Isthmus and Coalbank Slough Sub-basin Assessment and Restoration Opportunities

2011

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The **Coos Watershed Association** is a 501(c)(3) non-profit organization whose mission is "to provide a framework to coordinate and implement proven management practices, and test promising new management practices, designed to support environmental integrity and economic stability for communities of the Coos watershed." The Association, founded in 1994, works through a unanimous consensus process to support the goals of the Oregon Plan for Salmon and Watersheds. Our 21 member Board of Director includes representatives from agricultural, small woodland, waterfront industries, fisheries, aquaculture, local government, environmental organizations, industrial timberland managers, and state and Federal land managers.

Acknowledgements
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Bessie Joyce and staff coordinated the Coffee Klatches and assessment document development. In addition, survey technicians prepared much of the data analysis and maps. Dr. Jon Souder and the Coos Watershed Association Assessment Advisory Committee helped develop the prioritization process.

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Cover photo: Lower Isthmus Slough mainstem. CoosWA, 2010

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Acronyms

ACW	Active Channel Width
AHI	Aquatic Habitat Inventory
AUC	Area-Under-the-Curve
BLM	Bureau of Land Management
CFS	Cubic Foot per Second
CHT	Channel Habitat Types
CoosWA	Coos Watershed Association
CSIP	Coastal Salmonid Inventory Project
DEM	Digital Elevation Model
DEQ	(Oregon) Department of Environmental Quality
DSL	(Oregon) Department of State Lands
EDT	Ecosystem Diagnosis and Treatment
EMDS	Ecosystem Management Decision Support
ESA	Endangered Species Act
ESU	Evolutionarily Significant Unit
ESF	Elliott State Forest
GIS	Geographical Information System
HGM	Hydrogeomorphic
HSG	Hydrologic Soil Group
LW	Large Wood
NIST	National Institute of Standards and Technology
NOAA	National Oceanic and Atmospheric Association
NPS	Non-Point Source
NWI	National Wetlands Inventory
ODF	Oregon Department of Forestry
ODA	Oregon Department of Agriculture
ODF	Oregon Department of Forestry
ODFW	Oregon Department of Fish and Wildlife
ODWR	Oregon Department of Water Resources
OWEB	Oregon Watershed Enhancement Board
RCA	Restoration Consideration Areas
SRS	Stratified Random Sampling
TMDL	Total Maximum Daily Load
USACE	United States Army Corps of Engineers
USFS	United States Forest Service
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Society
WAB	Water Availability Basin
WAM	Watershed Assessment Method/Manual

Chapter 1: Introduction

Goals

This watershed assessment is based on current condition assessments of wadable tributary streams, roads and affected landowners within the Isthmus and Coalbank Slough sub-basins and their tributaries. The overall goal of the project is to develop a strategically-planned sub-basin restoration program that aims to:

> *Restore and maintain watershed processes that allow for habitat connectivity, sustained populations of anadromous fish, and other ecological functions.*

This document is arranged to provide the following pieces of information. Chapter 1 is an introduction to the development and purpose of the Watershed Assessments, and a general description of the Coos Watershed area. Chapter 2 is divided into two parts, the first of which provides a short background on the types of surveys conducted – 2A Survey Components. Chapter 2B contains the assessment information from the assessment area. Chapter 3 is also divided into two parts. Chapter 3A includes an introduction to the restoration strategy overall, and Chapter 3B ranks the restoration opportunities developed as a result of the prioritization process. Appendices include supplemental information about survey methods, data and notes used in calculations, standards and protocols, and other information useful in understanding watershed conditions.

Assessment and Restoration Plan Process

This assessment process was developed by the Coos Watershed Association (Coos WA) in 2005 as a unique and important approach to engaging the diverse habitats, ownership and land uses, typical of lowland areas (relative to larger forest tracts in the upland areas) in the assessment and prioritization process. Thus, a large amount of diverse information, from historical to biological to socio-economic, for example, is gathered as input into the development of a plan to improve habitat and water quality important to human quality of life and many marine and freshwater species.

The identification of current watershed conditions, potentials, and priorities will improve chances for successful restoration. The restoration of watershed processes, and habitat connectivity, in particular among freshwater and estuarine habitats, is central to improving salmonid habitat quality, diversity and quantity, thereby increasing the availability of fishery resources in the region. Improved water quality will also benefit the local shellfish growing industry, public health, aquatic recreation, and other beneficial uses.

These Sub-basin Assessments are consistent with, and complement the Oregon Plan for Salmon and Watersheds' goals to protect and restore marine resources and recover species under the Endangered Species Act (ESA). The development of the watershed assessment and identification of restoration priorities is comparable to the approaches outlined in the Oregon Watershed Assessment Manual (WAM) with modifications made where Coos WA deemed appropriate or was able to provide a more thorough data set, and or due to economic resources available. The Coos WA Assessment Advisory Committee provided guidance in the process of prioritization, and intensive outreach to sub-basin landowners has supplemented the assessment with a suite of landowner concerns and goals.

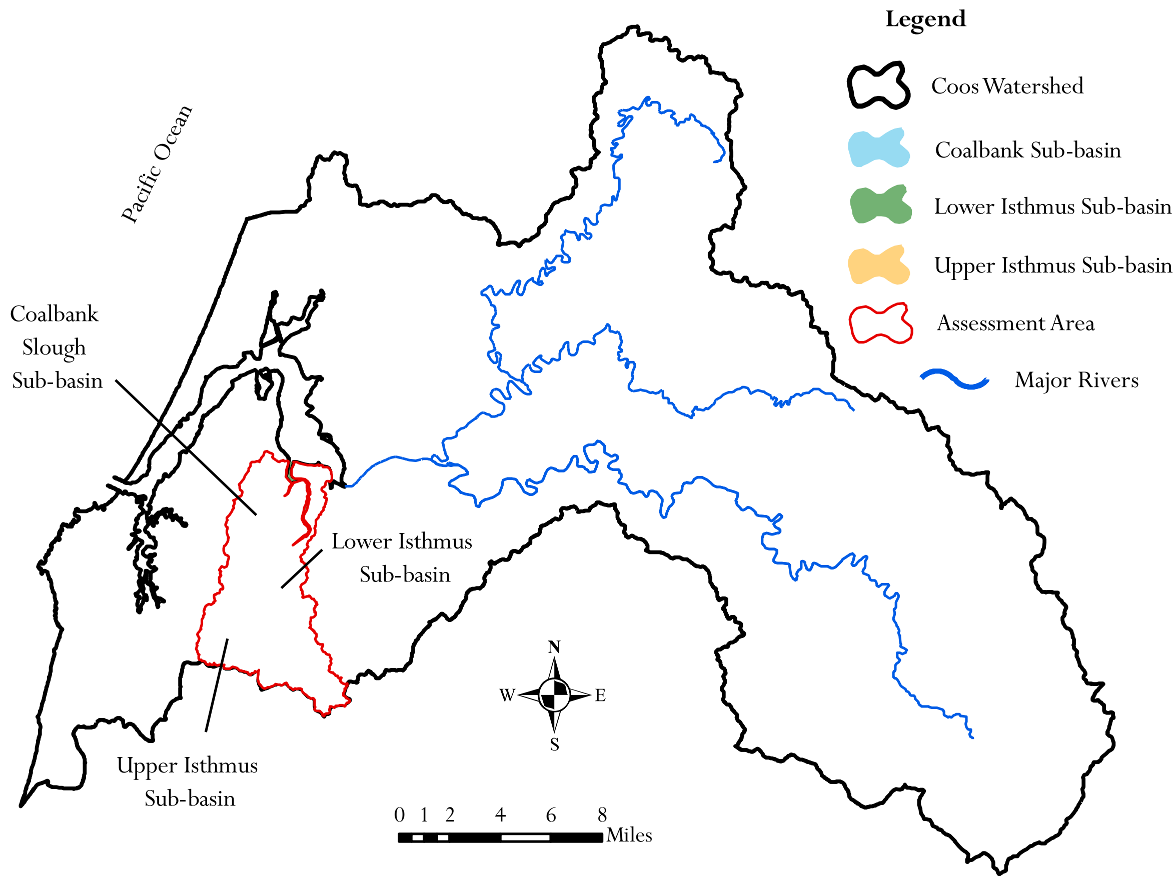
Physical Setting

Oregon Coast Range

Spanning 200 miles along the Pacific Ocean, the Oregon Coast Range is defined by a 30-40 mile wide swath of moderately high mountains average 1,500 feet in elevation. Slopes and drainage basins are consistently steep through the range, approaching 50° in many localities. Pacific storms buffet the range in the wet, winter months and support thick forests of Douglas fir and hardwood species. The average annual rainfall in the range is over 100 inches per year. Once home to an abundance of trout, salmon, and other fish, rivers and streams in the Coast Range now harbor a small fraction of the original aquatic population.

Figure 1-1 shows the Coos watershed with the assessment sub-basins located immediately south of the mid to upper estuary. Figure 1-2 shows an aerial view of the terrain and Coos Bay city limits. Together these sub-basins cover 21,456 acres, 5.4% of the Coos watershed area.

Figure 1-1: Assessment Area Location within the Coos Watershed

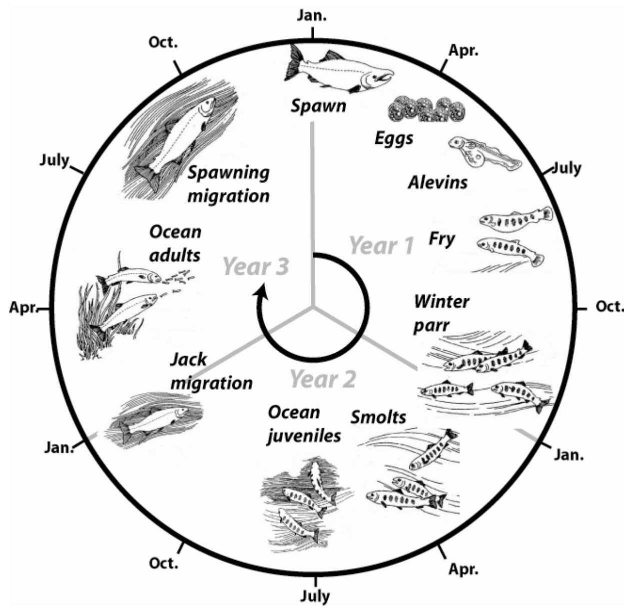


Geology

The Oregon Coast Range is a belt of uplifted land overlying the subducted Juan de Fuca plate. The land is composed of accreted oceanic sediments - mostly older marine sediments and sands, clays, and muds eroded from ancient mountains to the south and east. Deposited on the ocean floor in a great trough from the Klamath Mountains to Vancouver Island, these sediments were uplifted by the force of colliding continents and eroded once again creating relatively wide river mouths. This regionally extensive marine sandstone and siltstone is commonly referred to as the Tyee formation, and is vulnerable to soil erosion processes.

Upland topography in the Coast Range consists of convex ridge tops characterized by small soil slips and landslides (Roering et al., 1999). At the base of these steep sideslopes, in unchanneled valleys, soils accumulate and thicken over long periods and become saturated during rainfall events. The combination of thick soil and frequent saturation lends itself to episodic shallow landsliding (Heimsath et al., 2001).

Figure 1-3 – Coho Life Cycle



Fish

The Coos estuary supports important fishery resources. Five anadromous species of salmon and trout, (i.e., coho, Chinook, steelhead, searun cutthroat trout, and chum) Pacific lamprey, and a wide range of coastal species use its various habitats.

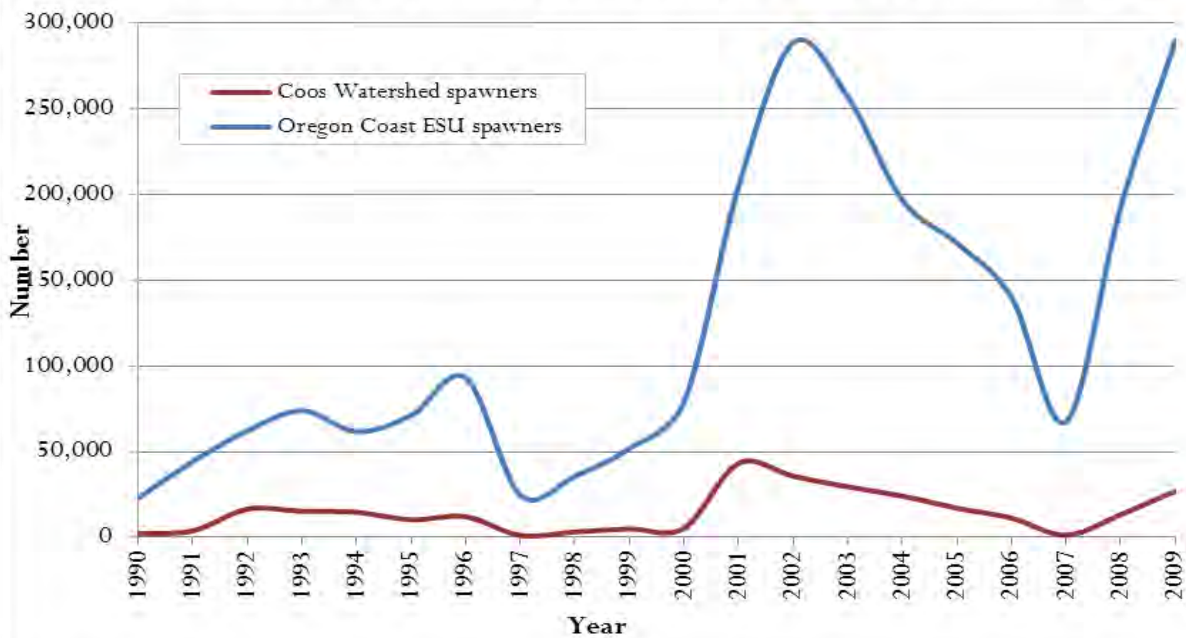
These assessments focus primarily on coho spawning, rearing and migratory habitat conditions and factors influencing those conditions. The coho life history cycle, summarized below and illustrated in Figure 1-3, is a key backdrop to assessment data analysis and planning watershed management.

Coho smolts typically migrate to sea in the spring of their second year, spend 16-20 months rearing in the ocean, and then return to freshwater in the Fall (October to January) to spawn as three-year-old adults. Egg to smolt survival is typically 2-3%. Coho typically seek small, relatively low-gradient tributary streams for spawning and juvenile rearing. Ideal spawning gravels are generally pea to orange-sized, and maintain cool, clean interstitial spaces for eggs and emerging young. Over-wintering habitat is primarily in off-channel alcoves and beaver ponds where juveniles can find protection from high-velocity flows. In general, coho prefer complex instream structure, i.e. large wood, and shaded streams for rearing.

A returning adult coho may measure more than two feet in length and weigh an average of eight pounds. After the first summer at sea, a small proportion of the males reach early sexual maturity and return that fall as two-year-old “jacks.” These jack returns have proven to be a fairly accurate predictor of adult abundance the following year, and serve as a key component for setting ocean coho fishing regulations.

On average, based on ODFW data, from 1990 to 2009 about 14% of the salmon in the Oregon Coast Coho Evolutionarily Significant Unit (ESU) were spawning in the Coos watershed, see Figure 1-4. Presently, the Oregon Coast Coho ESU is listed as threatened under the Federal Endangered Species Act (ESA). A significant factor in past de-listing of the species has been demonstrated willingness of the state of Oregon and its citizens to implement land management actions that help to rehabilitate freshwater salmon habitat.

Figure 1-4 Oregon Coast ESU and Coos Watershed Wild/Natural Coho Spawner Population Estimates 1990-2009 (post harvest)



Estuary

Estuaries are important for adult salmon, providing the necessary transition and holding areas for the fish before they begin their upstream migration. Estuaries also serve important functions for smolts, especially coho, by providing shelter from high flows while the juveniles prepare for their ocean phase. The Coos estuary is approximately 13,348 acres, the largest on the Oregon coast south of the Columbia River. It is a drowned river mouth variety in which winter floods discharge high volumes of sediment into and through the estuary, and in summer seawater inflow dominates the estuary due to low stream flow. The Coos estuary is designated as a Deep Draft Development estuary under the Oregon Estuary Classification system.

Sloughs are low-gradient tributaries to the main estuary and river channels that have freshwater inflow as well as saline tidal fluctuations. Tidal flushing may not be as complete in slough systems as in parts of the estuary that are closer to the ocean. Generally, sloughs consist of meandering channels that wind through fringing marshes and across mud flats to the main bay. Main stems of Isthmus, Coalbank and Davis Sloughs and lower reaches of many smaller tributaries in the assessment area display similar characteristics, however, many have been heavily altered from their natural state by land use practices such as the use of tide gates, dredging, diking and filling. (Hoffnagle, 1976)

Wetlands

Wetlands provide many important functions in a watershed, including water quality improvement, flood water attenuation, groundwater recharge and discharge, and fish and wildlife habitat. Wetlands are usually connected to a riparian zone, but sometimes occur in higher elevation areas with no obvious surface connection to a stream.

Water quality is improved by wetlands' ability to trap sediment and contaminants. Dense wetland vegetation acts to decrease rate of flow - allowing sediments to settle. Wetland vegetation can also take up certain nutrients and some toxins, thereby improving downstream water quality. The anaerobic environment of many wetland soils breaks down nitrogen compounds and keeps other compounds in a non-reactive form. However, the ability of a wetland to provide this function is limited.

Note: Floods help shape aquatic habitat by impacting channel morphology, sediment transport and deposition, and adjacent stream vegetation. Habitat quality for fish and other aquatic organisms also is formed by the interaction of these elements.

Wetlands alleviate downstream flooding by storing, intercepting, or delaying surface runoff. Wetlands within the floodplain of a river can hold water that has overtopped river banks. Floodwater de-synchronization occurs when wetlands higher in the watershed temporarily store water - reducing peak flows. The most effective wetlands at providing de-synchronization are generally located in the middle elevations of the watershed; these wetland locations are far enough away from the receiving water to create delay, but are low enough in the watershed to collect significant amounts of water. Wetlands, intimately associated with groundwater, can function to recharge the underlying aquifers. Wetlands are sources of groundwater discharge that may help extend stream flows into the drier summer months.

Human Impacts

Characterizing pre-European lifestyles and settlement patterns help to understand human impacts to the landscape, and how conditions have changed overtime.

Native Americans

Natives lived in numerous villages along the Coos River and estuary. Orvil Dodge states in his book, *A Pioneer History of Coos and Curry County* (1898), "Before the beginning of white man's interest in Coos Bay, Indian villages lined the east bank of the bay from South Slough to Empire. The resources of the area provided an abundant life for these people." Apart from marriages, these villages were largely independent of each other. Groups would migrate between more permanent winter homes along the river and estuary, and their seasonal camps farther upriver to follow the migration of salmon and lamprey and to harvest particular plants for food, tools, medicine and clothing. Fish and berries were dried and stored for other seasons of the year. The main staples of the Coos were fish, berries with occasional bear, venison or elk. Before significant trading with Europeans began in the early 1800's, everything the natives used was collected or developed from the local environment (although some trading between regions occurred, e.g. chirt found in the lower Coquille area was sought after for arrowheads).

The Coos tribes were known to be more docile than their neighbors to the north and south, and it was noted that these natives enjoyed a surprising amount of leisure time. Their initial encounters with whites were generally non-combative, however, after the 1856 Rogue River War between the whites and the natives there, all south coast tribes including the Coos, were forced to move to a fort near the mouth of the Umpqua River, and later to Yachats. A small number of Coos eventually moved back to the Coos Bay area either marrying into non-native families, or hiding from authorities with relatives that were married (Douthit, 1999 and CTCLUSI, 2006).

Settlement

European settlement had begun in the Coos Bay area by 1850, and in 1853 the Coos Bay Commercial Company was formed to promote white settlement of the area. Fueled by commercial interest in resource extraction and the potential for an excellent harbor, Coos Bay flourished rapidly. Initially, coal was the primary draw. The first coal mining in the watershed began in the 1850's and peaked in 1874 with 44,857 tons shipped to San Francisco that year. Mining in Coalbank Slough was one of the first activities to endanger salt marsh land. Marshes were either filled or structures were built upon stilts which slowed the water currents and allowed wood chips and sediments to deposit, in turn filling the land. Salt marshes began to disappear as millions of tons of coal were shipped through Coalbank Slough (Hoffnagle, 1976). The lumber industry, however, immediately surpassed coal mining in importance. Coos Bay lumber began shipments to California as early as 1854 (Case, 1983), and eventually became the world's largest forest products shipper in world. As the port grew, ship building also became a major industry in Coos Bay.

The City of Marshfield, which later became the City of Coos Bay, was incorporated in 1873. Much of Marshfield was built on fill and today's shoreline along the Coos Bay waterfront is entirely created from fill. Dry, buildable land was created by diking, draining and filling marshes. In 1858 the first sawmill was constructed at the tip of what became North Bend. Two years later a mill was built in Marshfield and continued in operation until 1885 and generated the sawdust that was spread several feet deep over the marsh lands creating a surface on which to erect buildings and streets.

Workers in the mines, forests, mills and ship-building industries fanned out with their families to settle the fertile land surrounding the bay, sloughs and rivers. The Homestead Act of 1862 required settlers to show proof of their farming activity in order to hold their homestead claim. As a result, the valleys, fertile with alluvial soil, were quickly cleared and cultivated for myriad crops. Fruit orchards, especially apples, were usually one of the first farming endeavors which laid claim to the land. Other crops included grains, roots, berries, and domestic grasses for pasture. Potatoes, if fields were rotated, were very lucrative, as well as dairies and creameries which flourished along the waterways. All farm products for market were transported by boat to Marshfield and Empire City, and many were shipped by the ton to San Francisco (Nelson, 1978).

Until a railroad was built that connected the Coos Bay area to the Coquille River, in 1893, easier access to the fast-growing markets of Coos Bay gave Coos Bay farmers an advantage over their Coquille counterparts, and resulted in a relatively faster pace of land cultivation. Lowland areas were especially known for their excellent farms and large amounts of produce shipped to market as a result of much labor and expense to bring these lands into cultivation. (Dodge, 1969)

Before the automobile age most transportation in Coos County was by boat. The farmers who lived in the Coos Bay drainage journeyed to town by steamboat or by gasoline launch. Between 1901 and 1930 passenger travel on the Coos River averaged almost 30,000 people per year. Roosevelt Highway was approved in 1921, with the southwestern Oregon portion completed in 1927. The Roosevelt ferry was put into operation in 1924 for highway traffic across the bay. (Case, 1983)

A fire in 1868 burned 300,000 acres of forest in much of what is now the Elliott State Forest (ESF). Many of the old pictures taken during the settlement days in the lowlands to the north and east of the main bay show tall snags towering over the undergrowth on the hills surrounding the bottom land – indicative of the fires. Besides the fires, most timber in the ridges remained the same until 1951 when it was bought by Weyerhaeuser Timber Company (Youst, 2003).

Surveyor's notes from 1919 provide some description of the vegetation and land uses in the valley bottoms and lower slopes at that time. The bottom land was being drained for cultivation by means of dikes, ditches and tide gates – many still in use today. In many areas the surveyor labels a salt water marsh and adds that it will be "good for cultivation when dyked and drained". Some low-elevation meadows were described as "stumped" indicating tree stumps possibly left as a result of logging, fire, or tree die-off due to hydrologic or tectonic changes. Other area streams were being straightened, especially in the lower valley regions, and occasional relic meanders are shown with dotted lines. Many of the lower slopes are described as "slashed and seeded" – brush cleared for pasture.

Land Management Impacts

Coos Bay's history of development, while relatively recent, stemmed remarkable change within the estuary. Changes in land use practices caused an increase of sediment load entering the estuary. A large proportion of the population settled in what became urban areas surrounding the estuary, sloughs and rivers. These urban areas are largely built on filled estuarine tidal marshes. Urban development has resulted in periodic storm water drainage and sewerage overflows into the estuary, which, combined with failing septic systems and agricultural run-off have caused high levels of fecal coliform bacteria in water. This has affected the use of parts of the estuary for recreation, fishing and oyster cultivation.

Farming and logging practices have affected these basins similar to other Coast Range drainages. Channelization, draining of wetlands, dredging, diking and tide gate placement on low-gradient reaches to create pasture and croplands have eliminated much of the riparian vegetation, decreased channel complexity and productivity, and interrupted the natural cycle of sediment flushing. Hoffnagle compares marsh extent between 1890 and 1970 reduced by 90% from 597 acres to 64 acres in Coalbank Slough, and by 84%, 335 acres to 58 acres, in Isthmus Slough (1976). In addition, the cumulative effects of upland forestry activities, such as riparian tree removal, soil disturbance, and historical large wood removal have damaged salmonid spawning gravels, decreased stream complexity, increased sediment introductions, and raised water temperatures. Low-gradient reaches are affected by both the adjacent land use practices and the down-stream effects of upland land use practices. Historic heavy industrial use of Isthmus Slough for shipping, waste disposal, and log handling and storage, combined with relatively minimal tidal flushing has led to extremely low amounts of dissolved oxygen (ODFW, 1979).

Several water bodies in the assessment area, mainly in the sloughs and lower reaches of streams, are currently listed by the Oregon DEQ as "water quality limited". The listings are a result of fecal coliform and dissolved oxygen levels exceeding standards for beneficial use. The Oregon DEQ is currently pending completion of Total Maximum Daily Loads, and Water Quality Management Plans for the Coos Watershed.

Chapter 2A: Components Assessed

Davis Slough main stem. CoosWA, 2010

CHAPTER 2A: Components Assessed

This assessment is based on scientific data gathered in the field, and background information researched which represents a selection of watershed processes and land management characteristics. This chapter describes the relationship between watershed processes and the components studied.

Land Use

Understanding land use and ownership help to characterize general land management issues and objectives. Land use activities influence the landscape by changing the timing and intensity of natural processes. Residential development, agricultural practices and forest management activities have the potential to significantly change the drainage patterns of water by increasing the amount of impervious surfaces. These issues are farther described in Hydrology, below.

Aquatic Habitat

Aquatic habitat conditions arise from the interactions between landform and land use. The Coos WA performed aquatic habitat surveys to characterize the status of in-stream salmon habitat features. Distribution and abundance of salmonids within a watershed or sub-basin varies with habitat conditions. Due to the complex life histories of salmon, different features and areas of the stream system are used during different parts of their life cycle. Understanding aquatic habitat components and their trends is a key step in achieving and maintaining suitable conditions.

