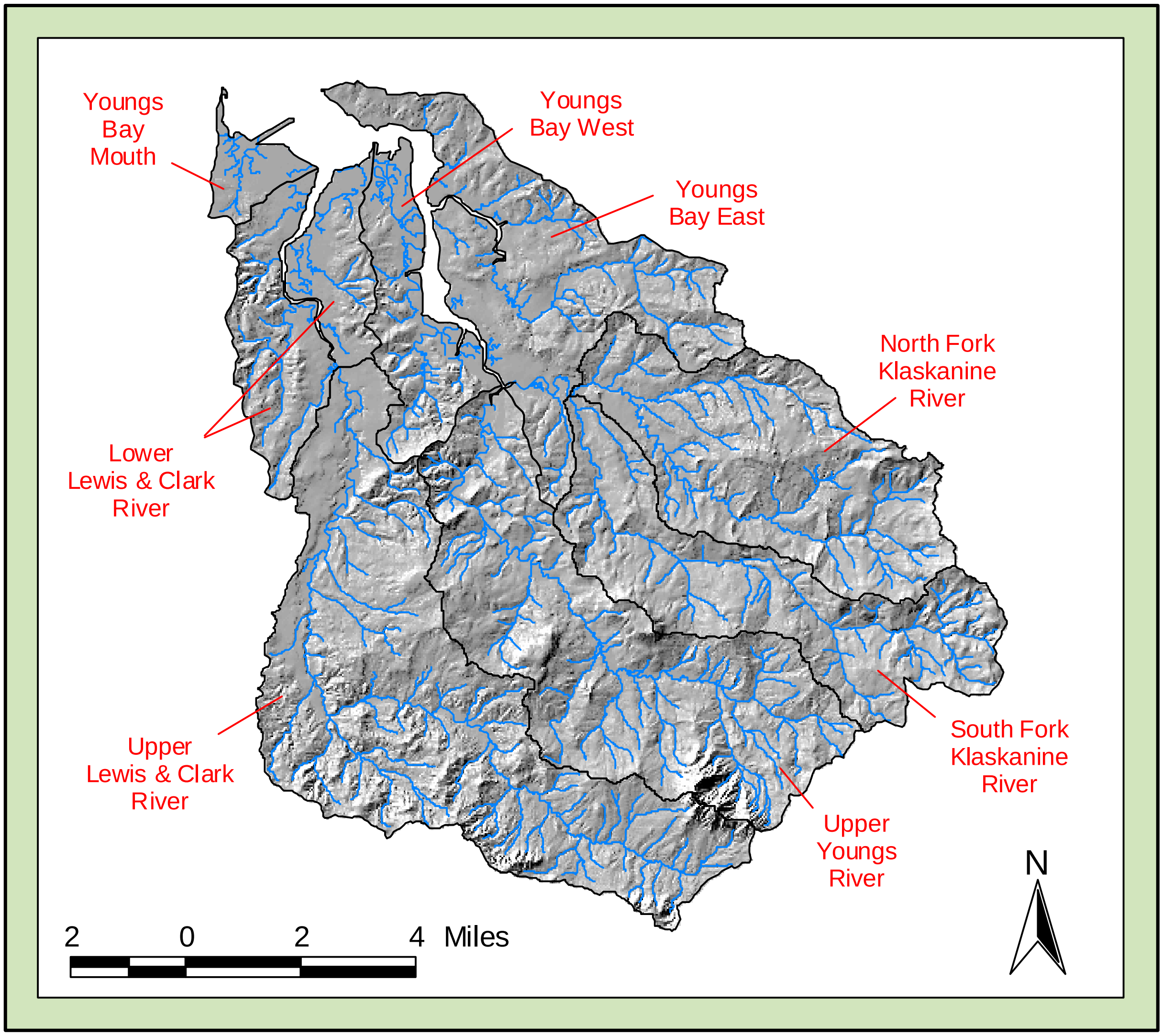
Youngs Bay
Watershed Assessment



E&S Environmental Chemistry, Inc.
and
Youngs Bay Watershed Council

August, 2000

Youngs Bay Watershed Assessment

Final Report

August, 2000

A report by:

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TABLE OF CONTENTS

APPENDICES

LIST OF TABLES

LIST OF FIGURES

ACKNOWLEDGMENTS

We would like to thank the Oregon Watershed Enhancement Board for providing the funds to complete this project. The Clatsop County Planning Office provided aerial photos for this assessment. Data was provided by ODFW, ODF, OWRD, CREST, and the ACOE. Thanks to watershed council coordinator, Jim Closson, for countless hours tracking down data, setting up meetings, field work, and review of the document. A special thanks to Diane Collier, Robert Stricklin, Jim Scheller, Paul See, Lisa Penner, Palmer Henningsen, Jane Warner and Keith Kahl for their help in remembering dates, locations and resources (documents, photos, maps, etc.) for the historical section. A special thanks also to Walt Weber for providing his insight and experience to the fisheries portion of this assessment.

Thanks to the following reviewers for their thoughtful insight:

Lee Cain
Theresa Delorenzo
Nancy Eid
Rene Fruiht
Jon Graves
Jim Hill
Jim Hunt
Ed Johnson
Keith Kahl
Don Leach
John McKesson
Steve McNulty
Barbe Minard
Mark Morgans
Dick Pellisier
Denis Roley
Jim Scheller
Tom Scoggins
Joe Sheahan
Robert Stricklin
Walt Weber

CHAPTER 1 INTRODUCTION

1.1 Purpose and Scope

The purpose of this watershed assessment is to inventory and characterize watershed conditions of the Youngs Bay watershed and to provide recommendations that address the issues of water quality, fisheries and fish habitat, and watershed hydrology. This assessment was conducted by reviewing and synthesizing existing data sets and some new data collected by the watershed council, following the guidelines outlined in the Oregon Watershed Enhancement Board (OWEB) watershed assessment manual (WPN 1999).

