Catching Slough, Daniel's Creek and Heads of Tide Sub-basin Assessment & Restoration Opportunities

APPENDICES

Appendix A - Survey Methods and Supplemental Data

Hydrology

The Oregon Watershed Assessment Manual (OWEB, 1999) was used as a guideline for rating potential risks of stream flow enhancement. This procedure was followed step by step to assess the Hydrologic processes present in the Catching Sub-basin ArcView 3.2a was used for the GIS analysis.

Numerous sources were needed for the hydrologic and water use condition characterization analysis. Stream flow data was collected from the US Geological Society (USGS), and Oregon Water Resources Department (OWRD), as well the Coos Watershed Association. Peakflow data was acquired from OWRD using their interactive mapping system. Precipitation data was collected from the Oregon Climate Service (OCS), and National Oceanic and Atmospheric Administration (NOAA). A GIS Prisms shapefile of the mean annual precipitation map was from OCS, and a NOAA Atlas 2 map was used for a 2-year, 24-hour precipitation component. Soil maps were acquired from the National Resource Conservation Service to determine Hydrologic Soil Groups (HSG) for analysis of the infiltration rate of agriculture lands.

Forestry, agriculture/rangeland, forest and rural roads, and urban and rural residential areas were evaluated for possible impacts on hydrology. Included within the rural road area, there are a small amount of urban roads.
GIS was used to calculate the area of road surfaces in each land use type, and total linear road lengths. Then, the linear lengths of roads were multiplied by default road widths set by OWEB (25 feet for forestry roads and 35 feet for rural residential) (OWEB, 1999). Once the road areas were calculated they were divided by the total area within that land use, and a percentage of total area of roads helped determine the potential risk for peak-flow enhancement.

In the water use section, water rights were compiled using the Water Rights Reporting System (OWRD, 2005) for water use analysis. Each individual permit or certificate was reviewed to determine type and amount of water use. Water availability reports for 50% exceedance levels were obtained for the Water Availability Reporting System (OWRD, 2005). The flow restoration assessments were obtained from ODFW and OWRD to determine need, opportunity, and priority of flow restoration in assessment areas. Supplemental Table A-1, contains individual stream net water availability for the Heads of Tide area.

Table A-1 Heads of Tide - Stream Net Water Available (CFS)

Stream/River	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Rogers	0.02	0	0	0	0	0.04	0.04	0.02	0.01	0.03	0.11	0
Bessey	0	0	0	0	-0.06	-0.16	-0.24	-0.19	-0.08	-0.03	-0.03	-0.01
Salmon	0	0	0	0	0	-0.01	-0.01	-0.01	-0.01	-0.01	-0.03	0
S. Fork Coos	1360	1230	965	529	173	12.9	-5.62	-3.97	-3.32	-80.2	650	1310
Total	1360	1230	965	529	172.94	12.77	-5.83	-4.15	-3.4	-80.21	650.05	1310
Mart Davis	0	0	0	-0.01	-0.07	-0.18	-0.3	-0.26	-0.1	0	0.05	0
Deton	0	0	0	0	0	0.01	0.01	0.01	0	0.01	0.02	0
Millicoma	870	879	693	403	197	87	33.8	16.9	22	51.5	478	920
Total	870	879	693	402.99	196.93	86.83	33.51	16.65	21.9	51.51	478.07	920

Aquatic Habitat Inventory

Aquatic habitat surveys were conducted in the summer of 2006 using the ODFW protocol *Aquatic Inventories Project: Methods for Stream Habitat Surveys* (Moore, et al., 2003). Survey reaches were selected based on the following three criteria. First, characteristics of the waterbody had to allow for practical use of current survey methods and equipment, i.e., it had to be wadable and outside the area of significant tidal depth fluctuations. The second criterion was that the stream had to be accessible to coho and be large enough to have habitat potential. The third criterion was landowner permission. Individual landowners are contacted each year for permission to allow Coos WA field staff access to conduct specific surveys. Reach beginnings and endings were determined by a number of factors including changes in habitat type, land use changes, and access to private property. Surveys generally started at the mouth and progressed upstream.

Channel Morphology Definitions

Active Channel Height is the vertical distance from the streambed to the top of the active channel. This measurement is taken in fast water units or at pool tail crests.

Active Channel Width is described as the distance across channel at "bank full" flow. The Active Channel Width is used to determine the size of the stream.

Bankfull Flow is the level that the stream flow attains every 1.5 years on average.

Floodprone Width is the distance across the stream channel and /or unconstraining terraces at Floodprone Height, which is determined by doubling the active channel height.

Secondary Channels include all off-channel units, such as alcoves, isolated pools, tributary units and backwaters that are not in the main or primary channel.

Valley and Channel Morphology codes summarize the channel's relationship with the surrounding landscape. These codes (see Table A-2) are used by the ODFW aquatic habitat survey protocol (Moore, et al., 2004), and are keyed in the table to the right.

Table A-2 ODFW Valley & Channel Morphology Codes

CH	Constrained by hillslope
TC	Constrained by terrace
CA	Constrained by alternating terrace and hillslope
CL	Constrained by landuse
US	Unconstrained single channel
UA	Unconstrained multiple channels
UB	Unconstrained braided channel

Valley Width Index is estimated by dividing the average Active Channel Width into the average Valley Floor Width.

W:D Ratio is the width to depth ratio average of the reach represented.

Unit Type Definitions (adapted from ODFW survey methods)

The composition and pattern of habitat unit types characterize the stream. Habitat unit identification is the basic information that indicates fish habitat potential (spawning, rearing, and cover). Comparing the numbers of slow water habitat types (pools and glides) and fast water habitats (riffles, rapids, cascades) within a stream section can indicate which habitat unit types are lacking. Habitat improvement techniques can address these deficiencies.

Unit Type: Habitat units are segments of the stream with similar characteristics. As a general rule of thumb for primary channel units, each is generally longer than the active channel width. Exceptions to this rule may include plunge pools, alcoves, backwater pools, and isolated pools. Habitat units are classified by channel shape, slope of the water's surface, and water velocity.

Cascade - A cascade is a type of fast-water habitat unit. Cascades are units with gradients of 3.5 to 10.0 percent or higher. Cascades have much surface turbulence, accompanied by high velocity flow. Many cascades are composed of step-pool sequences, which are small pools occurring between nearly vertical hydraulic jumps.

Culvert Crossing – A culvert crossing unit indicates the stream passes through a culvert. The culvert is evaluated for soundness, placement, and size.

Dry unit - A dry unit is a special type of habitat unit. Dry units may have any gradient and although they may have subsurface flow, are dry at the time of the survey. Dry units occur between wetted units.

Glide - A glide is a type of fast water habitat unit. A glides has a 0.5 percent gradient. Glides have a uniform cross-section and no surface turbulence. In contrast to pools, glides have no significant scour and deposition. In contrast to riffles, glides have no surface turbulence.

Plunge Pool - A plunge pool is a type of slow water habitat unit. Plunge pools are formed by the vertical force of water plunging over an object; a boulder, piece of large woody debris, bedrock shelf, culvert, or other form of structure. The plunging action usually scours a relatively deep section of the pool at its upstream end. Like all pools, plunge pools have a gradient of 0.0 percent.

Straight Scour Pool - Formed by mid-channel scour. Generally with a broad scour hole and symmetrical cross section.

Lateral Scour Pool - Formed by flow impinging against one stream bank or partial obstruction (logs, root wad, or bedrock). Asymmetrical cross section includes corner pools in meandering lowland or valley bottom streams.

Trench Pool - Slow flow with U or V-shaped cross section typically flanked by bedrock walls, and often very long and narrow with at least half of the substrate comprised of bedrock.

Dammed Pool - Water impounded upstream of channel blockage (debris jams, rock landslides).

Beaver Dam Pool - Dammed pool formed by beaver activity. In most cases this will be preceded by a SD (step over beaver dam).

Alcove - Most protected type of subunit pool. Alcoves are laterally displaced from the general bounds of the active channel. Substrate is typically sand and organic matter. Formed during extreme flow events or by beaver activity; not scoured during typical high flows.

Backwater Pool - Found along channel margins; created by eddies around obstructions such as boulders, root wads, or woody debris.
Part of active channel at most flows; scoured at high flow. Substrate is typically sand, gravel, and cobble.

Isolated Pool - Pools formed outside the primary wetted channel, but within the active channel. Isolated pools are usually associated with gravel bars and may dry up or be dependent on inter-gravel flow during late summer. Substrate is highly variable. Isolated pool subunits do not include pools of ponded or perched water found in bedrock depressions.

Puddled Unit - A puddle unit is found in a nearly dry channel but with sequence of small isolated pools less than one channel width in length or width.

Rapid - A rapid is a type of fast-water habitat unit. Rapids are units with moderately high gradients of 3.0 to 8.0 percent, occasionally greater. Rapids have significant surface turbulence, accompanied by high velocity flow and the formation of eddies and hydraulic jumps around the substrate.

Riffle - A riffle is a type of fast-water habitat unit. Riffles have a gradient of 1.0 to 4.0 percent. Riffles are usually shallow, with a uniform cross-section. The substrate in a riffle is generally composed of gravel or cobble. Redds are often constructed in riffle areas.

Step / Falls - A step is a special type of habitat unit. Steps are characterized by discrete breaks in the gradient of the stream. Steps are the most vertical of the habitat units. The vertical extent of a step may range from as low as 1 foot (0.3 meter) to as high as the highest waterfall. The heights of steps are usually measured instead of their gradients. Steps are usually wider than they are long. Steps can occur over a variety of objects or surfaces; from bedrock outcrops, logs, and culverts under roads.

Habitat Benchmarks

Aquatic habitat survey data, with the exception of bank stability, is compared to established ODFW Aquatic Inventory Project benchmark habitat values for West-side forested basins. These benchmarks are the most appropriate tool currently available for analyzing such data. (The Coos WA, however, anticipates future development of analysis tools for more accurately defining habitat benchmarks for tidally-influenced stream systems such as those in the assessment area.)

Habitat benchmarks are provided for pool depth, riffle gravel/ sediment, large wood, and bank stability. These benchmarks are presented on graphs in this assessment using dotted lines to represent desirable (good) levels, and solid lines to represent undesirable (poor) levels. See the Table A-3, below, for benchmark details.

ODFW developed benchmark standards for large wood by analyzing stream reaches whose habitat characteristics provided high productive capacity for salmonid species. These reference values were then compared to the frequency distributions of habitat characteristics within a basin or region. Analyzing the frequency distributions, ODFW generally accepted that values from the 66th percentile or higher represented

Table A-3 – Habitat Benchmark Details		
Parameters (ODFW Benchmarks)	**Undesirable**	**Desirable**
POOLS		
Pool Area (% Total Stream Area)	<10	>35
Pool Frequency (Channel widths between pools)	>20	5-8
Residual Pool Depth		
Small Streams (<7m width)	<0.2	>0.5
Medium Streams (≥7m to <15m)		
Low Gradient (Slope <3%)	<0.3	>0.6
High Gradient (Slope >3%)	<0.5	>1.0
RIFFLE SEDIMENT		
Width / Depth Ratio (Active channel based)		
"West Side" Streams	>30	<15
Gravel (% Riffle Area)	<15	>35
Silt-Sand-Organics (% Riffle Area)		
Sedimentary Parent Material	>20	<10
Volcanic Parent Material	>15	<8
Channel Gradient < 1.5%	>25	<12
LARGE WOOD* (15cm x 3m min. piece size)		
Pieces /100m Stream Length	<10	>20
Volume/ 100m Stream Length	<20	>30
Key Pieces (>60cm diameter & ≥10m long)/100m	<1	>3
Parameter (EPA Benchmark)		
BANK STABILITY		
Stable Banks (% not actively eroding)	<90	>90
* Values for streams in forested basins.		

desirable habitat conditions, and values from the 33rd or lower percentile represented undesirable conditions. The benchmarks developed from the distributions were then tailored to stream gradient as well as regional and geologic setting. Benchmarks for other characteristics (pool frequency and depth, and silt-sand-organics) were developed by comparing distributions and generally accepted or published values (Moore, 1997). The benchmark for riffle gravel was developed through correlation analysis between winter gravel estimates (habitat and spawning surveys) and summer gravel estimates (habitat surveys). If a reach has at least the threshold value for riffle gravel (35%) during summer habitat surveys, then sufficient gravel was generally available for spawning in pool tailouts and other common spawning habitat for coho (Kim Jones (ODFW), personal communication November 2001).