For example, deposition of sediment composed of fine silt and organics can cover over other substrates, potentially reducing pool depths, available spawning gravel, and overall stream complexity. Concentrations of silt and organic substrate occur more often if natural cycles of stream flooding and flushing are disrupted by removal of large wood, channel modification and tide gates.

Aquatic habitat survey data were used to qualify and quantify the “snap shot” of stream conditions. Coos WA surveys were the sole source of information for the aquatic habitat analysis except where otherwise noted. Survey data were compared to ODFW salmonid habitat benchmarks, (more on benchmarks in Appendix A), and resulting analysis will be used to direct and focus habitat restoration efforts. The aquatic habitat survey parameters used in this assessment include unit type, substrate type, pool depth and frequency, riffle sediment, large wood, and bank stability (in this assessment bank stability data are presented in the Sediment Sources sections).

Channel metric data were also collected as part of the Coos WA aquatic habitat surveys. Channel metrics, or morphology, describe stream attributes such as the channel’s adjacent landforms, dimensions, gradient and ratios of combined metrics. These attributes provide a part of the context in which streams are currently examined, and they assist in understanding stream habitat potentials. It is also insightful to compare current channel metrics and AHI information with historical information to understand how conditions have changed over time and how this change is influencing current stream conditions. Definitions of the different types of metrics measured here are listed in Appendix A.

Aquatic habitat survey areas were split into reaches and assigned a name. A map of aquatic habitat study reaches is presented for each assessment area. Coos WA attempted to avoid displaying the data in a way that will make it useable for regulatory purposes by conglomerating data into reaches based on valley and channel form.

Wetlands

Wetlands, and especially tidally-influenced wetlands, historically covered a much larger area than they do today. Subsequent to settlement, these areas were diked and causeways were built (filled) for roads and railroads. Tide gates were installed at many stream mouths to prevent saltwater flooding during high tides while facilitating drainage during low tides. Recognition of the historic extent of wetlands is key to understanding underlying hydrological processes affecting a stream system. Wetland information informs efforts to improve or restore natural drainage patterns, infrastructure improvement projects, and to identify potential wetland restoration actions.

Assessment of wetland conditions helps to characterize contributing influences to issues associated with stream-floodplain interaction. Historic estuarine and other hydric soils, along with historic vegetation communities, indicate the extent and nature of pre-settlement wetlands and inland extent of tidal influence. A rough assessment of current wetland conditions provides insight to potential restoration areas. Strategic wetland restoration could help to improve nearby pasture drainage and productivity, while improving water quality and fish habitat.

Sediment Sources

Because particles of silt and organic matter are easily transported by flowing water, sources of these particles, such as landslides, earthflows, or collapsing banks can affect large areas of habitat downstream from the source. Fine sediment, beyond natural background levels, is detrimental to fish and their habitat in many ways. When substantial erosion occurs spawning gravels become embedded often causing high rates of egg mortality. More than 10-15% fine sediment (silt/organics) reduces the flow of oxygenated water to the eggs (FRS, 2003). In the case of adult salmon, high concentrations of suspended sediment may delay or divert spawning runs (Mortensen et al. 1976). Additionally, as pools collect sediment, depth decreases and solar heating occurs more rapidly. Aggradation, or raising of the streambed, can influence flow levels, flooding and erosion.

The Sediment Sources component of this assessment evaluates the following four sources of sediment: 1) Bank stability (see aquatic habitat survey methods), in which the percentage of stream bank in each surveyed reach was determined as a being either covered or uncovered, and stable or unstable. 2) Slope stability, in which each sub-basin was evaluated for % of area at risk of slope failure in four risk categories from low to extremely high. 3) Road and landing surveys, in which roads and road drainage features were examined for erosion potential and compared to ODF Best Management Practices. 4) Stream crossing capacity evaluation, in which stream crossing sites were rated for their flow capacity compared to a 50-year event and their risk of failure. Sediment deposition within the stream channel was also reflected in the aquatic habitat analysis.

Bank Stability

Unstable banks contribute sediment through slumping, general deterioration, landslides, and earth flows. Banks are stable if they do not change appreciably during a set time frame (Ott, 2000). Banks are considered stable if they do not show signs of active erosion at the time of the survey, and less than 10% unstable banks is the desirable benchmark amount.

Road Sediment Surveys

Hydrologic connectivity occurs when road drainage is discharged directly into channels via culvert outflow or drainage ditch relief near stream channels (assumed to be within 100 feet). Either one of these conditions will potentially increase sediment transport volumes and flood stage elevations downstream.

Road surveys were conducted for three primary purposes: (1) to identify fish passage impediments at road stream crossings, (2) to determine the degree of road failure risk, and (3) to identify locations where hydrologic connectivity of road drainage ditches to live stream networks could be altered to filter road sediment before it reaches the stream.

Stream Crossings

Stream crossing failure is one of the largest catastrophic contributors of sediment to a stream, next to landslides (Robinson et al., 1999). Because of this, stream crossing capacity analysis was performed to determine whether each culvert is at risk of failure during a peak rainfall event. It is important to identify the stream crossings with the largest fill volumes that have undersized culverts when prioritizing which stream crossings pose the greatest risk to stream conditions.

Salmonid Distribution

Fish use extents are important to consider when evaluating conditions and planning restoration actions based on salmonid habitat requirements. This assessment includes maps of fish use gathered from ODF and the ODFW. These determinations will help inform habitat restoration designed to improve conditions for a specific fish species. Typically, steelhead will utilize higher gradient stream habitat than coho, but most steams in the assessment area are not high gradient streams. Chinook tend to stay in the mainstem streams and sloughs. Spawning survey results from specific stream segments are included in the fish distribution section, as well as any documented releases of hatchery fish.

Hydrology

Hydrologic data were used to study major factors within the sub-basin that have an effect on the local water cycle. These factors included precipitation, stream flow, land use and water use. They were used to develop a rating of the risks to altering stream flow. In addition to the Oregon Watershed Enhancement Board (OWEB) WAM hydrology assessment results, we also looked at the Oregon Water Resources Department's (OWRD) water availability and water use allocations within the lowlands.

In 1996, the Oregon Plan for Salmon and Watersheds outlined the Coastal Salmon Restoration Initiative which called for the development of Stream Flow Restoration Priority Areas in which ODFW and OWRD were to assess all Water Availability Basins (WABs) in Oregon based on stream flow and consumptive use issues. Prioritization was based on a combination of biological factors and consumptive water use. ODFW identified areas where flow enhancement was needed to support fish populations. OWRD identified areas where opportunity existed to enhance flow based on consumptive water use, or water right permits.

Landowner Input

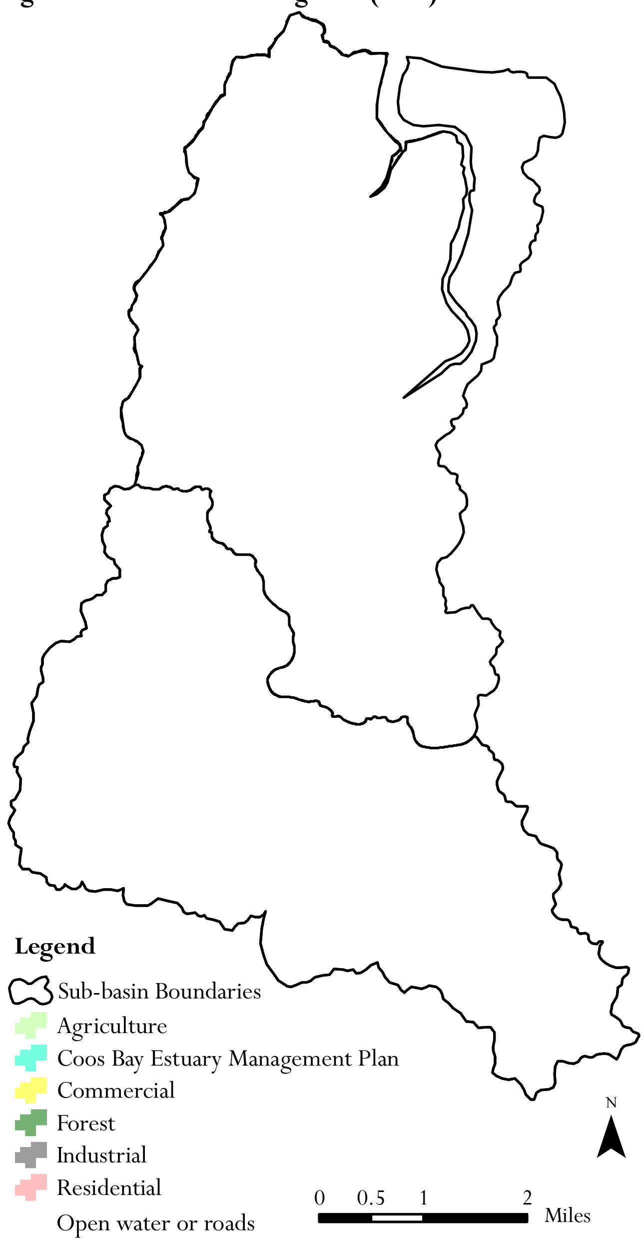
Local landowners were engaged primarily through a series of 'Coffee Klatch' meetings held to inform landowners of the surveyed watershed conditions, collect input from landowners to be used in the Assessment as additional resource issues for restoration prioritization, and to enlist landowner participation in watershed restoration efforts. It is understood that implementation of restoration projects is dependent upon the acceptance, understanding and will of landowners. This particular area of the Coos Watershed has a very high proportion of private landowners managing relatively small acreages therefore, participation of the community will be essential to successful restoration.

CHAPTER 2B: Sub-basin Assessment

Land Use

Understanding land use and ownership in the assessment area helps to characterize general land management issues and objectives. Land use activities influence the landscape by changing the timing and intensity of natural processes such as infiltration and runoff of precipitation. Residential development, agricultural practices and forest management activities have the potential to significantly change the drainage patterns of water by increasing the amount of impervious surfaces. Each land use type also has its particular implications for contributing non-point source pollution to waterways. For example, rural residential development increases the amount of impervious, paved surfaces and contributes polluted runoff from high-traffic roads as well as potential on-site septic maintenance failures. Agricultural and forestry practices, by nature, affect vegetation regimes, soil compaction, and stream flow. Examining the potential links between land use and sub-basin conditions can lead to improved management practices that accumulatively improve water quality and habitat.

Figure 2B-1 Landuse Categories (2009)



Land use distribution in the Coalbank and Isthmus Slough sub-basins, shown in Figure 2B-1, was grouped into major land use type categories. Table 2B-1 shows the acreage associated with each category for the sub-basin areas. Coalbank sub-basin had the highest percentage, 37%, of residential land use. This area included parts of Coos Bay proper and its urban waterfront. Residential land use also surrounds Coalbank slough and its tributaries, and stretches along Libby Road. Forest land use was the largest percentage, 53%, of land in this sub-basin. Agriculture composed 4% of the area and was located along upper reaches of the slough and its tributaries.

The Lower Isthmus sub-basin had the most industrial land use of all three sub-basins at 8% (486 acres), and most of this is concentrated along the west side of the slough. One of the major tributaries in Lower

Isthmus contains an old landfill site and an auto wrecking yard categorized as industrial. This sub-basin also contained the highest percentage, 6% (356 acres), of CBEMP[1] (Coos Bay Estuary Management Plan) designations, and these were also mostly located along Isthmus Slough with some along lower Davis Slough. Residential land use in the Lower Isthmus sub-basin composed 28% (1755 acres) of the area, and represents the communities of Eastside, Bunker Hill, Millington and the western side of Isthmus Heights. This sub-basin also contained the highest portion of commercial land use at 4% or 233 acres. Most of the commercial land use is concentrated at a golf course in the southern end of the sub-basin, and businesses near Millington and Eastside. While forestry is the most common land use in all assessment sub-basins, it was at its lowest in the Lower Isthmus area, covering 49% of the area, or 3,032 acres.

The Upper Isthmus sub-basin was heavily dominated by forestry land use, covering 84% of the sub-basin area, or 8,224 acres. Agricultural land use was also the highest in this area at 5%, or 510 acres. Residential land use was only 8% due to the fact that many homes were located on parcels classified as either forestry or agricultural land use. Most residential lands are dispersed along US Highway 101 or around the rural community of Greenacres.

Overall, for the total assessment area, forestry covered 66%, residential land use covered 21%, and the other categories were all 5% or less.

Table 2B-1 Landuse Categories (2009)

Total Area	Acres	% Sub-basin
Agriculture	1008	5%
CBEMP	652	3%
Commercial	377	2%
Forest	13639	66%
Industrial	593	3%
Residential	4243	21%
Coalbank		
Agriculture	177	4%
CBEMP	88	2%
Commercial	125	3%
Forest	2383	53%
Industrial	50	1%
Residential	1677	37%
Lower Isthmus		
Agriculture	321	5%
CBEMP	356	6%
Commercial	233	4%
Forest	3032	49%
Industrial	486	8%
Residential	1755	28%
Upper Isthmus		
Agriculture	510	5%
CBEMP	208	2%
Commercial	19	0%
Forest	8224	84%
Industrial	56	1%
Residential	811	8%

[1] Uses of lands zoned CBEMP are required by the County to follow specific guidelines to protect water-dependant and water-related activities, and natural resource conservation.

Aquatic Habitat

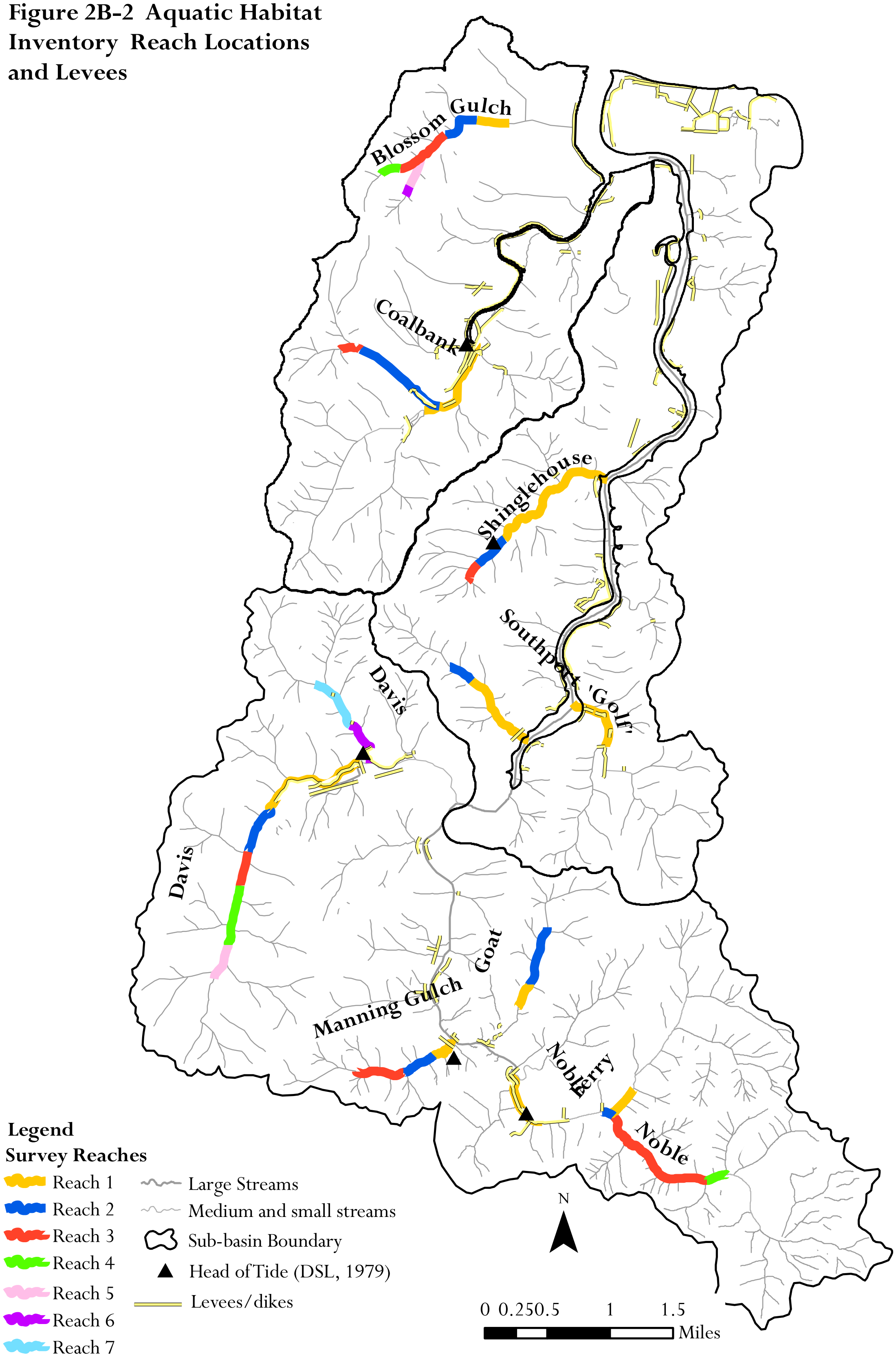
Coho populations are limited by the quantity of suitable habitat types available (Larkin, 1977). By quantifying stream characteristics, we can begin to make estimates of the current and potential quality of available habitat. Aquatic habitat inventories presented in this section include channel metrics, habitat unit type, substrate, riffle sediment, residual pool depth and frequency, large wood and riparian cover. Bank stability is presented in the following sediment sources section. This survey is designed for wade-able, forested, streams and therefore was not applied to the main stems of Isthmus, Coalbank or Davis Sloughs. Rather, surveys were conducted on selected tributaries to these water bodies.

Benchmark values are displayed for pools, large wood, and riffle sediment. These benchmarks, developed by ODFW, provide a method for comparing survey results with known natural stream regimes that support coho life cycles in Pacific Northwest forested streams. The benchmark value applied to bank stability was developed by EPA. While benchmark values are shown as desirable or undesirable, these values must still be viewed on a sliding scale within the context of the stream or watershed. An additional consideration is the uncertainty of how well these benchmarks and survey protocol apply to tidally influenced streams and wetlands. See Appendix A for a table of benchmark values for AHI parameters.

Figure 2B-2, below, shows the locations of the Isthmus and Coalbank Sub-basins and the AHI (Aquatic Habitat Inventory) study reaches. Specific colors of stream reaches are used here only to visually separate them from neighboring reaches. These groupings and name labels are for assessment display purposes and may not reflect the current actual names of individual tributaries. Stream reach names and numbers shown on the maps correspond to the stream reach names and numbers in the subsequent tables and graphs of AHI data.

Aquatic habitat inventories were conducted by Coos WA field staff in the summer of 2009 and 2010. Surveys proceeded from downstream, or ‘lower’, to upstream, or ‘upper’, reach units and data analysis is generally described here in the same fashion. Survey reaches were selected based on the three criteria described in Appendix A - Methods. Approximately 45% of the AHI candidate streams (before landowner permissions were sought) were ultimately surveyed totaling 22,925 meters of primary stream length.

Figure 2B-2 Aquatic Habitat Inventory Reach Locations and Levees



Channel Metrics

Channel metrics describe the channel's adjacent landforms, dimensions, gradient and ratios of combined metrics. These attributes provide a part of the context in which streams are currently examined, and they assist in understanding stream habitat potentials. It will also be insightful to compare current channel metrics and AHI information with historical information to understand how conditions have changed over time and how this change is influencing current stream conditions. Definitions of the different types of metrics measured here, including the ODFW Valley and Channel Morphology codes, are listed in Appendix A.

Channel metrics were surveyed as a standard part of the AHI, and are shown in Table 2B-2, below. For surveyed streams in the assessment area overall, the average ACW (active channel width) was 10.3 meters, and ranged between 1.8 in Manning Gulch and Blossom Gulch reaches 3 and 5, and 70 meters in Davis reach 6. Standard deviation was 15.5 meters. (Note: ACW's were measured every nine survey units and are not necessarily representative of the entire reach.) The average ACH (active channel height) was 0.6 meters, and ranged between 0.3 meters in Blossom Gulch 1 and Shinglehouse reach 2 and 3, and 1.3 meters in Shinglehouse reach 1. Standard deviation was 0.2 meters. Floodprone widths averaged 19.2 meters and ranged from 2.6 meters in Blossom Gulch reach 5 to 135 meters in Shinglehouse reach 1. Standard deviation was 29.5. Floodprone heights averaged 1.1 meters, ranged from 2.6 meters in Shinglehouse reach 1 to 0.6 meters in Blossom Gulch reach 1 and Shinglehouse reach 3, and had standard deviation of 0.4 meters. Stream gradient averages ranged from 0.1% in Blossom Gulch reach 1 and 2 and Shinglehouse reach 1, to 3.9% in Blossom Gulch reach 6.

Valley and channel morphology categorizes the adjacent land uses that may constrain the stream channel. The lower stream reaches were generally unconstrained in less developed and un-tide-gated areas, and constrained by terraces and hillslopes in other areas. Upper reaches were most commonly constrained by hillslope, and one reach, Davis reach 2, was constrained by landuse. Valley Width Index values indicate the potential of a stream to meander across the valley, regardless of its constraint, or surrounding land uses. Reaches containing the highest VWI (valley width index) values (>15) were Coalbank reach 2 (32.3 VWI), Davis reach 1 (16 VWI), Manning Gulch reach 2 (16 VWI), Ferry reach 1 (18 VWI), and Noble reach 2 (25 VWI). These unconstrained single channels, or channels constrained by terraces, would have the potential to improve coho rearing habitat if allowed to meander across the valley floors and improving channel-floodplain connectivity. Reaches with the lowest VWI values (<2) included Shinglehouse reaches 2 (1.6 VWI) and 3 (1.9 VWI), Southport reaches 1 (1.7 VWI) and 2 (1.9 VWI), and Davis reach 6 (1.2 VWI). These reaches were located within narrow valleys, are constrained by hillslopes and generally have low average gradients.

Primary stream (mainstem of survey stream) lengths totaled 22,925 meters and averaged 716.4 meters per survey reach. Primary stream area totaled 109,608 meters^2 and averaged 3425.3 meters^2 per reach. Secondary channels indicate the amount of off-channel habitat potentially beneficial to fish during high winter flows. Total secondary channel length was 1122 meters and averaged 35.1 meters per reach. Total secondary channel area was 3,317 square meters, and was an average 2.9% of total stream area. Reaches with the two highest percentages of secondary channel were Blossom Gulch reach 1 (17.4%), and Coalbank reach 2 (38.7%). There were seven survey reaches with no secondary channels. It will be important, again, to consider whether or not these channels are results of channel modifications, i.e. ditches, or are naturally formed.

Table 2B-2 Channel Morphology

Sub-basin	Stream	AHI Reach ID	Valley Width Index	Valley & Channel Morphology	Primary Stream Length (m)	Secondary Stream Length (m)	Primary Stream Area (m2)	Secondary Stream Area (m2)	% secondary channel of total stream area	Active Channel Width (m)	Active Channel Height (m)	Floodprone Width (m)	Floodprone Height (m)	Width Depth Ratio	Stream Gradient Avg	Entrenchment Ratio
Coalbank	Blossom Gulch	1	4	TC	414	54	3174	669	17.4%	13	0.3	29	0.6	43.3	0.1%	2.2
		2	2.2	CH	526	0	14175	0	0.0%	36	0.4	47	0.8	90	0.1%	1.3
		3	11	CH	648	15	792	11	1.4%	1.8	0.6	2.9	1.2	3	0.6%	1.6
		4	2	CH	397	32	520	9	1.7%	2.3	0.4	3.4	0.7	6.7	2.9%	1.5
		5	8	CH	461	18	443	6	1.3%	1.8	0.4	2.6	0.7	5.3	1.5%	1.4
		6	2.2	CH	104	0	101	0	0.0%	2	0.4	2.7	0.8	0.5	3.9%	1.4
	Coalbank	1	11.5	US	1249	169	8240	372	4.3%	8.7	0.8	15	1.6	11	0.3%	1.7
		2	32.3	TC	1250	20	1858	10	0.5%	2.9	0.7	5.8	1.4	4.1	1.1%	2
		3	2.2	CH	315	56	458	289	38.7%	2.6	0.6	4	1.2	4.3	3.2%	1.5
Lower Isthmus	Shingle-house	1	4.3	US	1583	181	30651	1541	4.8%	33	1.3	135	2.6	25.8	0.1%	4.1
		2	1.6	CH	437	0	6541	0	0.0%	26	0.3	29.5	0.7	89.1	0.2%	1.2
		3	1.9	CH	270	0	291	0	0.0%	3.4	0.3	5.2	0.6	11.3	1.9%	1.5
	Golf	1	13	US	753	89	4673	133	2.8%	11	0.5	28	1	22	0.3%	2.5
	South-port	1	1.7	CH	1050	24	4536	7	0.2%	46	0.4	65	0.9	111	0.5%	1.5
		2	1.9	CH	344	12	419	4	0.9%	3.2	0.4	5.2	0.9	7.3	2.5%	7.3
Upper Isthmus	Davis	1	16	TC	1518	43	4348	23	0.5%	6	1	9.1	2.1	5.8	0.2%	1.5
		2	5.8	CL	687	56	3119	66	2.1%	4.8	0.8	8.9	1.6	6	0.2%	1.8
		3	5	TC	406	0	1149	0	0.0%	6	0.6	15	1.2	10	0.3%	2.5
		4	5	TC	951	49	2259	15	0.7%	3.7	0.6	5	1.1	6.7	0.7%	1.4
		5	2.2	CA	685	15	1137	6	0.5%	3	0.4	4.5	0.8	7.4	1.1%	1.5
		6	1.2	CH	680	0	1762	0	0.0%	70	0.4	95	0.8	175	0.5%	1.4
		7	13	TC	754	37	1088	17	1.5%	2.7	0.5	3.6	0.9	6	0.5%	1.3
	Manning Gulch	1	10	US	373	40	2158	46	2.1%	9.5	0.9	9.5	0.9	10.6	0.3%	6.8
		2	16	US	474	13	1121	5	0.4%	3.8	0.6	35	1.2	6.3	0.5%	9.2
		3	13.3	US	706	20	656	6	0.9%	1.8	0.5	13.1	1.1	3.3	1.1%	6.8
	Goat	1	4.5	CA	456	25	554	4	0.7%	2.5	0.4	3.2	0.8	6.3	0.5%	1.3
		2	2.2	CH	895	49	1073	18	1.6%	2.5	0.4	3.3	0.8	6.7	1.1%	1.3
	Ferry	1	18	US	439	0	380	0	0.0%	2	0.5	3.8	1	4	0.2%	1.9
	Noble	1	14	TC	1660	30	4481	15	0.3%	4.4	0.8	9.5	1.6	5.4	0.3%	2.4
		2	25	TC	129	15	344	23	6.3%	4.8	0.6	6	1.2	8	0.4%	1.3
		3	5.8	CA	1961	47	6385	17	0.3%	3.7	0.5	5	1	7.3	0.4%	1.4
		4	4.5	TC	350	13	722	5	0.7%	3.6	0.4	4.8	0.8	9	0.5%	1.3

Habitat Unit Types

Habitat unit types provide a useful "snap-shot" of general stream conditions for analyzing habitat diversity, complexity and suitability for salmonids during their different life stages. Benchmark values indicate, pool amounts are best when they compose more than 35% of the stream reach, and less than 10% is undesirable. Figure 2B-3 shows the relative quantities of different habitat unit types in each survey reach. These data indicate pools, riffles and glides are the most common unit types in the survey reaches – typical of low-gradient coastal streams.