It is important to note that many watershed processes cannot be characterized as either good or bad. Rather, these processes must be evaluated by their likely impact on valued resources such as salmonid habitat or water quantity and quality. By summarizing the existing conditions of the Youngs Bay watershed we hope to help natural resource managers and watershed council members understand the complex interactions associated with watersheds. It is through this understanding that watersheds can be managed to protect the natural resources valued by local and national communities.

This assessment is diagnostic. It does not prescribe specific actions for specific stream segments. The intent of this assessment is to provide a decision-making framework for identifying areas of the watershed in need of protection and restoration. The assessment is conducted on a watershed level recognizing that all parts of a watershed function as a whole and that alteration or loss of one watershed process can affect many other processes in the watershed.

1.1.1 The Decision Making Framework

The main product of the OWEB watershed assessment is a set of wall-size maps (housed by the watershed council) to be used as a decision-making framework for selecting appropriate sites for on-the-ground restoration. The maps are organized so that they can be directly related to the U.S. Geological Survey (USGS) 1:24,000 quad sheets. Included on the maps are outlines of the quad sheet boundaries, township section, and range lines. These maps allow the information to be compiled by section (Public Land Survey System) and located. By compiling stream information by section, information can be used to make intelligent, science based decisions on where restoration will be most successful. All sites selected from the maps for restoration should be field checked before restoration or protection. Wall-size maps provided to the watershed councils include anadromous fish distribution, channel habitat type, riparian conditions, and possible fish barrier locations. Additional data are provided in a digital format to the watershed councils. This document supplements and expands on the information contained in the maps. The maps in this document are intended to provide summary visual representation of the data used in this assessment. They are not meant to provide site-specific information. The wall size maps and digital data should be used for identification of on-the-ground restoration opportunities.

1.1.2 Geographic Information Systems (GIS) Data Used in this Assessment

Geographic Information Systems (GIS) are widely used to store and analyze environmental data for the purposes of evaluating watershed condition and guiding appropriate restoration activities. GIS data are only as accurate as their scale and source data. GIS data must be critically reviewed to assure an accurate representation of on-the-ground conditions in a watershed. Key GIS data sets were evaluated for confidence in positional accuracy and in representing actual watershed conditions.

Major GIS data that were used in the development of this assessment are listed in Table 1.1. Following is a description of each of the data layers used in developing this watershed assessment.

<u>Streams (1:24,000):</u> Stream coverages were obtained from the State Service Center for GIS (SSCGIS) and are a part of the Baseline 97 data set. Streams were digitized from the 1:24,000 USGS quads. A visual check of the stream coverage demonstrated that they match the USGS quadrangles, although the positions of the streams were often different from the streams on the aerial photos.

<u>Channel Habitat Types (1:24,000):</u> The 1:24,000 stream coverage was attributed with gradient, side slope constraint, and order, and classified into channel habitat type classes according to the protocol outlined in the OWEB manual (WPN 1999).

<u>Land Use (1:24,000):</u> The land use map was created using three coverages/zoning from CREST (1:24,000), ownership (1:24,000), and a 1992 LANDSAT image obtained from CREST and C-CAP. The three coverages were combined and land use was delineated based on these three attributes. For example, if the LANDSAT image classified the land as bare, and zoning was Exclusive Farm Use, then this polygon was attributed as agriculture. Additionally, if the LANDSAT image classified the

Table 1.1 Primary GIS data used in developing this watershed assessment.

Coverage	Scale	Source	Notes
Streams	1:24,000	SSCGIS	
Channel Habitat Types	1:24,000	E&S	Streams attributed by E&S
Land use	1:24,000	E&S; CREST; C-CAP; SSCGIS	Created by E&S by combining data
Vegetation	30 meter	OSU-Extension	CLAMS 1995 LANDSAT
Aerial Photos	1 meter	Clatsop County Planning Office	MAY, JUNE, JULY 1994 natural color
Watershed Boundaries	1:24,000	SSCGIS	Created for the councils by SSCGIS
Roads	1:100,000	ODF	Updated DLG; Ad Hoc
Digital Elevation Models	10 meter	SSCGIS	
Riparian Vegetation	1:24,000	E&S	Attributed 1:24,000 streams from aerial photo interpretation
Riparian Shade	1:24,000	E&S	Attributed 1:24,000 streams from aerial photo interpretation
Salmonid Distribution	1:100,000	ODFW	Field Biologists
ODFW Habitat Surveys	1:100,000	ODFW	Attributed 1:100,000 streams from field surveys
Hatcheries, release sites, fish counts	1:250,000	BPA	Currently being corrected
Dikes	1:24,000	ACOE	Consistent with USGS quads
Debris Flow Potential		DOGAMI	
Points of Diversion	1:24,000	OWRD	Currently being updated

land as developed and the zoning was in the urban growth boundary, this polygon was attributed as developed. The forest lands were delineated by ownership, and categorized as Private Industrial Forest, Private Non-Industrial Forest, State Forest, or Miscellaneous Forest (for those areas where ownership was not specifically identified). All areas characterized as wetlands by the LANDSAT scene were maintained in the coverage.

Zoning. There is no metadata (data describing the coverage) associated with these data. This coverage was provided by CREST and is believed to be the most up to date zoning information for Clatsop County at the time of this assessment. The coverage is currently being updated.

Ownership. Ownership was characterized by Oregon State University using the 1991 Atterbury Ownership maps. This coverage does not include land sales since 1991. It is our assumption that all land sales in the North Coast watersheds were sales that kept the land in the same category. For example, the sale of Cavenham lands to Willamette Industries kept the land in the Industrial Forest category.

C-CAP LANDSAT image. These data consist of one LANDSAT Thematic Mapper scene which was analyzed according to the Coastal Change Analysis Program (C-CAP) protocol to determine land cover. C-CAP inventories coastal submersed habitats, wetland habitats, and adjacent uplands through analysis of satellite imagery (primarily LANDSAT Thematic Mapper), aerial photography, and field data. These are interpreted, categorized, and integrated with other spatial data in a geographic information system. Details on the creation of these coverages can be found in the metadata provided to the watershed council.