The bank stability benchmark is considered an anticipated average minimum performance level possible under various geomorphic conditions which will provide favorable biological conditions over time (McCullough, 1999). This benchmark, ≥90% stable, is the standard suggested by the US Environmental Protection Agency, Region 10 (Bauer, Ralph, 1999).

Benchmark parameters and desirable / undesirable standards developed by ODFW are shown in Table A-3 (Table modified from Moore, 1997).

Wetlands Inventory

Wetland conditions were evaluated in two ways: (1) we looked at the historical extent of wetlands; and (2) we identified potential wetland restoration opportunities using the Hydrogeomorphic Assessment maps developed by Scranton, 2004. This wetland evaluation does not include site-specific ranking or prioritization of potential restoration sites, but rather takes a broad scale look at a critically important habitat type in the assessment sub-basins.

The historical extent of wetlands in the assessment area was determined from three sources of data. First, soils provide the most reliable indication of wetlands because they tend to not change over time. Specific types (series) can be further used to identify areas where the soils developed under tidal inundation (Brophy, 2005). In the Catching Assessment area, these soil series include Brallier, Blachly,Chetco, Chisore, Dement, Digger, Fluvaquents-Histosols Complex, Geisel, Honeygrove, Langlois, Nestucca, Rinearson, Salander, Templeton, Willanch, and Wintley. Soil types indicative of freshwater inundation are based on *Hydric Soils of Oregon* (NRCS, 1995), which, along with National Wetland Inventory data, is used to create the historical wetland maps (USFWS, 1998). The *Soil Survey of Coos County* (USDA-SCS, 1989) and its electronic data layer is used to identify soil series formed under tidal influence (Brophy, 2005).

HGM Class Definitions

(from metadata at
http://www.coastalatlas.net/metadata/TidalWetlandsofOregonsCoastalWatersheds,Scranton,2004.htm)

Potential Wetlands and/or Restoration Consideration Areas (RCAs) were defined as upland or non-tidal areas that might deserve closer scrutiny as possible candidates for restoration of tidal circulation, pending landowner involvement. These areas were identified based solely on coarse-scale geotechnical information from available data layers. No on-site feasibility investigations were conducted, and sociopolitical factors were not considered. These are generally lands that are diked or may have been partially filled or ditched for agricultural or commercial purposes. An unknown portion of the restoration consideration areas (RCAs) are palustrine wetlands or riparian uplands that never experienced tidal flooding, due to naturally-formed barriers.

Marine-sourced Low Tidal Marsh. These are tidal marshes that are inundated at least once daily during the majority of days during the growing season, and which are in portions of the lower estuary usually dominated by marine waters. They were labeled MSL. In most instances they were considered synonymous with polygons labeled E2EMN on NWI maps, and/or 2.5.11 in the ODFW maps of the Oregon Estuary Plan Book, when such data were available.

Marine-sourced High Tidal Marsh. These are tidal marshes, also in the lower estuary, not meeting the Marine Sourced Low Tidal Wetland inundation criterion (i.e., are inundated less frequently). They were labeled MSH. In most instances they were considered synonymous with polygons labeled E2EMP on NWI maps, and/or 2.5.12 in the ODFW maps of the Oregon Estuary Plan Book, when such data were available.

River-sourced Tidal Wetland. These are tidal marshes or tidal forested wetlands that experience cyclic water level fluctuations as a direct or indirect result of tides at least once during every annual growing season. They are located in the upper estuary, commonly along river channels with a consistently strong sea-ward flow. They include some undiked wetland polygons labeled by NWI as PEMR, PEMS, or PEMT, and/or hydric soils in river locations below the DSL-identified head of tide, and/or polygons labeled 2.5.13 in the ODFW maps of the Oregon Estuary Plan Book, when such data were available. In some instances where channels are deeply incised it is doubtful that some polygons labeled as RS are truly tidal wetlands, because tidal range may be merely on the order of inches, incapable of flooding adjacent lands over natural levees. However, in other upriver settings channels are not incised and have the capability of being tidally inundated, but this cannot be determined from aerial photographs.

Potential Tidal Forested Wetland. This includes lands currently covered by woody vegetation that are suspected of experiencing tide-related inundation at least once annually, but for which definitive field data are lacking. This includes wetlands labeled E2F* or E2S* by the NWI, as well as wetlands that NWI labeled PSS* or PFO* and which adjoin tidal channels and apparently are not diked. It also includes wetlands coded 2.5.14* by ODFW in the Oregon Estuary Plan Book. These are mostly relict spruce swamps and willows existing near their physiological threshold for salinity. Many probably became established in tidal zones due to fresher hillslope seepage and/or due to presence of "nurse logs" that, due to elevated position above the marsh surface, provided a microenvironment subject to less-frequent inundation, thus facilitating germination and survival during their sensitive early years.

Fill. This includes lands that have been filled and/or compacted for human use and no longer function as a wetland. This includes dikes, dirt and paved roads, railroads, highways, gravel driveways, dredging spoils, golf courses marina jetties and buildings that are spatially connected to the attributes listed above. A few of these polygons may never have been tidal wetlands; such post-facto determinations are difficult to make without field data. Due to time constraints this layer is not complete and there are locations where infrastructure has not yet been classified as filled lands. The DSL Inventory of Filled Lands was consulted, as was the Army Corps of Engineers (USACE) permits database. From these it was apparent that most fills identified by these sources are shown as such on this map, but information from the sources was not applied systematically in creating the map. Also, not all dikes could be identified with the imagery used and therefore this map should not be used as an inventory of diked marshes.

Sediment Sources

Slope Stability

A 10-meter Demographic Elevation Model (DEM) was used for the GIS analysis of the slopes of this sub-basin. An ODF classification of potential risks of slopes was used to group the slopes in to larger categories for analysis. They are as follows:

<u>Low Risk:</u> Less than 40% slope, essentially no risk of a rapidly moving debris flow. Gentle to moderate slope steepness precludes shallow landslides, but area may be subject to deep-seated, slower moving slides.

<u>Moderate Risk:</u> 40-60% slope, debris flows (moves down-slope as a semi-fluid, watery mass scouring soils from the slope in its path) may occur.

<u>High Risk:</u> 60-70% slope, debris flows fairly common after major storms, and sometimes after moderate storms, steep to very steep slopes with steep stream channels.

Extreme Risk: More than 70% slope, multiple rapidly moving debris flows during major storms and moderate intensity storms. Very steep slopes with confined stream channels.

A geology layer was obtained from the State Service Center of GIS, and used to determine the types of underlying parent material present in the lowlands.

Road Sediment Survey (Road and Landing)

Coos Watershed Association completed road and landing surveys using Pacific Watershed Associates methodology as adapted by the Coos WA. Coos WA surveyors were trained by Dan K. Hagans of Pacific Watershed Associates.

Each drainage feature location was mapped and a data form filled out. Up to 63 fields are collected per site, and a stream profile and cross section is taken to calculate the volume of sediment at risk at each stream crossing.

The length and the slope of each ditch contributing flows to the site was measured and compared to the 2003 Oregon Forest Practices Act Best Management Practices for ditch-length recommendations (see below). Each of the culverts was evaluated for size and condition, and upgrade and maintenance recommendations were made where needed.

Data collected at fish bearing stream crossings was used to determine if the crossing created a fish passage barrier.

The effectiveness of road drainage features was evaluated using a slightly modified Pacific Watershed Associates protocol. The data collected has been entered into a Road and Landing Access Database, Excel Spreadsheets and exported into ArcView. This is used to track the status of road systems and for more comprehensive basin-wide sediment budget modeling. Key fields that describe sediment hazard included road gradient and side slopes, ditch length, proximity to stream channels, and potential delivery volumes. Ditch length is only one of three factors, the other two being gradient and soil type (permeability), that determine erosion potential and sediment transport from ditches. This survey and analysis work has enabled Coos WA to make informed recommendations for road drainage projects that will reduce chronic sediment delivery as well as prevent catastrophic road fill failures.

Recommended Ditch Lengths
Cross-drainage structures

Science and Monitoring
Soil properties and road grade have a major influence on ditch erosion and potential for gullies to develop (Arnold, 1957). ODF monitoring found that culverts comprise about 35 percent of the cross drainage structures used on forest roads in western Oregon. Waterbars and ditch-outs each make up about 15 percent of the cross drainage structures used in western Oregon. Many roads also had non-engineered drainage features (water flowing across the road without any structure). ODF monitoring also found that roads with steeper grades (over 9 percent) often had fewer cross drains than less steep roads, with spacing exceeding that recommended to reduce ditch erosion.

Implementation
The location and installation of cross-drainage structures is the final element of drainage, and recognizes there are many ways to drain a road. Local experience is important here. First, look for opportunities that do not require the use of structures across the road. Use of ditch-outs as roads cross ridges is very effective, as are grade reversals. Cross drains must be placed more frequently as road grades get steeper and in more erodible materials, like decomposed granite. The culvert spacing guidelines in Table 2 are based on Arnold (1957) but have been simplified to consider only two soil types, normal and erodible. Most soils are considered normal. Erodible soils include decomposed granitics in southwest Oregon, volcanic ash in eastern Oregon, and any soils with natural gullies or a history of surface erosion problems at that location.

Table 2. Typical minimum culvert spacing for erosion control

	Culverts draining to forest floor	
Road Grade	**Normal Soils**	**Erodible Soils**
0 to 1 % dry season	1500 feet	1000 feet
*0 to 1 % wet season**	*300 feet*	*300 feet*
2 to 5 %	1000 feet	700 feet
6 to 12 %	700 feet	400 feet
13 to 19 %	400 feet	250 feet
over 20 %	250 feet	150 feet

** water ponds on flat grades so extra drainage is needed for roads used during wet periods*

Table 2 is applicable for effective, well-maintained structures only. If waterbars are used, they should be installed at closer spacing, since waterbars can be easily damaged if filled with sediment by traffic (authorized or unauthorized). Note that the lengths in Table 2 are typical, and should always be adjusted to make sense for local conditions. If another local criteria effectively works to keep sediment out of streams, it should be used instead of the criteria in Table 2.

(Excerpt from Installation and Maintenance of Cross Drainage Forest Practices Technical Note Number 8, *Version 1.0,* June 20, 2003, Oregon Department of Forestry)

Stream Crossing Drainage Evaluation

Using ArcView 3.2a, Coos WA was able to calculate the area of land above each stream crossing that drains into that site. We used the ArcView extension Spatial Utilities to collect these calculations. Using the Oregon Road/Stream Crossing Restoration Guide, 1999, we were able to get the current CFS (cubic feet per second) capacity of each culvert using the existing culvert diameters from recent Coos WA road and landing surveys. The fifty and one hundred-year peak flow events were calculated using the drainage area for each stream crossing multiplied by the common peak flow values found in the Oregon Road/Stream Crossing Restoration Guide. We then subtracted the current CFS capacity of the culvert from the CFS that a fifty and one hundred- year event will produce to determine if the current culvert will pass both of these events.

The Coos WA road and landing surveys determined that several of the stream crossing culverts were currently plugged or crushed and, therefore, restrict flow. Using of the Oregon Road/Stream Crossing Restoration Guide, we were able to calculate the percent of cross-sectional area loss to account for the percent of flow restriction. By doing this, Coos WA was able to recalculate the CFS capacity of all restricted stream crossing sites and compare these values with CFS requirements for fifty and one hundred-year peak flow events.