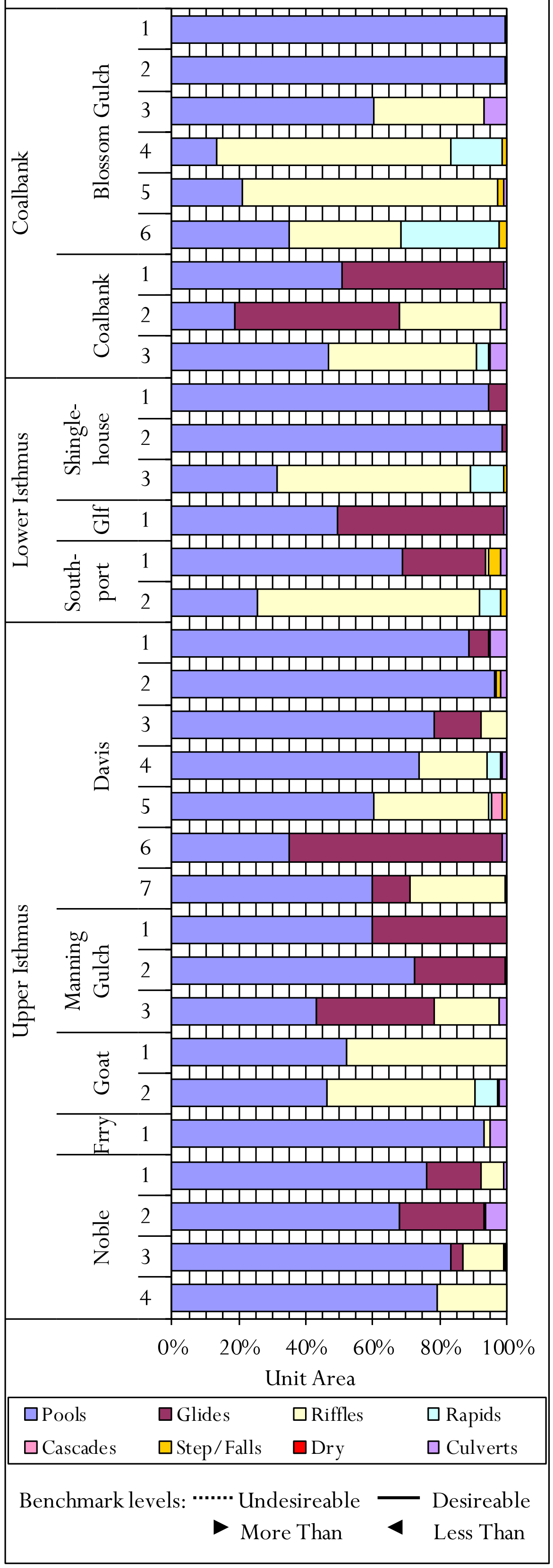
Quality salmon habitat is characterized by a diversity of pools and pool types (types are not distinguished here). Pools provide critical habitat for resting, rearing, finding cover from predators and high winter flows, as well as cool-water refuge during summer high temperatures. (Pool frequency and residual pool depth are presented later in this section.)

Overall, the average amount of pool area in surveyed steams was 62% of a given reach and the standard deviation was 26%. The first two reaches of Blossom Gulch were entirely pools. Note: the mouth of Blossom Gulch is tide gated, and the channel is in an underground culvert from the gate to the beginning of reach 1). While these values indicate very high amounts of pool area per reach, it remains important to consider the potential influences of human-caused factors, such as tide gates, dredging and other channel modifications, that may account for exaggerated pool area.

Unit type analysis indicates that five of the 32 AHI reaches did not meet the desirable benchmark level of 35% pool area, and two reaches, Davis reach 6 and Blossom Gulch reach 6, contained exactly 35% pool area. Reaches containing the poorest amount of pool area included Blossom Gulch reaches 4 (13%) and 5 (21%), and Coalbank reach 2 (19%).

Figure 2B-3 shows that riffles and then glides were, respectively, the second and third most abundant unit types after pools. Riffles provide opportunity for invertebrate production that feed juvenile salmon while also providing cover from predators, such as birds, due

Figure 2B-3 Unit Types



to the broken surface of the water. The benefits of riffles are maximized when in conjunction with quality pool habitat, and a pool to riffle ratio of 1:1 provides optimum food and cover conditions for juvenile coho (Ruggles, 1966). Assessment data show overall pool to riffle ratio was approximately 1:0.24, with a high abundance of pool area in most of the study reaches.

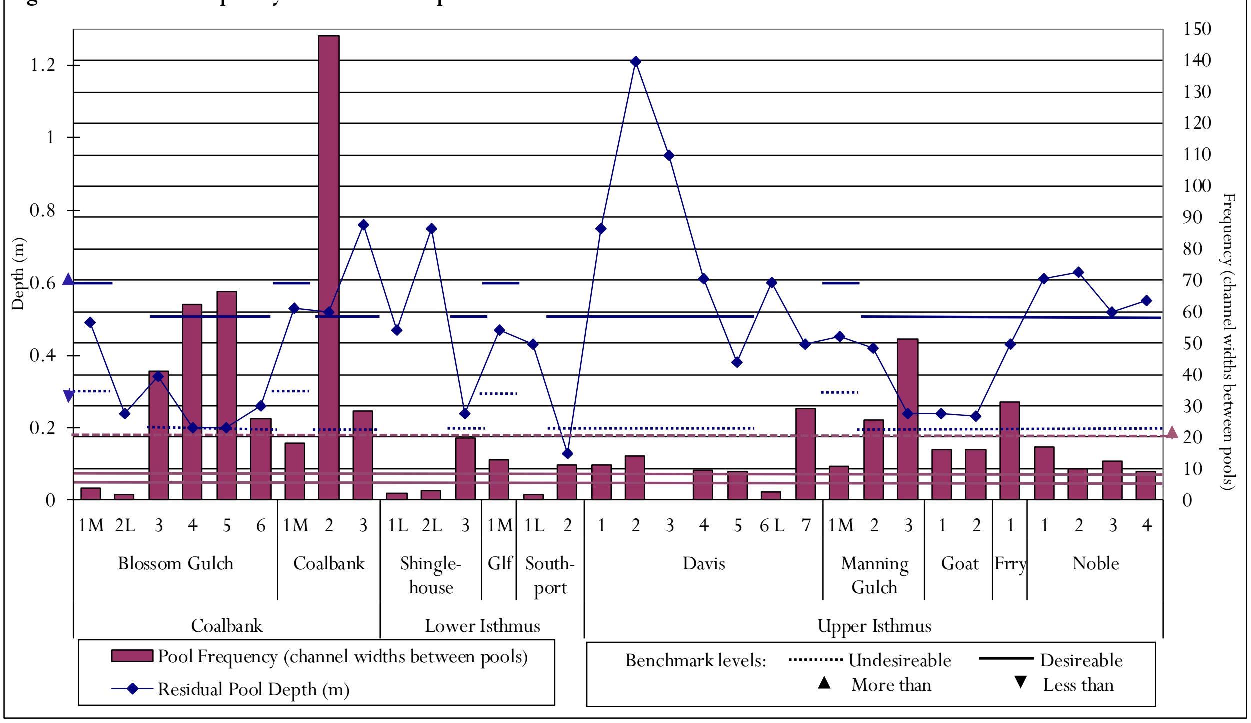
Overall, riffles averaged 20% with standard deviation of 24%, and range from zero to 77% in Blossom Gulch reach 5. Glides averaged 13% with standard deviation of 19%, and range from zero to 64% in Davis reach 6. The high percentage of riffles and glides may be the result of aggradation – filling in of the channel with sediment. It will be important to examine the types and amounts of substrate within these units and the amount of riffle sediment.

Pool Frequency and Residual Pool Depth

Pools provide important habitat for juvenile and adult fish, and benefits tend to increase with depth and frequency. Residual pool depth is the depth of a pool assumed to remain during low-flow periods. During the dry, warm summer months residual pools may be the last, and most crucial habitat remaining for fish. Pool frequency is the number of channel widths between pools, and indicates the availability of pool habitat within a stream reach. Higher numbers mean that pools are less frequent.

Figure 2B-4 shows residual pool depth on the left axis and pool frequency on the right axis. Benchmarks for pool depth are linked to active channel width, and are differentiated on the figure. All AHI reaches were considered small streams (<7 meter ACW), unless labeled with an M or L to indicate medium (7-15 meter ACW) and large streams (>15 meters ACW). Note: ACW's are not representative of the entire stream reach. Small streams are subject to residual pool depth benchmark levels of undesirable at <0.2 to desirable at >0.5 meters, and low-gradient medium streams are subject to residual pool depth benchmark levels of undesirable at <0.3 to desirable at >0.6 meters. No benchmark level for residual pool depth is indicated for large, >15 meter ACW, stream reaches.

Figure 2B-4 Pool Frequency and Residual Depth



Ten small to medium sized reaches exceeded the desirable benchmark level for residual pool depth, 15 reaches had pool depths above the undesirable level, and three reaches had depths less or equal to the undesirable level. Overall average residual pool depth was 0.48 meters with standard deviation of 0.31 meters, and ranged from 0.13 meters in Southport reach 2 to 1.21 meters in Davis reach 2 (beaver pond).

Desirable benchmark levels for pool frequency range from 5-8, while frequency values over 20 are undesirable. Ten survey reaches exceeded the undesirable level of 20 for pool frequency, with four of these reaches in Blossom Gulch alone. Coalbank reach 2 had an extremely high pool frequency meaning it had the least amount of pools between channel widths. Fifteen reaches had pool frequencies below 20 but above the desirable range, none of the reaches were in the five to eight desirable range, and six reaches had pool frequencies less than five. Overall pool frequency averaged 23.0 with standard deviation of 7.6, and ranged from 1.6 in Blossom Gulch reach 2 to 147.7 in Coalbank reach 2. It will be insightful to compare and contrast the amounts of large wood in the reaches with desirable and undesirable pool frequencies.

Substrate

Substrate type and quality is heavily influenced by the condition of upstream sediment sources and transport mechanisms within the sub-basin. Sediment is addressed in several components of this assessment including AHI surveys of substrate type, riffle sediment, and bank stability, as well as road sediment surveys of at-risk stream crossing sites. See Sediment Sources in the next section of this document.

Stream substrate surveys provide information about channel coarseness, complexity, gradient and sediment transport. Larger amounts of cobble, boulders and bedrock tend to be found in higher gradient reaches, while lower reaches tend to have more sand, and silt/organics. In addition, the downstream transport of gravel and other sediments during various seasonal flows is a dynamic process that continually reshapes habitat within the active stream channel and floodplain.

Substrate influences survival of salmonids at different life stages. For example, spawning habitat is negatively influenced by high percentages of silt and sand in riffle areas, while pools with cobbles and boulders provide important winter rearing habitat. Streams with bedrock substrate have increased high-flow velocity due to the smoothness or lack friction against the water flowing downstream. Bedrock substrates are often the result of historical splash damming or landslides, and the increased velocity expedites the transport of more sediment downstream. High velocity flows can negatively impact fish, especially juveniles, as they must expend more energy to keep from being washed down stream. Bedrock also does not provide spawning opportunities and, where there is poor riparian cover; bedrock substrate can increase stream temperatures.

Figure 2B-5 shows the average percentages of different substrate types surveyed in the AHI stream reaches. These data show that the overall majority of stream substrate was sand, averaging 53% with standard deviation of 15.6%. Blossom Gulch reaches contained the highest amounts of sand, 78% and 75% in reaches 2 and 1 respectively, and the lowest amount of sand, 25%, was surveyed in Blossom Gulch reach 6. Manning Gulch also had very high amounts of sand. Gravel, the next highest substrate type, averaged 26% with standard deviation of 14.5%. Gravel amounts ranged from 2% in Blossom Gulch reach 1 to 48% in Noble reach 4. Silt/organics composed an average 8% of the substrate, with standard deviation of 8.6%, and were located primarily in lower stream reaches and or behind constrictions such as tide gates.

Seven reaches, dispersed throughout the assessment, contained no silt/organics, while five reaches contained 20-24% silt/organics. The average amount of silt/organics was 8% with standard deviation of 8.6. Deposition of silt/organics can cover over other substrates, potentially reducing stream complexity – especially if natural cycles of stream flooding and flushing are disrupted by channel modifications.

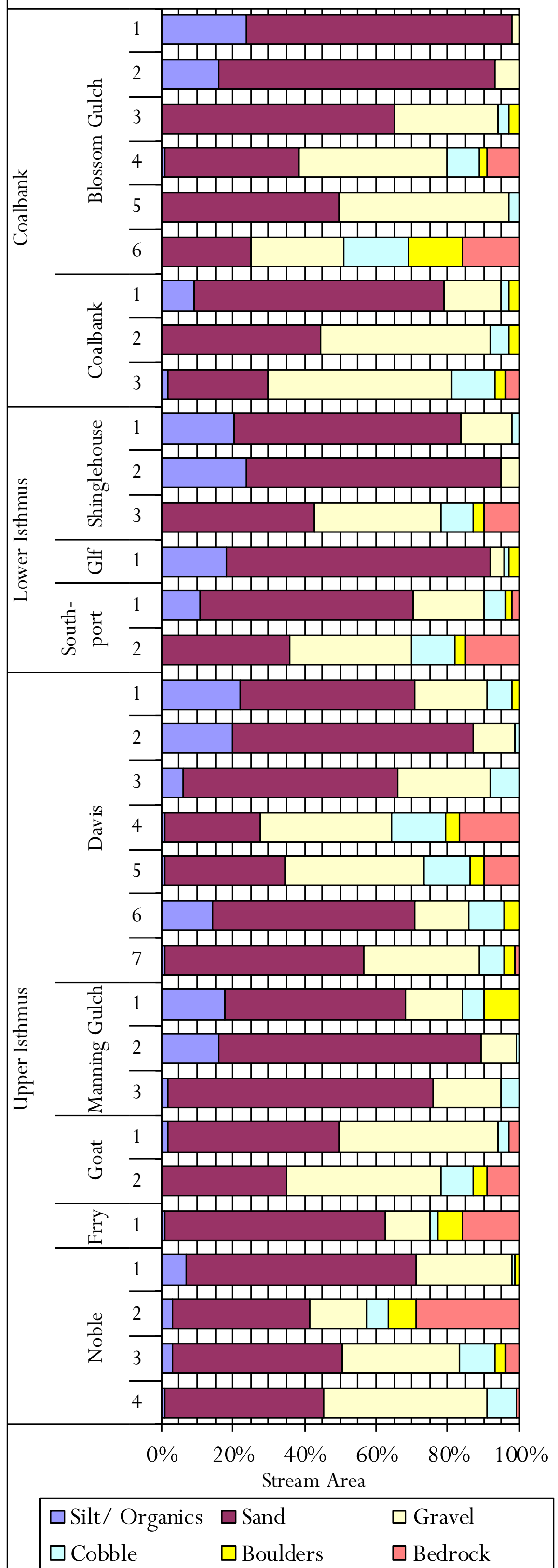
Cobble mean value was 6% with standard deviation of 4.8%. Cobble amounts ranged from 0% in Blossom Gulch reaches 1 and 2, and Shinglehouse reach 2, to 18% in Blossom Gulch reach 6. Bedrock mean value was 5% with standard deviation of 7.2%. Bedrock substrate amounts ranged from 0% in 17 reaches, to 29% in Noble reach 2. Boulder mean value was 3% with standard deviation of 3.3%. Eleven reaches had no boulders surveyed, while Blossom Gulch reach 6 had 17% boulder substrate.

Large Wood

Large wood in the stream provides an important source of cover for fish, especially in pools. As it decomposes, large wood creates an energy source for the food chain. Wood also helps create pools and new channels increasing complexity and diversity of habitat. Pieces and volume of large wood refers to dead and dying wood within the stream channel. Pieces must be a minimum of 15 centimeters in diameter and 3 meters in length. All root wads are considered large wood. Key pieces of large wood refer to downed wood within the stream channel that is a minimum of 60 centimeters in diameter and 10 meters in length. The overriding value of key pieces is that they resist downstream transport by high winter or flood flows. Key pieces also anchor and retain other pieces of wood around which other material is deposited and trapped. Key pieces represent the long-term wood retention ability of the stream.

Benchmark levels for large wood were developed for streams in forested basins. While many of the tributary streams in the survey area are forested, some lower-gradient streams should be considered within the context of broad valleys that were historically wetland-dominated and, thus may require different large wood

Figure 2B-5 Substrate Types



benchmark levels. The forested stream benchmark levels used in this analysis are as follows: wood pieces per 100 meters of stream length should not be less than 10 and ideally is more than 20. Volume of wood should not be less than 20 meters^3 and ideally is more than 30 meters^3. There should not be less than one key piece, and ideally there is more than three key pieces per 100 meters of stream.

Figure 2B-6 shows the number of large wood pieces, volume and key pieces per 100 meters of stream in the survey area. The average number of large wood pieces was 5.9 with standard deviation of 5.1. Southport reach 2 contained the highest number of pieces, 21.5/100 meters, and was the only reach that met the desirable benchmark amount for pieces. Six other reaches had more than 10 pieces/100 meters, and two reaches, Ferry reach 1 and Noble reach 4 had no qualifying pieces of large wood.

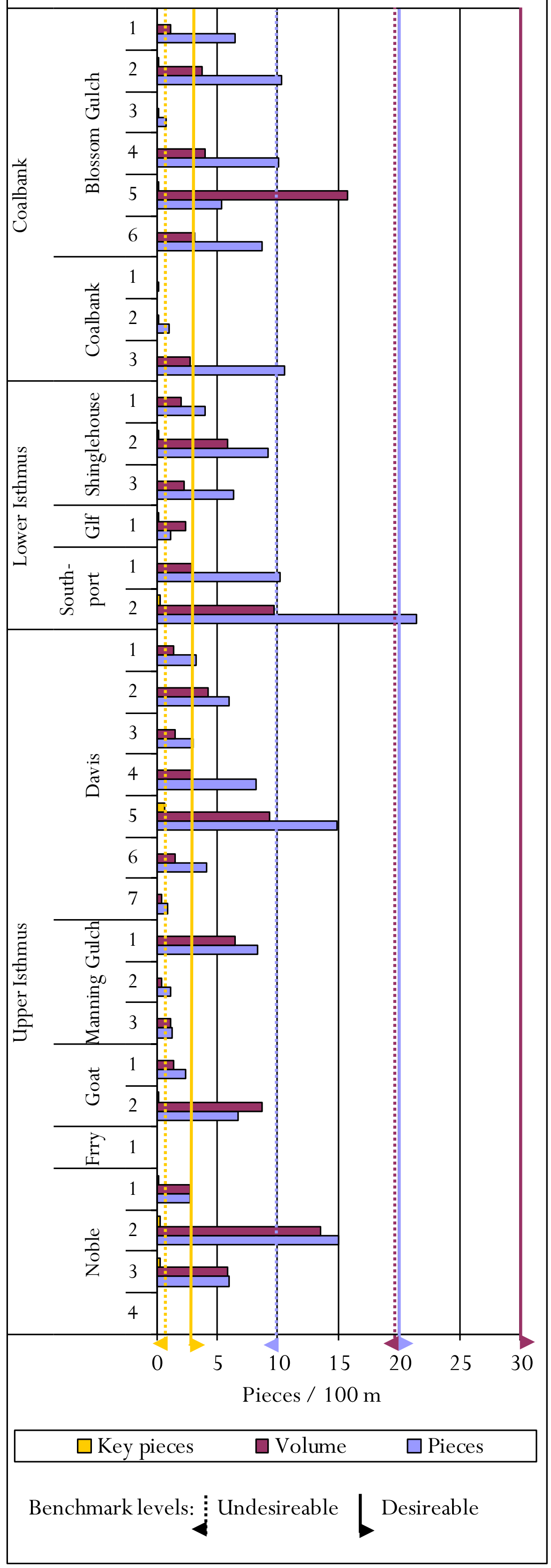
Large wood volume averaged 3.7 with standard deviation of 3.9. Volumes ranged from zero in three reaches to 15.8 in Blossom Gulch reach 5. None of the survey reaches met the benchmark levels for the desirable volume of large wood or even exceeded the undesirable volume level.

Key pieces of large wood averaged 0.08 with standard deviation of 0.14. Key pieces ranged from zero in 22 of the reaches to 0.6 in Davis reach 5. None of the reaches met even the undesirable benchmark amount, of one, for key pieces. Two reaches, Noble reach 4 and Ferry reach 1 had no qualifying large wood recorded in the survey.

Riffle Sediment

Riffles are fast-water units usually having shallow, uniform cross-sections, gravel or cobble substrate and gradients of 1% to 4%. Silt, organics, and sand are referred to as ‘fine sediments’. Sand, silt and organic matter are natural components of stream systems. However, excessive deposits of fine sediments severely restrict spawning habitat for salmonids by filling in the interstitial spaces between larger substrate particles – gravel and cobble. Newly spawned eggs, developing embryos and newly hatched alevins require these gaps

Figure 2B-6 Large Wood



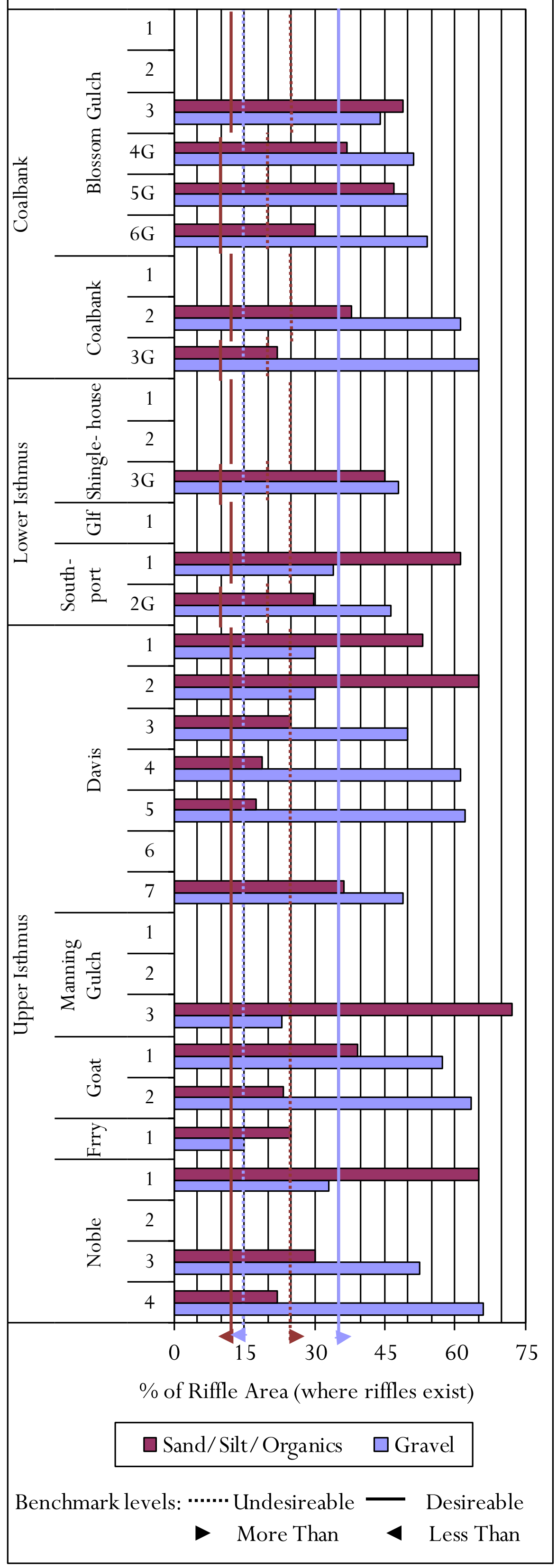
between substrate particles for physical space and the delivery of well-oxygenated water (Everest, et al. 1985). High rates of pre-emergent salmon egg mortality is often linked to an inadequate supply of oxygen caused by the introduction of fine sediment to streambed gravels. If fine sediment is above 10-15% it reduces the flow of oxygenated water to the eggs (FRS 2003).

Figure 2B-7 shows the percentages of gravel and fine sediments surveyed specifically within riffle units. Two sets of benchmarks are displayed on the graphs – the blue lines indicate gravel amounts should not drop below 15% of the riffle unit, and are most beneficial when more than 35% of the unit is gravel. Benchmarks for fine sediments (sand/silt/organics), shown in maroon, vary due to channel gradient and parent rock material. All reaches were located in areas of sedimentary parent material and most reaches had gradients of less than 1.5%, except those identified with a G in Figure 2B-7. Reaches with lower gradients (<1.5%) provide the most desirable habitat when riffle sediment is less than 12% of the unit, and undesirable when levels are more than 25% of the unit. Reaches with gradients above 1.5% (G) provide desirable habitat when fine sediment is less than 10% of the riffle unit, and more than 20% riffle sediment is undesirable. Reaches absent data on these graphs did not contain riffles.

Riffle sediment analysis of surveyed streams indicates in most reaches there were very high amounts of gravel, however also very high amounts of sand/silt/organics or fine sediment. Mean percentage of gravel in riffles was 48% with a standard deviation of 14%. Gravel amounts in riffle reaches ranged from 15% in Ferry reach 1 to 66% in Noble reach 4. All reaches with riffles contained gravel amounts at or above the undesirable benchmark amount of 15%, and 16 reaches exceeded the desirable benchmark amount of 35% or more gravel in riffles.

