant management.

DEQ consulted with project staff on questions of methods and provided base funding for the project utilizing "EPA 319" grant dollars.

2. SHADOW Model Data Inputs

Running the SHADOW Model requires 11 input columns for each of the 245 reaches in the assessment. Data was entered into an Excel spreadsheet with the following input columns:

1. Reach Identification Code tells where the reach is and whether the reach has been divided into two separate banks,

2. Selected Y/N tells if a reach is included in the current SHADOW Model run or excluded,

3. % Tree Overhang tells how much of the channel is shaded by tree canopy in decimal %,

4. Active Channel Width is the width of the bankfull channel in feet,

5. Length is the reach length in feet,

6. Tree Height is the height in feet of the trees contributing shade to the stream,

7. Tree to Channel Slope is the angle of the bank between the bankfull channel and the base of the closest trees providing shade,

8. Stream Orientation is the aspect of the reach in classes 0 (North-South), 45 and –45 (Diagonal), or 90 (East-West),

9. Tree to Channel Distance is the average distance in feet of shade trees from the bankfull channel,

10. Shade Density is the canopy density in decimal % for trees adjacent to the stream,

11. East/West/Both instructs the model whether the calculation is for both banks (B) or only one bank (E or W).

Additional information required by the model for the Lower Mainstem Coquille was the latitude (43 degrees) and the magnetic declination (19 degrees).

Stream reaches are numbered starting at the top and proceeding downstream (see Appendix 1 for the Excel data spreadsheet and GIS map layer). The Lower Mainstem was broken into the following reaches:

- Lower Mainstem (MM 01 - 53)

Each tributary has its own subwatershed. Only the fish-bearing portion(s) of each tributary as shown on Oregon Department of Fish and Wildlife "Fish Distribution Maps" was included in this survey. In the area above fish distribution narrow, easily shaded, steep canyons are present. The predominant land use is forestry and riparian areas are subject to episodic management. Stream shading recovers quickly after harvest because tree to channel distances are small and lesser tree heights can provide shade for these narrow confined channels.

The tributary streams are listed below in order from upstream to downstream along with their reach codes:

- Grady (GD 01 - 03)
- Gray (GR 01 - 06)
- Hall (HA 01 - 17)
- Fishtrap (FT 01 - 11)
- Glen Aiken (GA 01 - 04)
- Rink (RK 01 - 09)
- Cunningham (CU 01 - 17)
- Fat Elk (FE 01 - 06)
- China (CH 01A - 07)
- Beaver (BE 01 - 17)
- Hatchet (HT 01 - 11)
- Lampa (LA 01 - 08)
- Bear (BR 01 - 36)
- Sevenmile (SE 01 - 20)
- Ferry - Geiger (FG 01 - 10).

Additional reaches added after the initial reach identification codes were assigned the existing reach number with a letter suffix added (A-C). Fourteen of the reaches were divided into separate banks because the vegetation varied enough between the two banks that they were required to be split. In these cases the reach takes two lines of the spreadsheet with an E or W suffix appended to the reach identification code. Reaches that have an aspect of 90 degrees and were divided into two banks (RK07W, CH02W, FG06W, MM51W) have the W (north) bank dropped from the analysis. This was done because the SHADOW model only uses the E (south) bank to calculate shade for these reaches.

Lotus 123 provides the software platform on which the SHADOW model is run. Individual data columns are copied from the Excel spreadsheet, pasted into a Lotus 123 spreadsheet, and formatted for the SHADOW model. The specific conditions for that run are set prior to running the model. This report presents the results from three model runs. The first run used all of the data on current vegetation to get current shade, and the second run used data on *potential natural vegetation* to get *target shade*. Section 7 describes in more detail how target shade values were developed. The third run used data from a set of paired photo/field plots to validate the model output. The data from the photogrammetric analysis of the plots was run through the model and the <u>computed</u> shade values were compared to shade values measured in the field using a Solar Pathfinder instrument (see Section 6).