<u>Vegetation:</u> The vegetation characterization was completed using a 1995 LANDSAT image from the Coastal Landscape Analysis and Modeling Study (CLAMS) being conducted jointly by the OSU Extension office and the Pacific Northwest Research Station. The LANDSAT scene was characterized into broadleaf, mixed, and conifer-dominated stands, which were further delineated into four categories based on conifer size (small, medium, large and very large).

<u>Aerial Photos:</u> Aerial photos were obtained from the Clatsop County Planning Office and were taken in May, June, and July of 1994 by Spenser Gross. Aerial photos were natural color digital ortho photos with a 1 m pixel size.

<u>Watershed Boundaries</u> (1:24,000): Watershed boundaries were digitized and corrected by the SSCGIS according to the watershed council's input. Sixth field subwatersheds were delineated using the Water Resources Department's Water Availability Basins as a base.

Roads (1:100,000): Road data were obtained from the Oregon Department of Forestry (ODF). ODF maintains fire road information for the entire state of Oregon. These road coverages were developed using the USGS digital line graphs (DLG) as a base and then updated on an ad-hoc basis determined by data availability. The extent of updates that have been included in the roads coverage in these watersheds is unclear. However, a visual check of the data with the aerial photos demonstrated that the data were fairly thorough. A more detailed evaluation is needed to evaluate the how well this data set represents 'real-world' values.

Digital Elevation Models (DEMs; 10 m): The 10 m-resolution DEMs were obtained from the SSCGIS. Ten meter resolution refers to the cell size attributed with elevation data. Cell sizes in this coverage are 10 m by 10 m, or approximately 1,000 sq. ft. DEMs were mosaiced and sinks were filled.

Riparian Vegetation and Shade: The 1:24,000 stream coverage was attributed from aerial photo interpretation (see Aerial Photos above). Attributes include vegetation class and shade. Metadata have been provided with the digital data.

Salmonid Distribution (1:100,000): Salmonid distribution coverages were obtained from the Oregon Department of Fish and Wildlife (ODFW). ODFW mapped current salmonid distribution by attributing 1:100,000 stream coverages based on survey data and best professional judgment of local fish biologists. Distributions identified spawning, rearing and migration areas. Theses coverages are dynamic data sets that are scheduled to be updated every two years. These data are available on ODFW's website (*http://www.dfw.state.or.us*).

ODFW Fish Habitat Surveys (1:100,000): Field surveys of stream channel conditions by ODFW were attributed onto 1:100,000 scale stream layers. Two layers exist, including habitat units and reach level data. Reach level data generalize habitat unit data to give an overview of current habitat conditions. Reach level data can be used as a reference point for later comparative work or for the analysis of overall stream conditions. Habitat data are all of the unit data for the entire survey and are a representation of the condition of the stream at the time of survey. These data change annually since streams are dynamic systems.

Hatcheries, Release Sites, Fish Count Sites (1:250,000): Salmonid release, count, and hatcheries data were obtained from the Bonneville Power Administration on a

1:250,000 scale. Although the on-the-ground locations are not exact on our base map, they provide a general representation of the areas where fish were released or surveys were conducted.

National Wetlands Inventory (1:24,000): The primary source for wetland information used in this assessment was National Wetlands Inventory (NWI) maps created by the U.S. Fish and Wildlife Service. Very few of the NWI quads were digitized for the Youngs Bay or Nicolai-Wickiup watersheds, so information was generally derived from hard copy NWI maps. Digital data were used for the Skipanon watershed. NWI maps were created from interpretation of 1:58,000 scale aerial photos that were taken in August of 1981 and were generated as an overlay for USGS quadrangles. It is important to note that NWI wetland maps are based on aerial photo interpretation and not on ground-based inventories of wetlands. On-the-ground inventories of wetlands often find extensive wetlands that are not included on the NWI maps.

Dikes: (1:24,000): The dikes coverage was created by the Army Corps of Engineers (ACOE) and came from an ACOE study on lower Columbia River flood control. Data were compared to dikes on the USGS quadrangles and found to be consistent.

Debris Flow Potential: The ODF created debris flow hazard maps based on underlying bedrock geology, slope steepness, historical landslide information, and stream channel confinement where applicable. Slope data were generated from 1:24,000 DEMs. These maps were created to show areas where on-the-ground investigation is prudent before conducting land management and development activities. Further information was provided with the digital data.

Points of Diversion (1:24,000): Points of diversion were mapped by the Oregon Water Resources Department (OWRD) by digitizing individual water rights into a township coverage. Only permitted and certificated rights were digitized. All water rights should be up-to-date and maintained by OWRD. Links from points of diversion to actual water rights were found to be missing in this assessment, which was probably due to the database needing updates (Bob Harmon pers. comm.).

1.1.3 Data Confidence

GIS data vary in how well they represent actual on-the-ground conditions. Several of the data sets used to develop this assessment need to be evaluated and compared to on-the-ground conditions before restoration or final conclusions are made about ecosystem processes. Data sets in need of further evaluation have been listed in the Recommendations section of this document. A few of these will be discussed here because they have characteristics that must be kept in mind while reading this document.

Land Use and Wetlands

The land use was refined from a LANDSAT scene, zoning, NWI, and ownership (see section 1.8) which have all been field verified. NWI data were not available digitally for the entire area and so were used only in the areas of digital coverage. Other wetland data were derived from the LANDSAT scene. NWI data are much more accurate since they are derived from aerial photo interpretation. Consequently, some areas that have been classified as wetlands are really agricultural fields. As NWI data becomes more readily available in digital format, the land use coverage should be updated. All land use categories should be field verified before restoration actions begin. We believe that this land use coverage is a fair representation of land use in the watershed for the scale of this assessment. It is most likely an under representation of wetland areas.

Roads

The roads coverage is a key coverage used to evaluate potential sediment sources and changes in watershed hydrology associated with road construction. However, it is not clear that road coverage accurately represents on-the-ground conditions in this watershed. The road coverage was developed from the 1:100,000 USGS digital line graphs. These coverages were then updated on an ad-hoc basis from aerial photos and other information as it became available. A visual comparison of the data to aerial photos found the roads coverage to be fairly thorough. Although this coverage represents the best available data for roads, the data are suspect. A study needs to be developed to determine the accuracy of the roads data.