Average percentage of sand/silt/organics within riffles was 39% with standard deviation of 16%. Fine sediment amounts ranged from 17% in Davis reach 5 to 71% in Manning Gulch reach 3. Sixteen of the 22 reaches with riffles have fine sediment levels above the

Figure 2B-7 Riffle Sediment



undesirable benchmark levels, six reaches contained fine sediment amounts in the range between the desirable and undesirable levels, and none of the reaches had desirable benchmark amounts of fine sediment.

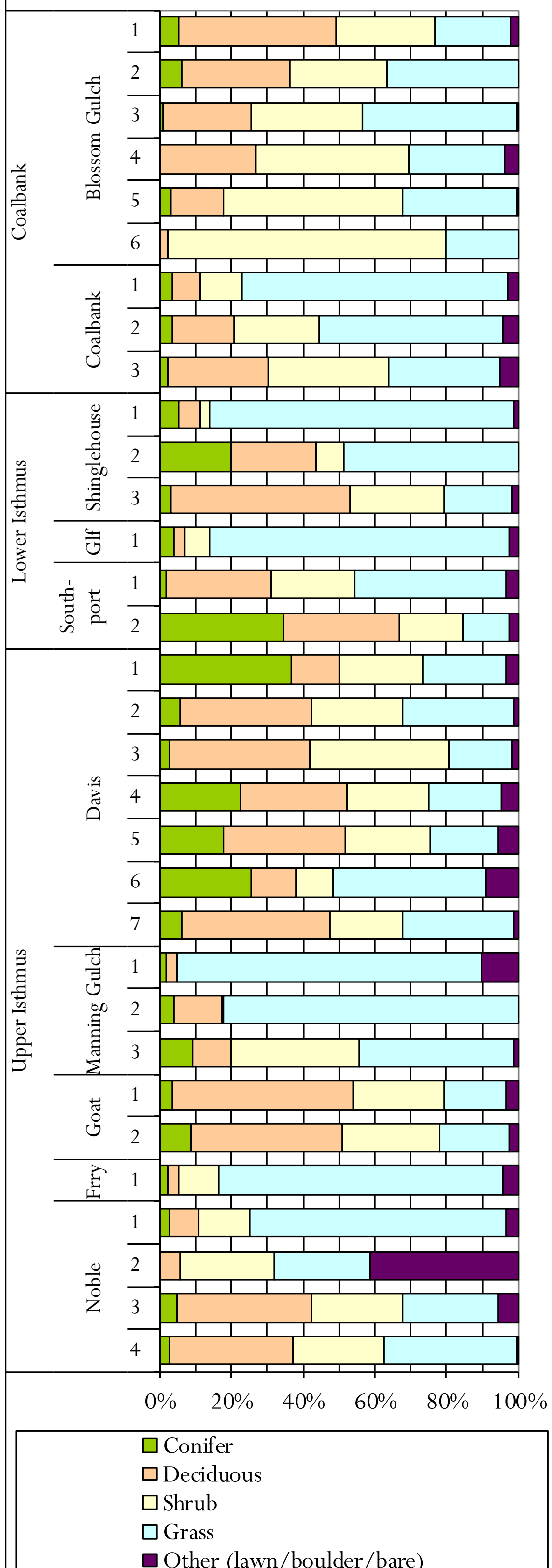
Riparian Cover Type

Riparian cover type refers to general types of vegetation found adjacent to the stream channel. Riparian zones provide many functions vital to the maintenance of high quality fish habitat and water quality. Riparian trees, especially conifers, are the major source of large wood in streams, and standing trees and root wads help keep large wood anchored in place. Shade over the channel helps keep stream temperatures low in downstream reaches. Riparian vegetation is an important ecosystem component for many types of wildlife, provides habitat for invertebrates that are a major food source for fish, and contributes organic debris that provides nutrients to the stream system.

Deep and expansive roots of riparian trees and shrubs reduce bank erosion, consequently contribute less sediment to the stream, and provide filtering of runoff from the surrounding landscape. The root systems of trees, shrubs and grasses bind and hold the soil together, and help absorb the force of stormwater flows (NRM R30 and NRM R02, 2002). Reed canary grass, however, is not adequate for long term bank stability and, in many places on the south coast of Oregon, its shallow root system allows undercutting of the channel eventually resulting in bank failure. Bank stability, closely associated with riparian cover type, is displayed in the Sediment Sources section of this assessment.

Amounts of each riparian cover type are shown in Figure 2B-8. Types include conifer, deciduous, shrub, grass, and other (lawn, boulder, bare). Surveys were made within 10 meters perpendicular to the stream reach. Mean conifer cover of stream reaches was 8% with a standard deviation of 10%. Three reaches did not contain any conifer cover, and the larger amounts of confer cover were on Davis reach 1 with 37%, and Southport reach 2 with 35%. The deciduous cover

Figure 2B-8 Riparian Cover Type



mean value was 24% with standard deviation of 15%. All of the reaches had some amount of deciduous cover ranging from 2% on Blossom Gulch reach 6, and 50% on both Shinglehouse reach 3 and Goat reach 1. Shrub cover mean value was 24% with standard deviation of 15%. All reaches contained shrubs except Manning Gulch reach 1. Shrub cover amounts ranged from zero on Manning Gulch reach 1 and 1% on Manning Gulch reach 2, to 78% on Blossom Gulch reach 6. Grass cover mean value was 41% with standard deviation of 23%. Every reach contained grass cover and amounts ranged from 13% in Southport reach 2 and 85% on Shinglehouse reach 1 and Manning Gulch reach 1. Other cover types averaged 4% with standard deviation of 7%. Four reaches did not have any 'other' cover types recorded, and Noble reach 2 has the largest amount with 41% 'other' cover.

Sediment Sources

Because particles of silt and organic matter are easily transported by flowing water, sources of these particles, such as landslides, earthflows, or collapsing banks can affect large areas of habitat downstream from the source. Fine sediment, beyond natural background levels, is detrimental to fish and their habitat in many ways. When substantial erosion occurs spawning gravels become embedded often causing high rates of egg mortality. More than 10-15% fine sediment (silt/organics) reduces the flow of oxygenated water to the eggs (FRS, 2003). In the case of adult salmon, high concentrations of suspended sediment may delay or divert spawning runs (Mortensen et al., 1976). Additionally, as pools collect sediment, depth decreases and solar heating occurs more rapidly. Aggradation, or the raising of the streambed, can influence flow levels, flooding and erosion.

The Sediment Sources component of this assessment evaluates the following four sources of sediment: 1) Bank stability (see aquatic habitat survey methods), in which the percentage of stream bank in each surveyed reach was determined as being either covered or uncovered, and stable or unstable. 2) Slope stability, in which each sub-basin was evaluated for % of area at risk of slope failure in four risk categories from low to extremely high. 3) Road sediment surveys, in which roads and road drainage features were examined for erosion potential and compared to ODF Best Management Practices. Recommendations for road upgrades are shown in Chapter 3B. 4) Stream crossing capacity evaluation, in which stream crossing sites were rated for their flow capacity compared to a 50-year event and their risk of failure. Sediment deposition within the stream channel is also reflected in the aquatic habitat analysis for substrate and riffle sediment.

Bank Stability

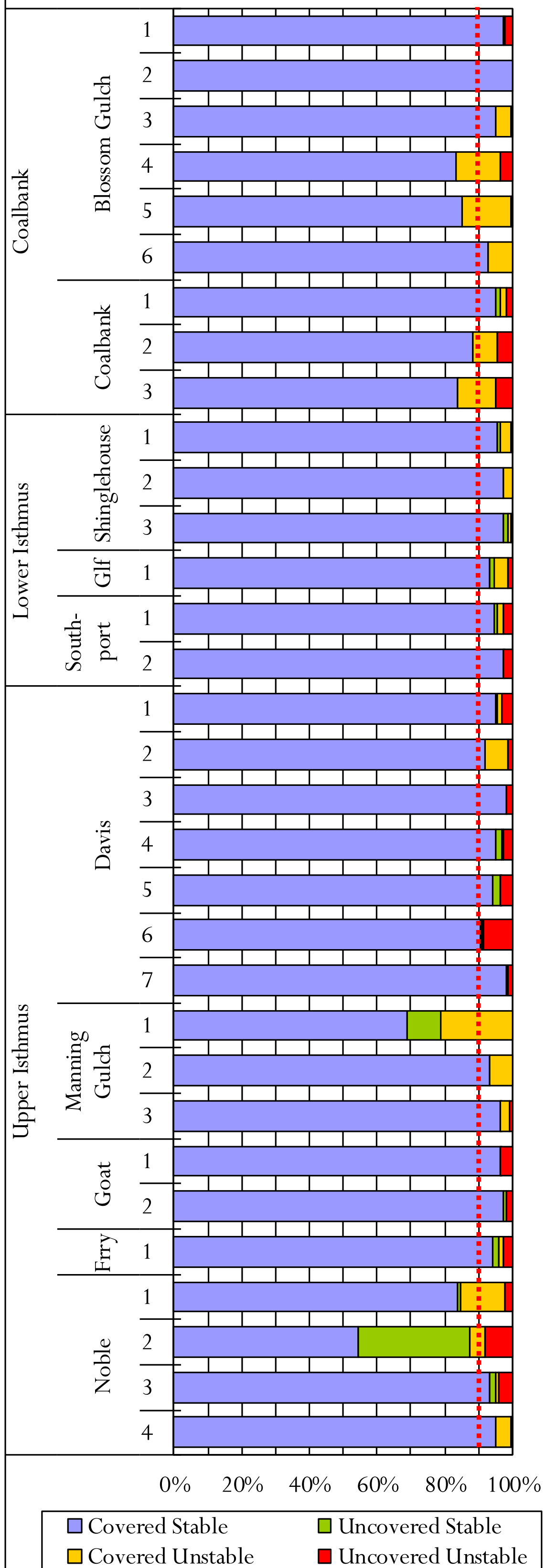
Bank stability, shown in Figure 2B-9, displays the amounts of stream bank in different combinations of vegetation cover or absence (uncovered), and stable or unstable bank conditions. (See Figure 2B-2 in the previous AHI section for reach locations.) The benchmark level for stream bank stability indicates desirable level of at least 90% stable, or not actively eroding. The majority of all assessed stream banks were covered stable, but seven of the 32 reaches exceeded the 10% benchmark level for unstable banks. These unstable banks, however, were mostly covered, and uncovered unstable banks did not exceed 10% in any of the reaches. The highest amount of uncovered unstable banks, 8%, was found in Davis reach 6. The relatively large amount of covered unstable banks identified in the survey is mainly due to undercut and slumping stream banks covered with Reed canary grass. Also, many sedge-covered stream banks in tidal reaches of streams experience continual natural erosion and deposition of sediments.

The Coalbank sub-basin stream reach average amount of covered stable banks wa 91%. The average amount of covered stable banks was 7%, and 2% for uncovered unstable banks. The sub-basin had four reaches exceeding the benchmark levels for unstable banks. The most unstable of these was Coalbank reach 3 with 16% and Blossom Gulch reach 4 with 17% unstable banks. Blossom Gulch reach 2 was completely covered stable, and only Coalbank reach 1 had any amount, 1%, of uncovered stable banks.

The Lower Isthmus sub-basin did not have any reaches exceeding the benchmark level for unstable banks, but all reaches had some small amount of unstable banks. Four reaches contained 1% uncovered stable banks. The average amount of covered unstable banks was only 2%, and 1% for uncovered unstable banks. The average for covered stable banks was 96%, and the most stable reach was Shinglehouse reach 3 with 98% covered stable banks.

Upper Isthmus sub-basin had three reaches exceeding the benchmark levels for unstable banks. The average amount of covered stable banks was 91%, and ranged from 54% in Noble reach 2 to 98% in Goat reach 2 and Davis reaches 3 and 7. This sub-basin had a relatively high amount of uncovered stable banks, mostly found in Noble reach 2 which had 33% in this class. This particular reach was a fish hatchery raceway with hardened banks and no riparian vegetation.

Figure 2B-9 Bank Stability



Slope Stability

Unstable slopes often lead to shallow slope landslides and deep seated soil creeps. It is important to note that landslides are natural processes important to streams for recruiting gravel, boulders, and large woody debris into the channel. However, acceleration of this process by human activities can have serious impacts to the aquatic ecosystem. Slope, vegetation, and geology all have direct relationships to the slope stability of an area.

Presence of mature vegetation is an important component on stable slopes. "There is some evidence that the removal of trees on steep slopes (greater than 80%) makes an area vulnerable to shallow landslides, and can lead to temporary acceleration of the landslide rate. This vulnerability begins when many of the finer roots of the harvested trees become rotten (about 4 years) and ends once the replacement stand has developed a dense root network (about 30 years for wet portions of the state)" (OWEB, 1999). Many of the upland slopes in the assessment area are commercial forests on short harvest rotations, most are harvested in 30 or 40 year rotations. Because of this, there may be chronic slope problems from this type of land management. Adhering to Best Management Practices during forest harvesting is important to minimize loss of soil on unstable steep slopes.

The hillslope, or slope stability analysis, shown in Figure 2B-10, indicates that 76.8% of the assessment area, which covers 26.66 total sq. kilometers, was in the low risk category for landslide potential, and approximately 19.9% was at moderate risk. High risk was identified for 3.0% of the area, and extremely high risk covered 0.3% of the area. High and extremely high risk areas totaled 3.3% of the area. The locations of these slope risk classifications are shown in Figure 2B-11, below. As this analysis shows, the assessment area had mostly low risk hill slopes. Compared to our past assessments of the Lowlands, Head of Tide, and Catching and Daniels Sub-basins, the Isthmus assessment area has the lowest risk of hill slope failure of all of these areas in the Coos Watershed.

Figure 2B-10 Hillslope Risk Classifications

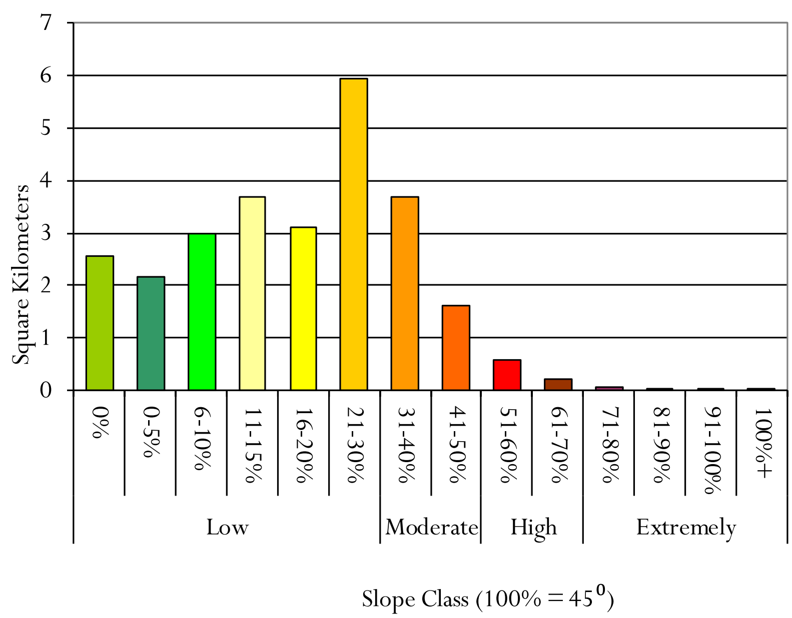
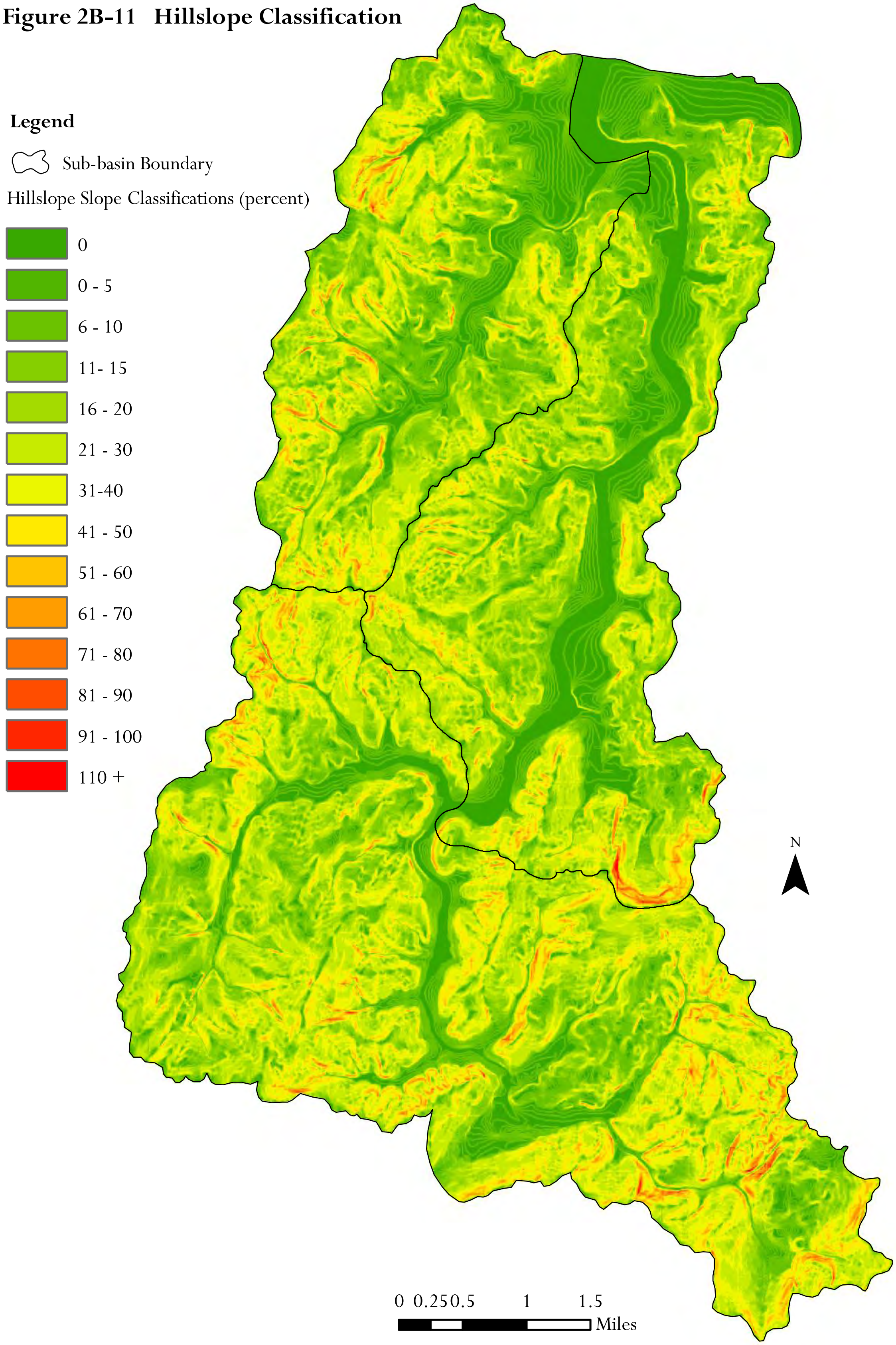


Figure 2B-11 Hillslope Classification



Road Sediment

Sediment delivery to streams occurs when road drainage is discharged directly into stream channels via culvert outflow and sediment delivery is assumed when drainage ditch relief is within 100 feet of stream channels. Either one of these conditions will potentially increase sediment transport volumes and flood stage elevations downstream.

Road surveys were conducted for three primary purposes: (1) to identify fish passage impediments at road stream crossings, (2) to determine the degree of road failure risk, and (3) to identify locations where hydrologic connectivity of road drainage ditches to live stream networks could be altered to filter road sediment before it reaches the stream.

Table 2B-3 Road Sediment Survey Site Summary

Site Type	Number of Sites	Number of Ditches	Existing Ditch Lengths (ft)
Stream Crossing	106	146	Avg. 290
			Min. 25
Ditch Relief	138	189	Avg.338
			Min. 50
			Max. 2060
Ditch Out	162	242	Avg. 369
			Min. 10
			Max. 2100
Potential Landslide	1	1	Avg.390
			Min. 390
			Max. 390
Ponding/Gullied Road Surface	23	40	Avg. 362
			Min. 50
			Max. 390
Totals	430	618	

Road-Related Erosion

The Isthmus and Coalbank Slough sub-basin road and landing survey was conducted between June 2008 and August 2010. All private roads were surveyed where landowner permission was granted. Table 2B-3 provides a summary of the surveyed road sites and lengths in the assessment area. Figure 2B-12 shows the locations of the road surveys and site types. A total of 81.3 miles of road were surveyed in the assessment area, and the total number of sites was 430. The average number of drainage sites per mile was 5.3. There were 106 stream crossings, 138 ditch relief culverts, 162 ditch outs, one potential landslide and 23 road surface sites. See Restoration Opportunities for recommended drainage feature upgrades.

Stream Crossing Drainage Evaluation

The 127 stream crossing culverts studied in the road and landing survey were ranked for their ability to properly drain the area upstream during a fifty-year rain event, see Table 2B-4. Fifty three (37%) of the stream crossings in this survey were considered at risk for improper drainage or failure because they were undersized. At-risk culverts are further ranked in Table 2B-4 based on the percentage of associated drainage area they can properly drain during a 50-year rainfall event. The number of culverts in each failure risk level

Table 2B-4 At-risk Stream Crossing Evaluation

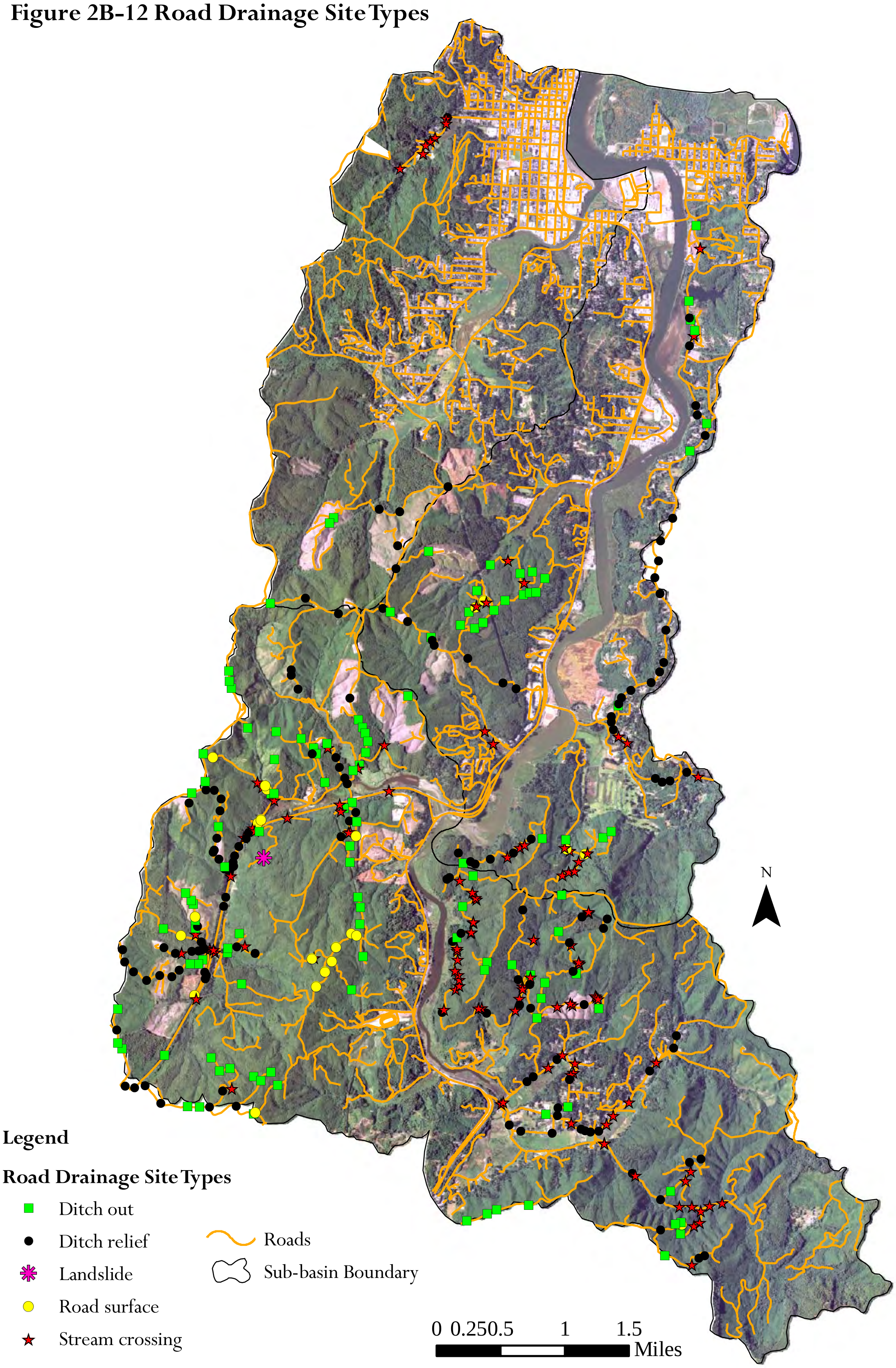
50-Yr. Rainfall Fill Failure Risk	Fill Volume Size Class									
	Minimal		Small		Medium		Large		Very Large	
	Sites	Yds^3	Sites	Yds^3	Sites	Yds^3	Sites	Yds^3	Sites	Yds^3
Low	-	-	1	38	11	253	3	415	-	-
Medium	-	-	4	87	1	61	1	290	-	-
High	-	-	4	127	2	145	3	533	-	-
Very High	2	18	8	243	5	376	7	1354	-	-

For *Failure Risk*, Low = 76% - 100%; Moderate = 51% - 75%; High = 26% - 50%;
Very High = 0% - 25%
For *Fill Volumes*, Minimal = ≤ 10 $yds.^3$; Small = 10 - 50 $yds.^3$; Medium = 51 - 100 $yds.^3$; Large = 101 - 500 $yds.^3$; and Very Large = > 500 $yds.^3$.

(left column) spread across the table depending on the associated fill volume size class. It is important to consider both failure risk and fill volume since it is the fill that becomes the sediment source upon failure of the crossing.