Riparian enhancement projects can establish vegetation that the landowner desires and the site can support while working towards the *target shade* goals. This information can be used by private landowners and the projects committee to determine where increases of shade can be expected in riparian areas and better tailor site management and planting prescriptions. This type of detail will allow CWA to better measure riparian project successes where an increase in shade was identified as a project goal.

3. Data Collection

CWA project staff collected information on the 245 reaches through aerial photo interpretation, use of topographic maps, and use of a GIS stream layer. Aerial photo interpretation used the BLM 2002 aerial photo set.

Aerial photos were used to determine:

- canopy overhang over the stream (decimal percent)
- shade density of the canopy adjacent to and over the stream (decimal percent)
- riparian buffer width (feet)
- existing riparian vegetation composition (using community codes)
- whether a road was located within 100 feet of the stream (Y/N)

Topographic maps were used to determine:

- reach orientation using an orientation template

GIS stream layer was used to determine:

- reach lengths

Project staff collected additional information on the reaches and verified data collected from aerial photos through taking 116 field plots. Field plots were distributed throughout most of the tributaries (63 plots) and along the entire mainstem (53 plots).

Data collected from field plots included:

- bank angle/terrain slope (decimal percent)
- tree to channel distance (feet)

- tree heights (feet)
- bankfull channel width (feet)
- species of riparian trees present
- shade on the channel using Solar Pathfinder instrument (tributary plots only because the mainstem was too deep to take multiple readings across its width)

4. Confidence in Data and Methods Used for Filling Data Gaps

The level of confidence for data indicates how accurate that number is compared to the actual measurement in the field. Field measurements are assumed to be the most accurate, and extrapolated/interpolated numbers are assumed to be the least accurate. The level of confidence for data used in the model was: first level (highest) was for field data, second level was for aerial photo interpretation data, and third level (lowest) was for extrapolated/interpolated values. In all cases, first level data was used where available. Then second and third level data were used in that order. The methods for extrapolating/interpolating values are described below.

Methods for Extrapolating and Interpolating Values

The 116 reaches with field plots (first level) had complete information, which left 129 reaches with only aerial photo and topographic map data available. For these 129 reaches information was missing for four of the data columns (tree to channel distance, tree heights, tree to channel angle, bankfull channel width) required to run the model.

Missing values were interpolated from nearby reaches containing field plots both up- and downstream of the reach with the missing values. For the remaining reaches missing values were extrapolated from the nearest reach with field measurements.

5. SHADOW Model Output

The model output was converted to reach weighted averages and is presented in Table 1. For the tributaries the current shade is 68% and the target shade is 94%. For the Lower Mainstem the current shade is 7% and the target shade is 26%.

Table 1 gives the current and potential percentage shaded area for all stream channels in the Lower Mainstem Coquille River and tributaries. These values are the results of two SHADOW model runs. One calculates shade using current condition data, and the second predicts shade by changing the input to potential natural vegetation conditions. The reach identification codes are listed in parentheses under the stream name. The predominant land use for each stream or group of reaches is listed in the second column. Forest designates timber production areas, Ag designates predominantly agricultural use, and Ag/RR designates mixed agricultural and rural residential use.

Table 1. Current and Potential Shaded Area of the Lower Mainstem Coquille River and Tributaries.

Subwatershed	Land Use	Current Shaded Channel %	Potential or Target Shade %	Potential Shade Increase %
Grady (GD01-03)	Forest RR/Ag	65.0	96.9	31.9
Gray (GR01-06)	RR/Ag	55.2	95.1	39.9
Hall (HA01-02,08-10,13)	Forest	74.4	96.3	21.9
Hall (HA03-07,11-12,14-17)	Ag	64.1	93.1	29.0
Fishtrap (FT01,03-07)	Forest	79.4	96.8	17.4
Fishtrap (FT02,08-11)	Ag	28.5	96.4	67.9
Glen Aiken (GA01-04)	RR/Ag	87.9	97.1	9.2
Rink (RK01-05)	Forest	82.9	94.5	11.6
Rink (RK06-09)	Ag	74.8	97.2	22.4
Cunningham (CU01-03A,04-10,12-13)	Forest	86.1	97.6	11.5
Cunningham (CU3B,11,14-17)	Ag Ag/RR	50.3	96.7	46.4
Fat Elk (FE01-06)	Ag	70.9	95.9	25.0
China (CH01-02)	Forest	91.9	99.1	7.2
China (CH03-07)	Ag	45.9	88.6	42.7