Stream Temperature

Continuous stream temperature data was collected using HOBO Water Temp Pro loggers (Part #H20-001) made by Onset Computer Corporation. The sampling interval was set at 30 minutes and each unit was deployed at the same sites throughout the study to minimize equipment bias. Pre and post-deployment accuracy checks and field audits were done with a National Institute of Standards and Technology (NIST) calibrated digital thermometer. Onset BoxCar Pro version 4.3 software was used to launch and download the loggers, plot graphs and export data to Excel. The *Temperature* 1.1 macro developed by the Oregon DEQ was used to process the data files to provide metrics used to assess the temperature standards. Methods described in the Stream Temperature Protocol chapter of the *Water Quality Monitoring Technical Guide Book* (Oregon Plan for Salmon and Watersheds, 1999) were used to standardize logger accuracy checks, site selection, and field audits. Post-season ice-bath audits showed the HOBO units to be functioning correctly, all rated Grade A. Field audits were taken once during the summer for most units. Ratings for the field audits ranged from Grade A to Failing. All units received a passing grade.

Most of the sites consisted of one temperature logger below the water surface attached to a rebar spike driven into the stream bed. At sites in deep stream channels, the temperature logger was affixed to a heavy cement block resting on the stream bottom. Logger sites were chosen to give a representative idea of the water temperatures throughout the streams.

Riparian Shade

The results and all associated data for the shade analysis have been attached to a GIS map. A similar set of data and GIS maps are made from the results of stream temperature surveys. The two maps (temperature and shade) are overlaid to analyze where insufficient shading of the streams is correlated with elevated stream temperatures. Those reaches where the stream heating is occurring can then be prioritized and targeted for riparian restoration. The highest priority areas for restoration are where there is a clear connection between lack of stream shading and heating of the water column.

The full results of the shade analysis, shade values, for all stream reaches are presented below in Tables A-4 through A-6.

The assessment streams and their fish-bearing tributaries were divided into reaches based on aspect, streamside vegetation, and reach breaks determined by the aquatic habitat inventory. If the vegetation of two sides of the stream differed significantly they were averaged and analyzed together.

The stream reaches were examined on topographic maps and the aspect determined for each reach. The streams were each divided into three sets of reaches corresponding to: forested narrow canyons with steeper gradient; smaller, well-drained upper valleys; and broader, poorly-drained, lower valleys.

The stream reaches were analyzed on aerial photos for canopy overhang (estimated at 10% classes), buffer width (measured in 6 foot increments), tree to channel distance (measured in 6 foot increments), existing vegetation composition (recorded as conifer, deciduous, mixed conifer and deciduous, blackberry/shrub, grass, and clear-cut), and presence of a road within 100 feet (Y or N).

DEQ supplied a stereoscope, and BLM supplied a work station and a copy of their 2002 aerial photo set. The reaches were made into a GIS shape file for use in later analyses. The reach lengths (in feet) were measured using the GIS shape file. Also, GIS was used with the 2005 Digital Orthophoto Quad-

Table A-4 Catching Slough Sub-basin - Shade Values

		Steep Canyon	Upper Valley	Lower Valley
All Streams	current	84%	45%	16%
	potential	99%	99%	82%
Boone	current	87%	--	28%
	potential	99%	--	100%
Cardwell	current	76%	--	--
	potential	100%	--	--
Catching	current	79%	--	14%
	potential	99%	--	98%
Catching Slough	current	64%	27%	7%
	potential	99%	99%	55%
Matson	current	86%	55%	18%
	potential	97%	97%	99%
Panther	current	98%	--	--
	potential	100%	--	--
Ross Slough	current	82%	50%	11%
	potential	100%	99%	95%
Seelander	current	86%	--	50%
	potential	100%	--	98%
Stock Slough	current	87%	51%	13%
	potential	99%	99%	98%
W. Sumner Trib.	current	83%	--	0%
	potential	99%	--	100%
Wilson	current	94%	--	35%
	potential	99%	--	100%

Table A-5 Daniel's Creek Sub-basin - Shade Values

		Steep Canyon	Upper Valley	Lower Valley
All Streams	current	90%	79%	29%
	potential	99%	93%	91%
Daniels	current	79%	69%	28%
	potential	99%	95%	92%
Beaver B.	current	97%	84%	--
	potential	98%	94%	--
Morgan	current	97%	78%	26%
	potential	98%	91%	88%
Wren Smith	current	91%	87%	48%
	potential	99%	93%	94%

rangles to cross reference the 2002 aerial photos to better represent current conditions.

Landowners along the streams were contacted for permission to enter their property for the purpose of taking field plots. The purpose of the field plots was to gather additional data on the reaches that could not be determined directly from the aerial photos. Tree heights (in feet) and tree to channel slopes (in 5% classes) were measured at six plots at two streams in each basin.

All data was entered into an Excel spreadsheet. Separate worksheets were constructed for use in running the SHADOW model for current and potential vegetation. The current vegetation run took all measured and estimated data that described current conditions and used the SHADOW model to calculate the current shading of the streams. The potential vegetation run used estimated values for the potential climax vegetation community, shown in Table A-7 (tree height, tree-channel distance, canopy overhang, canopy density) along with current measures such as tree-channel slope to calculate the potential stream shading under vegetative climax conditions.

Table A-6 Heads of Tide Sub-basin - Shade Values

		Steep Canyon	Upper Valley	Lower Valley
All Streams	current	92%	40%	43%
	potential	96%	97%	99%
Rogers	current	97%	48%	--
	potential	97%	98%	--
Packard	current	96%	56%	--
	potential	98%	97%	--
Straw Gulch	current	25%	--	--
	potential	25%	--	--
Mart Davis	current	99%	93%	43%
	potential	95%	97%	99%
Deton	current	97%	--	--
	potential	95%	--	--
Woodruff	current	90%	--	--
	potential	97%	--	--
Bessey	current	99%	--	--
	potential	97%	--	--
McKnight	current	46%	--	--
	potential	93%	--	--
Salmon	current	96%	--	--
	potential	94%	--	--
Dellwood	current	96%	--	--
	potential	95%	--	--
Bridges	current	99%	17%	--
	potential	97%	97%	--
Hendrick-son	current	--	0%	--
	potential	--	97%	--
Caroline Bar	current	99%	--	--
	potential	100%	--	--

The potential vegetation for each stream type was determined by the Coos WA staff. Current and potential shade values for all streams, and each stream, in the assessment area are also shown in Tables A-4 though A-6. The potential vegetation is the community that would develop if the area was left alone for hundreds of years. The narrow, steep canyons are expected to develop dense conifer stands with a mature height of 200'. Because of changes in soil types and tidal influence, the valleys are separated. The upper valleys with well-drained soils are expected to develop dense deciduous stands with a mature height of 120'. The lower valleys with poorly-drained soils are expected to develop spruce stands with a mature height of 140'.

Table A-7 Characteristics of Potential Vegetation for the Three Landforms in the Assessment Areas

	Canopy Overhang	Canopy Density	Tree-Channel Distance	Tree Height
Conifer Forest Steep Canyon	80%	90%	15'	200'
Deciduous Forest Well-drained Upper Valley	90%	90%	5'	120'
Spruce/Willow Forest Poorly-drained Lower Valley	70%	90%	10'	140'

SHADOW Validation Protocol

The SHADOW model results were validated with direct measurements in field plots. This validation shade measured from field plots and the SHADOW model shade are compared in Tables A-8 through A-10. The plot measurements included: tree-channel slope (in 5% classes), tree-channel distance (in feet), tree heights (in feet), active channel width (in feet), canopy overhang (estimated in 10% classes) and canopy density (estimated in 10 % classes). The shade on the active channel was measured using a Solar Pathfinder instrument. A transect of the channel was established and for each 10' of active channel width a shade reading was taken. These readings were then averaged for the shade over the length of the transect. The field measurments were then fed into the SHADOW model to produce current shade values for those points. The current shade as determined from SHADOW and the Solar Pathfinder instrument were compared to analyze whether the results of the SHADOW model are close to what is actually measured in the field. The SHADOW model has limitations such as not taking into account topographic shading (i.e., that which is caused by a steep ridge next to the stream) and only taking one tree height for a calculation when there may be two tree canopy heights at a point. The Solar Pathfinder has limitations in that it is time consuming to take multiple plots that produce an average value for a point.

Given the limitations of both the SHADOW model and the number of Solar Pathfinder readings taken, all of these values are within an acceptable range. The largest disparity between actual and modeled shade for each sub-basin is 20% in the Catching Slough sub-basin, with the standard deviation of this data set being 8.9%. The mean of 1.9% shows us that although the modeled shade is sometimes more or less than the actual amount, it is not overly egregious. In the Daniel's Creek sub-basin none of the differences between actual and modeled shade are above 17%, with the standard deviation of this data set being 8.1%. The mean of 2.2% shows us that although the modeled shade is sometimes more or less than the actual amount, the SHADOW model

Table A-8 Catching Sub-basin SHADOW Validation Results

Map ID #	SHADOW Shade %	Validation Shade %	Difference %
CC 18	68	63	5
CS 7	42	61	-19
WC 5	98	97	1
PC 9	100	87	13
MC 4	46	58	-12
MC 6	17	6	11
MC 2	94	90	4
CC 15	83	82	1
WC 14	96	81	15
CC 5	90	92	-2
WC 13	94	89	5
MC 7	0	0	0
MC 18	82	69	13
RS 28	7	4	3
WC 4	94	98	-4
RS 30	35	44	-9
CS 2	74	67	7
		Mean	**1.9**
		Std. Dev.	**8.9**

Table A-9 Daniel's Creek Sub-basin SHADOW Validation Results

Map ID #	SHADOW Shade %	Validation Shade %	Difference %
BBC2	97	92	5
BBC5	92	96	-4
BBC8	83	85	-2
WSC8	96	94	2
WSC11	91	94	-3
WSC16	82	66	16
DC9	19	28	-9
DC18	28	24	4
DC24	72	87	-15
DC30	13	24	-11
DC76	7	16	-9
MC12	76	75	1
MC16	86	90	-3
		Mean	**-2.2**
		Std. Dev.	**8.1**

results should be very close to actual shade. In the Heads of Tide area, the largest discrepancy between actual and modeled shade is 22%, with the standard deviation of this data set being 11.0%. The mean of 6.3% shows us that the modeled shade is most often slightly more than the actual amount (except HD01, where shade was underestimated).

Table A-10 Heads of Tide Sub-basin – SHADOW Validation Results

Map ID #	SHADOW Shade %	Validation Shade %	Difference %
MK02	93	86	7
WD01	15	10	5
DT03	96	84	12
WD04	95	83	12
PC01	79	57	22
SG01	11	6	5
HD01	0	19	-19
RG03	25	17	8
BS01	99	94	5
		Mean	**6.3**
		Std. Dev.	**11.0**

Salmonid Distribution

Fish presence data is based on the classification of streams according to ODF Forest Practice Rules. General 'fish use' classification is assumed in basins draining more than 60 acres and where the gradient is less that 20%. Extent of fish presence was expanded for streams where Coos WA surveys confirmed fish presence.

Data for anadromous fish species extents are gathered from GIS layers available through ODFW. Historical salmonid stocking records, for releases directly into assessment streams, were also obtained from ODFW.

Spawning Surveys

Coos WA spawning surveys were conducted in conjunction with the ODFW Coastal Salmonid Inventory Project (CSIP). The CSIP coho inventory estimates coastal coho escapement by surveying a combination of standard reaches, surveyed annually, and random reaches, selected with stratified random sampling (SRS) criteria including predicted spawner density and geographic location (Nickelson and Jacobs, 1998). The SRS method improves population estimates by reducing bias in reach selection. However, for restoration efforts within a particular basin, selecting reaches associated with projects or within priority regions was required. On streams that had CSIP random reaches, the Coos WA surveys were conducted according to the descriptions of those surveys. The surveys increased the sampling frequency of these reaches that are usually only surveyed once every five years.

The length of survey reaches range from .31 km to 1.57 km and average .96 km of stream length. All reaches were sub-divided into segments which averaged .26 km in stream length to increase the resolution of fish counts, redd counts, and gravel estimates. Generally, segment breaks were located at permanent landmarks such as bridges or tributaries for easy relocation. Survey lengths were measured with a hip chain.

Full-season standard and supplemental reaches were surveyed every seven to ten days (except when high turbidity prevented fish counts) so that the data could be used to calculate Area-Under-the-Curve (AUC) coho population estimates. The AUC calculation estimated the abundance of adult and jack coho in a given stream reach.