Channel Habitat Types

Channel habitat types were determined using GIS. Field verification found that these data accurately represent actual on-the-ground conditions (through visual comparison). However, the channel habitat type should be further verified in the field before any restoration actions occur.

Riparian Vegetation and Shade

Riparian conditions need to be further evaluated and ground truthed before restoration actions occur. A visual comparison of field checks to the aerial photo interpretations found the data to be fairly consistent. After site selection using the GIS data, the stream reach identified should be field checked for actual on-the-ground conditions. A more rigorous analysis of the GIS data could also be performed (field data have been provided to the watershed council).

Overall, the confidence in the GIS data is moderate. Field data are always a better choice; however, it is expensive, time intensive and often unfeasible for very large areas. Time can be saved by using the GIS data to select possible sites for restoration. Field verification can then define the exact conditions present. Used in this way the GIS data can provide an efficient decision-making framework to guide restoration activities.

1.2 Setting

The Youngs Bay watershed is a fifth field watershed located in the northwest corner of Clatsop County (Figure 1.1). Youngs Bay is an arm of the Columbia River estuary. It is approximately two miles wide at its confluence with the Columbia River estuary and is situated between the cities of Astoria and Warrenton. The Lewis & Clark River, Youngs River, Klaskanine River, and Wallooskee River flow into Youngs Bay, draining approximately 184 sq. mi. of land (Figure 1.2). The primary economic land use in the Youngs Bay watershed is timber harvest, with some agriculture in the lowlands.

1.3 Ecoregions

The state of Oregon has been divided into ecoregions based on climate, geology, physiography, vegetation, land use, wildlife and hydrology. Each of these ecoregions has characteristic patterns of climate, geology, topography, and natural vegetation that shape and form the function of the watersheds. Dividing the state and the watersheds into different ecoregions permits regional characteristics to be applied in that region. The Youngs Bay watershed spans portions of three ecoregions (Omernik 1987): the Coastal Lowlands, Coastal Uplands and Willapa Hills ecoregions.

Youngs Bay Watershed

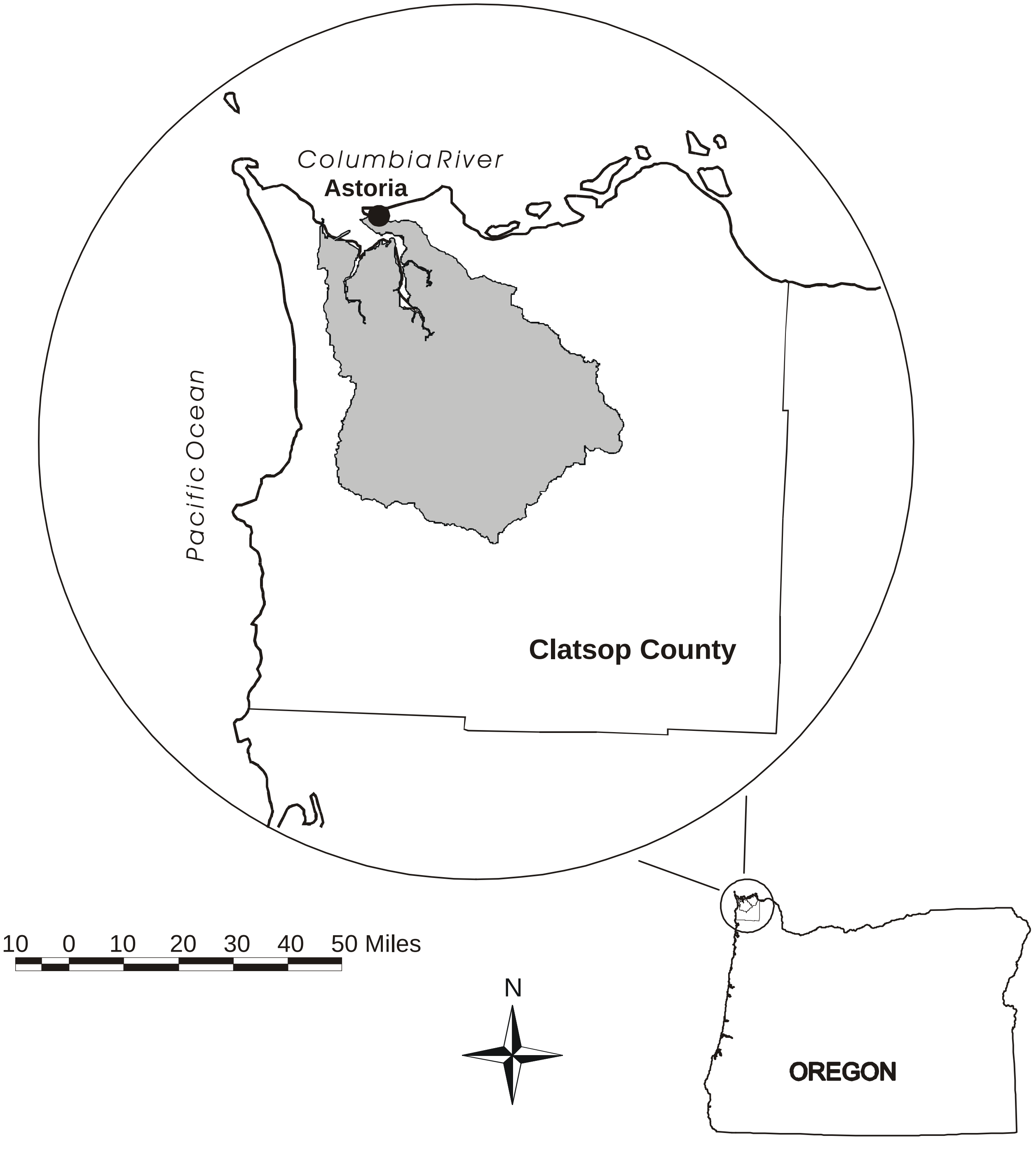


Figure 1.1. Physical location of the Youngs Bay watershed.