Table 1 cont. Current and Potential Shaded Area of the Lower Mainstem Coquille River and Tributaries.				
Subwatershed	**Land Use**	**Current Shaded Channel %**	**Potential or Target Shade %**	**Potential Shade Increase %**
Beaver (BE01,05,12-14)	Forest	84.5	97.9	13.4
Beaver (BE02-04,06-11,15-17)	Ag	39.9	88.7	48.8
Hatchet (HT01-04,06A,09)	Forest	88.5	97.5	9.0
Hatchet (HT05-06B,10-11)	Ag	27.5	93.9	66.4
Lampa (LA01-02,05)	Forest	90.3	96.7	6.4
Lampa (LA03-04,06-08)	Ag	37.0	96.7	59.7
Bear (BR01-08,09-16,18,21,24AB-31)	Forest	88.7	96.8	8.1
Bear (BR17,19-20ABC,32-36)	Ag	53.3	86.9	33.6
Sevenmile (SE01-11,13,15-16)	Forest	91.8	98.3	6.5
Sevenmile (SE12,14,17-20)	Ag	21.7	40.2	18.5
Ferry-Geiger (FG01-02,04-05)	Forest	84.6	96.8	12.2
Ferry-Geiger (FG03,06-10)	Ag City	58.5	96.8	38.3
All Tributaries	All Uses	67.9	93.8	25.9
Lower Mainstem (MM01-53)	Ag	7.2	25.7	18.5
All Reaches	All Uses	53.1	77.2	24.1

Note: If land use changes repeatedly along a stream some different uses may be lumped under one classification due to scale problems.

6. Model Calibration and Data Accuracy Check

A series of 63 plots, each covering 100’ of tributary stream channel, was selected for model validation. These plots represented the full range of channel widths in the tributary watersheds. The plots were measured on aerial photos for canopy overhang % and shade density %. The plots were measured in the field for bankfull channel width, tree heights, tree-channel slope, and tree-channel distance. Also in the field, the Solar Pathfinder instrument was used to measure the shade on the channel for the month of August. August was used because the solar loading is high and the SHADOW model calculates unshaded channels for the reference date of August 1. No validation plots were taken on the mainstem because the water was too deep, thus preventing the use of the Solar Pathfinder.

The photo interpretation data and the field data were used to run the SHADOW model for the 63 validation plots. The shaded stream values were compared for the SHADOW model output and the Solar Pathfinder (SP). The initial average difference between SHADOW and SP results was 16%. Four of the SP outlier values were adjusted by dropping one of the multiple readings for that plot. Twelve of the SHADOW outlier values were adjusted by reevaluating overhang, density, tree height and/or tree-channel distance values. The second validation run (after adjustment of outliers) had an average difference for the 63 point plots of 5.66%, with a range of 0-34%. After trying SHADOW model runs with systematic reductions in canopy overhang in an attempt to reduce shade by approximately 5%, it was decided that no adjustment would be used on the input data to correct this factor. Thus, the SHADOW model output gave an average of 5% higher readings than the Solar Pathfinder field measurements. This variability is likely the product of the limitations of the accuracy and precision of both the Solar Pathfinder and the SHADOW model.

Bruce, it was good to talk to you on the phone this PM. We discussed clarifying where the Benner report was used and where you deviated from it. I was confused in this narrative but you did a good job of articulating it over the phone.