In the assessment area, 22 of the 53 culverts were ranked as having very high risk of failure, potentially releasing 1991 yrd^3 of fill. Nine were ranked as having high risk, potentially releasing 805 yds^3 of fill. Seven ranked moderate, potentially releasing 507 yds^3 of fill. Fifteen of them ranked low, potentially releasing 706 yds^3. There was a total of 4009 yds^3 of fill at these 53 at-risk culverts, and none of the sites contained fill amounts in the very large category.

Figure 2B-12 Road Drainage Site Types



Wetlands

National Wetlands Inventory

Wetland types were assessed using the 1979 NWI (National Wetland Inventory) GIS database. This information provides a rough sketch of post-development wetland types in the assessment area. Table 2B-5 shows the area and amount of each NWI general wetland type within the sub-basins and for the total assessment area, and Figure 2B-13 shows the locations of the NWI wetland types.

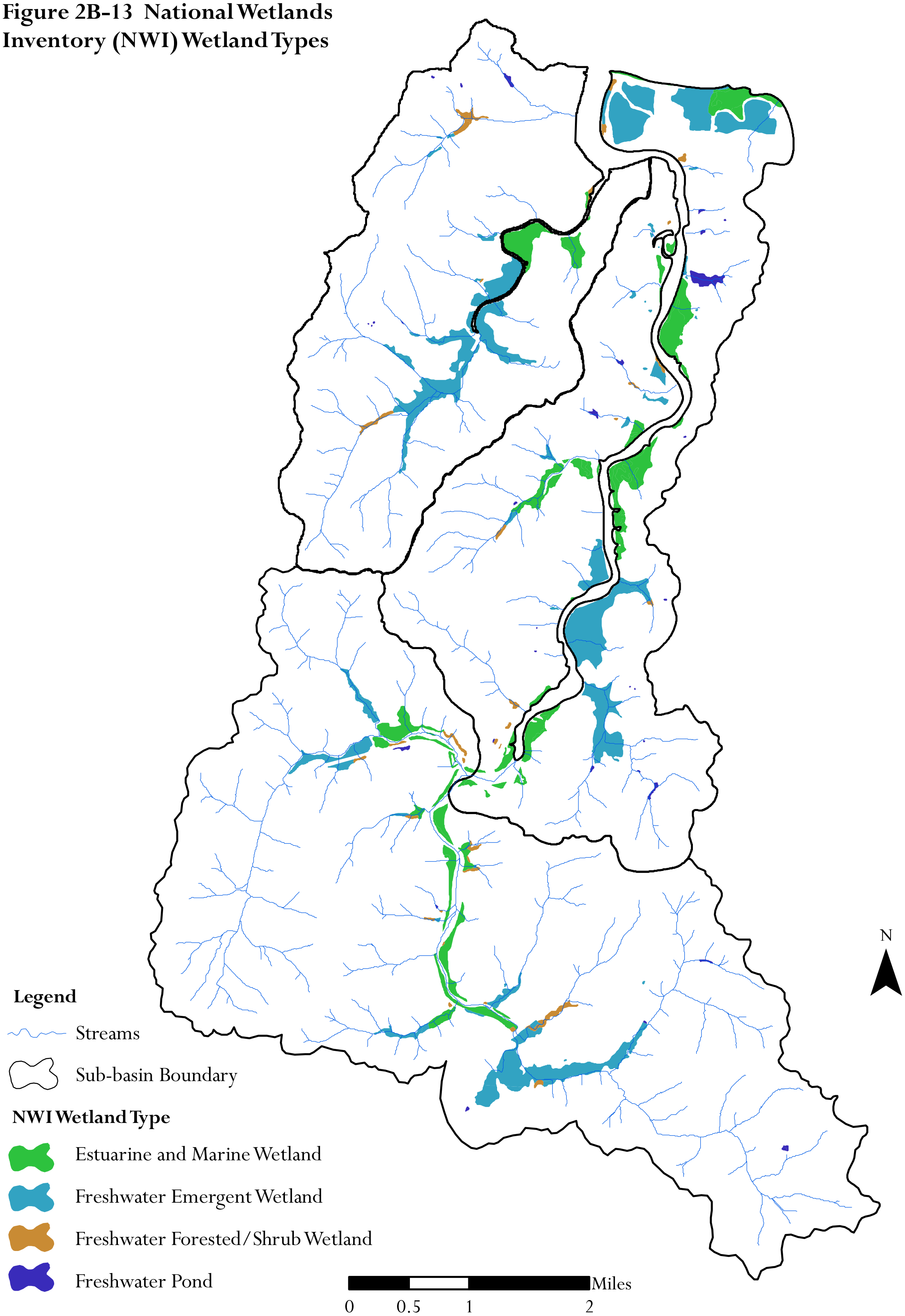
The Coalbank assessment area contained the highest proportion, 217 acres (71%) of freshwater emergent wetland, which was located along the slough and tributaries in agricultural areas. This sub-basin also contained the smallest amount, 66 acres (21%) of estuarine and marine wetland largely concentrated in two restored marshes lower in the sub-basin. Most forested/shrub wetlands were present along mid to upper Blossom Gulch and upper Coalbank. The Lower Isthmus sub-basin contained the most acreage of freshwater emergent wetlands, 454 acres (57%) in diked areas near the mouth of the slough, and farther up the mainstem in diked agricultural and commercial recreation areas. This sub-basin contained the smallest amount of freshwater forested/shrub wetlands with only 18 acres (2%) found in small scattered fragments. Estuarine and marine wetlands covered 304 acres (38%) in wetlands along the main slough and one of its main tributaries, Shinglehouse Slough. Upper Isthmus contained 159 acres (38%) of estuarine and marine wetland mostly found along the main stem of Isthmus and Davis Sloughs. Freshwater wetland covered 226 acres (54%) and was found in the agricultural mid reaches of Davis Slough and Noble Creek. The area contained 31 acres (7%) of forested/shrub wetland in small pieces scattered around the sub-basin.

The assessment area overall contained 529 acres (35%) estuarine and marine wetlands, 898 acres (59%) freshwater emergent wetlands, and 69 acres (5%) freshwater forested/shrub wetlands. Several freshwater ponds were located around the assessment area, and most are highly altered from natural conditions. Most of these wetland areas were historically inundated by tides and were estuarine and marine wetlands before diking and tide gates were installed. Much of what is identified as estuarine and marine wetlands on the NWI database have had tidal inundation restored subsequent to initial development. The following sections have more information on wetland restoration opportunities.

Table 2B-5 National Wetland Inventory (NWI) Wetland Type Acreage and Percent of Sub-basin

Wetland Type	Total Area		Coalbank		Lower Isthmus		Upper Isthmus	
Estuarine and Marine	529	35%	66	21%	304	38%	159	38%
Freshwater Emergent	898	59%	217	71%	454	57%	226	54%
Freshwater Forested/Shrub	69	5%	20	7%	18	2%	31	7%
Freshwater Pond	34	2%	4	1%	24	3%	6	1%

Figure 2B-13 National Wetlands Inventory (NWI) Wetland Types



Fish Distribution

Fish Distribution

Distribution of coho, Winter Steelhead and Fall Chinook within the assessment area, based on ODFW surveys, is shown in Fig. 2B-14. A brief summary of selected salmonid life history patterns is provided in Appendix B. Steelhead and coho have very similar distribution in the assessment area, with steelhead use extending just beyond coho use in some of the upper stream segments. In a few places coho use is indicated beyond that of steelhead. Chinook primarily keep to the mainstem of Isthmus Slough and the lowest portion of Davis Slough. ODF stream classifications indicate general fish use extending beyond that of steelhead and coho use in tributaries to Davis Slough, and in a few other small streams. ODF also indicates no fish use in several of the headwater reaches of Davis Slough, Coalbank Slough and Southport Creek in upper the Lower Isthmus area. These classifications are based on stream gradient and drainage area, as well as site specific surveys conducted in those stream segments.

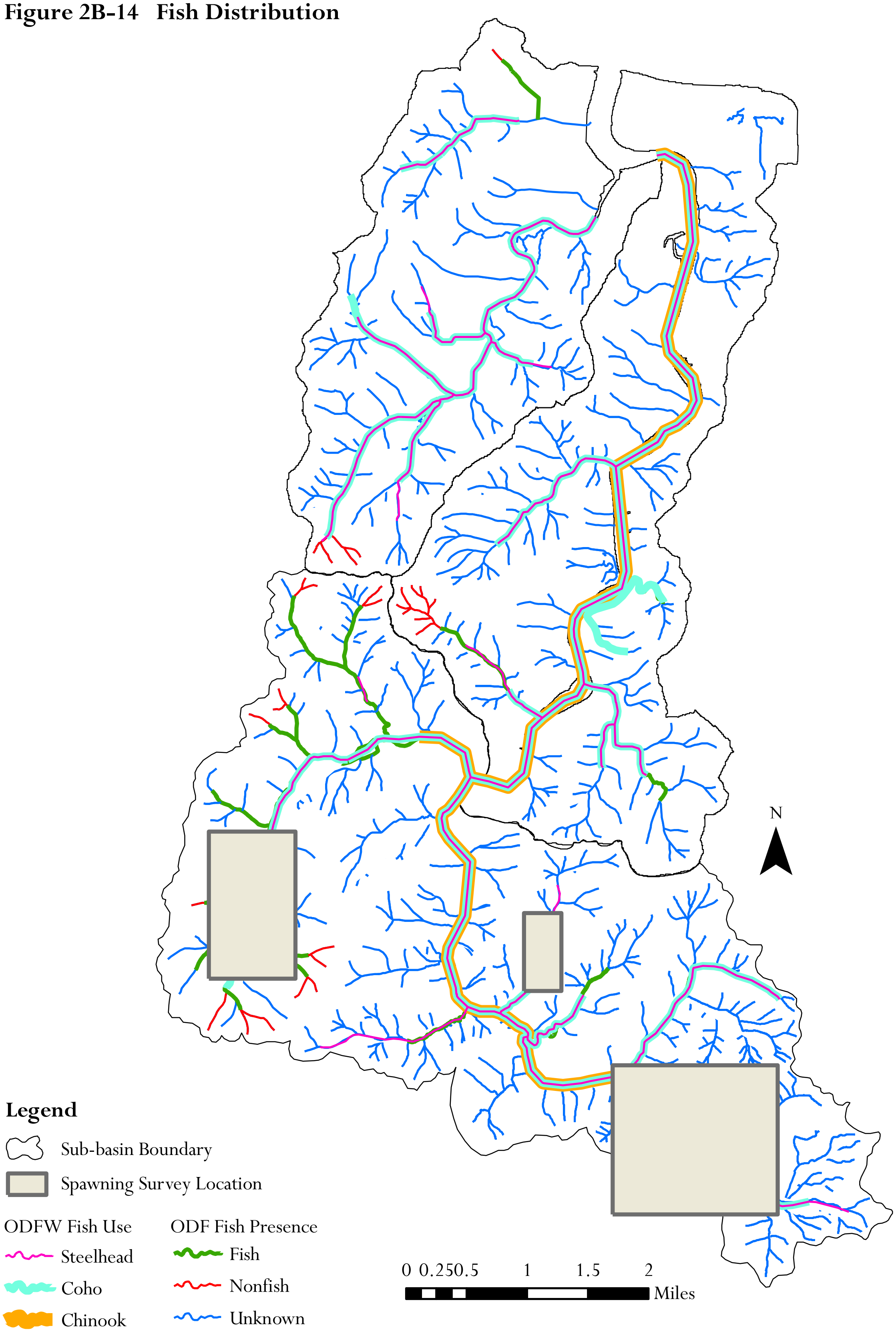
Spawning

Table 2B-6 Coho Spawning Density

Reach	AUC/mile (adults & jacks)	Gravel (m^2)	Gravel (m^2)/ Female
Davis Creek Reach 1 Seg 1	3.88	215	98.17
Davis Creek Reach 1 Seg 2	99.67	420	15.38
Goat Creek Reach 1 Seg 1	0	610	na
Noble Creek Reach 1 Seg 1	5.62	254	90.39
Noble Creek Reach 1 Seg 2	27.13	867	72.01

Spawning surveys were conducted by CoosWA in the winter of 2008-2009 in selected stream segments shown in Figure 2B-14. Table 2B-6 shows the estimated Area Under the Curve (AUC) per mile, amount of spawning gravel, and spawning density as amount of gravel available per female. Each segment was surveyed weekly from early November through early March. Davis Creek Reach 1 Segment 1 was 1.45 miles in length, contained 3.88 AUC/ mile, 215 meters^2 of gravel and provided approximately 98.17 meters^2 of gravel per female. Davis Creek Reach 1 Segment 2 was 0.61 miles in length, contained 99.67 AUC/ mile, 420 meters^2 of gravel, and 15.38 meters^2 of gravel per female. The change in fish use between these two consecutive stream segments may be due to the relative abundance of spawning gravel in Segment 2 and because fish use ends near the end of Segment 2. Goat Creek Reach 1 Segment 1 was 0.56 miles long and zero coho were observed although the segment contained 610 meters^2 of gravel. Noble Creek Reach 1 Segment 1 was 1.11 miles long, contained 5.62 AUC/ mile, 254 meters^2 of gravel and 90.39 meters^2 of gravel/ female. Noble Creek Reach 1 Segment 2 was 0.91 miles long, contained 27.13 AUC/ mile, 867 meters^2 of gravel, and 72.01 meters^2 of gravel per female. All of these spawning areas appear to be underutilized compared to the 5.85 meters^2 of gravel preferred per female (Sandercoch, 1991).

Figure 2B-14 Fish Distribution



Stocking Records

Located on Noble Creek in the Upper Isthmus Sub-basin, the Noble Creek Hatchery was founded in 1984. Fish releases into Noble Creek began in 1984 but official records beginning at that time could not be obtained. Hatchery records, from ODFW and personal communication with the hatchery manager, see Table 2B-7, show the numbers and age of chinook, coho and Winter steelhead releases from 1991 to 2010.

Table 2B-7 Noble Creek Hatchery Releases

	Chinook			Coho	W. steelhead
Year	approx. # unfed fry	pre-smolts	smolts		
1991	0	340,425	39,828	89,030	5,010
1992	0	397,905	51,946	98,994	0
1993	0	488,567	50,835	61,655	0
1994	400,000	712,134	0	54,965	10,602
1995	400,000	425,480	0	70,540	5,090
1996	400,000	274,137	0	73,335	4,980
1997	400,000	428,069	0	121,912	5,297
1998	400,000	262,298	0	117,134	4,898
1999	350,000	922,063	0	119,024	6,158
2000	350,000	1,191,787	0	125,967	4,700
2001	350,000	692,751	0	110,063	5,211
2002	0	736,035	0	54,717	4,515
2003	0	660,439	0	80,086	0
2004	0	644,445	0	37,560	0
2005	0	662,920	0	0	0
2006	0	575,639	0	0	0
2007	0	583,000	0	0	0
2008	0	614,625	0	0	0
2009	0	614,625	0	0	0
2010	0	614,625	0	0	0

Chinook have always been the main species generated from the Noble Creek hatchery. From 1994 to 1998 approximately 400,000 unfed Chinook fry were released each year, and from 1999 to 2001 approximately 350,000 unfed fry were released each year into tributaries of Isthmus Slough. These were the last releases of unfed fry from the Noble Creek hatchery. Chinook pre-smolts have been released every year from 1991 to 2010, and averaged 592,098 per year with the highest numbers in 1999 and 2000. The release counts are for eyed-eggs only, as fish are not counted at the time of release. Approximately 200,000 of these pre-smolts are released into Blossom Gulch, in the Coalbank sub-basin, each year since 1995. In the past these fish were fed at the Noble Creek hatchery, but are now being fed at the Bandon fish hatchery. Chinook smolts were released from 1991-1993 and averaged 47,536 smolts per year.

Coho smolts were released from 1991 to 2004. Coho smolts released averaged 86,784 per year during that time. Much smaller numbers of Winter steelhead smolts were released in 1991 and 1994 through 2002. During that time Winter steelhead releases averaged 4,705 per year. Currently, only chinook are released from the hatchery.

Hydrology

Precipitation

Annual precipitation in the Coalbank sub-basin is 65 inches at the lowest elevations. Rainfall gradually decreases as the elevation increases to a minimum of 63 inches, averaging 64.3 inches for the whole sub-basin (OCS, 2010). The precipitation intensity for a 2-year event is 2.78 inches in 24 hours (OWRD, 2010).

Annual precipitation in the Lower Isthmus sub-basin is 65 inches at the lowest elevations. Rainfall gradually decreases as the elevation increases to a minimum of 59 inches, averaging 62.1 inches for the whole sub-basin (OCS, 2010). The precipitation intensity for a 2-year event is 2.75 inches in 24 hours (OWRD, 2010).

Annual precipitation in the Upper Isthmus sub-basin is 63 inches at the lowest elevations. Rainfall gradually decreases as the elevation increases to a minimum of 57 inches, averaging 59.1 inches for the whole sub-basin (OCS, 2010). The precipitation intensity for a 2-year event is 2.73 inches in 24 hours (OWRD, 2010).

Stream Flow

Annual peak stream flow for assessment sub-basins was obtained using the Peak Flow Estimation Program (OWRD, 2010). They use hydrologic prediction equations and physical watershed characteristics to estimate peak flows. Figure 2B-15 shows the estimated peak discharge at the confluence of Lower Isthmus Slough and Coos Bay for storm events at two to five hundred year reoccurrence intervals. The bankfull storm event is estimated to be 2,620 cubic feet per second (cfs). On the other extreme, a maximum discharge for a 500-year storm event is estimated to be 7,110 cfs.

Annual peak stream flow for Upper Isthmus are shown in Figure 2B-16. This estimate includes Davis, Noble and Ferry Creeks. The bankfull peak discharge (1290 cfs), and the 500-year storm event would yield an estimated 3610 cfs.

Annual peak stream flow for Coalbank Slough are shown in Figure 2B-17. Bankfull stream flows are 234 cfs, and 500-year storm event is estimated to be 1050 cfs.

Figure 2B-15 Lower Isthmus Slough Peak Discharge Estimate (OWRD, 2010)

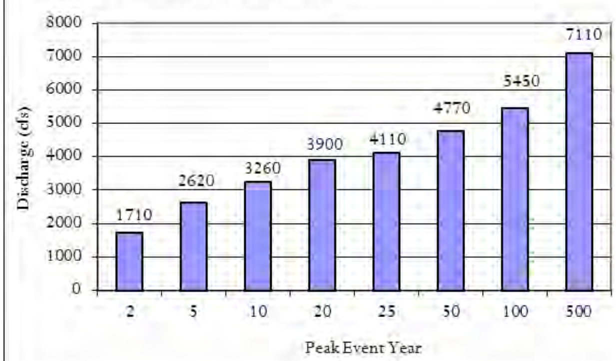


Figure 2B-16 Upper Isthmus Peak Discharge Estimate (OWRD, 2010)

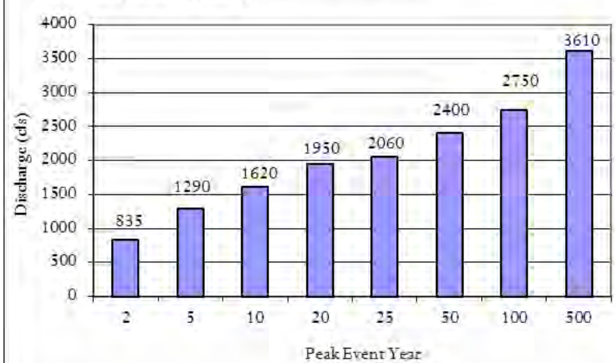
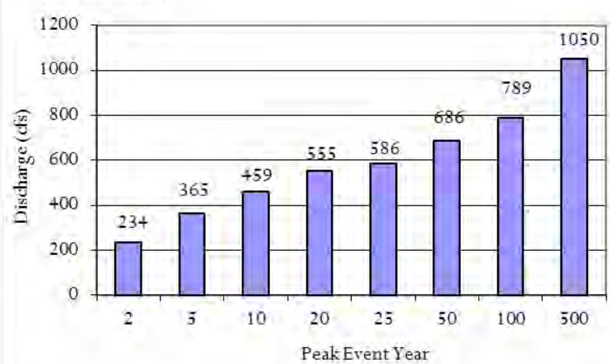


Figure 2B-17 Coalbank Peak Discharge Estimate (OWRD, 2010)



Land Use Effects on Hydrology

Land uses, as they affect surface conditions, can be used to make general evaluations of the hydrologic condition of a watershed. Of particular concern is the effect of land uses on peak stream flow, since increases in runoff can contribute to flooding, erosion, and culvert failures. The most important determinant for peak-flow increases is the ability of soils to absorb rainfall.

The impacts from agriculture on hydrology are dependent on the type of cover and management treatments, as well as the characteristics of the soils (OWEB, 1999). We assessed these factors and compared them to the change in runoff from the background condition. This change will be rated as follows: < 0.5 inches is Low, 0.5 to 1.0 inches is Moderate, and > 1.5 inches is High.

Table 2B-8 Hydrologic Soil Groups

Sub-basins	Percentage of Agriculture Lands with HSG				Change in Runoff (inches)	Risk
	A	B	C	D		
Coalbank	0%	55%	0%	45%	0.65"	Moderate
Lower Isthmus	0%	22%	0%	78%	0.70"	Moderate
Upper Isthmus	0%	21%	0%	79%	0.70"	Moderate
Total	0%	33%	0%	67%	0.67"	Moderate

Table 2B-8 shows the sub-basins with agriculture lands, percentage of HSG (hydrologic soil group), change in rainfall runoff, and associated risk of altering peak flow conditions. There are two types of HSG present in the assessment area, and each has its own effects on runoff. The HSG Class B has moderate infiltration rates and moderately low runoff. The HSG Class D has very slow infiltration rates and the highest runoff rates. Agriculture has a greater effect on runoff in areas where soils have a high infiltration rate compared to areas where soils are relatively impermeable in their natural state (USDA, 1986). The Coalbank sub-basin has more soils with a high infiltration rate. In the Coalbank sub-basin, the change in runoff from the background conditions increased by 0.65 inches. Because of this, the potential risk of peak-flow increases is Moderate. In both Lower and Upper Isthmus sub-basins, the change in runoff from the background conditions increased by 0.70 inches, which also is rated as Moderate.

Within the Lower Isthmus forest use area there are 17.9 total linear miles of forest roads which take up approximately 2% of the forested area. Within the Upper Isthmus forest use area there are 78.3 total linear miles of forest roads which take up approximately 3% of the forested area. Within the Coalbank forest use area there are 14.3 total linear miles of forest roads which take up approximately 2% of the forested area. The potential risk of significantly increasing peak flows becomes high with when 8% or more of the forested area is roads (OWEB, 1999). Because of this low percentage, the relative potential impact for peak-flow increases in forest use is low in all of the Isthmus Assessment area.

There are approximately 0.5 linear miles of rural roads in the Lower Isthmus residential area, or 1% of the residential area. The Upper Isthmus Sub-basin has 2.4 linear miles of rural roads, or 5% of the residential area. Coalbank Sub-basin has 0.5 linear miles of rural roads, or 3% of the residential area. The Coalbank and Lower Isthmus residential area, ranks as a low potential risk, while Upper Isthmus has a moderate risk for peak-flow enhancement.

Water rights

There are three main sources of water rights in the assessment area: surface water, groundwater, and instream. According to the OWRD, the most senior water right in the assessment area was established in 1917 for irrigation of surface water from Davis Slough. Table 2B-9 displays the different types of water use in the assessment area. Total allocated water rights for the entire watershed are 17.167 cfs. The greatest consumptive use in the assessment area is in Ferry Creek, which is 11 cfs used for municipal purposes year round. The instream rights were established in 1992 by ODFW for Davis Slough from Chard Creek (near Family Four stables) to the head of tide for the purpose of anadromous and resident fish rearing. No other streams in the assessment area have instream rights established.

Table 2B-9 Maximum Water Use

Type of Use	CFS
Storage	1.100
Irrigation	2.761
Municipal	11.000
Industrial	0.356
Commercial	0.003
Domestic	2.000
Agriculture	1.270
Total	**17.167**

Water Availability

Water availability was estimated using the Water Availability Report System (OWRD, 2010). The assessment area has two Water Availability Basins (WAB), Davis Slough, and Isthmus Slough (which includes Coalbank, Lower Isthmus, and Noble Creek area). The average of water available was based on the 50 percent exceedance level.

The net water available for the Isthmus assessment area, shown in Table 2B-10, is derived from subtracting the consumptive uses and reserved instream flow from the estimated natural stream flow. There is water available throughout the year in the Isthmus area, but Davis Slough has a water deficit during April and May.

Table 2B-10 Net Available Water by Water Availability Basin (cfs)

Stream	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Isthmus Slough	132	143	102	68.10	32	14.4	5.48	2.15	1.53	2.16	24.10	109.0
Davis Slough	6.59	8.19	3.19	-0.01	-0.04	0.12	0.07	0.03	0.06	0.11	0.44	3.39

Stream Flow

Davis Water Availability Basin (WAB) received the highest level ranking for need to restore in-stream flow for fish use. Isthmus has a high ranking of need. Also, none of these WABs were a priority for flow restoration (ODFW/OWRD, 2003). The Oregon Watershed Enhancement Board Watershed Assessment Manual ranks flow restoration opportunity based on an increase in consumptive use of more than 10% of natural stream flow (OWEB, 1999). The Davis WAB has a consumptive use greater than 10% during the months of July through September, and as high as 54% in September. The Isthmus WAB consumptive use deficit extends from July to October, and peaks at over 20% in August. Although, the consumptive use is much larger than 10% in these sub-basins, indicating opportunity to restore instream flow, none of these WABs are designated as a priority.

Landowner Input

CoosWA met with assessment area landowners in a series of community meetings referred to as Coffee Klatches.

The first round of meetings was held in the spring of 2009. A total of 1,111 meeting invitations were delivered to people owning land within the assessment area, and Coffee Klatches were held in each of the three assessment area regions. A total of 74 individuals representing 60 ownerships spanning 20,512 acres attended the meetings. Overall attendance was 5.4% of the ownerships contacted and 11.34% of land within the assessment area, see Figure 2B-18, below. Attendees were asked to provide input about their values, concerns and goals regarding their property.