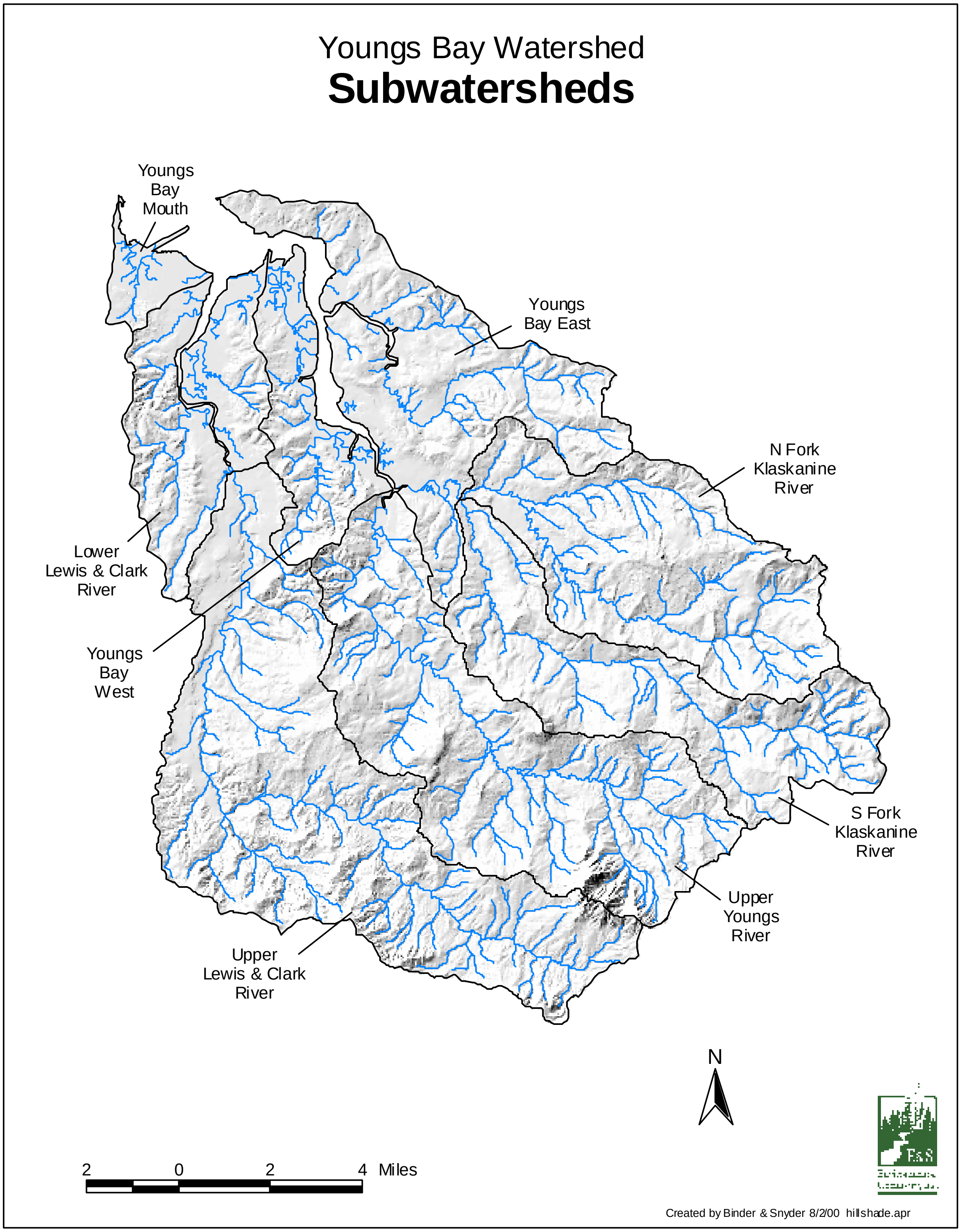


Figure 1.2. Subwatersheds of the Youngs Bay watershed illustrating topography based on a 10 m Digital Elevation Model (DEM).

The Coastal Lowland ecoregion occurs in the valley bottoms of the Oregon and Washington coast and is characterized by marine estuaries and terraces with low gradient meandering streams. Channelization and diking of these streams is common. Elevations in this ecoregion run from 0 to 300 ft and the watershed receives 60 to 85 in of annual rainfall. Potential natural vegetation includes Sitka spruce (*Picea sitchensis*), western hemlock (*Tsuga heterophylla*), western red cedar *(Thuja plicata*), Douglas-fir (*Pseudotsuga menziesii*), grand fir (*Abies grandis*) red alder (*Alnus rubra*), and estuarine wetland plants (Franklin and Dyrness 1973).

The Coastal Upland ecoregion extends along the Oregon and Washington coast and is typically associated with the upland areas that drain into the coastal lowland ecoregions. The Coastal Upland ecoregion is characterized by coastal upland and headland terraces with medium to high gradient streams. Elevations run from 0 to 500 ft and the watershed receives 70 to 125 in of precipitation. Potential natural vegetation includes Sitka spruce (*Picea sitchensis*), western hemlock (*Tsuga heterophylla*), western red cedar *(Thuja plicata*), Douglas-fir (*Pseudotsuga menziesii*), grand fir (*Abies grandis*) and red alder *(Alnus rubra*; Franklin and Dyrness 1973).

The Willapa Hills ecoregion extends from the southern portion of Clatsop County north to the southern extent of the Puget sound. The Willapa Hills ecoregion is characterized by low rolling hills and mountains with medium gradient streams. Elevations range from 0 to 3,000 feet and the watershed receives 50 to 100 inches of precipitation annually. Potential natural vegetation includes Sitka spruce (*Picea sitchensis*), western hemlock (*Tsuga heterophylla*), western red cedar *(Thuja plicata*), Douglas-fir (*Pseudotsuga menziesii*), grand fir (*Abies grandis*) and red alder *(Alnus rubra*; Franklin and Dyrness 1973).