7. Potential Natural Vegetation

The potential natural vegetation is the riparian community that would exist on a site if it had been undisturbed for a long period (i.e., mixed large hardwoods and conifers in steep mountain streams or a hardwood swamp in the Coquille Valley). The potential natural vegetation community is assumed to give the potential shade for that subwatershed and provides the target shade values for that subwatershed. Between the historic period and the present day some factors which shaped or controlled the potential vegetation may have changed. Historically, the Lower Mainstem Coquille River had a braided channel, numerous large log jams composed of old growth logs, was unconfined, and the swamps and marshes that covered the floodplain were flooded for long periods. A large population of beavers lived on the floodplain as well and altered the hydrology in the riparian communities. Although the river does continue to make contact with its floodplain, many of these conditions have now changed. These mainstem modifications include the draining and filling of multiple braided channels, confinement to a single main channel, removal of the vast majority of woody debris, some levee construction, and removal of the vast majority of the beaver population. All of these changes affect the potential natural vegetation and may make it different from the historic plant communities found in the 1800's as reported by Benner [1].

Restored riparian stands that are proportional in width to the stream channel can provide shade equivalent to site potential shade throughout the watershed. In these restored stands the height of the trees and the width of the riparian band have to be proportional to the width of the channel for the shade to equal site potential levels. On timber production lands with narrow channels, a dense band of hardwoods and scattered conifers retained during harvest operations and backed by a reproduction stand of 30'-50' tall Douglas-fir would give as much shade as site potential old growth trees. On agricultural lands with broader channels, a dense planting of willow and/or other shrubs next to the bankfull channel backed by a mixed stand of tall hardwoods would provide

[1] Benner, Patricia. 1991. Historical Reconstruction of the Coquille River and the Surrounding Landscape.

adequate shade if the riparian band is proportionate in width to the stream channel. The single mainstem channel is now so wide in most reaches that it cannot be effectively shaded.

Vegetation in the lower Coquille watershed was divided into six distinct potential natural vegetation communities. Some of the tree species are widespread in the different communities, but the proportion of the primary shade they provide varies with their proportion of the community and their maximum size. The first two communities, moderate gradient canyon and small valley hardwood, are found only on the tributary streams. The other four communities are found primarily on the main valley floodplain, but they may extend up the valley of a tributary as well.

Tributary Streams

Moderate Gradient Canyon (MGC)

The Moderate Gradient Canyon community is found in small to medium sized canyons with moderate gradients (2-4%). The channels are moderately confined or confined with the bankfull channel width ranging from approximately 3' to 15'. Four reaches had wider bankfull channels; two were in low gradient sections (22' and 31') and two were in reservoirs on Ferry-Geiger and Rink creeks(50' and 60'). There is terrace development in most reaches, but little or no floodplain development adjacent to the channel. Large hardwoods (bigleaf maple 100', myrtle 90', and alder 100') line the lower slopes and the edge of the streams at an average distance of 3' for the alders and 10-15' for the other species. Douglas fir (inland) or Sitka spruce (coastal) dominate the slopes and reach heights of approximately 200'. These large conifers begin at an average of 40' from the bankfull channel and were excluded from the potential vegetation because they don't contribute appreciable shade to the small channels due to their small proportion of the streamside community. The potential shade on the four wider reaches may be underestimated because conifers were excluded from the calculations for potential tree height. Additional conifers include western redcedar and western hemlock (together up to 50% of the shade producing conifers). These conifers add diversity to the riparian community and may produce large woody debris for the stream if they fall towards the channel. The understory often provides additional shade to the channel; it is dominated by salmonberry, sword fern and vine maple.

Another potential vegetation type called Steep Gradient Canyon is found higher in each stream system above the limit of fish distribution. In these narrow, steep gradient canyons conifers grow closer to the channel and consequently provide the majority of shade to the channel. These steep canyons were excluded from this survey because they are upstream of the limit of fish distributions.