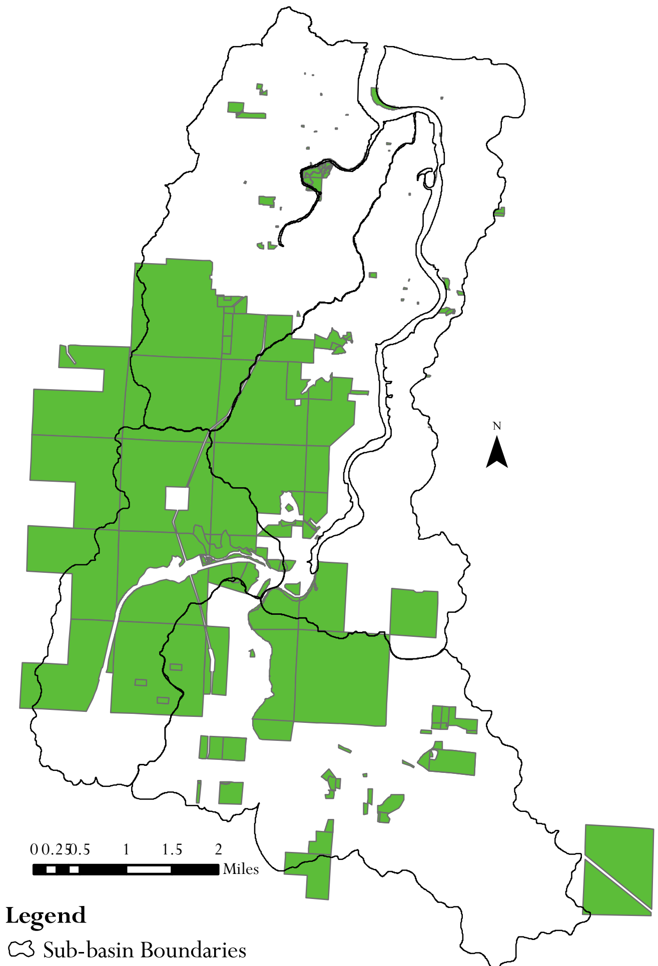
Table 2B-11 lists landowner community values, (i.e. why they live where they do), and desired future, or vision, for their neighborhoods. Landowners in all assessment area regions generally value the micro-climate, community and family, and most commonly, a sense of rural living, natural areas and wildlife. Landowners' vision for the future commonly included improvement or conservation of natural resources and wildlife, improved services such as sewers and roads, and improved community or social relationships. Future vision responses were more varied than the responses associated with community values. These lists were developed out load as a group, rather than in individual written surveys.

Table 2B-11: Assessment Area Landowner Community Values and Vision, 6/2009

Why Live Here?	Vision for future 10-20 years
Lower Isthmus	
Not so much flooding	Keep rural character
Wild and natural vegetation	More fish in Isthmus Slough
In country; but close to town	City sewers
Clean, non-polluted	Herons in Slough
Out of fog	Better aquatic habitat and practices
View of slough and changing tides	Tsunami warning system and response
Enjoy slower pace of life	Good water quality for fish and shellfish
Nice weather	Biking and walking paths
Nice community	
Upper Isthmus	
Grange!	Stay the same
Community	Gated community
Quiet	No fishing down in slough
Open space with not much traffic	Limited building
Friendly neighbors	More fish
Beautiful area: trees, water, birds	Paved roads
Good weather	Clean water and understanding of conditions
Wildlife	Better communitication with timber owners and neighbors
Away from D.C. (federal government)	
Safe; little crime	
Coalbank	
Rural, but still close to town and work	Reasonable and effective regulation
Wild West	Fewer people
Fishing and crabbing	Less garbage
Good weather	Less flooding
Less traffic	More community spirit / involvement
Affordability	Improved infrastructure
Family history	Balanced development
Wildlife	
Natural areas	
Sense of community	
Good place to raise kids	

Landowners were asked to rank their top three land management concerns and top three land management objectives in a written survey format. Lists of individual responses and the categories developed from the responses are shown in Table A-5 in Appendix A.

Figure 2B-18 Coffee Klatch Representation



Landowners ranked their top three land management concerns for both their own personal property and adjacent property (P), and for the watershed as a whole (W), resulting in up to six concerns per person. Landowner concerns in the Coalbank area, see Figure 2B-19, were relatively concentrated on Surface Drainage issues with 66% of respondents indicating this as the top concern for their personal property, and 60% indicating this as the top concern for the watershed. The next highest priority concern category in the Coalbank area was for Habitat at the watershed level. Lower Isthmus Slough landowners were most concerned about Water Quality and Quantity issues at their own and adjacent property (see Figure 2B-20); 43% of respondents at this meeting ranked issues in this category as their first priority concern. Other leading concerns in this region included Habitat and Development at the personal and adjacent property level, and Local Economy issues at the watershed level. Upper Isthmus area landowners indicated the most first priority concerns for Water Quality and Quantity issues at both the personal property scale; 24% ranked this as first priority, and the watershed scale; 32% ranked this as first priority (see Figure 2B-21). Twenty percent of respondents indicated top priority concern for Surface Drainage at the watershed scale. Overall, concerns in the whole assessment area, Figure 2B-22, focused on Water Quality and Quantity and Surface Drainage. For both of these issue categories first priority concern at the watershed scale was slightly higher than at the personal property scale. (Note, road maintenance issues are often also surface drainage issues, ie. culvert upgrades, and are therefore grouped with surface drainage issues.)

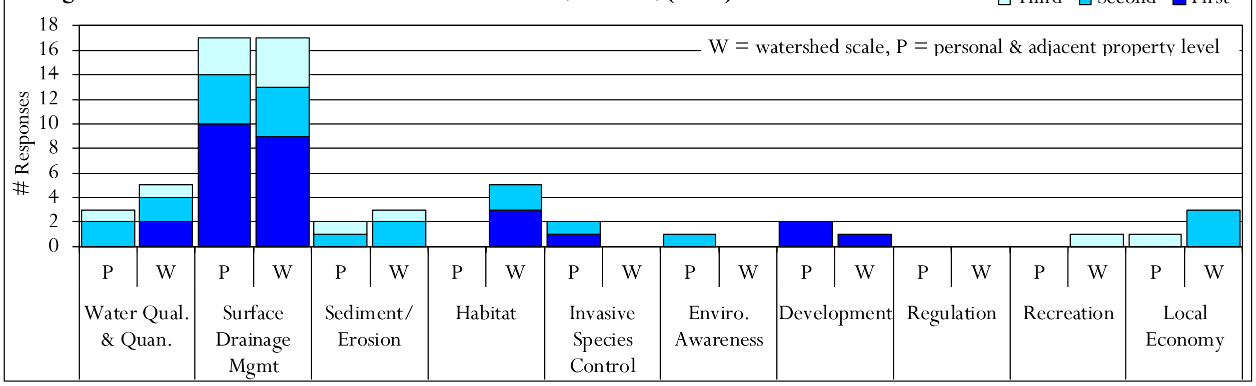


Figure 2B-19 **Coalbank Area Landowner Concerns, 6/24/09, (N=15)**

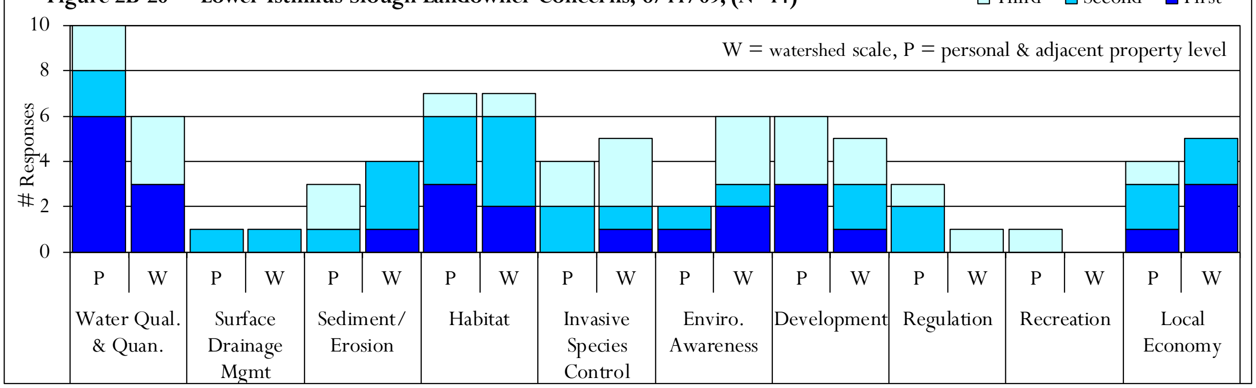


Figure 2B-20 **Lower Isthmus Slough Landowner Concerns, 6/11/09, (N=14)**

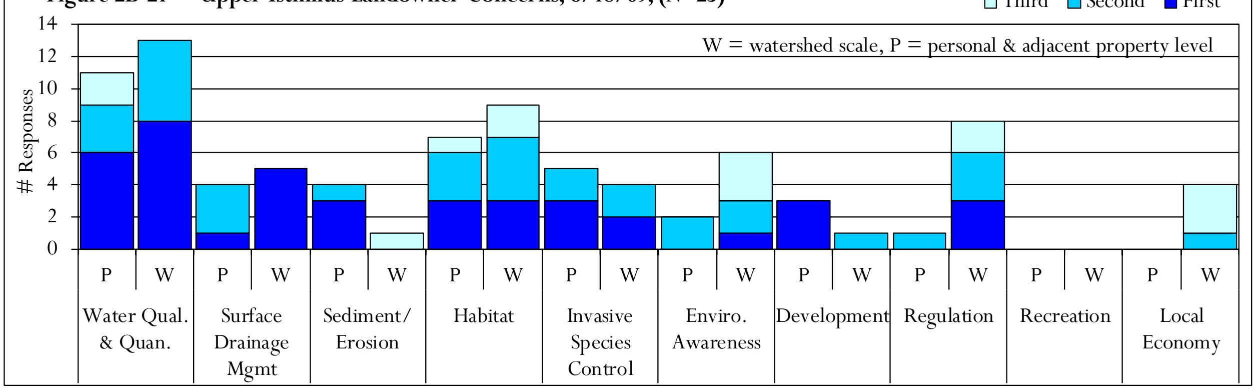


Figure 2B-21 **Upper Isthmus Landowner Concerns, 6/18/09, (N=25)**

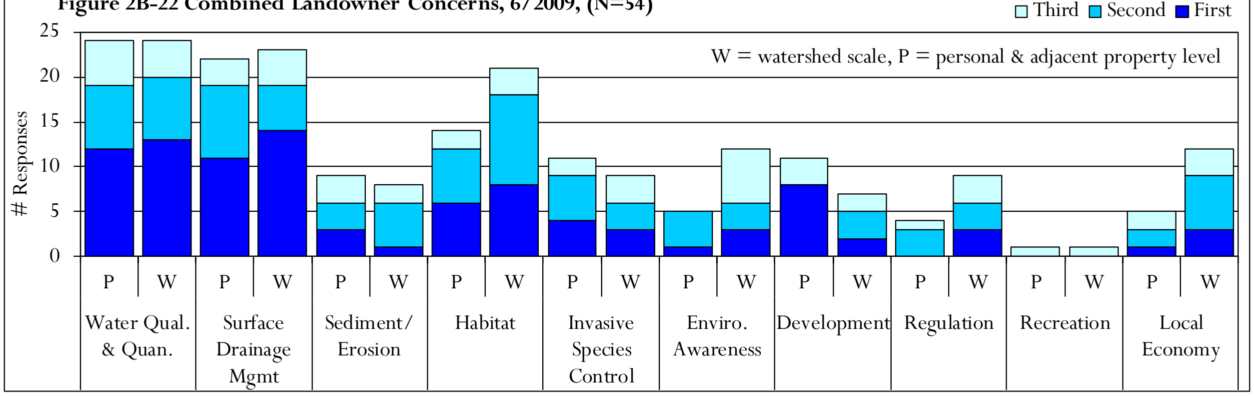


Figure 2B-22 Combined Landowner Concerns, 6/2009, (N=54)

During the first Coffee Klatch meeting, landowners were also asked to list their top three land management objectives for their property. Objectives categories were developed based on the range of responses provided by landowners and a list of those responses by category is in Table A-6 in Appendix A. Coalbank area landowners indicated their top priority land management objectives were in the Conservation/Enhancement category with 33% of respondents specifying objectives within this category as their first *and* second priority (see Figure 2B-23). The next most common objective category was Fix Drainage, with 27% of respondents indicating objectives within this category as their first priority objective. Lower Isthmus landowners' most frequent first priority land management objectives (see Figure 2B-24) were split between the Improve/Sell and Residential/Retirement categories with 29% of respondents indicating objectives within these categories as their first priority. Residential/Retirement was also the second priority for 21% of respondents, making this category the most common priority for Lower Isthmus landowners. Objectives within the Conservation/Enhancement category were also very common in Lower Isthmus, but were of lower priority. Landowners in the Upper Isthmus area, 32% of respondents, indicated objectives within the Residential/Retirement category as their first priority (see Figure 2B-25), and 24% of respondents indicated objectives within the Agriculture category as their first priority. While objectives within the Conservation/Enhancement category were the most common, most objectives in this category were a second priority. Overall combined responses, see Figure 2B-26, show that objectives within the Conservation/Enhancement category are much more common than other categories, yet objectives within the Residential/Retirement category have the most first-priority rankings.

Figure 2B-23 Coalbank Area Landowner Land Management Objectives, 6/24/09 (N=15)

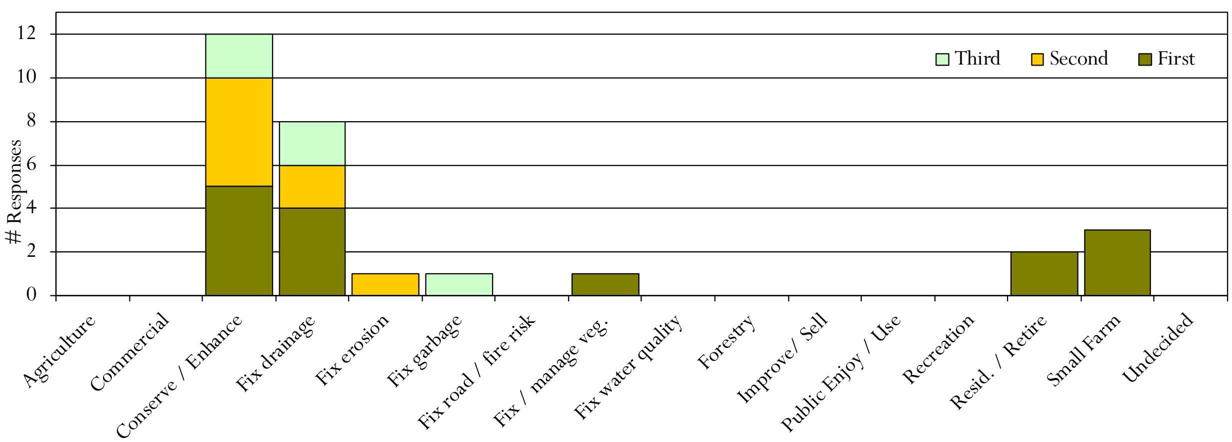


Figure 2B-24 Lower Isthmus Landowner Land Management Objectives, 6/11/09 (N=14)

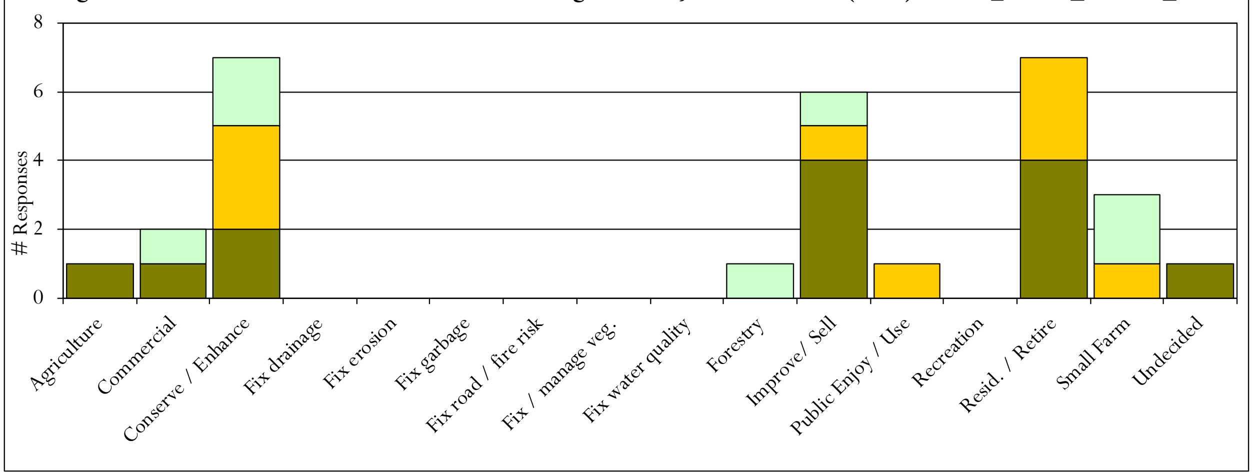


Figure 2B-25 Upper Isthmus Landowner Land Management Objectives, 6/18/09 (N=25)

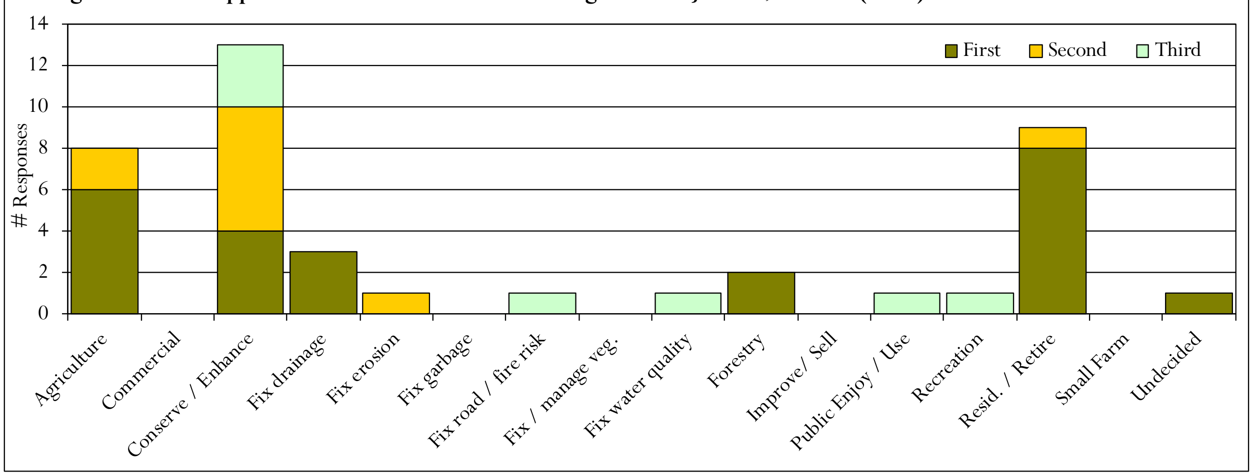
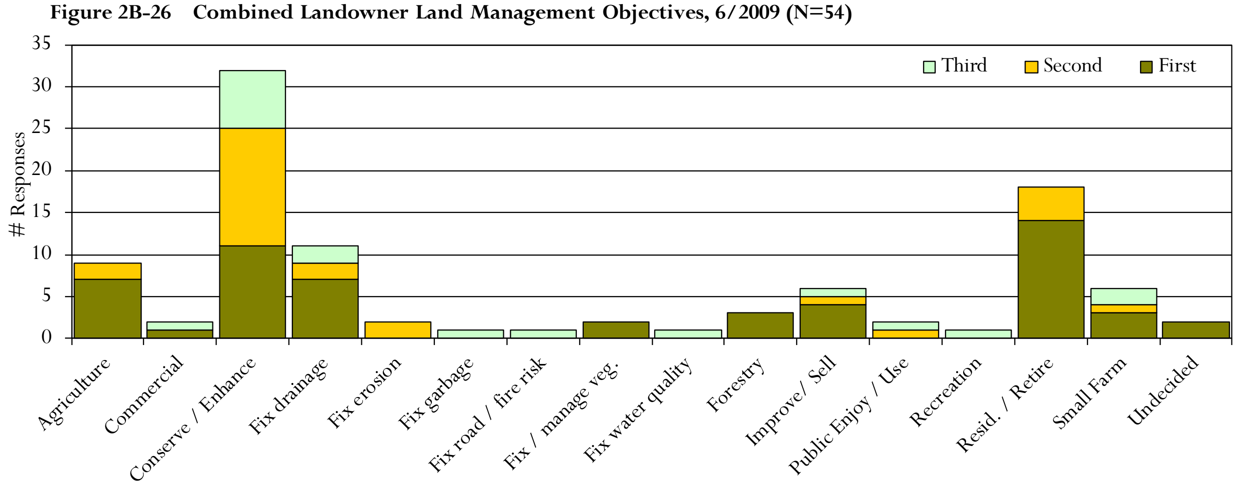


Figure 2B-26 Combined Landowner Land Management Objectives, 6/2009 (N=54)



Chapter 3: Restoration Opportunities

Shinglehouse Slough, CoosWA, 2010

This chapter is devoted to prioritizing restoration of watershed processes within the assessment areas, and is divided into two sections. Chapter 3A: Restoration Strategy explains the Coos WA approach to restoration, defines the potential restoration actions, and describes the prioritization process. Chapter 3B: Restoration Priorities lists the priority rankings for potential actions for each sub-basin area. Chapter 3B also provides recommendations for road upgrades, and a broad ranking of tidal wetland restoration priority.

CHAPTER 3A: Restoration Strategy

The goal of this restoration strategy is to capitalize on project opportunities that improve the function of ecological processes while preserving or enhancing socio0economic stability and the overall livability of these sub-basins for the community. The goal of restoration, in this case, is to rehabilitate watershed conditions that allow for habitat connectivity, and sustained anadromous fish populations, as well as other ecological functions such as water quality, and natural sediment transport. Our intention is to combine landowner interests, concerns and local economics with a strictly biological ranking to determine which restoration actions have the most synergistic potential. Once the restoration actions are prioritized, which is a product of this assessment effort, CoosWA is then guided by the priority level of an action as well as the organization's internal restoration strategy matrix. The CoosWA restoration strategy matrix table is in Appendix C.

Potential Restoration Actions

Below are short discussions of 15 potential restoration actions considered in this restoration strategy, followed by a description of the scoring and ranking system used to prioritize the actions within regions of each sub-basin. Actions were scored for a series of biological criteria and socio-economic criteria for the region(s) appropriate for that action (see Appendix A: Prioritization Methods and Prioritization Scoring Tables).

1. **Add or restore secondary and off-channel features** would involve excavation of pools or ponds adjacent to the stream to recreate winter rearing habitat for coho salmon. The ponds must be constructed with freshwater flow that will keep the outlet of the pool open and connected to the main stream. The freshwater flow must be from a clean source that does not produce significant amounts of sediment that would cause the pool to fill.

Quality salmon habitat is characterized by a diversity of pools and pool types. Pools provide critical salmonid habitat for resting, rearing, finding cover from predators and high winter flows, as well as cool-water refuge during summer's high temperatures.

2. **Culvert replacements** would involve removing existing culverts and replacing them with culverts or bridges that are able to pass the anticipated 100-year flood event and which are at least as wide as the bank full width of the stream. New culverts would be embedded to create a stream-simulation to ensure full fish passage.

3. **Landslide area protection**, essentially head wall protection, would involve retaining additional conifers in steep, landslide prone tributary draws. This land management action would be implemented with the long-term intent of large wood recruitment to streams.

4. **Large wood (LW) placement** helps rehabilitate natural stream conditions by the strategic placement of large logs into the stream channel using heavy equipment. While natural recruitment of wood into the stream channel is best, manual placement of large wood into the channel has the potential to improve habitat conditions over time by altering the flow velocity and pattern which contributes to natural development of other aquatic habitat features such as pools, gravel recruitment and sorting, and secondary channels.

5. **Levee removal** would involve end-hauling or spreading existing levees thinly to allow the stream to flood pasture areas. This project may involve building levees to protect houses or other infrastructure. The project would cause land to flood more often, but may allow land to drain more quickly as flood waters subside. Also, sediment would be deposited on floodplains which would reduce channel sediment deposition and build up potentially productive land, countering the subsidence processes.

6. **Levee setback** would involve moving levees away from stream banks to allow for improved stream function including meandering, localized flooding and development of natural streamside vegetation.

7. **Reshape stream channel** would involve reconstructing stream channels by creating a natural, meandering channel pattern in places in which channels have been ditched or banks hardened. This would usually only be done in cases in which riparian planting and fencing was going to occur at the same time.

8. **Riparian forestry** would involve leaving a wider no-harvest riparian buffer and retaining more conifers in the riparian areas than are required under the Oregon Forest Practices Act. This action would be most significant in non-fish-bearing streams where no requirement currently exists to maintain riparian buffers.

9. and 10. **Riparian planting and fencing** would involve excluding livestock from the stream with appropriate fencing designs. Fences would usually be set 15 to 35 feet off the stream and buffers would be planted with a diverse mix of conifers, hardwoods, and shrubs. Planting prescriptions would be designed to meet both landowner and biological objectives using native trees and shrubs.

11. **Road upgrades** typically would involve upgrading or adding additional cross-drain culverts or upgrading stream crossing culverts in order to help prevent ditch water from discharging into streams and help prevent road fills from becoming saturated and failing.

12. **Tide gate relocation** would involve removing the tide gate from its existing stream crossing and moving it, usually upstream in order to maximize the tidal exchange. This action would involve construction of levees to protect infrastructure and pasture.

13. **Tide gate removal** would involve removing tide gates from stream crossing bridges or culverts to allow tidal water to flow upstream. The project may involve raising levees to protect upstream landowners and replacing the stream crossing structure to increase the flow capacity for tidal fluctuation.

14. **Tide gate replacement** would involve replacing the existing, top-hinged gates with improved, fish-friendlier designs including side-hinged gates or gates with a mitigator device that holds the gate open longer. Replacement gates would be expected to maximize the amount of time that the gate remains open, allow fish passage during the entire open time, and allow a saltwater mixing zone upstream of the tide gate.

15. **Wetland restoration** would involve restoring hydrological processes to allow an area that was historically inundated at least seasonally by removing tide gates and levees. Supplemental restoration activities may include planting native vegetation, constructing drainage networks or pools, and placing large wood.