The Area-Under-the-Curve population estimates are calculated as:

$O_i=[\Box^{a}{}_{h=1} (C_{hi}\ T_{hi})]/D$
where
a = number of periods
C_{hi} = mean count in period h for stream segment i,
T_{hi} = number of days in period h for stream segment i, and
D = average spawning life of coho salmon in survey segments (11.3 days) (Jacobs and Nickelson, 1998).

The AUC was calculated for each stream and for each segment. In order to compare fish density between segments of different lengths, AUC/km was derived by dividing the AUC by the segment length. Similarly, redd counts were divided by the segment length for redd density.

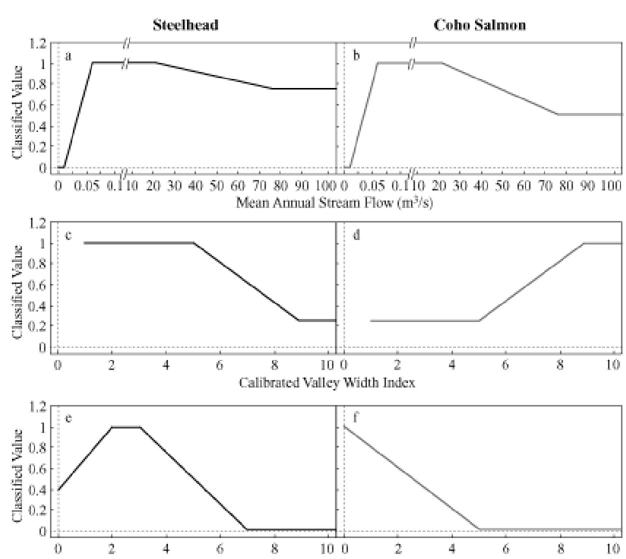
Because of the dynamic nature of streams during high winter flows, the area of available coho spawning gravel was estimated approximately once a month. These estimates were used as a measure of available spawning habitat. Using the estimates, gravel area per spawning female was calculated. Because of the low carcass recovery on most streams, a female per area of spawning gravel was calculated based upon an assumed equal female to male ratio. In order for gravel to be included in the coho spawning gravel estimate, it had to meet the following requirements: diameter of 2-15 cm, less than 50% fines or larger rock, minimum of 20 cm depth of gravel deposit and a minimum of $2m^2$ surface area.

Intrinsic Potential for Coho Smolt Production

Intrinsic Potential is the capability of a stream reach to support specific fish species. In our case, we are interested in the potential of a stream to support coho salmon. The application of the intrinsic potential concept to Oregon coastal streams is the result of work by Kelly Burnett and colleagues at the U.S. Forest Service's (USFS) Pacific Northwest Research Station for the Coastal Landscape Analysis and Modeling Study (CLAMS). The method is generically a "habitat suitability index," and in this case is based on three geomorphic characteristics of the stream reach: channel gradient, valley-width index, and mean annual stream flow, as shown in Figure A-1 above (Burnett et al., 2007).

The three separate indices are used to determine the intrinsic potential of a stream reach for coho salmon (or steelhead) through the following formula:

Figure A-1 Habitat Suitability Indices (HIS) For Steelhead and Coho Salmon Juveniles (Burnett et al., 2007)



$$IP = \sqrt[3]{F_I * VW_I * G_I}$$

Where:

IP = Intrinsic Potential (Scale: 0 – 1),

F_I = Flow Index (Scale: 0 – 1),

VW_I = Valley Width Index (Scale: 0 – 1), and

G_I = Channel Gradient Index (Scale: 0 – 1)

The above equation represents the geometric mean of the index scores shown in Figure A-1 for the mean annual stream flows, valley-width index, and channel gradient. Note that in geometric means if any one of these indices is zero then the resulting intrinsic potential index will also be zero. Reaches with an index of 0.75 or greater are rated as "high" for their potential to produce coho salmon smolts.

The intrinsic potential of a given stream reach can be used to infer its ability to sustain coho smolts (its original use), as well as to estimate historic coho spawning populations (Lawson et al., 2004). Using the Lawson et al. procedures, a given stream reach is first classified by whether its stream gradient is greater than 0.5% (less than 0.5% gradient is considered wetlands). For reaches less than 0.5% gradient, the following formula was used to estimate the number of coho smolts that could be supported:

$$S = 0.0741L(V - W)P$$

Where:

S = Potential number of smolts produced in the reach,

L = Reach length, in meters,

V = Valley width, in meters

W = Active channel width, in meters

P = Intrinsic potential of the reach (unitless), and

0.0741 = Number of smolts per square meter of potential habitat.

The formula for stream reaches with channel gradients greater than 0.5% is:

$$S = (0.3405)(0.5)LWP$$

Where:

S = Potential number of smolts produced in the reach,

0.3505 = Number of smolts in main channel pools,

0.5 = Proportion of area in pools based on assumed 50%:50% pool:riffle ratio

L = Reach length, in meters,

W = Active channel width, in meters, and

P = Intrinsic potential of the reach (unitless).

Individual stream reaches were aggregated to provide an estimate of the number of coho smolts that could be produced for each sub-basin. Estimates of the intrinsic potential of a sub-basin to produce coho adults use a range of 1% (poor) and 10% (good) ocean survival of smolts to adults (Lawson et al., 2004). These two numbers provide the low and high estimates of adult spawners in each sub-basin.

Habitat Limiting Factors to Coho Production

Estimates of summer smolt production capacity were determined with the Habitat Limiting Factors Model (HLFM) described by Nickelson (1998) and modified by Rodgers et al (2005). Results for assessment streams are shown in Chapter 2, and results for assessment stream individual reaches are shown below in Tables A-11 through A-14. Habitat data, the basis of the model, was collected by Coos WA in summer using the ODFW Aquatic Habitat Inventory (AHI) protocol. AHI data was collected from the tide gates, or stream mouths, to the end of anadromous fish usage, except where landowners denied access. Winter AHI data was not collected. To estimate smolt production we first used the predictive model developed by Rodgers et al (2005) to estimate summer and winter parr production. Then we multiplied the summer parr value by the density independent survival rate of 0.72 for summer parr to smolt. We multiplied the winter parr value by the density independent survival rate of 0.90 for presmolt to smolt. These survival rates were derived by Nickelson (1998).

Summer habitat limitations due to high stream temperatures were accounted for only in reaches where summer stream temperature was available (see Temperature Methods). Reaches were considered limiting for summer habitat where a seven-day average maximum exceeded the Oregon state salmonid rearing standard of 64^{o}F (18 ^{o}C) and were therefore excluded from available habitat for that season. This method may overstate the limitations caused by temperature since juvenile fish in such reaches may be able to move into cooler reaches or niches within a warm reach, or use the reach at a time in the season that is cooler. Also, less is known about the effects of high stream temperatures on coho rearing habitat in the estuarine setting that many of these reaches encompass, i.e. Catching Slough, Ross Slough, and Stock Slough. Additionally, not all reaches evaluated for habitat limiting factors had temperature data. The amount of area with temperature data is indicated on the habitat limiting factors analysis tables (see below).

This limiting factors analysis does not incorporate availability of winter spawning gravel into production estimates. Winter smolt production estimates could be high if spawning gravel was limited or if available gravel had an excess of fine sediment that lowered egg to fry survival rates. Another model assumption is that the bottleneck is based on a spatial (i.e., habitat) limitation and not a biomass bottleneck (i.e., one large fish is equivalent to many small fish).

This analysis also fails to incorporate spatial availability of winter and summer habitat. If summer and winter habitats are separated by distances that limit movement between them, habitat connectivity could limit smolt production. For example, if areas with high winter habitat production are inaccessible by fish rearing in non-temperature limited reaches during the summer, it is possible that summer habitat could limit production because fish can not access the better winter rearing habitat.

The limiting factors analysis is a useful tool for examining the AHI data at the sub-basin level. Because of the high potential utility of the limiting factors analysis in prioritizing restoration work, it is recommended that summer and winter fish population data, and winter habitat data be collected on a sample of streams to test the Rodgers et al (2005) predictive model used to estimate winter parr and smolt production.

Table A-11 Stream Reach Detail, Coho Habitat Limiting Factors - Lower Catching Sub-basin											
Stream	Reach #	Capacity/Km				Ratio of Summer Parr to Winter Pre-Smolt Capacity	Ratio of Summer Smolt to Winter Smolt Capacity	Stream Temperature		Most Limiting Habitat
		Summer Parr	Summer Parr to Smolt	Winter Pre-smolt	Winter Pre-smolt to Smolt			Data Available	% Stream Length >64ºF (18ºC)*	
Ross Slough	1	6,067	4,247	1,489	1,340	4.1	3.2	Yes	100%	Summer
	2	5,026	3,518	1,412	1,271	3.6	2.8	Yes		Summer
Stock Slough	1	7,394	5,176	2,073	1,866	3.6	2.8	No	0%	Winter
	2	2,195	1,537	572	515	3.8	3.0	No		Winter
	3	852	597	226	204	3.8	2.9	No		Winter
	4	504	353	162	146	3.1	2.4	Yes		Winter
	5	1,151	805	319	287	3.6	2.8	Yes		Winter
	6	519	363	211	190	2.5	1.9	No		Winter
	7	866	606	321	289	2.7	2.1	Yes		Winter
	8	350	245	172	155	2.0	1.6	No		Winter
	9	635	444	210	189	3.0	2.3	Yes		Winter
	10	342	240	290	261	1.2	0.9	Yes		Summer
	11	170	119	138	124	1.2	1.0	Yes		Winter
Matson	1	4,886	3,420	1,500	1,350	3.3	2.5	Yes	27.22%	Winter
	2	1,067	747	302	272	3.5	2.7	No		Winter
	3	1,473	1,031	421	379	3.5	2.7	Yes		Winter
	4	1,180	826	386	348	3.1	2.4	No		Winter
	5	1,004	703	278	250	3.6	2.8	Yes		Winter
	6	1,121	784	294	265	3.8	3.0	Yes		Summer
	7	3,301	2,311	873	785	3.8	2.9	Yes		Summer
	8	426	298	185	166	2.3	1.8	Yes		Winter
	9	1,885	1,319	500	450	3.8	2.9	Yes		Winter
	10	863	604	585	526	1.5	1.1	Yes		Winter
	11	550	385	209	188	2.6	2.0	Yes		Winter
	12	1,307	915	431	388	3.0	2.4	Yes		Winter
Petock	1	1,689	1,182	468	421	3.6	2.8	Yes	0%	Winter
	2	200	140	224	202	0.9	0.7	Yes		Summer

*Length assumes that where no data is available the 7-day average maximum temperature is below 64ºF (17.78ºC).

Table A-12 Stream Reach Detail, Coho Habitat Limiting Factors - Upper Catching Sub-basin										
		Capacity/Km				Ratio of Summer Parr to Winter Pre-Smolt Capacity	Ratio of Summer Smolt to Winter Smolt Capacity	Stream Temperature		Most Limiting Habitat
Stream	Reach #	Summer Parr	Summer Smolt	Winter Pre-smolt	Winter Smolt			Data Available	% Stream Length >64ºF (18ºC)*	
Seelander	1	2,653	1,857	1,306	1,176	2.0	1.6	Yes	34.71%	Summer
	2	1,480	1,036	518	466	2.9	2.2	Yes		Winter
	3	1,106	774	335	302	3.3	2.6	Yes		Winter
Wilson	1	2,125	1,487	542	488	3.9	3.0	Yes	20.65%	Summer
	2	1,414	990	406	365	3.5	2.7	Yes		Winter
	3	178	125	240	216	0.7	0.6	No		Summer
	4	3,200	2,240	2,814	2,533	1.1	0.9	No		Summer
	5	938	656	299	269	3.1	2.4	No		Winter
	6	548	384	247	223	2.2	1.7	Yes		Winter
	7	549	385	175	158	3.1	2.4	No		Winter
	8	401	280	203	183	2.0	1.5	Yes		Winter
	9	914	640	309	278	3.0	2.3	Yes		Winter
Boone	1	1,348	944	419	377	3.2	2.5	Yes	54.32%	Summer
	2	2,138	1,497	1,412	1,271	1.5	1.2	Yes		Summer
	3	562	393	272	245	2.1	1.6	No		Winter
	4	435	304	155	139	2.8	2.2	No		Winter
	5	297	208	221	199	1.3	1.0	No		Winter
Catching	1	4,865	3,406	1,347	1,212	3.6	2.8	Yes	40.08%	Summer
	2	1,578	1,105	634	571	2.5	1.9	No		Winter
	3	1,349	944	352	316	3.8	3.0	Yes		Summer
	4	694	486	237	213	2.9	2.3	Yes		Winter
	5	1,028	720	278	250	3.7	2.9	Yes		Winter
	6	753	527	223	200	3.4	2.6	No		Winter
	7	566	396	162	146	3.5	2.7	No		Winter
	8	945	661	435	391	2.2	1.7	No		Winter
	9	366	256	154	139	2.4	1.8	Yes		Winter
	10	221	155	210	189	1.1	0.8	Yes		Summer
*Length assumes that where no data is available the 7-day average maximum temperature is below 64ºF (17.78ºC).										