Small Valley Hardwoods (SVH)

The Small Valley Hardwoods community is found in small valleys with low gradients (1-2%) and unconfined channels. The bankfull channels range from approximately 5' to 18' wide with a few reaches up to 25' wide. There is full terrace development, and the stream is usually connected to the floodplain. Alder (up to 90') and deciduous shrubs (willow, red osier dogwood, salmonberry, ninebark, indian plum) line the edge of the streams at an average distance of 5' for the alders and 0' for the shrubs. Large hardwoods (bigleaf maple 100', myrtle 90', and Oregon ash 110') cover the terrace/floodplain beginning 10-15' from the bankfull channel. Douglas fir (inland) or Sitka spruce (coastal) dominate the slopes and reach heights of approximately 200'; these large trees begin an average of 75' from the bankfull channel and don't provide significant shade to the relatively narrow stream channels. Additional conifers include western redcedar, grand fir and western hemlock (together up to 50% of the shade producing conifers). The understory is sparse due to the full shade from the dense overstory canopy and shrubs, but dense stands of pasture grasses, Himalaya blackberry or reed canary grass develop down to the bankfull level where light is available.

Lower Mainstem Valley

A wide variety of plant communities was found in the lower Coquille watershed at the time Euroamerican settlement began. A report describing the plant communities and their extent as of the late 1800s was used in the preparation of this report (Benner 1991). The historic plant communities Benner used have been lumped into four community types for this report. They will be presented following the general description common to the whole mainstem.

The mainstem has a low gradient (between 0 and 1%), and the channel width ranges from approximately 200' at the confluence of the middle and south forks to 700' wide near the mouth. There is only one channel with no braiding, full terrace development, and the river frequently goes overbank in winter and covers all or most of the floodplain. Because of extensive modification of the river channel from historic conditions, each site has to be evaluated before deciding what community it can now support. For this reason, the distribution of potential vegetation communities (see Appendix 1) is meant only as a guide and not a blueprint for restoration. The four mainstem potential communities used in this report are: Timbered Swamp with Brushy Understory (symbol TSB), Timbered Marsh with Grass Understory (symbol TMG), Timbered Dry Bottomland (symbol TDB), and Marsh Prairie (symbol MAP). These four communities are described below with the descriptions based on the Benner report (1991).

<u>Timbered Marsh with Grass Understory (TMG)</u>

This was the most common community type and covered approximately 45% of the bottomlands (Benner 1991). Also included under this symbol is "Timber, brush and grass swamp with surface water and pond lilies". TMG was found between reaches MM24 and MM38 and consisted of braided channels lined with trees and grass-like plants (sedges, rushes,etc.). TMG supported a large population of beavers on the floodplain and was modified by their activities. TMG was sometimes separated from the main channel by a natural berm that supported a drier community (TDB). TMG overstory was dominated by willow and Oregon ash with occasional alder, bigleaf maple and crabapple. The maximum height of these trees is reduced because of the saturated soils and long periods of inundation. The understory was dominated by grass-like species such as slough sedge, small-fruited bullrush and other species.

Timbered Swamp with Brushy Understory (TSB)

This was the second most common community type at the time of settlement and covered approximately 40% of the bottomlands. The community was found from reach MM18 to MM47 and consisted of braided channels lined with trees and shrubs. TSB was sometimes separated from the main channel by a natural berm that supported a drier community (TDB). Significant sized trees of species that either tolerate or prefer seasonally flooded soils dominated the overstory including alder, bigleaf maple, Oregon ash, willow and occasionally Sitka spruce and myrtle. The maximum height of these trees is reduced because of the saturated soils and long periods of inundation. The brushy understory included crabapple, salmonberry, willow, creek dogwood, ninebark, gooseberry, and 'briers'.