Various project types considered in our restoration strategy may raise questions within adjacent communities as to the implications and impacts of these projects. Their function in terms of ecological processes, as well as how the project may affect landowners, is discussed below. At this point, these are conceptual project actions only and only in a few cases have specific projects been proposed.

Tide Gates

Tide gates have a major influence on lowland estuarine streams. Mainstem tide gates significantly change the movement of water, sediment, and fish into and out of the stream systems. Smaller tributary tide gates also cause potentially valuable salmon rearing areas to be inaccessible to migrating fish. While technology in 'fish-friendlier' tide gates is advancing, the ability of newer designs to significantly improve fish passage and to address problems with sediment movement and water temperature have not been proven.

Although relocating or removing the main tide gate is considered from strictly biological perspective, the Coos WA does not make any assertions about the viability of such a project. Such large scale changes would require a significant engineering and design study and does not match well with most landowner concerns. Removal of some of the smaller culvert tide gates, especially in association with culvert improvement, does seem to have the potential to improve conditions. Even with these smaller projects, care would need to be taken in design to protect adjacent landowners.

Wetlands

Land historically drained for agricultural cultivation is often difficult to maintain for its current purpose and many bottomland owners are in constant battle against field drainage issues. In these conditions, wetland plants threaten to reestablish dominance over preferred crops – often rendering pastures marginal or economically unproductive for grazing.

Coos WA sees the potential for mutual benefits to landowners and to watershed function with strategic wetland restoration. Many contemporary land managers are finding that taking advantage of natural systems helps increase productivity of their operation. Properly managed, wetlands have the ability to attenuate and desynchronize flooding in other downstream areas of the sub-basin by allowing large volumes of water to be stored during peak flow events, especially when located in the mid reaches of a stream system. Wetlands increase ground water recharge and in some cases can extend dry season stream flow. Wetlands are prime off-channel and over-wintering fish habitat, which in many sub-basins, is the habitat limiting factor to coho production. Wetlands could potentially be designed specifically for the purpose of storing water during high flow periods while allowing downstream areas to drain more effectively. The use of strategic dikes around the wetland could be employed to protect nearby areas from possible flooding. Wetlands also function as natural sediment catchments and could function for this purpose in sub-basins suffering from chronic sediment issues. Dense vegetation can filter sediment from runoff entering the wetland from adjacent land uses. Wetlands can reduce sediment coming downstream by slowing the rate of flow and catching the sediment that falls out of the water column.

Wetland restoration, although not feasible for the entirety of historical wetlands, would help alleviate some of the top landowner concerns if strategically placed and managed, as well as provide key habitat and improved watershed function.

Prioritization Process

Prioritization regions were designated with the intent of focusing the prioritization scoring process on the actions most appropriate for the landscape type or region within the sub-basin. Regions were determined roughly by elevation, stream order and watershed processes with consideration of dominate vegetation, tidal influence and channel width. Region designations were not intended to remain static or to disallow an action otherwise determined appropriate. While data collected from the AHI reaches provide an important snap-shot representation of sub-basin stream conditions, restoration actions are certainly not limited to these streams or reaches. The biological scoring of potential actions was not based exclusively on data from these reaches, but rather, a combination of specific stream data and a broader knowledge of region conditions and watershed function.

Restoration prioritization was determined by Coos WA through a process of scoring and ranking of each potential action for two sets of criteria within each prioritization region appropriate for that action. One set of criteria was used to evaluate actions for biological efficacy towards habitat restoration based on assessment data and limiting factors analysis. Scores for biological criteria are assigned within the context of current watershed conditions and the amount of biological benefit estimated as a result of the potential action. The other set of criteria addressed socio-economic feasibility question. Appendix A contains detailed information about the methods of prioritization, score definitions and the scoring tables for each sub-basin.

The prioritization scoring process results in two sets of combined weighted scores for each action using higher scores to indicate the likelihood of successful results. The six biological criteria include the action's estimated ability to restore watershed processes, restore connectivity, address habitat limiting factors, longevity of the project type, preservation of a unique habitat type, and the extent that the action type has been proven effective. The socio-economic feasibility criteria, used as a filter to the identified biological priorities, include the action's estimated likelihood of success, educational benefit, ability to address local landowner concerns, measurability of effects, implementation feasibility (i.e. local politics), fundability, and cost range.

Table 3A-1 Priority Levels and Implications

Priority	Implications and Coos WA Approach
(green)	Implementation would be easier and project would have a high biological return. Coos WA would support the project and seek funding.
(yellow)	Implementation would be harder, but project would have a high biological return. Coos WA would seek to build partnerships and educational demonstration opportunities.
(blue)	Implementation would be easier, but project would have a lower biological return. Coos WA may assist with project design, but would not be a lead in funding development.
(red)	These projects either have low scores for biological returns *and* socio-economic feasibility, or received a score of zero for a particular criterion. Implementation is considered unlikely.

Contrasting of the aggregate scores, based on the two sets of criteria for each action, was done using a threshold of two, and particular criteria acting as 'deal killers' if receiving a score of zero. The score threshold system was used to determine levels of priority and inform the nature of Coos WA's involvement with project development. The levels of priority and Coos WA approach are indicated in the sub-basin restoration prioritization charts using the colors shown in Table 3A-1. The levels are shown in Table 3A-1 in descending order from green or high priority, to red or low priority.

A potential action that scores above a two in both categories (biological and socio-economic) falls into the green priority level. These projects are more likely to be easily implemented and data analysis shows that such projects will have high biological returns. Actions receiving a yellow priority level were scored above a two in the biological category and below a two in the socio-economic category. Coos WA will seek opportunities to build partnerships and provide educational materials to interested landowners to increase project support. Actions within the blue priority level were scored below two for biological returns and above two for socio-economics. In this case Coos WA may assist with project design but would not take a lead role in funding development due to the lower biological benefits. Actions in the red priority level are those that scored low in both categories, or received a zero for particular criteria. See Appendix A for prioritization methods and score sheets.

CHAPTER 3B: Restoration Priorities

This section introduces the potential for watershed restoration actions based on assessment data analysis (see Chapter 2B) and the prioritization process.

Prioritization of Potential Restoration Actions

Potential restoration actions and their score-derived priority ranking within each of the two prioritization regions are listed in Table 3B-1 and 3B-2. Detailed score tables for each action based on the series of biological and socio-economic criteria are in Appendix A. The colors correspond to the prioritization score level or rank described earlier in Table 3A-1.

Table 3B-1 Tidal & Lowlands Region Ranking of Actions

Sub-basin location		Rank	Action
Lowlands and tidally influenced region	Coalbank		Riparian planting
			Culvert replacements
			LW placement
			Wetlands
			Tide gate removal
			Restore secondary/off-channel
			Levee removal
			Reshape channel
			Tide gate replacements
			Tide gate relocation
			Riparian fencing
			Road upgrades
			Levee setback
	Lower Isthmus		Riparian planting
			Levee removal
			Wetlands
			Tide gate removal
			Tide gate replacements
			Tide gate relocation
			LW placement
	Upper Isthmus		Culvert replacements
			Riparian planting
			Tide gate replacements
			Levee removal
			Levee setback
			LW placement
			Reshape channel
			Restore secondary/off-channel
			Tide gate relocation
			Wetlands
			Riparian fencing
			Road upgrades
			Tide gate removal

Figure 3B-1, see map below, shows the locations and boundaries of the two prioritization regions within each sub-basin and the aquatic habitat inventory (AHI) reaches within those regions. The majority of AHI reaches are within the tidal and lowlands region, with some upper reaches extending just past the tidal and lowlands rough boundary.

Lowlands and tidally influenced region

Table 3B-1 shows that in the lowlands and tidally influenced area of the Coalbank sub-basin, top ranked actions are riparian planting, culvert replacements, large wood placement and wetland restoration. These potential actions scored high for both biological and socio-economic criteria. Yellow ranked actions include tide gate removal, restoration of secondary streams/off-channel areas, levee removal and reshaping stream channels. These actions scored high for biological returns but lower for socio-economics. Additionally, results of any action, but particularly tide gate removal, depends on the specific site and related conditions. Potential actions with blue scores include tide gate replacements and relocations, riparian fencing and road upgrades. These actions scored higher in socio-economics but lower for biological criteria. Levee setback received the lowest priority ranking.

In the Lower Isthmus lowlands and tidally influenced area riparian planting, levee removal and wetland restoration received the highest priority ranking. The majority of existing levees in this area are already breached and removal would hasten restoration of the wetlands they border. Alternatively, while there are not significant opportunities for traditional riparian planting in Lower Isthmus, planting and vegetation management on remnant levees along the main stem slough could provide ‘upland habitat islands’, and help control the invasive plants dominating most levees. Tide gate removal in this region was given yellow priority ranking, meaning it scored higher for biological criteria than for socio-economics. Tide gate replacements scored higher for socio-economic criteria than for biological returns. Tide gate relocation and large wood placement had low scores for both criteria and ranked as the lowest priority actions.

In the Upper Isthmus lowlands and tidally influenced area, top ranked potential actions included culvert replacements, riparian planting, and tide gate replacements. These potential actions ranked high for both sets of criteria. Actions with yellow ranks, or high biological scores and low socio-economic scores, included levee removal and setback, large wood placement, reshaping the channel, restoring secondary/ off-channel areas, tide gate relocation and wetland restoration. Riparian fencing and road upgrades scored lower for biological returns and higher in socio-economics. Tide gate removal received the lowest priority rank due a score of zero for implementation feasibility.

Uplands / forest region

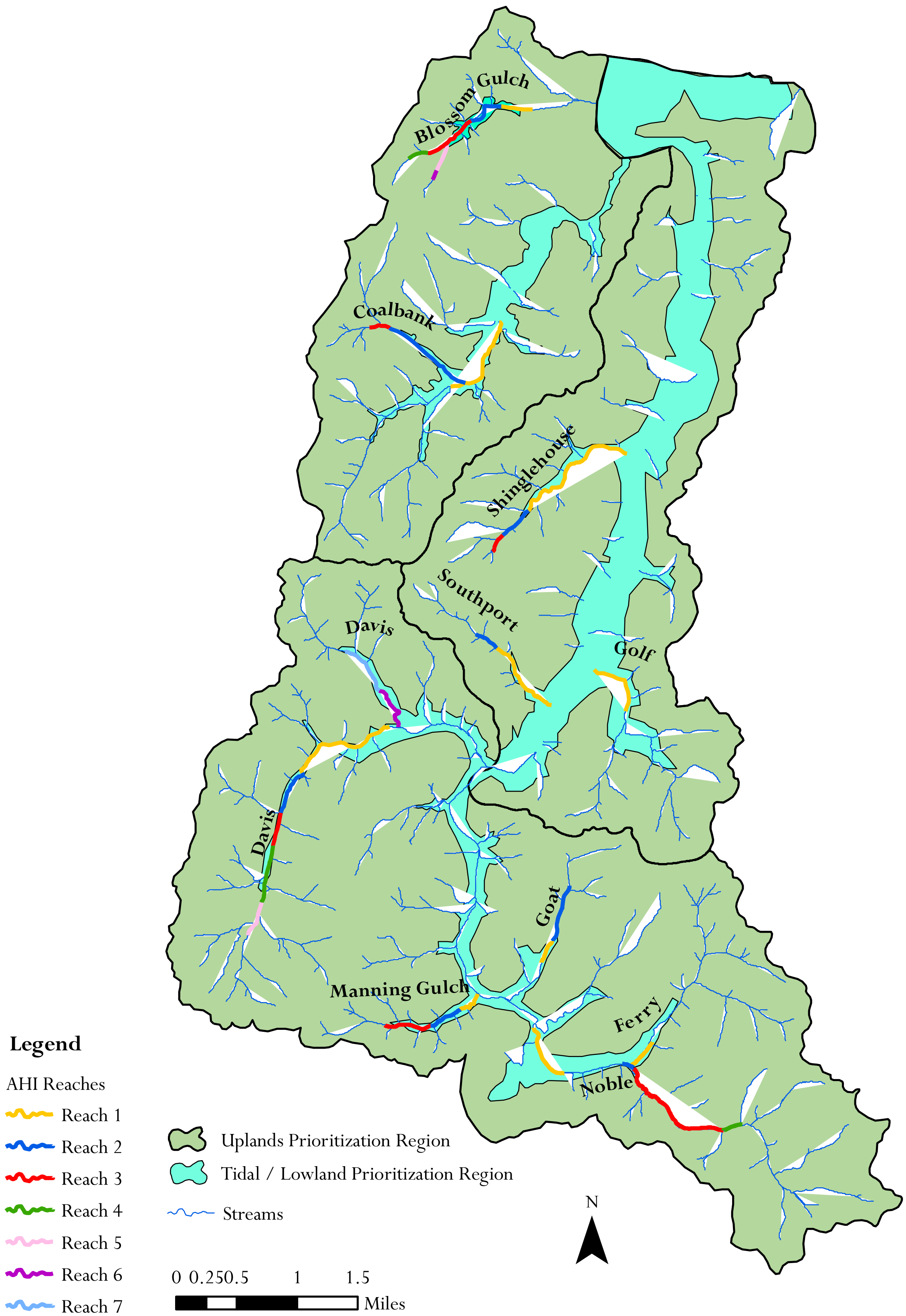
The uplands and forested region of the assessment area was much more extensive than the lowlands and tidally influenced area, see Figure 3B-1, yet there was less fish presence and potential actions largely related to sediment control. In the uplands of the Coalbank sub-basin, large wood placement ranked the highest. These would occur in the upper reaches of streams with fish. Riparian forestry ranked high for biological returns but low for socio-economic criteria, mostly due to a low score for fundability. Road upgrades and decommissions ranked high for socio-economic criteria and low for biological returns, mostly due to low scores for restoring habitat connectivity.

Table 3B-2 Uplands and Forest Region Ranking of Actions

Sub-basin location		Rank	Action
Uplands / forest region	Coalbank		LW placement
			Riparian forestry
			Road upgrades
			Road decommissions
	Lower Isthmus		Road upgrades
			Road decommissions
			Riparian forestry
			Landslide area protection
	Upper Isthmus		LW placement
			Culvert replacements
			Road upgrades
			Road decommissions
			Riparian forestry
			Landslide area protection

In the Lower Isthmus uplands, road upgrades and decommissions received the top priority rank. Riparian forestry and landslide area protection received a yellow rank for high scores on biological criteria, and low scores for socio-economics. In the Upper Isthmus uplands large wood placement, culvert replacements, road upgrades and road decommissions received the top priority rank. Riparian forestry and landslide area protection received yellow level ranks for high scores for biological criteria and low scores for socio-economic criteria.

Figure 3B-1 Prioritization Regions and AHI Reaches



Sediment Control

Sediment loading, best treated at its source, can be addressed in many ways. Careful consideration should be taken when planning landuse activities that disturb the already erosion-prone soil. Carefully directing the drainage of run-off through proper culverts, road-side ditches and away from road surfaces will reduce its erosion potential. Table 3B-3 displays treatment recommendations based on the Isthmus and Coalbank sub-basin road and landing survey analysis. "New structures needed" are based on Oregon Department of Forestry, 2003, Best Management Practices addressing ditch lengths. "Replacement structures needed" address all road drainage features, and are based on the Pacific Watershed Associates Road and Landing Survey Protocol adapted by the Coos WA.

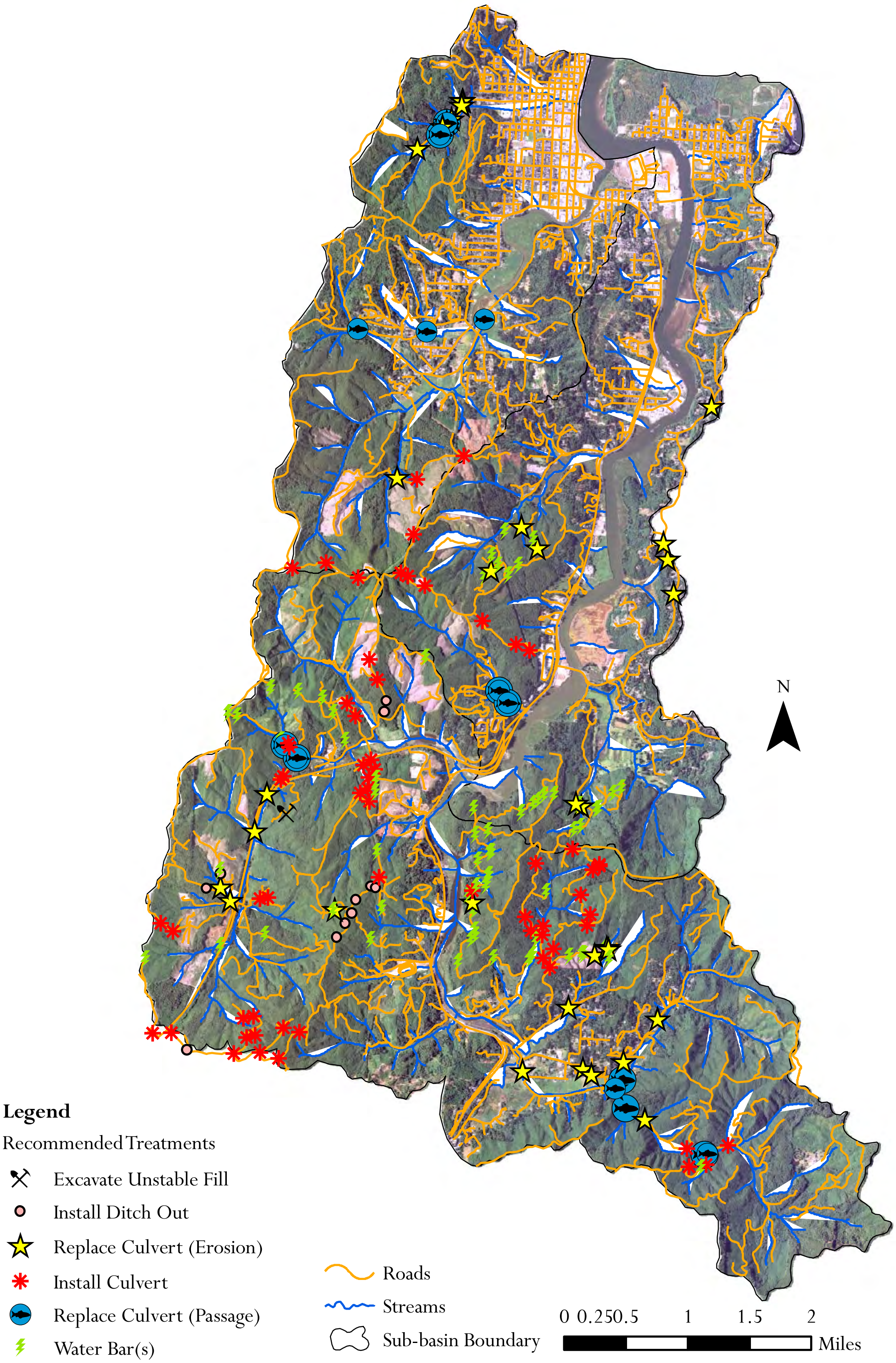
Figure 3B-2 shows the locations of recommended treatment sites. Based on the Coos WA road and landing surveys, Isthmus and Coalbank sub-basins need 71 new ditch relief culverts to reduce road related sediment. Of the existing 127 stream crossing structures, 47 culverts needed to be upgraded to a larger size, including six that were are rusted out. Thirteen sites were listed as fish passage barriers. Of the 145 existing ditch relief culverts, eleven were rusted out and need to be replaced. The potential landslide site needs the unstable fill excavated and restabilized. Twenty three road surface sites have ponding water in the middle of the road. These sites need water bars installed to divert water to the outboard edge of the road.

Drainage sites with high upgrade immediacy should be addressed first. These sites include: thirteen stream crossings, five road surface sites, and one ditch out. These sites have the greatest potential for future erosion from excessive ditch lengths, unstable fill, culvert failure, and/or active erosion.

Table 3B-3 Road & Landing Treatment Recommendations

Site Type	New Structures Needed To Meet BMP	Replacement Structures Needed
Stream Crossing	89 Cross Drain Culverts	47 Culverts (34 Erosion, 13 Fish Passage)
Ditch Relief	71 Cross Drain Culverts	11 Cross Drain Culverts
Ditch Out	70 Cross Drain Culverts	None
Potential Landslide	Excavate Unstable Fill	None
Ponding/Gullied Road Surface	18 Cross Drain Culverts	None
Totals	248	40

Figure 3B-2 Road Sediment Treatment Recommendations



Estuarine Wetland Restoration Ranking

Tidal wetlands, including formerly-tidal wetlands, were assessed for historical tidal influence and subsequent alterations including ditches, culverts and dikes, and were then ranked based on the level of alteration. Assessment of these alterations was conducted using 2005 infrared aerial photos, and other data listed in Appendix A.

The estuarine wetland restoration ranking process concluded that within the 1,808 acre wetland assessment area, 1,314 acres have some level of restoration potential, while 372 acres have current conservation value, and at least 122 acres of former wetland are now roads and or dikes (this total does not include US Highway 101 and Highway 42). Figure 3B-3, below, shows the location and rank of these wetlands. Field checks and outreach to landowners are needed to thoroughly complete the assessment and plan for restoration implementation where feasible.

The 382 wetland polygons assessed in this process, those not deleted (see Methods), cover 8% of the whole assessment area, not including open water. Results of the restoration priority rankings for each rank in each sub-basin area are shown in Table 3B-4, below.

Table 3B-4 Restoration Priority Rank Acres

	Conservation	Rest. High	Rest. Med	Rest. Low	Rds/Dks	Totals
Coalbank	2	194	13	113	28	350
Lower Isthmus	230	286	91	234	35	876
Upper Isthmus	140	172	76	134	59	583
Totals	372	652	181	481	122	1,808

Conservation Priority

Conservation priority ranking composed 372 acres, or 21%, of the assessed tidal wetland area. The Lower Isthmus sub-basin contained the largest area of this ranking, 230 acres; 26% of the tidal wetlands in the Lower Isthmus area, and 29% of that area had stormwater potential. Conservation areas in Lower Isthmus were along the eastern edge of the main slough opposite US Highway 101, Shinglehouse Slough, and the undiked area of the Millicoma marsh near Eastside. Shinglehouse Slough was not tide-gated at the mouth and was not densely developed, however, there are small industrial areas, an auto wrecking yard, and a non-operational landfill immediately adjacent to the slough which provided enough 'development' to assign stormwater potential to that area. Upper Isthmus sub-basin had just over 140 acres of conservation priority wetlands composing 24% of the tidal wetlands in that area, most of which were fringed along the main stem slough. Stormwater potential was considered for 56% of that area, along US Highway 101 and Highway 42. Coalbank sub-basin hydrology has been heavily altered by ditching, diking and tide gates, and had only two wetland acres in conservation priority.

High Priority Restoration

High priority restoration ranking was assigned to 36%, 652 acres, of the tidal wetland in the assessment area. All sub-basins had more acreage in this rank than any other rank. Coalbank sub-basin contained 194 acres, 55%, of high priority restoration ranking, and 56% of that area had stormwater potential. The Lower Isthmus sub-basin had a high amount of high priority rankings, 286 acres, or 33%, and 56% of that acreage was considered to have stormwater potential near where industrial, commercial and residential developments are expanding. The Upper Isthmus area has 172 acres, or 30%, ranked for high restoration priority, and 56% of that acreage had stormwater potential.

Medium Priority Restoration

Medium priority ranking made up 10%, 181 acres, of the assessed tidal wetland area. The Coalbank sub-basin contained 13 acres, or 4%, in the medium priority rank and there was no stormwater potential designated for these acres. The Lower Isthmus area contained 91 acres in this rank, or 10% of the wetland assessment area and most of this was in a diked portion of the Millicoma marsh. The Upper Isthmus area contained the highest amount and proportion of medium priority acres at 76 acres, or 13%. Stormwater potential was assigned to 18% of the area within the medium priority rank. Most stormwater potential opportunities are clustered along US Highway 101 and developed areas in the Lower Isthmus and Coalbank sub-basins.

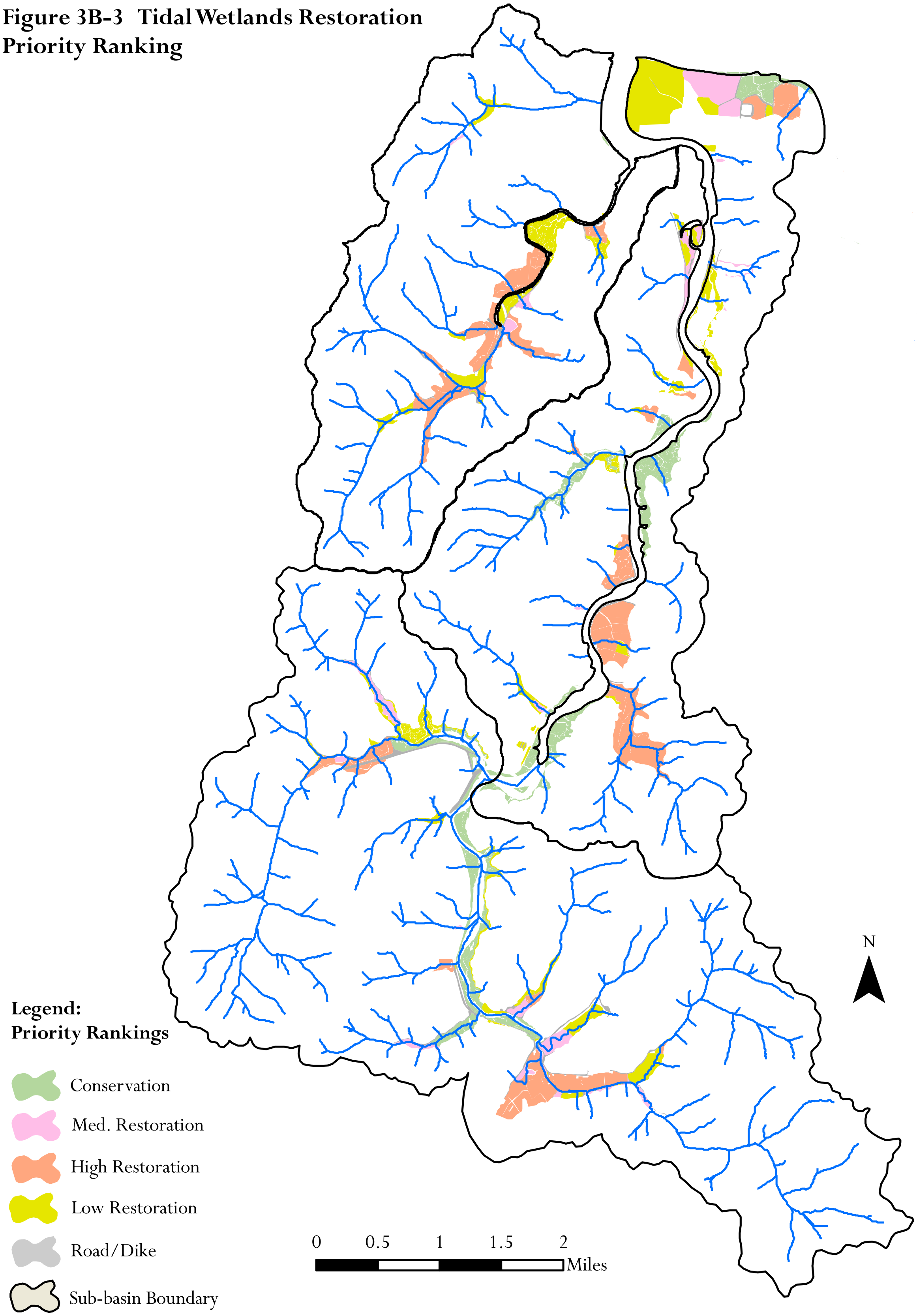
Low Priority Restoration

Low priority ranking made up 27%, or 481 acres, of the assessed tidal wetlands. Most low priority rankings were located in the Lower Isthmus sub-basin, with 234 acres. The Coalbank sub-basin had the highest percentage of low priority acres with 32%. The Upper Isthmus sub-basin contained 134 acres, or 23%, in this rank. Many of these wetland areas would have been ranked as conservation wetlands but either the National Wetlands Inventory or the HGM database classified them as palustrine (non-estuarine) or other than tidal marsh. Also, many other wetlands in this rank are relatively unaltered except for a breached dike. Upper and Lower Isthmus and Coalbank sub-basins were the only areas within this rank showing stormwater potential. Most of this is a large, diked wetland area at the mouth of Isthmus Slough, (on fill material) below the community of Eastside.