1.4 Population

Population in the Youngs Bay Watershed is concentrated in the lower elevations, around the cities of Astoria and Warrenton (Figure 1.3). Since 1950 the population of Oregon has doubled and the cities of Astoria and Warrenton are predicted to increase in population at a rate of one percent annually (CH2M Hill 1996, 1997). Historically, population growth in Oregon was associated with changes in the natural resource industries. However, recent changes in population have been more associated with in-migration due to quality of life concerns. Population growth can be attributed to in-migration and is predicted to continue to increase, leading to increased pressures and demands on natural resources such as water supply and water quality.

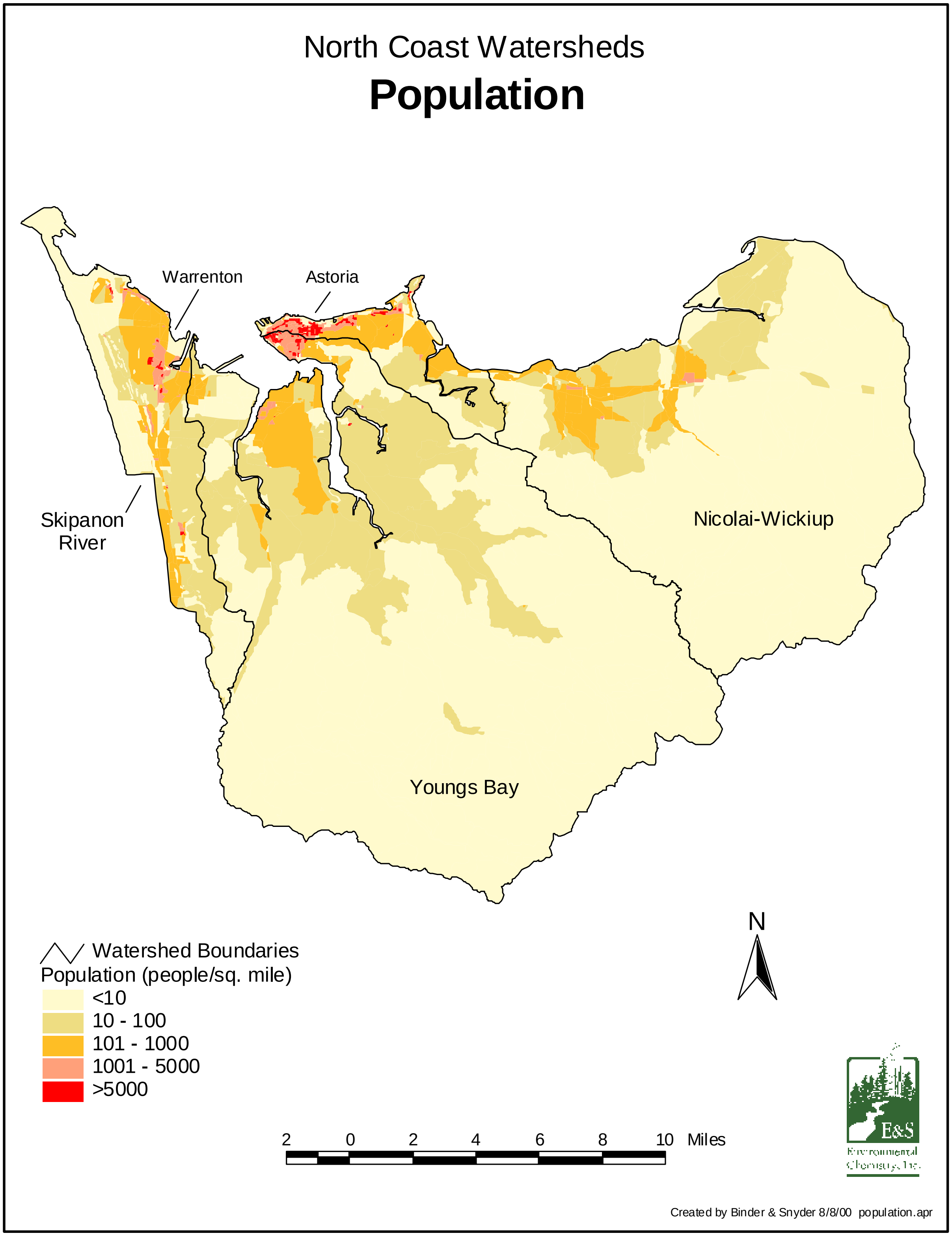


Figure 1.3. Population in the Skipanon, Youngs Bay, and Nicolai-Wickiup watersheds.

1.5 Climate and Topography

The Youngs Bay watershed experiences a coastal temperate climate strongly influenced by the Pacific Ocean and related weather patterns (Taylor and Hatton 1999). Climate in the Pacific Northwest usually includes an extended winter rainy season followed by a long, dry summer season. In Astoria, air temperatures range between a mean daily minimum of 35° F in January and a mean daily maximum of 70° F in August (OSU-Extension 2000).

Precipitation patterns reflect a strong orographic effect in which precipitation increases with elevation as moist air masses rise over high terrain causing them to cool and drop more precipitation. Mean annual precipitation ranges from 74 inches in the lowlands to 122 inches in the highlands, based on the PRISM model which accounts for these orographic effects (Daly et al. 1994). Snow accumulations are infrequent and transient in the Oregon Coast Range. Rainfall is the primary source of precipitation in the Youngs Bay watershed.

Topography in the Youngs Bay watershed is typical of the Pacific Northwest coast. The terrain is characterized by steep upland slopes which provide sediment and organic material to the alluvial plain and estuary below. Much of the lowlands were historic floodplains and wetlands that were drained and diked for agricultural purposes. Elevations in the watershed range from sea level at the mouth to 3,290 ft in the headwaters.

1.6 Geology

Geology in the Youngs Bay watershed consists of Quaternary marine and non-marine terrace deposits and alluvium in the lowlands, with Miocene and marine sandstone, siltstone, and shale in the uplands. The coastal mountains are the result of uplifted sea bed deposits.