Timbered Dry Bottomland (TDB)

This higher, drier type was found primarily on narrow natural berms formed by flood deposition lower in the system and now also found on man-made levees. A second type, "Wooded Bottomland Mostly Floodplain", was found covering the floodplain in the upper reaches (MM01 – 17). It was lumped into TDB because of the similarities in landscape position and species composition. The dominant tree species included Sitka spruce (lower reaches), myrtle, bigleaf maple, Oregon ash and red alder. The woody understory included crabapple, willow, chittum and vine maple. The tall overstory species and long branches provided more shade for the main channel than any other community. Since the late 1800's the Lower Mainstem has largely been confined to a single channel, and sediment loads have increased due to anthropogenic activities. These conditions have led to the formation of natural berms along many sections of the banks in all of the potential vegetation types. Both the natural berms and man-made levees can support TDB, but their extent has not been mapped and is very difficult to determine from aerial photos. The successful establishment of suitable tree species on these sites would provide near-bank cover for fish, large woody debris for the channel, significant roosting habitat for birds, and some shade from large trees for the channel. Due to the removal of the vast majority of large woody debris (LWD) from the Coquille River and the importance of LWD as habitat for salmonids, including cover from predators, the CWA recommends that whenever possible these trees should be left in place if they fall in the river.

Marsh Prairie (MAP)

This seasonally and (occasionally) tidally inundated vegetation type occurs along the lower reaches (MM43-53) in the first 11 river miles. In these reaches a combination of long periods of inundation, salt water intrusion, heavy vegetative competition and heavy winds largely excludes woody vegetation, thus limiting the vegetation to a variety of sedges, rushes and related vegetation. These species only grow to an average height of

3' and provide very little shade to the river or cover along the banks. TDB can be planted on natural berms that have accreted in these reaches over the last 150 years and on man-made levees. Due to the almost total lack of trees in MAP, any trees establishing on berms have a disproportionately large habitat value. The trees would provide near-bank cover for fish, large woody debris for the channel, significant roosting habitat for birds, and large trees provide some shade for the channel.

Table 2 presents the characteristics of potential natural vegetation communities of the Lower Mainstem Coquille River and tributaries.

- Bankfull channel is the channel width range in feet.
- Overhang is the decimal percentage of the channel covered by tree canopy.
- Shade density is the decimal percentage of sidelight blocked by the canopy.
- The middle columns are the dominant tree species that produce shade.
    - The top number is the average distance in feet between the trees and the bankfull channel;
    - The bottom number is the average height in feet of the mature trees.
    - For timbered dry bottomland (TDB) there are two sets of values for each tree species in the table. The top set is for inland reaches MM 01-44 and associated portions of tributaries, and the bottom set is for coastal reaches MM 45-53 (i.e., UMCA 15'/90' inland, 15'/70' coast). This distinction is necessary because trees growing along the river near the coast are stunted in height because of the wind, soil salinity and soil saturation.
- The species codes are:
    - ALRU red alder,
    - ACMA bigleaf maple,
    - UMCA myrtle,
    - FRLA Oregon ash,
    - Willow spp.,
    - Dominant Conifers (Douglas fir and Sitka spruce).
- The Potential Trees column presents two average values for the potential natural vegetation (except as noted above for TDB); the top number is the average distance in feet between the trees and the bankfull channel, and the bottom number is the average height in feet of the mature trees.

Table 2. Characteristics of Potential Natural Vegetation Communities of the Lower Mainstem Coquille River and Tributaries

Community	Bankfull Channel	Overhang %	Shade Density %	ALRU	ACMA	UMCA	FRLA	Willow spp.	Dominant Conifers	Potential Trees
Moderate Gradient Canyon (MGC)	3-15	0.9	0.9	5’ 100’	10’ 100’	15’ 90’	--	0’ 30’	40’ 200’	10’ 100’
Small Valley Hardwood (SVH)	5-18	0.9	0.9	5’ 90’	15’ 100’	15’ 90’	10’ 110’	0’ 30’	75’ 200’	10’ 100’
Timbered Brushy Swamp (TBS)	197-560	0.2	0.7	0’ 75’	10’ 70’	--	0’ 75’	0’ 60’	--	0’ 75’
Timbered Marsh Grass (TMG)	300-360	0.2	0.6	0’ 75’	--	--	0’ 75’	0’ 60’	--	0’ 70’
Timbered Dry Bottom (TDB)	185-540	0.3 0.2	0.8 0.6	10’/90’ 10’/75’	15’/110 --	15’/90’ 15’/70’	15’/110 15’/90’	0’/60’ 0’/30’	15’/150 10’/90’	15/110 10/90
Marsh Prairie (MAP)	153-834	0.0	0.9	--	--	--	--	--	--	0’ 3’