Table A-13 Stream Reach Detail, Coho Habitat Limiting Factors - Daniel's Creek Sub-basin										
		Capacity/Km						Stream Temperature		
Stream	Reach Id	Summer Parr	Summer Parr to Smolt	Winter Pre-smolt	Winter Pre-smolt to Smolt	Ratio of Summer Parr to Winter Pre-Smolt Capacity	Ratio of Summer Smolt to Winter Smolt Capacity	Data Available	% Stream Length >64ºF (18ºC)*	Most Limiting Habitat
Daniel's	1	2,128	1,490	585	526	3.6	2.8	Yes	33%	winter
Daniel's	2	4,286	3,000	900	810	4.8	3.7	Yes	33%	winter
Daniel's	3	4,140	2,898	951	856	4.4	3.4	Yes	33%	winter
Daniel's	4	945	662	258	233	3.7	2.8	Yes	33%	winter
Daniel's	5	655	459	196	176	3.3	2.6	Yes	33%	winter
Daniel's	6	2,301	1,611	1,132	1,019	2.0	1.6	Yes	33%	winter
Daniel's	7	89	63	65	59	1.4	1.1	Yes	33%	winter
Daniel's	TJ#11	1,199	839	1,001	900	1.2	0.9	Yes	33%	summer
Daniel's Beaver Branch	1	108	108	81	72	1.3	1.5	Yes	0%	winter
Daniel's Beaver Branch	2	768	768	200	180	3.8	4.3	Yes	0%	winter
Daniel's Beaver Branch	TJ#7	55	55	44	40	1.2	1.4	Yes	0%	winter
Morgan	1	4,911	3,438	1,029	926	4.8	3.7	Yes	0%	winter
Wren Smith	1	2,569	1,798	544	489	4.7	3.7	Yes	0%	winter
Wren Smith	2	1,034	724	265	239	3.9	3.0	Yes	0%	winter
Wren Smith	3	2,725	1,907	587	528	4.6	3.6	Yes	0%	winter

*Length assumes that where no data is available the 7-day average maximum temperature is below 64ºF (17.78ºC).

Table A-14 Stream Reach Detail, Coho Habitat Limiting Factors - Heads of Tide Sub-basin										
		Capacity/Km						Stream Temperature		
Stream	**Reach Id**	**Summer Parr**	**Summer Parr to Smolt**	**Winter Pre-smolt**	**Winter Pre-smolt to Smolt**	**Ratio of Summer Parr to Winter Pre-Smolt Capacity**	**Ratio of Summer Smolt to Winter Smolt Capacity**	**Data Available**	**% Stream Length >64°F (18°C)***	**Most Limiting Habitat**
Bridges	1	1,643	1,150	557	502	2.9	2.3	Yes	0%	winter
	2	2,633	1,843	1,229	1,106	2.1	1.7	Yes		winter
Mart Davis	1	3,023	2,116	769	692	3.9	3.1	Yes	0%	winter
	2	1,555	1,088	561	505	2.8	2.2	Yes		winter
	3	1,491	1,045	635	572	2.3	1.8	Yes		winter
	4	1,223	856	796	716	1.5	1.2	Yes		winter
	5	1,007	705	419	377	2.4	1.9	Yes		winter
Deton	1	2,936	2,055	818	736	3.6	2.8	Yes	0%	winter
	2	34,926	24,448	9,702	8,732	3.6	2.8	Yes		winter
	3	6,087	4,261	1,220	1,053	5.0	4.0	Yes		winter
	Trib 1	333	233	755	679	0.4	0.3	Yes		summer
Caroline Bar	1	0	0	83	75	0.0	0.0	Yes	0%	summer
	2	42	30	1,180	1,062	0.0	0.0	Yes		summer
Hendrickson	1	1,722	1,205	413	372	4.2	3.2	Yes	0%	winter
	2	0	0	132	118	0.0	0.0	Yes		summer
	3	0	0	64	58	0.0	0.0	Yes		summer
	4	120	84	260	234	0.5	0.4	Yes		summer
Packard	1	3,304	2,313	1,003	902	3.3	2.6	Yes	100%	summer
	2	3,460	2,422	1,252	1,126	2.8	2.2	Yes		summer
	3	2,943	2,060	1,243	1,119	2.4	1.8	Yes		summer
	4	1,259	881	587	528	2.1	1.7	Yes		summer
Straw Gulch	1	150	105	132	119	1.1	0.9	Yes	0%	summer
Woodruff	1	3,196	2,238	845	761	3.8	2.9	Yes	0%	winter
	2	4,755	3,329	1,229	1,106	3.9	3.0	Yes		winter
	3	3,195	2,236	713	642	4.5	3.5	Yes		winter
	Trib 10	582	407	586	527	1.0	0.8	Yes		summer
	Trib 13	888	621	966	869	0.9	0.7	Yes		summer
Rogers	1	4,279	2,995	1,086	978	3.9	3.1	Yes	76%	summer
	2	1,505	1,054	475	428	3.2	2.5	Yes		winter
	3	1,567	1,097	722	649	2.2	1.7	Yes		winter
Bessey	1	1,105	773	341	307	3.2	2.5	Yes	0%	winter
McKnight	1	1,373	961	638	574	2.2	1.7	Yes	0%	winter
	2	1,225	857	347	312	3.5	2.7	Yes		winter
Dellwood Trib	1	1,264	885	307	276	4.1	3.2	Yes	0%	winter
Salmon	1	509	357	498	448	1.0	0.8	Yes	0%	summer
	2	969	678	293	264	3.3	2.6	Yes		winter
	Trib 1	572	400	262	236	2.2	1.7	Yes		winter

*Length assumes that where no data is available the 7-day average maximum temperature is below 64°F (17.78°C).

Landowner Input and the Coffee Klatch Process

Landowners were engaged in the Coos WA assessment process primarily through a three-part series of 'Coffee Klatch' neighborhood meetings held in the current assessment area. These multi-faceted meetings served as an outreach mechanism to cultivate support of the Association's overall goals, engage landowners in the assessment and prioritization process, and to improve knowledge of watershed dynamic functions and local sub-basin conditions.

To foster a less formal meeting atmosphere more conducive to positive, neighborly interaction, the Coffee Klatches were each held in someone's home within the sub-basin as often as possible. Mailing lists were compiled from digital tax lot ownership layers using ArcView GIS 3.2, and edited to include owners residing within the state of Oregon and owning parcels of one acre or more in size. Invitation letters were mailed with a stamped return postcard included, on which landowners could register a number of people to attend the Coffee Klatch, decline attending at this time, or express disinterest.

The purpose of the first Coffee Klatch meeting was to introduce the Coos WA and its assessment process, (present preliminary assessment data summaries if available), and inquire about landowners' top watershed concerns and values. This input from landowners is later incorporated into the socio-economic feasibility scoring procedure within the restoration prioritization process. Input was collected in the following forms. First (after a round of introductions and explanation of the process), meeting attendees were asked as a group to list what they value most about the sub-basin (assessment) area in which they live or manage land. Landowners were also asked what they would like to see happening there in the next 10 to 20 years. Responses to these questions were called out by attendees and Coos WA staff recorded them on a large, visible flip chart. These lists, along with meeting notes, were used to supplement the Assessment's narrative describing local watershed values and issues.

Table A-15 Landowner Responses 1st Coffee Klatch

Concern Category	Concerns sub-categories from surveys
Water Quality & Quantity	• Drinking water protection • Water rights and disputes • High stream temperature • Turbidity • Lowering water table
Drainage Structure Management	• Tide gates • Culvert upgrades • Ditch maintenance needs • Debris build-up in channel • Increased flooding, slower drainage
Encroaching Development	• Gas pipeline • Measure 37 • Increased traffic • Loss of privacy
Fish / Wildlife Habitat & Environmental Quality	• Declining fish runs • Need to restore habitat for mammals etc.
Rural Economy	• Losing family farms • Lose of agricultural land use • Unproductive pastures
Sediment & Erosion	• Livestock access to streams • Upland erosion and downstream affects • Silting of channel • Banks eroding • Beavers causing bank erosion
Regulations & Government Interference	• Conservation takes land out of economic production • Government control of private land • Ditch maintenance tied up in permit process
Environmental Awareness	• Problems with illegal garbage dumping • Proper use and disposal of pesticides
Invasive Species Control	• Aquatic weeds • Blackberry control
Road Maintenance	• Increasing flood affect on roads • Road deterioration • Stream bank erosion encroaching upon roads

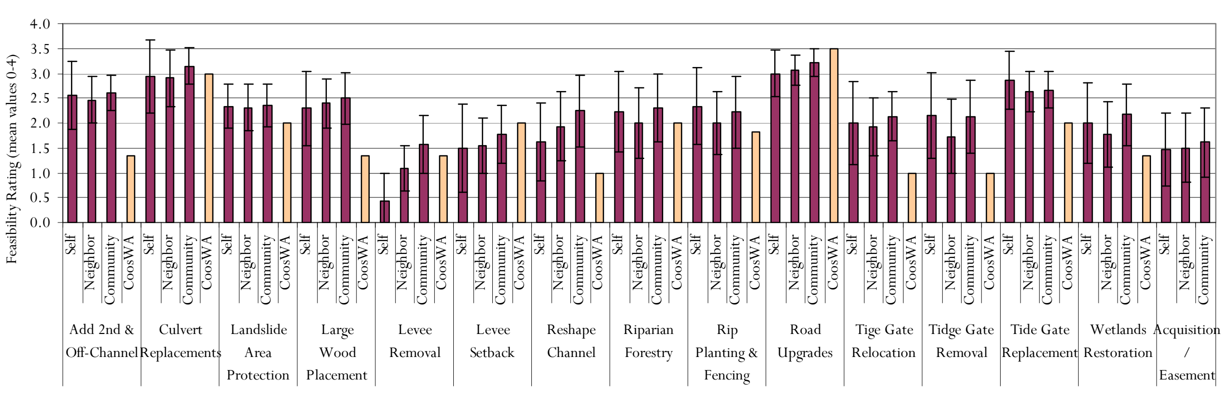
Collection of landowner concerns information was done in a more anonymous way. Landowners were handed a survey sheet on which they listed their top three watershed-related concerns for the Coos watershed area, and then for their own and adjacent property. The survey also asked attendees to list their top three land management goals, and provided space for additional comments. Responses regarding landowner concerns were later used to develop issue categories, and each response was assigned to one of the categories shown in Table A-15. Graphed responses by category are shown in the main body of the Assessment – Chapter 2A, B and C. 'Concerns' data were later referenced during the Coos WA process of prioritizing potential actions (see Prioritization Methods, below).

Table A-16 – Sample of Potential Action Feasibility Survey		
Key 0: absolutely not, 1: potentially but unlikely, 2: likely at least in part, 3: generally true, 4: absolutely, NA: not applicable		
Potential Action	**Question**	**Rating (circle one)**
1. Add secondary & off-channel features	Would this project address <u>your</u> needs or concerns?	NA 0 1 2 3 4
	Do you think this type of project would be accepted by your <u>neighbors?</u>	NA 0 1 2 3 4
	Do you think this type of project would be accepted by the <u>community?</u>	NA 0 1 2 3 4

The second Coffee Klatch meeting focused on increasing landowner understanding of restoration actions. This component consisted of a slideshow presentation briefly describing approximately 14 types of restoration projects and then conducting a bussed tour of local project sites. Projects implemented by the Coos WA were referenced as much as possible for photos, success stories and site visits. While specific results of the second Coffee Klatch did not become part of the Assessment, it is assumed that the outreach activity helped to inform landowner input regarding potential restoration actions requested in the subsequent, third Coffee Klatch.