Roads and Dikes

Many wetland polygons in the assessment area were classified as fill and designated as a road, a dike or a dike-road serving both purposes. A total of 122 acres, or 7%, of the assessment area was in this category and the majority of those acres were in the Upper Isthmus area. It was considered important to retain the formally-tidal, road/dike acreage in the assessment, but with the understanding that any treatment of roads/dikes would, in most cases, be significantly different from treatment of the adjacent wetlands.

Figure 3B-3 Tidal Wetlands Restoration Priority Ranking



Appendix A: Survey Methods and Supplemental Data

Land Use

Table A-1: Property class categories	
Property Class #	Land use category
100s and 700s	Residential
200s	Commercial
300s	Industrial
400s and 600s	Forestry
500s	Agricultural
900s	Refer to zoning code

Land use categories and distribution were developed based on the December, 2009, Coos county tax assessor's ownership database and GIS files. Attribute Property Class C was primarily used to designate parcels into the following categories, shown in Table A-1, using ArcMap 9.3. Where type of land use was not evident by the property class, the zoning code was used. *All* parcels where the zoning code deferred to the Coos Bay Estuary Management Plan were listed and mapped as such. In ArcMap, ownership parcels were clipped to the outer boundary of the assessment area. Parcels spanning internal sub-basin boundaries were not clipped, and were generally assigned to the sub-basin containing the majority of the parcel. Roads, streets, highways and waterways are not included on the tax assessor's database or the land use distribution assessment. A total of 6,387 polygons were assessed using these methods.

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 66^{th} percentile or higher represented

desirable habitat conditions, and values from the 33^{rd} 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, $\geq$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).

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.		

Wetlands Inventory

The wetland inventory map was developed using the National Wetlands Inventory (1979) GIS database, and is displayed based on the attribute WETLAND_TY or wetland type. Wetland type 'estuarine and marine deepwater' is not shown.

Estuarine Wetland Restoration Ranking

The estuarine wetland restoration ranking was developed using the Estuary Assessment: Component XII of the Oregon Watershed Enhancement Manual (Brophy 2007). This method addressed all tidal fringe wetlands in the selected sub-basins. This method relied heavily on GIS analysis with recommended field checks. The Estuary Assessment organized current and historic indicators of tidal influence for wetlands using the coastal Oregon HGM wetland GIS layer (Scranton, 2004) as a base. Wetland polygons missing from the HGM layer were supplimented with the 1979 National Wetlands Inventory GIS layer. This added 51 acres of assessment wetlands missing from the HGM layer. Information about each of the 372 assessed wetland polygons was gathered from the following GIS databases:

- Historic aerial photos, 1939 and 1942
- Hydrogeomorphic tidal wetlands map (Scranton, 2004)
- Color Infrared (CIR) aerial photos, 2005
- National Wetlands Inventory map

- Natural Resource Conservation Service soil survey map
- Oregon Estuary Plan Book map
- Oregon Natural Heritage Information Center historic vegetation map
- USGS topographic maps

Information for each polygon was tallied in an attribute table and used to develop tidal wetland status scores and ultimatly to designate restoration priority rankings based on level of alteration. Definitions of the rankings are shown below in Table A-4.

Tidal and historically tidal wetlands were ranked for restoration priority level, or were designated as being solely a road or dike and were therefore not ranked but remained in the assessment. Ranks ranged from conservation to high, medium and low priority restoration (see Table A-4). Ranking levels were assigned to each assessment wetland polygon according to the number of alterations apparent on the CIR 2005 infrared aerial images. Alterations considered in this ranking were ditched channels, dikes (including breached dikes) and presence of culverts. Sites with no apparent alterations were then checked for HGM classification. If the unaltered site was a marine sourced low or high marsh it was then ranked as a Conservation site, and if the HGM class was Restoration Potential it was then ranked as a Low Restoration priority site. Some apparently unaltered sites were not present on the HGM database and had to rely on NWI information. In these cases, if the site's NWI classification contained a modifier indicative of current or past tidal influence it was ranked as Conservation, and sites with no NWI tidal modifier were ranked as Low Restoration priority.

Table A-4: Restoration Rank Definitions	
Conservation	Wetlands showing intact features that should be considered for permanent protection in current condition. Ditching, diking and culverts were not apparent.
Restoration, High	Heavily altered wetlands with all three alterations: ditching, diking and culverts.
Restoration, Med	Altered wetlands with two alterations.
Restoration, Low	Lightly altered wetlands with one alteration.

The order of the ranks or priority should be considered in terms of a chosen restoration approach or strategy. The Coos Watershed Association's approach to restoration places conservation of intact habitats as a first priority, followed by restoration of heavily altered habitats where feasible, and restoration of the least altered habitats as a lower priority. This hierarchy is reflected in the rank priority for this assessment.

Some wetland polygons were removed, as directed by Brophy, from the assessment analysis due to their level of alteration and unliklihood that restoration actions would be feasible. Polygons were removed or clipped if they were: fill material with development on it, such as houses or a city; or US Highway 101 and 42.

Sub-basins were split or grouped for ease of discussing location information. Upper Isthmus sub-basin consists of the Davis Slough and Noble Creek drainages. Lower Isthmus sub-basin is the main stem of Isthmus Slough, from the mouth of Davis Slough to the confluence with the Coos estuary. Most wetland polygons associated with Blossom Gulch, just north of Coalbank Slough, were dropped from the assessment due to urban development.

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:

Low Risk: 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.

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

High Risk: 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.

Stream Crossing Drainage Evaluation

Using ArcMap 9.3, 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

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)

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.

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:

$$O_i=[\sum^{a}_{h=1} (C_{hi}\ T_{hi})]/D$$

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.

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 assessment area. ArcMap 9.3 was used for 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.

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 ArcMap 9.3and 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.

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-5, below. Graphed responses by category are shown in the main body of the Assessment. 'Concerns' data were later referenced during the Coos WA process of prioritizing potential actions (see Prioritization Methods, below). Landowner land management objectives are shown in Table A-6, below.

The second Coffee Klatch meeting focused on increasing landowner understanding of restoration actions. This component consisted of a bussed tour of local project sites in the summer of 2009. Projects implemented by the Coos WA in similar sub-basins around the estuary were highlighted. 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 understanding of restoration projects. Input regarding potential restoration actions is requested in the subsequent third Coffee Klatch.

Table A-5: Landowner Concerns Issue Categories	
Concern Category	**Concerns sub-categories from surveys**
Water Quality & Quantity	• Quality of rural water sources (temperature, bacteria, sediment, toxics) • Quantity of rural water sources • Low oxygen levels in slough • Pollution abatement • Stormwater issues • Water table and groundwater recharge • Spring-fed well water quality and quantity • Insecticides and fungicides in the water • Soil contamination • Salt water contamination of fresh water areas • Water rights • Septic systems
Surface Drainage Management	• Flooding of roads and property • Too much standing water on my property or yard – won't drain • Need for tide gates and tide gate maintenance • Standing water causes mosquitoes and bad smells • Freshwater drainage • Desire for a free flowing stream • Dredge the slough • Culvert upgrades and maintenance • Beavers blocking bridges and culverts • Road drainage feature maintenance • Floods are increasing locally in frequency and magnitude
Sediment & Erosion	• Erosion associated with roads and bare ground • Stream bank erosion • Sediment in streams and water sources • Bank erosion due to dredging • Land loss and sinkholes • Loss of trees due to water back-up • Clear cutting causing soil erosion • Livestock too close to streambanks • Landslides
Habitat	• Decrease in wild fish populations • Decrease in wildlife populations • Removal of the dike to allow the area to flood • Clear cutting causing loss of habitat • Restoration of natural areas for wildlife • Fish passage • Endangered species • Overall health of trees and viable soil • Other wildlife (opossum-moles, bears, etc.)

Table A-5 (Continued): Landowner Concerns Issue Categories	
Concern Category	**Concerns sub-categories from surveys**
Invasive Species Control	• Weeds in pasture or yard • Weeds on streambanks or natural areas • Other invasives (i.e. non-native crabs, snails, plant diseases, etc.) • Eradication of scotch broom • Gorse at Al Pierce Log dump
Environmental Awareness	• Public needs to be better informed on stewardship or laws protecting natural resources • Clear cutting of land adjacent to small streams • Timber operators relationships with local landowners • Unauthorized land use • Wildfire • Public access fishing issues • Issues of public access or dumping
Development	• Land use changes and suburban sprawl • Local population increasing • Deforestation around the watershed • Filling-in of wetlands • Protect slough from detrimental development • Overuse • Local population decreasing
Regulation	• Difficult permit processes • Too much government regulation • Not enough government regulation, need more • Written agreement with landowners
Recreation	• Access to recreational lands or waterways (due to permission or human safety issues)
Local Economy	• Decline of commercial fisheries • Ability to generate income from your property • Flood water carries weeds that are poisonous to livestock • Natural resource use: forests and fisheries • Natural resource use: destructive extraction resources (i.e. coal bed methane, mineral sand mining, etc.) • Uncertain about future of property (return to wetlands?) • Trees to fill-in uneven areas • Concerned over willows and alders taking over • Maintain viable communities around the watershed • Fences • Change in economic value of land (i.e. increased taxes)

Table A-6: Landowner Land Management Objectives Categories List	
Objective Category	**Objectives list from surveys**
Agriculture	Improve pastures Grow berries, fruit, vegetables Farm Planning a large garden Livestock Maximize profits from agriculture and forestry from niche markets without messing the property up Raise fish Nursery Largest native oyster bed on the west coast!
Commercial	Commercial A nice piece of commercial property with a developed concern for the environment
Conservation / Enhancement	Nothing Keep making it more natural - be a good land steward Maintain/restore for juvenile salmonid habitat How about leaving it alone! We have a nice creek and would like to enhance it if we could Birds Eliminate invasive plants Provide clean water and air Controlling all brush Maintain natural estuarine functions Fish passage Salamanders Restore orchards and woodland Landscaping for birds, wildlife Quiet enjoyment of rural nature Do not destroy vegetation Good natural environment - fish and wildlife Get rid of non-native plants (blackberries) Leave it better than I found it Encourage natural vegetation and wildlife Sell to watershed association Turn back to natural conditions To keep it as a natural habitat Water quality and fish habitat Restore salmon run on Coalbank Slough Widlife refuge Like to see it as a natural preserve someday Keep as a natural estuary for fish and wildlife

Table A-6 Cont.: Landowner Land Management Objectives Categories List	
Fix drainage	Our property needs drainage - it is always wet and spongy Culvert repair Need culvert replaced to get to our property Water confined to channels and not spread over entire surface Tide gate to Little Creek from our property (3 different parcels) higher than ditch draining water from our property No more flooding Add dirt to ditch to match tide gate level Stabilize dike system Water backup has caused my property to become a swamp Finding a suitable and effective way to keep and remove the water off my property, as requested by the City of Coos Bay Be able to be outside on our property without hoards of mosquitoes
Fix erosion	Keep it from falling in the ditch Road erosion
Fix garbage	Clean up garbage that floats through with tide
Fix road / fire risk	Improve road and fire control ability
Fix vegetation management	Have access to ground - able to move through the foliage
Fix water quality	Improve water quality
Forestry	Grow trees Managing small woodlot Forestry
Improve/ Sell	Develop and sell - 2 sites Develop Develop as better home site New house in progress Develop and sell some of the land Pass on a high-quality property
Public Enjoyment / Use	Possible future outreach/ education activities Public access for fishing and education

Table A-6 Cont.: Landowner Land Management Objectives Categories List	
Residential / Retirement	Just live there Personal residence, privacy with views of slough, area Live on part of it Just live there Live there - 1 site Live there Residence probably 15-20 more years Residential Live and enjoy Provide recreational opportunities Just residential Enjoy in old age Enjoy the fruit trees and land the way it is Just enjoy my trees and land Enjoy it Be able to use lower part of property Maintain it as is and enjoy where we live Residential Our house
Small Farm	Hobby farm Hobby farm Create small farm for family-use Gardening/ animal husbandry Keep my horses on it Garden
Undecided	Not sure - will have to discuss with partner We have "free water" that seems to go to waste, not used. Getting stream banks/bed over grown and undeveloped. Don't know what to do.

Table A-7 – Sample of Potential Action Feasibility Survey

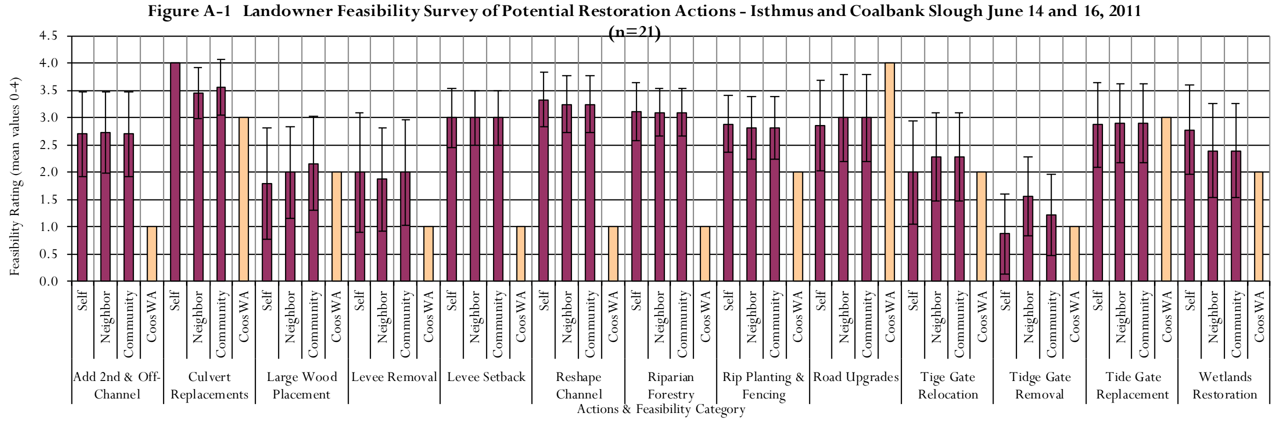
Key 0: absolutely not, 1: potentially but unlikely, 2: likely at least in part, 3: generally true, 4: absolutely, NA: not applicable

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 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 14 potential restoration actions. 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-7. Results of the survey are shown in Figure A-1, and described below.

The third and final round of Coffee Klatches, consisting of only two meetings, was held in June, 2011. A total of 21 individual landowners attended the meetings comprising only 1.9% of the landowners contacted by mail. Landowners were asked to complete a survey of their acceptability, or feasibility, level regarding the different types of potential restoration projects that were described in a power point presentation and on a handout sheet. Each person scored the feasibility level for each project type for their own property, their adjacent neighbors, and for the surrounding community. The results of the survey, combined with CoosWA's initial scores for the 'landowner concerns' criteria, are shown in the chart below. The purpose of the surveys and comparison to CoosWA scores is to check on whether CoosWA has portrayed landowner concerns accurately in its prioritization process. Higher scores indicate higher feasibility with landowners, and scores range from 0-4. These results indicate that CoosWA has underestimated the feasibility of five project types by one or more points. These include adding secondary and off-chanell features, levee removal, levee setback, reshaping stream channel, and riparian forestry. CoosWA underestimated feasibility of three project types by 0.5-0.9 points. These include culvert replacements, riparian planting and fencing and wetlands restoration. CoosWA's scores fairly matched those of landowners for large wood replacement, tide gate relocation, tide gate removal and tide gate replacement. CoosWA overestimated feasibility of road upgrades by one point. The most feasible project types according to landowners are culvert replacements, reshaping the stream channel, riparian forestry and road upgrades.

Figure A-1 Landowner Feasibility Survey of Potential Restoration Actions - Isthmus and Coalbank Slough June 14 and 16, 2011 (n=21)



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.

Table A-8 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

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-8, 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-8, 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-9 and A-10, 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 3B – Prioritization Priorities. Resulting scores of the prioritization process for the sub-basins are provided in the following section titled Prioritization Score Tables.

Table A-9 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-10 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-11 **Degree of Alteration: Isthmus and Coalbank Slough sub-basins 6/2011** (High/Med/Low)

Coal-bank		**Lower Isthmus**		**Upper Isthmus**					
Tidal	**Uplands**	**Tidal**	**Uplands**	**Tidal**	**Uplands**	**Process**	**Sub-Process**	**Indicators of Process**	**Land Management that Alters Process**
H	M	M	H	H	M	Hydrologic Processes	Water quantity	Peak flows	Roads, culverts, ditches, loss of wetlands, land use, tide gates
								Base flows, stream temperature	Water withdrawals
							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
H	M	M	M	M	M	Sediment Movement Processes	Sediment delivery	Landslide frequency & magnitude	Roads, forest practices
								Eroding streambanks	Altered riparian vegetation, upland hydrology, channel simplification
								Surface erosion	Grazing, roads, removal of vegetation
								Floodplain deposition (tidal and flood delivery)	Tide gates, levees, channel simplification, ditching
H	H	H	M	H	M	Riparian Processes	Large wood Delivery	Large wood quantity & size	Removal of upland & riparian vegetation, road & stream crossings
							Stream shading	Temperature	Removal of riparian vegetation, water withdrawals
							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
H	M	H	M	H	L	Channel Processes	Large wood Transport	Large wood quantity & size	Stream/ road crossings, dikes
							Sediment transport	Channel incision / aggradation	Tide gates, culverts, channel modification
							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)
H	M	H	M	M	M	Biological Processes	Nutrient cycling (food web; carcasses; microorganisms, nutrient uptake)	Dissolved oxygen, aquatic vegetation, water-borne pathogens	Unfiltered nutrient run-off (livestock, septic)
							Beavers	Beaver dams	Beaver removal, riparian vegetation removal
							Evapotranspiration	Water table level, local weather (RH)	Vegetation clearing
							Fish migration / connectivity	Fish presence	Road/stream crossings, tide gates, channel constrictions
H	L	M	n/a	H	n/a	Floodplain Processes	Sediment deposition	Buildup of islands and wetlands; subsidence and accretion	Levees, tide gates, roads
							Channel migration	Meandering, oxbows, alcoves; off-channel areas	Channel armoring, riparian roads
							Nutrient exchange	Macroinvertebrate production	diking, riparian vegetation removal
							Channel / floodplain interaction	Current velocity; hydrograph, wetlands, flooding	Diking, tide gates, roads

Table A-12 Coalbank 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= Lowlands and tidally influenced areas	Tide gate removal	4	2	2	3	0	3	14	3	3	1	2	1	3	3	16	2.65	1.65		8
	Tide gate replacements	1	1	2	1	0	2	7	2	1	3	2	3	4	3	18	1.25	2.85		10
	Tide gate relocation	2	1	2	1	0	2	8	2	2	2	2	2	2	2	14	1.50	2.00		12
	Riparian planting	4	0	3	2	2	3	14	3	2	2	3	2	3	3	18	2.30	2.30		5
	Riparian fencing	1	0	2	1	1	1	6	2	1	2	2	2	2	4	15	0.95	2.05		13
	Restore secondary/off-channel	4	2	2	2	3	2	15	2	3	1	2	2	3	3	16	2.55	1.85		7
	Levee removal	4	2	1	4	4	3	18	3	2	1	2	1	4	2	15	2.80	1.65		6
	Levee setback	3	1	1	2	2	2	11	2	3	1	2	2	4	1	15	1.80	1.85		11
	Culvert replacements	3	2	2	2	1	3	13	3	1	3	2	3	3	2	17	2.30	2.80		2
	Reshape channel	4	2	3	4	3	4	20	4	3	1	3	1	4	1	17	3.25	1.80		3
	LW placement	4	0	2	1	2	4	13	2	3	2	2	2	3	3	17	2.05	2.20		9
	Road upgrades	1	1	2	2	0	3	9	3	1	4	3	4	2	2	19	1.50	3.40		4
	Wetlands	4	3	3	4	4	4	22	3	3	2	4	2	3	1	18	3.55	2.30		1
2= Uplands /	LW placement	3	1	3	2	3	3	15	3	2	2	2	2	3	3	17	2.35	2.25		2
	Riparian forestry	3	1	2	4	1	2	13	3	2	1	3	2	1	2	14	2.25	1.70		4
	Road upgrades	2	0	2	2	0	3	9	3	1	4	3	4	2	2	19	1.50	3.40		1
	Road decommissions	2	0	2	4	0	3	11	4	1	2	3	2	3	4	19	1.80	2.40		3

Table A-13 Lower Isthmus Slough Sub-basin Prioritization Scores

		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					
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
1= Lowlands and tidally infl	Tide gate removal	1	2	2	4	2	3	14	3	2	1	2	1	3	4	16	2.15	1.65		4
	Tide gate replacements	1	1	2	1	2	1	8	2	1	3	2	3	1	2	14	1.25	2.50		5
	Tide gate relocation	2	2	2	1	2	2	11	2	2	1	1	2	3	1	12	1.85	1.65		6
	Riparian planting	3	1	2	2	2	2	12	2	2	2	3	3	3	3	18	2.00	2.50		3
	Levee removal	4	1	2	4	2	2	15	2	2	2	3	3	3	3	18	2.55	2.50		2
	LW placement	2	0	2	1	2	2	9	2	1	1	1	2	2	2	11	1.35	1.55		7
	Wetlands	4	2	2	4	4	3	19	3	1	2	2	2	3	2	15	3.00	2.15		1
2=Uplands	Riparian forestry	2	2	2	4	1	2	13	2	2	2	1	2	2	2	13	2.25	1.95		3
	Road upgrades	2	2	2	2	2	3	13	3	2	4	3	4	3	2	21	2.10	3.55		1
	Landslide area protection	1	2	2	4	1	2	12	3	2	2	1	2	1	2	13	2.00	1.95		4
	Road decommissions	3	0	2	4	2	3	14	3	2	2	3	3	3	4	20	2.15	2.65		2

Table A-14 Upper Isthmus 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= Lowlands and tidally influenced areas	Tide gate removal	4	3	3	4	3	3	20	3	2	1	2	0	3	3	14	3.40	1.30		6
	Tide gate replacements	3	3	2	1	2	2	13	3	1	4	2	4	2	2	18	2.35	3.35		2
	Tide gate relocation	3	3	2	1	2	2	13	2	3	1	2	1	1	1	11	2.35	1.25		13
	Riparian planting	3	1	2	3	1	3	13	3	1	2	3	2	3	3	17	2.20	2.25		8
	Riparian fencing	1	0	2	1	0	1	5	2	1	3	3	3	2	4	18	0.90	2.75		12
	Restore secondary/off-channel	3	2	2	2	3	3	15	3	2	1	2	1	4	2	15	2.40	1.65		10
	Levee removal	4	3	3	4	3	3	20	3	2	1	2	1	3	2	14	3.40	1.55		3
	Levee setback	3	3	2	1	2	2	13	2	2	1	1	1	2	2	11	2.35	1.30		11
	Culvert replacements	4	3	2	2	2	3	16	3	1	4	3	3	3	2	19	2.85	3.20		1
	Reshape channel	4	2	3	4	3	3	19	3	3	1	2	1	3	2	15	3.15	1.60		5
	LW placement	4	1	3	2	2	3	15	3	2	1	3	2	3	2	16	2.55	1.90		9
	Road upgrades	3	0	2	2	1	3	11	3	1	3	3	3	2	3	18	1.80	2.80		7
	Wetlands	4	3	3	3	3	3	19	2	2	1	2	2	3	1	13	3.25	1.70		3
2= Uplands / Forest	LW placement	4	2	3	2	2	3	16	3	2	2	3	2	3	3	18	2.80	2.30		3
	Riparian forestry	3	1	2	4	1	2	13	2	2	2	2	2	1	2	13	2.25	1.90		5
	Culvert replacements	3	3	2	2	1	3	14	3	1	4	3	4	3	2	20	2.55	3.50		1
	Road upgrades	3	1	2	2	1	3	12	3	1	4	3	4	2	2	19	2.05	3.40		2
	Landslide area protection	2	2	2	4	1	2	13	3	2	1	1	2	2	2	13	2.25	1.70		6
	Road decommissions	2	1	2	4	1	3	13	4	2	2	3	2	3	3	19	2.10	2.40		4

Appendix B - Fish Life History

Table A-15 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: Restoration Strategies Matrix Table

Table A-16 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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