1.7 Vegetation

Vegetation cover in the Youngs Bay watershed was characterized using the 1995 CLAMS data. CLAMS characterized the vegetation by classifying satellite imagery into 15 categories (Table 1.2). The satellite data were acquired in 1988 and updated in 1995. Garono and Brophy (1999) summarized CLAMS data for the Rock Creek watershed by combining these categories to describe the spatial patterns of conifers and open areas. We have used this same approach for the Youngs Bay watershed.

Table 1.2. Twelve categories of land cover present in the 1995 CLAMS data set. Categories 0 = background, 2=water, and 5= cloud are not shown (Garono and Brophy 1999). DBH is diameter at breast height.

Class	Cover type	Description
1	Shadow	Background (portions of the data file that do not contain image information)
3	Open	Open (0-40% vegetation cover)
4	Semi-closed	Semi-Closed (41-70% vegetation cover)
6	Broadleaf	Broadleaf (#70% broadleaf cover)
7	Mixed, small conifers	Mixed broadleaf/conifer: <70% broadleaf cover; small conifers (# 1 ft [25 cm] DBH)
8	Mixed, medium conifers	Mixed: <70% broadleaf cover; medium conifers (1-2 ft [26-50 cm] DBH)
9	Mixed, large conifers	Mixed: <70% broadleaf cover; large conifers (2-3 ft [51-75 cm] DBH)
10	Mixed, very large conifers	Mixed: <70% broadleaf cover; very large conifers (> 3 ft [75 cm] DBH)
11	Conifer, small	Conifer: >70% conifer cover, conifers small (#1 ft [25 cm] DBH)
12	Conifer, medium	Conifer: >70% conifer cover, conifers medium (1-2 ft [26-50 cm] DBH)
13	Conifer, large	Conifer: >70% conifer cover; conifers large (2-3 ft [51-75 cm] DBH)
14	Conifer, very large	Conifer: >70% conifer cover; conifers very large (>3 ft [75 cm] DBH)

1.7.1 Large Conifers

Prior to European settlement, Oregon coastal forests were dominated by conifers (Franklin and Dyrness 1988). These forests were changed dramatically by human activities such as forest harvest, which changed both the age structure and species present in these forests (Garono and Brophy 1999). Conifers, especially old growth, play an important role in ecosystem function in Oregon watersheds by providing shade and large woody debris to streams, slope stabilization, and habitat for wildlife (Naiman and Bilby 1998). Additionally, near-coast stands can receive precipitation in the form of fog drip. Old growth forests generate more fog drip precipitation than younger stands. However, it is not likely that this precipitation input will have much affect on stream flows. Understanding the age and distribution of conifers within a watershed is essential for managing the system to maintain ecosystem function.

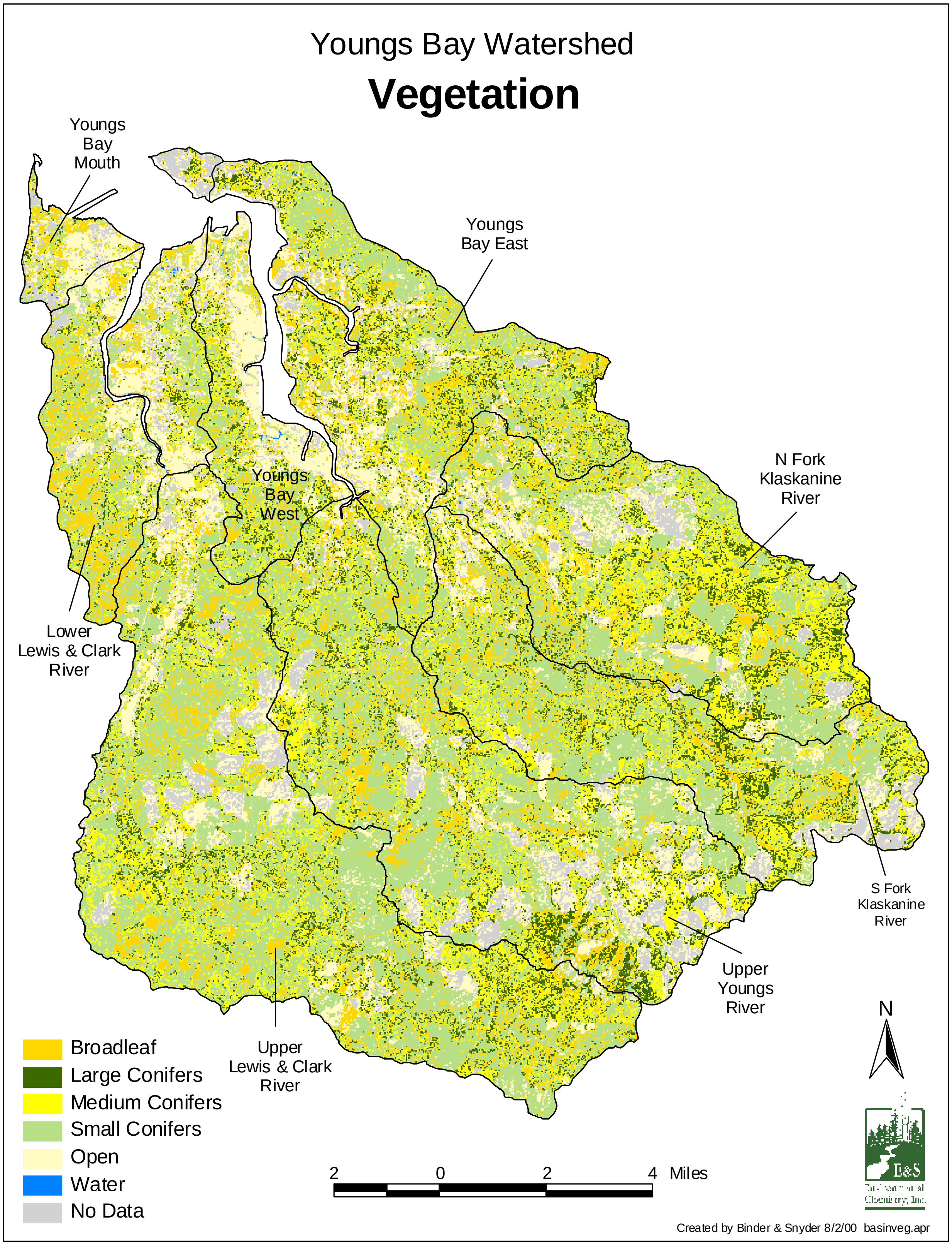
Following the methodology provided in Garono and Brophy (1999), we divided large conifer data into two distinct classes: Mixed Forest/Large Conifers (Classes 9+10+13+14) and Large Conifers (Classes 13+14). The Mixed Forest/Large Conifers class contains those areas that include large conifers, but may be dominated by a broadleaf forest while the Large Conifer Class is actually dominated by large conifers (>70 percent conifer cover). Mixed Forest/Large Conifers represent less than 10 percent of the forests in the Youngs Bay watershed (Figure 1.4; Table 1.3). The Youngs Bay watershed is dominated by Broadleaf (16 percent) and small conifer (27 percent) stands, probably the result of clearcutting over the past 150 years. Less than 1 percent of the watershed is occupied by large conifer dominated stands. The majority of forest land in the Youngs Bay watershed is occupied by forests with no large conifers.