The focus of the third Coffee Klatch is to present the draft Assessment's summarized results, and to conduct a 'ground-check' of Coos WA's portrayal of landowner concerns using another, more structured survey. The survey asked specific questions and requested specific answers (multiple choice format) regarding concerns associated with the list of potential restoration actions (see Table A-17 in Prioritization Methods, below). The survey was handed out to Coffee Klatch attendees and a Coos WA presenter 'walked' through the questionnaire showing sample photos of action types and providing descriptions of what each action may entail. Landowners answered, in multiple choice format, the same three questions for each restoration action. A sample section of the survey is provided below in Table A-16.

Figure A-1 Landowner Feasibility Survey of Potential Restoration Actions - Catching Slough (21 surveys) 6/08



Prioritization Methods

The process used for prioritizing potential restoration actions was developed by the Coos Bay Lowland Assessment Advisory Committee during a workshop held in November, 2005. The Advisory Committee consists of 16 professional experts in watershed and salmon fishery management from the Coos Bay area and the Pacific Northwest. Elements of the process developed during the workshop were then refined by Coos WA staff and reviewed by the Advisory Committee. Results of the process include a ranking of restoration opportunities at the sub-basin region level, and general descriptions of the Coos WA approach to those actions, (i.e. assistance with design, funding and outreach) based on the ranking, or priority, levels. The steps and elements of the process are provided below, and the overall restoration strategy and Coos WA approach is described in Chapter 3 of this document.

A selection of potential habitat restoration, or rehabilitation, actions was prioritized for each of three to four geographical regions within each sub-basin. The suite of potential actions is provided below in Table A-17, and described in Chapter 3. Each potential action was evaluated within the context of the appropriate sub-basin region. Due to variations in land condition and land form, actions may be evaluated for a region in one sub-basin and not evaluated for the same region number in another sub-basin. Regions were labeled with numbers that generally correspond to the following geography; (1) tidally influenced area, (2) lower valley, (3) upper valley, or major tributary, and (4) forested uplands.

Next, the degree of alteration from natural conditions was assessed for a series of watershed processes within each region. Degree of alteration was indicated as either H, M or L (High, Moderate or Low), and was assigned based on assessment data and Coos WA staff knowledge. Table A-18, below, shows the different watershed processes and characteristics evaluated in this step of the prioritization process, and the evaluation results for each region of each sub-basin.

The most significant step in the prioritization process was assigning scores to each potential action for two categories of criteria – biological and socio-economic. Definitions of the 13 criteria and their scores, zero to four, are shown in Tables A-19 and A-20, below. Coos WA staff evaluated each potential action case-by-case, assigning a series of scores based on survey data, field knowledge, and experience with landowners, grantors and project types. Individual scores for each action were then multiplied by the relative weights of the corresponding criterion, and totaled for the two main categories. Using a threshold of two, the aggregate scores for socio-economic and biological criteria were used to determine the level of priority for each action. The level of priority, shown using colors, directs the nature of Coos WA involvement in restoration actions and projects, and is described in Chapter 3 – Prioritization Process. Resulting scores of the prioritization process for the sub-basins are provided in the following section titled Prioritization Score Tables.

Table A-17 Potential Actions
Tide Gate Removal
Tide Gate Replacements
Tide Gate Relocations
Riparian Planting
Riparian Fencing
Levee Removal
Levee Setback
Add/Restore Secondary and Off-Channel Features
Culvert Replacements (erosion and/or passage)
Roads Upgrades
Reshape Channel
Large Wood Placement
Wetlands Restoration
Acquisitions / Easements
Riparian Forestry Practices
Landslide Area Protection
Road Decommission

Table A-18					Processes Degree of Alteration			
Sub-basin	**1**	**2**	**3**	**4**	**Process**	**Sub-Process**	**Indicators of Process**	**Land Management that Alters Process**
Catching	M	H	M	M	**Hydrologic Processes**	Water quantity	Peak flows	Roads, culverts, ditches, loss of wetlands, land use, tide gates
Daniel's	M	M					Base flows, stream temperature	Water withdrawals
Heads of Tide	M	H	M			Tidal exchange	Changes in water elevations, temperature, salinity	Tide gates, levees, channel simplification
						Hyporheic flow (subsurface water)	Infiltration, run-off, temperature	Ground water withdraws, vegetation clearing, compaction
Catching	M	H	H	H	**Sediment Movement Processes**	Sediment delivery	Landslide frequency & magnitude	Roads, forest practices
Daniel's	H	H					Eroding streambanks	Altered riparian vegetation, upland hydrology, channel simplification
Heads of Tide	H	H	H				Surface erosion	Grazing, roads, removal of vegetation
							Floodplain deposition (tidal and flood delivery)	Tide gates, levees, channel simplification, ditching
Catching	H	H	H	M	**Riparian Processes**	Large wood Delivery	Large wood quantity & size	Removal of upland & riparian vegetation, road & stream crossings
Daniel's	H	H				Stream shading	Temperature	Removal of riparian vegetation, water withdrawals
Heads of Tide	H	H	H			Nutrient production/ storage	Invertebrate production, dissolved oxygen, aquatic vegetation	Nutrient loading, removal of riparian vegetation
						Bank stabilization	Bank shape, channel bed load	Removal/ planting of riparian vegetation
Catching	H	H	H	M	**Channel Processes**	Large wood transport	Large wood quantity & size	Stream/ road crossings, dikes
Daniel's	H	H				Sediment transport	Channel incision / aggradation	Tide gates, culverts, channel modification
Heads of Tide	M	H	H			Sediment size sorting	Substrate composition	Channel simplification, increase fine sediment inputs
						Channel migration	Incision, sinuosity	Channel armoring or straightening
						Hydraulics	Current velocity, channel cross section & gradient	Channel simplification (straightening, removing large wood)
Catching	H	H	H	M	**Biological Processes**	Nutrient cycling	Dissolved oxygen, aquatic vegetation, water-borne pathogens	Unfiltered nutrient run-off (livestock, septic)
Daniel's	M	H				Beavers	Beaver dams	Beaver removal, riparian vegetation removal
Heads of Tide	H	H	H			Evapotranspiration	Water table level, local weather (RH)	Vegetation clearing
						Fish migration / connectivity	Fish presence	Road/stream crossings, tide gates, channel constrictions
Catching	H	H	H	M	**Floodplain Processes**	Sediment deposition	Buildup of islands and wetlands; subsidence and accretion	Levees, tide gates, roads
Daniel's	L	H				Channel migration	Meandering, oxbows, alcoves; off-channel areas	Channel armoring, riparian roads
Heads of Tide	H	M	H			Nutrient exchange	Macroinvertebrate production	diking, riparian vegetation removal
						Channel / floodplain interaction	Current velocity; hydrograph, wetlands, flooding	Diking, tide gates, roads

Table A-19 Biological Criteria Score Definitions							
Biological Criteria			**Scores**				
Weight	Criterion	Statement	0	1	2	3	4
25%*	Processes [1]	This action re-establishes natural watershed processes and maintains functional processes.	Does Not Address Any Impaired Processes	Partially Improves At Least One Impaired Processes	Significantly Improves At Least 1 Moderately-Impaired Process	Significantly Restores At Least 1 Highly-Impaired Process	Significantly Restores 3 Or More Highly-Impaired Processes
25%	Connectivity [2]	This action improves or re-establishes habitat connectivity.	Does Not Restore Any Connectivity	Partially Restores Connectivity For Some Life Stages/Species To At Least Some Moderate Quality Habitat	Significantly Restores Connectivity For Some Life Stages/Species To Some High Quality *Or* Lots Of Moderate Quality Habitat	Significantly Restores Connectivity Of Most Stages/Species To A Moderate Amount Of High Quality Habitat	Restores Full Connectivity For All Life Stages For All Species To A Large Amount Of High Quality Habitat
20%	Limiting Factors [3]	This action will promote healthy coho populations by removing one or more limiting factor(s).	Does Not Address Any Coho Life-History Bottlenecks	Addresses One Coho Life-History Bottleneck, But Not The Primary One	Addresses The Primary Coho Life-History Bottleneck, But Low to Moderate Effect on The Bottleneck	Has A High Likelihood Of Significantly Relieving The Primary Life-History Bottleneck	Has A High Likelihood Of Significantly Relieving The Primary And Secondary Life-History Bottlenecks
15%	Longevity	The effects of this action will persist into the future.	Expected Life Span ≤10 Years	Expected Life Span 11-25 Years	Expected Life Span 26-50 Years	Expected Life Span 51-100 Years	Project Expected To Be Self Maintaining In Perpetuity
5%	Unique Habitat Type [4]	This action will benefit or provide specifically needed or unique habitat types.	Does Not Address Any Needed Or Unique Habitat Types	Partially Addresses One Needed Or Unique Habitat Type	Partially Addresses More Than One Needed Or Unique Habitat Type	Completely Addresses One Needed Or Unique Habitat Type	Completely Addresses More Than One Needed Or Unique Habitat Type
10%	Proven Technique	This action will use a technique proven to be successful or test the effectiveness of a new restoration technique.	Technique Known Not To Be Effective	Technique Unproven, But Not Experimental Or Innovative	Technique Experimental And/Or Innovative, But Efficacy Unknown	Technique Proven To Be Effective	Technique Proven To Be Effective And Innovative

* A score of zero results in red priority level ranking for this action as a whole.

1. See watershed processes table - High/Medium/Low degrees of process impairment.

2. Life stages accessible, quality of habitat assessed, extent of habitat assessed.

3. See Reeves et.al. limiting factors analysis.

4. I.e. spruce bogs, tidal swamps, braided channels, anastomosed channels, high salt marshes, off-channel habitats, estuarine habitat, and other needed habitat.

Table A-20 Socio-Economic Criteria Score Definitions							
Socio-Economic Criteria			**Scores**				
Weight	Criterion	Statement	0	1	2	3	4
25%*	Likelihood of success	This action is highly likely to fulfill its goals.	Not Likely To Be Successful	Small Likelihood Of Success	Project Likely To Meet Some Goals	Project Likely To Meet Most Goals	Project Likely To Meet All Goals
10%	Educational benefit	This action will provide educational or outreach benefits.	No Educational Or Outreach Benefits	Few Educational Or Outreach Benefits	Local Outreach And Educational Benefits	Regionally-Prominent Outreach And Educational Benefits	Nationally-Prominent Outreach And Educational Benefits
20%*	Landowner concerns	This action addresses a stated landowner concern.	Meets No Landowner Objectives In The Sub-Basin	Meets At Least One Landowner's Objective, But May Conflict With Objectives of Other Landowners	Meets At Least One Landowner's Objectives, But May Conflict With Other Objectives of that Landowner	Meets More Than One Landowners' Objectives And Does Not Conflict With Any Other Landower(s) Objectives	Meets All Landowners' Objectives And Will Result In A Synergistic Effect For Other Projects
15%	Measurability	The effects of this action will be measurable through monitoring.	Benefits Of The Project Cannot Be Measured	Monitoring Is Possible, But Beyond The Capacity Of The Organization To Conduct	Monitoring Will Be Expensive And Require Long-Term Study	Monitoring Is Feasible With Known Protocols	Monitoring Has A High Likelihood Of Leading To Publishable Results
5%*	Implementation Feasibility	This action is highly likely to be feasible, and political or social resistance to this action is unlikely.	Unlikely To Be Implementable Because Of Political And Social Constraints	Has Potential To Be Politically Or Socially Divisive	Some People In The Sub-Basin Will Like The Project And Others Will Be Neutral Or Oppose It	Most People In The Sub-Basin Will Be Supportive Of The Project	People In The Sub-Basin And Local And Political Leaders Will Be Supportive Of The Project.
15%*	Funding	This action is highly likely to be funded. There are no significant social, political, or other constraints to funding this action.	This Project Is Unfundable	This Project Is Unlikely To Be Funded By Known Source	This Project Can Probably Be Funded From Known Sources, But It Might Be Difficult	This Project Will Likely Be Funded From Known Sources	This Project Is Highly Likely To Be Funded From A Source We Would Like To Develop
10%	Cost	This action provides an acceptable cost/benefit ratio and is within the abilities of the funding and implementing groups.	> $1,000k	$250k-1,000k	$100k - $250k	$50-$100k	< $50k

* A score of zero results in red priority level ranking for this action as a whole.