8. Target Shade and Solar Loading

The solar energy input, or solar load, has been calculated for the latitude of the Lower Mainstem Coquille watershed at 2440 BTU/square foot/day using a flat plane solar collector (Renewable Resource Data Center http://rredc.nrel.gov/solar/). This means that a square foot of stream that is totally unshaded would receive 2440 BTU/square foot/day of solar energy during a full, clear day in August. To get the current solar loading for any given stream reach, you multiply the total possible load (2440 BTU/square foot/day) by the area of the stream channel that is unshaded, thus giving the amount of sun the channel receives. Table 3 gives values for the current shade and target shade provided by the potential natural vegetation by various land uses as well as for the Lower Mainstem Coquille River. The lower half of the table shows the current and target solar loading. The difference between current and potential future conditions is shown in the shade increase column.

Table 3. Current and Target Shade and Solar Loading of the Lower Mainstem Coquille River and Tributaries.

Watershed	Current Shade	Target Shade	Shade Increase
Tributary Forest Lands	86.6	97.2	10.6
Tributary Agricultural and Rural Residential Lands	51.9	90.6	38.7
Entire Tributaries	67.9	93.8	25.9
Entire Lower Mainstem Coquille River	7.2	25.7	18.5
Watershed	**Current Solar Load**	**Target Solar Load**	**Reduction**
Tributary Forest Lands	327.0	68.3	79.1
Tributary Agricultural and Rural Residential Lands	1173.6	229.4	80.5
Entire Tributaries	783.2	151.3	80.7
Entire Lower Mainstem Coquille River	2264.3	1812.9	19.9

Note: Shade values are percentages and solar load values are BTU/square foot/ day.

Time to Reach Site Potential Vegetation

The time required to develop site potential vegetation is based on the assumed growth rate for alder and spruce on the different sites. This is calculated as site index (SI), which is the expected height of trees after 45 years for alder and 100 years for spruce. The assumed site index for each site is presented in parentheses in the following text.

The second assumption is that there will be no catastrophic events that would kill trees or severely limit their growth. These events include catastrophic fire, wind damage, flood damage, or insect attacks. These events could kill or remove entire stands of trees and restart the clock for those sites.

The third assumption is that the width of the riparian stand is proportional to the width of the stream channel. A riparian stand that is too narrow or not planted densely enough lets more light through and would not provide site potential shade.

<u>Tributaries</u> - the current average height of trees in the forestry sections of the tributaries is 49'. Based on the alder growth rate (SI 100) the time to reach the potential vegetation height of 100' would be 32 years. If there are no trees on the site, then planted alders would take 45 years to reach a height of 100' and provide site potential shade.

The current average height of trees in the agricultural/rural residential section of the tributaries is 22'. Based on alder growth rate (SI 90), the time to reach the potential vegetation height of 90' would be 40 years. If there are no trees on a site, then planted alders would take 45 years to reach the site potential height of 90'.

Mainstem - the current average height of trees over all of the mainstem reaches is 43'. On the upper reaches, alder are expected to reach a maximum of 90' and spruce 150'. The time required for existing 43' alders to reach 75' would be 33 years (SI 90). If there are no trees on a site, then planted alders would reach 90' in 45 years. The time required for 43' tall spruce to reach 150' would be 75 years (SI 150). If there are no trees, then planted spruce would take 100 years to reach the site potential height of 150'.

On the lower reaches in the heavy winds, the time required for 43' spruce to reach the site potential of 90' would be 62 years (SI 90). If there are no trees on a site, then planted spruce would take 100 years to reach the site potential height of 90'.

Appendix 1. Lower Mainstem Coquille and Tributaries GIS Layer and Riparian Spreadsheet

Appendix 2. Model Calibration Data Sheets

Appendix 3. Site Index Tables for Douglas-fir, Sitka Spruce and Alder