Prioritization Scoring Tables

Table A-21 Catching Slough Sub-basin Prioritization Scores

Region	Potential Action	Restores Processes	Restores Connectivity	Limiting Factor(s) addressed	Longevity	Unique habitat	Proven technique	Biological Flat Score	Likelihood of success	Educational benefit	Landowner concerns	Measurability	Implementation feasibility	Fundability	Cost	Socio-Economic Flat Score	Weighted Biological	Weighted Socio-economic	Overall Project Priority	Overall Ranking
		Biological Criteria							Socio-Economic Feasibility											
	Criterion weight	0.25*	0.25	0.2	0.15	0.05	0.1		0.1*	0.05	0.35*	0.05	0.3*	0.1*	0.05					
1= Main Sloughs	Wetlands	4	3	3	4	4	4	22	3	3	1	3	1	4	2	17	3.6	1.8	Yellow	1
1= Main Sloughs	Levee removal	4	2	2	4	3	1	16	3	3	1	4	1	3	2	17	2.8	1.7	Yellow	2
1= Main Sloughs	Riparian planting	3	1	2	4	2	2	14	2	3	1	3	2	3	3	17	2.3	1.9	Yellow	3
1= Main Sloughs	Riparian fencing	1	0	1	1	0	3	6	3	1	2	3	4	2	4	19	0.9	2.8	Blue	4
1= Main Sloughs	Road upgrades	1	0	0	2	0	3	6	2	1	3	3	3	2	3	17	0.9	2.7	Blue	5
1= Main Sloughs	Levee setback	1	1	2	2	2	2	10	2	2	2	1	2	1	2	12	1.5	1.9	Red	6
1= Main Sloughs	Restore secondary/off-channel	4	2	1	1	1	1	10	2	2	1	2	0	2	2	11	2.0	1.1	Red	7
1= Main Sloughs	LW placement	3	0	2	1	0	2	8	1	2	1	1	1	2	2	10	1.5	1.2	Red	8
2= Tidegated sloughs	Culvert replacements	4	1	1	2	0	3	11	3	1	3	3	4	3	3	20	2.1	3.2	Green	1
2= Tidegated sloughs	Riparian planting	3	1	3	4	1	3	15	3	2	2	3	3	3	3	19	2.6	2.6	Green	2
2= Tidegated sloughs	Wetlands	3	3	2	4	3	2	17	3	3	1	3	1	3	3	17	2.9	1.7	Yellow	3
2= Tidegated sloughs	Tide gate removal	4	2	2	4	2	2	16	2	3	1	2	1	3	2	14	2.8	1.5	Yellow	4
2= Tidegated sloughs	Levee removal	4	2	1	4	2	2	15	3	3	1	3	1	3	3	17	2.6	1.7	Yellow	4
2= Tidegated sloughs	Tide gate replacements	1	1	2	1	1	2	8	2	3	2	2	4	1	3	17	1.3	2.6	Blue	6
2= Tidegated sloughs	Reshape channel	4	2	1	4	1	3	15	2	3	1	2	0	2	2	12	2.7	1.1	Red	7
2= Tidegated sloughs	Riparian fencing	1	0	1	1	0	3	6	3	1	2	3	4	2	4	19	0.9	2.8	Blue	8
2= Tidegated sloughs	Road upgrades	1	0	0	2	0	3	6	2	1	3	3	3	2	3	17	0.9	2.7	Blue	9
2= Tidegated sloughs	Levee setback	1	1	1	2	1	2	8	2	2	2	1	2	2	3	14	1.3	2.0	Blue	10
2= Tidegated sloughs	LW placement	3	0	1	2	1	2	9	2	2	1	2	2	2	2	13	1.5	1.7	Red	11
2= Tidegated sloughs	Tide gate relocation	2	1	2	1	2	2	10	2	3	1	2	1	2	2	13	1.6	1.4	Red	12
2= Tidegated sloughs	Restore secondary/off-channel	2	1	1	0	1	1	6	1	2	1	2	1	2	3	12	1.1	1.3	Red	13
3= Tributaries	Wetlands	4	3	3	4	3	3	20	3	2	2	3	2	3	3	18	3.4	2.3	Green	1
3= Tributaries	Culvert replacements	4	2	2	2	0	3	13	3	1	3	3	4	3	3	20	2.5	3.2	Green	2
3= Tributaries	Riparian planting	3	2	3	4	1	3	16	3	2	2	3	3	3	3	19	2.8	2.6	Green	3
3= Tributaries	Levee removal	4	2	3	4	2	1	16	3	3	2	3	2	4	4	21	2.9	2.5	Green	3
3= Tributaries	Road decommissions	4	2	2	4	2	3	17	3	2	2	3	2	3	4	19	2.9	2.4	Green	5
3= Tributaries	LW placement	3	1	3	2	2	3	14	3	2	2	3	3	3	2	18	2.3	2.6	Green	6
3= Tributaries	Reshape channel	4	3	2	4	1	3	17	2	3	1	2	1	3	3	15	3.1	1.6	Yellow	7
3= Tributaries	Road upgrades	2	0	1	2	0	3	8	3	1	4	3	3	3	3	20	1.3	3.3	Blue	8
3= Tributaries	Riparian forestry	3	1	2	2	1	2	11	3	2	2	2	2	2	3	16	2.0	2.2	Green	9
3= Tributaries	Levee setback	2	2	2	2	1	2	11	2	2	2	1	2	3	4	16	2.0	2.2	Green	10
3= Tributaries	Riparian fencing	1	0	1	1	0	3	6	3	1	2	3	4	2	4	19	0.9	2.8	Blue	11
3= Tributaries	Restore secondary/off-channel	1	1	2	1	1	1	7	2	2	2	2	2	3	4	17	1.2	2.2	Blue	12
4= Uplands	Culvert replacements	3	3	1	2	0	3	12	3	1	3	3	4	3	3	20	2.3	3.2	Green	1
4= Uplands	Road upgrades	3	0	2	2	0	3	10	4	1	4	3	4	3	3	22	1.8	3.7	Blue	2
4= Uplands	Riparian forestry	3	2	1	2	3	2	13	3	3	2	2	2	2	3	17	2.1	2.2	Green	3
4= Uplands	Landslide area protection	3	1	2	4	3	2	15	2	2	2	1	2	1	3	13	2.4	1.9	Yellow	4
4= Uplands	Road decommissions	3	1	0	2	1	3	10	3	2	2	3	2	3	4	19	1.7	2.4	Blue	5

Table A-22 Daniel's Creek Sub-basin Prioritization Scores

Region	Potential Action	Restores Processes	Restores Connectivity	Limiting Factor(s) addressed	Longevity	Unique habitat	Proven technique	Biological Flat Score	Likelihood of success	Educational benefit	Landowner concerns	Measurability	Implementation feasibility	Fundability	Cost	Socio-Economic Flat Score	Weighted Biological	Weighted Socio-economic	Overall Project Priority	Overall Ranking
		Biological Criteria							Socio-Economic Feasibility											
	Criterion weight	0.25*	0.25	0.2	0.15	0.05	0.1		0.1*	0.05	0.35*	0.05	0.3*	0.1*	0.05					
1 = Valley bottoms	Tide gate removal	2	1	2	3	2	3	13	3	2	2	3	2	3	4	19	2.0	2.4	(green)	5
1 = Valley bottoms	Tide gate replacements	1	1	2	1	2	2	9	2	3	2	2	3	2	4	18	1.4	2.5	(blue)	8
1 = Valley bottoms	Tide gate relocation	0	1	0	1	1	1	4	2	1	2	2	2	1	4	14	0.6	2.0	(red)	12
1 = Valley bottoms	Riparian planting	3	0	3	4	3	3	16	3	3	2	3	3	3	3	20	2.4	2.7	(green)	2
1 = Valley bottoms	Riparian fencing	2	0	2	1	0	3	8	3	2	2	3	3	3	4	20	1.4	2.7	(blue)	7
1 = Valley bottoms	Add secondary/off-channel	1	1	2	1	3	2	10	2	2	2	3	2	3	3	17	1.4	2.2	(blue)	11
1 = Valley bottoms	Levee removal	4	3	2	4	2	2	17	3	3	1	3	2	4	2	18	3.1	2.1	(green)	2
1 = Valley bottoms	Levee setback	0	1	1	2	0	2	6	2	2	2	2	2	2	2	14	1.0	2.0	(red)	12
1 = Valley bottoms	Culvert replacements	1	1	0	1	1	3	7	3	1	3	3	4	3	3	20	1.0	3.2	(blue)	8
1 = Valley bottoms	Reshape channel	4	3	3	4	1	3	18	3	2	1	2	1	2	2	13	3.3	1.5	(yellow)	2
1 = Valley bottoms	LW placement	3	1	3	3	2	1	13	2	2	1	3	1	3	2	14	2.3	1.5	(yellow)	9
1 = Valley bottoms	Road upgrades	1	0	0	1	0	3	5	3	1	3	3	4	3	3	20	0.7	3.2	(blue)	8
1 = Valley bottoms	Wetlands	2	2	3	4	3	3	17	3	2	1	3	2	3	2	16	2.7	1.9	(yellow)	3
2 = Forested uplands	LW placement	2	2	3	3	3	3	16	2	2	1	3	1	3	2	14	2.5	1.5	(yellow)	6
2 = Forested uplands	Riparian forestry	3	0	2	4	3	3	15	3	2	2	3	2	3	3	18	2.2	2.3	(green)	3
2 = Forested uplands	Road upgrades	2	0	0	1	0	3	6	3	1	4	3	4	3	3	21	1.0	3.6	(blue)	3
2 = Forested uplands	Culvert replacements	3	4	3	1	1	3	15	3	2	4	3	4	3	3	22	2.9	3.6	(green)	1
2 = Forested uplands	Road decommissions	4	2	0	4	0	3	13	4	1	1	3	3	3	3	18	2.4	2.3	(green)	1
2 = Forested uplands	Landslide area protection	3	1	2	4	2	2	14	2	2	2	1	2	1	4	14	2.3	2.0	(green)	1

Table A-23 Heads of Tide Sub-basin Prioritization Scores

Region	Potential Action	Restores Processes	Restores Connectivity	Limiting Factor(s) addressed	Longevity	Unique habitat	Proven technique	Biological Flat Score	Likelihood of success	Educational benefit	Landowner concerns	Measurability	Implementation feasibility	Fundability	Cost	Socio-Economic Flat Score	Weighted Biological	Weighted Socio-economic	Overall Project Suitability	Overall Ranking
		Biological Criteria							Socio-Economic Feasibility											
	Criterion weight	0.25*	0.25	0.2	0.15	0.05	0.1		0.1*	0.05	0.35*	0.05	0.3*	0.1*	0.05					
1: Mainstem River Ag. Land	Tide gate removal	3	2	2	4	1	3	15	2	3	2	3	2	3	4	19	2.6	2.3		3
	Tide gate replacements	1	1	2	1	1	2	8	2	2	3	2	4	2	4	19	1.3	3.1		5
	Riparian planting	3	1	2	4	1	3	14	3	3	2	3	3	3	3	20	2.4	2.7		7
	Riparian fencing	1	0	0	1	0	3	5	3	2	2	3	3	3	4	20	0.7	2.7		15
	Add secondary/off-channel	3	2	2	2	2	2	13	2	3	2	2	2	3	3	17	2.3	2.2		10
	Levee removal	4	2	2	4	2	4	18	2	3	1	1	1	3	3	14	3.0	1.5		10
	Levee setback	1	1	2	2	1	2	9	2	3	2	1	2	3	2	15	1.5	2.1		15
	Reshape channel	1	0	0	1	0	2	4	1	2	2	3	2	3	4	17	0.6	2.2		6
	LW placement	3	0	2	1	1	2	9	2	3	1	2	1	3	3	15	1.6	1.6		6
	Wetlands	4	3	2	3	3	3	18	3	3	1	4	2	4	2	19	3.1	2.1		4
2: Tributary Streams	Riparian planting	3	2	2	3	3	3	16	3	3	2	4	3	3	3	21	2.6	2.7		5
	Riparian fencing	1	0	0	1	0	3	5	3	2	2	3	3	3	4	20	0.7	2.7		13
	Add secondary/off-channel	1	1	2	1	1	1	7	2	1	3	3	3	2	4	18	1.2	2.8		12
	Culvert replacements	3	1	2	2	1	3	12	3	1	4	3	4	3	3	21	2.1	3.6		2
	Reshape channel	3	0	2	1	1	2	9	1	2	2	3	3	3	4	18	1.6	2.5		7
	LW placement	4	2	4	2	3	3	18	4	3	2	3	3	3	3	21	3.1	2.8		1
	Road upgrades	3	0	2	1	1	3	10	3	3	4	3	4	3	3	23	1.7	3.7		2
	Road decommissions	4	3	2	4	2	3	18	3	2	2	3	2	3	4	19	3.2	2.4		1
	Riparian forestry	2	1	2	4	1	3	13	3	2	2	3	2	2	2	16	2.1	2.2		5
3: Upland / Forest	LW placement	1	0	1	2	1	2	7	2	2	2	3	2	2	4	17	1.0	2.2		6
	Riparian forestry	3	2	1	3	3	2	14	2	3	2	2	2	2	2	15	2.3	2.1		4
	Road upgrades	3	0	1	1	1	3	9	3	2	4	3	3	3	4	22	1.5	3.4		3
	Culvert replacements	3	1	1	2	1	3	11	3	2	4	3	3	3	4	22	1.9	3.4		1
	Landslide area protection	3	0	2	4	3	2	14	2	3	2	1	2	1	3	14	2.1	2.0		2
	Road decommissions	3	2	2	4	1	3	15	3	2	2	3	2	3	4	19	2.6	2.4		1

Appendix B - Fish Life History

Table A-24 Generalized Life History Patterns of Anadromous Salmon, Steelhead, and Trout in the Pacific Northwest [1]									
Species	**Adult Return**	**Spawning Location**	**Eggs in Gravel**[2]	**Young in Stream**	**Freshwater Habitat**	**Young Migrate Downstream**	**Time in Estuary**	**Time in Ocean**	**Adult Weight (avg.)**
Coho *Oncorhynchus kisutch*	Oct - Jan	Coastal streams, shallow tributaries	Oct - May	1+ yrs	Tributaries, main-stem, slack water	Mar – Jul (2nd yr)	Few days	2 yrs	5-20 lb (8)
Chinook (spring) *Oncorhynchus tshawytscha*	Jan - July	Main-stem large and small rivers	July - Jan	1+ yrs	Main-stem large and small rivers	Mar – Jul (2nd yr)	Days-months	2-5 yrs	10-20 lb (15)
Chinook (fall) *Oncorhynchus tshawytscha*	Sept - Nov	Coastal rivers and streams lower reaches	Oct - Jan	Days-weeks	Little time in fresh water	Shortly after leaving gravel	Days-months	2-5 yrs	10-20 lb (15)
Chum *Oncorhynchus keta*	Sept - Jan	Coastal rivers and streams lower reaches	Sept - Mar	Days-weeks	Little time in fresh water	Shortly after leaving gravel	4-14 days	2.5-3 yrs	
Steelhead (winter) *Oncorhynchus mykiss*	Nov - Jun	Tributaries, streams, and rivers	Feb - Jul	1-3 yrs	Tributaries	Mar – Jul (2nd yr)	Less than a month	1-4 yrs	5-28 lb (8)
Coastal Cutthroat Trout *Oncorhynchus clarki*	Jul - Dec	Tiny tributaries of coastal streams	Dec - Jul	1-3 yrs (2 avg.)	Tributaries	Mar – Jun (2nd -4th yr)	Less than a month	0.5-1 yr	0.5-4 lb (1)

1 Life history patterns vary – fish in each watershed may have unique timing and patterns of spawning, growth, and migration.

2 The eggs of most salmonids take 3-5 months to hatch at the preferred water temperature of 50-55^{O} C; steelhead eggs can hatch in 2 months.

(Table adapted from the Oregon Watershed Enhancement Board Watershed Assessment Manual)

Appendix C - Solar Load Reduction

Solar Load Reduction Calculations

Current shade and potential shade levels are used to calculate the predicted reduction in solar energy load that could be achieved if the estimated potential shade levels are reached. The percent sun values calculated by SHADOW (the amount of unshaded stream) for both current and potential vegetative levels are multiplied by the potential solar load for each reach, which is a value obtained by multiplying the reach area by our local solar constant of 470.8 kcal/ft^2/day, and this gives the amount of solar load for each reach. This number represents the potential heat energy introduced by the sun on each reach, and adding the solar load for each reach gives the total solar load for a stream in calories per day.

Potential Reduction

Current and potential shade values for each stream (weighted average of reaches) were calculated using the SHADOW model. Inputs to the model include data describing the existing conditions (tree height, tree-channel distance, canopy overhang, canopy density, valley morphology, and aspect) to calculate current shade. The model calculated potential shade using estimates for climax vegetation characteristics along with known features (aspect and valley morphology). Appendix A - Riparian Shade provides more details on using the SHADOW model.

Riparian Planting

Coos WA calculated future shade resulting from a variety of hypothetical planting techniques, see Table A-25. The estimated input values used in calculating the resulting shade, using the SHADOW model, are shown in Table A-26

Table A-26 shows the percent of shade on stream channels produced from planting techniques that differ in their tree species, buffer width, stream orientation, active channel width, and growth stage. (Column headings are defined below, see indent.) Comparison of these scenarios can help riparian managers plan the most effective actions for temperature reduction. Managers should note that potential shade values can often be attained in a shorter time period by planting native species other than the historical climax vegetation (i.e., use of willow cuttings can reduce the time needed to produce potential shade).

Table A-25 demonstrates that, for all stream channel widths, hardwoods/willow and willow/hardwood/conifer plantings provide a high percentage of shade the quickest and that increases through the years. On a 10-foot channel width, these two types provide almost complete shade in thirty years. Willows would provide shade the fastest, being nearly fully grown by ten years, but with a lower shade percentage and little increase with age. Hardwoods provide the lowest amount of early shade, but by twenty years have exceeded the shade provided by willows, and are close to the willow/hardwood/conifer percentages after thirty years.

Table A-25 Percent shade produced from planting techniques					
ACW	**Measurement**	**Species type and buffer width**			
		Willow 15'	**Hardwoods Willow 15'**	**Hardwoods 15'**	**Willow/Hardwoods/ Conifers 35'**
10 ft	Overhang, % of ACW	50	50	0	50
	Tree Height (ft)	15	25	25	25
	Bank Slope ^{o}	45	45	45	45
	Tree-Channel Distance (ft)	1	1	5	1
	Shade Density %	80	65	40	70
20 ft	Overhang, % of ACW	50	50	50	50
	Tree Height (ft)	15	50	50	50
	Bank Slope ^{o}	45	45	45	45
	Tree-Channel Distance (ft)	1	1	5	1
	Shade Density %	90	65	50	70
30 ft	Overhang, % of ACW	50	75	75	75
	Tree Height (ft)	15	70	70	70
	Bank Slope ^{o}	45	45	45	45
	Tree-Channel Distance (ft)	1	1	5	1
	Shade Density %	95	70	60	80

ACW: Active Channel Width - distance across channel at "bank full" flow.
Diag.: Diagonal orientation of the stream in relation to the sun's path from east to west. Same re sults for 45^{o} northeast or 135^{o} northwest.
NS: North-south orientation of the stream.
EW: East-west orientation of the stream.

Table A-26 Estimated input values of planting techniques										
ACW	**Planting Technique**	**10 year growth**			**20 year growth**			**30 year growth**		
		Diag.	**N S**	**E W**	**Diag.**	**N S**	**E W**	**Diag.**	**N S**	**E W**
10ft	Willow 15'	77	63	79	78	64	79	79	65	80
	Hardwoods/willow 15'	89	83	90	92	93	92	97	100	95
	Hardwoods 15'	69	52	73	85	82	86	94	96	95
	Willow/Hardwoods/Conifers 35'	83	73	83	92	92	91	97	100	95
20ft	Willow 15'	48	35	57	50	36	59	52	37	61
	Hardwoods/willow 15'	67	51	71	80	69	80	90	91	89
	Hardwoods 15'	40	28	48	69	48	71	84	79	83
	Willow/Hardwoods/Conifers 35'	60	42	65	78	66	79	89	88	87
30ft	Willow 15'	33	24	39	35	24	41	36	25	43
	Hardwoods/willow 15'	48	36	56	69	48	70	83	77	82
	Hardwoods 15'	2	19	33	54	33	60	74	57	75
	Willow/Hardwoods/Conifers 35'	42	29	49	67	46	69	80	70	80

Appendix D – Restoration Strategies Matrix Table

Table A-27 Strategies to sustain and restore conditions in the Coos Watershed			
STRATEGY	**APPROACH**	**BENEFITS**	**DRAWBACKS**
Protect and restore the best habitat	Fully restoring and protecting the most productive areas first to maximize biological integrity.	Often more successful to protect / enhance functioning systems than to work on severely damaged areas. More cost-effective if long-term protection insured. Serves as anchor habitat to seed other areas. Preserves key habitats. Can be used as a reference condition.	May be little improvement to already functional areas. Owners of quality habitat may not see the need for conservation efforts. Future owners could drastically change management practices without adequate habitat protection.
Address coho habitat bottlenecks	Identify bottlenecks to production of coho salmon.	Most likely approach to increase coho populations. Programmatically cost-effective. Attractive to funders. Has clear goals and objectives.	Based on models that have some uncertainty. Data intensive. May be limited by landowner willingness to participate. May have secondary bottlenecks.
Fix the worst habitat	Rehabilitate the most highly impaired habitat.	Working in areas that have a lot to gain. Alleviate damage to down-stream reaches. Raises the local 'standard' among landowners. May be the last chance to 'save' an area.	Even with large expenditures, system may, as a result of chronic or residual problems, be able to reach only moderate productivity. High risk of failure.
Fill in the gaps	Concentrate on areas with previous projects and aim to entirely restore or rehabilitate an area.	Bolsters previous projects. Enhances community pride, and may encourage neighbors to work together. Habitat connectivity enhances monitoring opportunities.	Lower individually-valued projects may take priority over higher individually-valued projects in other areas.
Best biological response for the cost	Concentrate efforts on projects and sites estimated to have the lowest expense for the greatest gain in productivity.	More projects accomplished with increasingly scarce funds. Highly efficient at the site-specific project scale. May be easier to secure funding.	Concentrates on economics rather than watershed processes. May ignore important, but expensive projects. May not make the most sense at the landscape level.
Focus on partnerships	Build and maintain relationships so that over time trust and partner self-sufficiency increases.	Familiarity may smooth the process. Known track record. Continuity of people and projects. Partner may be more likely to provide match. Focuses outreach. Partner may graduate from need for cost-share and assistance.	May appear as favoritism. May pass by others that need help more. May stray from focus on biological need and systematic approach.
Opportunistic	Pursue projects as the opportunity with landowners arises. Also known as "Picking the low hanging fruit" or "shotgun approach".	Landowner-friendly. Quick response to projects with low planning costs. Higher potential for fee-for-services opportunities. May help build partnerships	Projects don't build on one another and may not follow a natural sequence. Less favorable with grantors. Oriented towards project-specific goals.
Greatest potential gain	Concentrate on areas that have the largest disparity between the current smolt productivity and the intrinsic potential of coho and steelhead.	Has a high likelihood of resulting in efforts that will increase the population of target species.	Knowledge of stream-specific smolt production is data intensive. Approach is species specific and would de-emphasize less commercially important species.

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