1.7.2 Open Areas

Open areas within a watershed can indicate pastureland and meadows as well as recently harvested timberlands. Open areas can have a large influence on hydrology and slope failure (WPN 1999, Naiman and Bilby 1998, Binkley and Brown 1993). These data were collected in 1995 and many of the open areas have most likely been replanted. Consequently, these data represent the conditions as they existed in 1995. Pacific Northwest forest ecosystems are constantly in a state of flux where open areas are replanted, and new open areas created through clearcutting. Approximately 20 percent of the Youngs Bay watershed is open area, much of which is agricultural lands at lower elevations in the watershed (Table 1.3). Higher elevation subwatersheds, including the North and South Fork Klaskanine River and the Upper Lewis & Clark and Youngs River, have open areas ranging from 8 to 20 percent. These watersheds were dominated by mixed small conifer stands ranging from 18 to 50 percent of the total watershed area.

1.8 Land Use

Watershed processes are often affected by land management practices which increase watershed disturbance. For example, management of forest land for timber harvest can influence



Youngs Bay Watershed

Vegetation

Created by Binder & Snyder 8/2/00 basinveg.apr

Figure 1.4. Vegetation cover in the Youngs Bay watershed. Vegetation was characterized by the OSU-Extension using a 1995 LANDSAT scene. Vegetation categories have been aggregated to show the relative distribution of conifers.

Table 1.3. Vegetation cover in the Youngs Bay watershed, based on satellite imaging classification from the 1995 CLAMS study (OSU-Extension 1995).

	Total Area	Broadleaf	Lg. conifers	Mixed Lg. conifers	Mixed - Very lg. conifers	Very lg. conifers	Med. conifers	Mixed - Med. conifers	Mixed - Sm. conifers	Sm. conifers	Open	
Subwatershed	mi^2	%	%	%	%	%	%	%	%	%	%	
Lower Lewis & Clark River	14	21.1	0.1	4.5	0.1	0.0	1.2	7.9	26.8	4.0	24.7	
N Fork Klaskanine River	26	12.3	1.2	8.5	0.2	0.0	11.4	15.0	17.9	14.4	13.0	
S Fork Klaskanine River	23	12.4	0.1	5.3	0.0	0.0	0.7	9.0	50.0	4.0	15.7	
Upper Lewis & Clark River	47.2	16.8	0.2	5.4	0.2	0.0	2.3	7.6	32.7	6.9	21.6	
Upper Youngs River	36.6	13.2	0.7	9.0	0.3	0.0	4.7	14.2	42.9	3.8	7.7	
Youngs Bay East	24.0	17.5	0.6	9.4	0.2	0.0	3.5	12.6	27.6	6.5	15.3	
Youngs Bay Mouth	3	19.2	0.2	3.2	0.1	0.0	1.0	4.9	11.2	1.4	35.6	
Youngs Bay West	9.2	12.5	0.3	7.0	0.2	0.0	3.1	9.8	22.6	4.2	31.8	
Total	183.0	15.9	0.6	7.4	0.2	0.0	4.6	11.3	26.8	7.2	18.8	

watershed hydrology (increased peak flows) by increasing road densities and clearing vegetation (WPN 1999; Naiman and Bilby 1998). Wetlands are often drained for agriculture because of their rich organic soils, resulting in habitat loss and the disconnection of floodplains from the rivers. By understanding the land management activities and their associated economic values, land managers and watershed council members can better evaluate the effects of watershed disturbance on their watersheds and how to mitigate those impacts on natural ecosystem processes.

The land use map was created using three coverages: zoning from the CREST, ownership, and a 1991 LANDSAT image obtained from CREST and C-CAP. The three coverages were combined and land use was delineated based on these three attributes. For example, if the LANDSAT image classified the land as bare, and zoning was Exclusive Farm Use, then this polygon was attributed as agriculture. Additionally, if the LANDSAT image classified the land as developed and the zoning was in the urban growth boundary, this polygon was attributed as developed. The forest lands were delineated by ownership, and categorized as Private Industrial Forest, Private Non-Industrial Forest, State Forest, or Miscellaneous Forest (for those areas where ownership was not specifically identified). All areas characterized as wetlands by the LANDSAT scene were maintained in the coverage and verified using the National Wetlands Inventory (NWI) data where available. It is likely that many of the areas characterized as wetlands are actually farmed land. These wetlands are categorized by the NWI as farmed wetlands based on aerial photo interpretation. Since we have maintained NWI and satellite identified wetlands over all other categories (such as zoning or ownership), many agricultural areas are actually categorized as wetlands. Metadata (data describing the GIS coverage) for the LANDSAT image and the ownership coverage were included with this assessment. There were no metadata provided with the zoning coverage.

As in most coastal Oregon watersheds, the dominant land use in the Youngs Bay watershed is industrial forest, accounting for 67 percent of the watershed's total area (Table 1.4; Figure 1.5). The lowland areas of the watershed have some agriculture in the floodplains and development located around the cities of Astoria and Warrenton. Watershed processes in the Youngs Bay watershed today are most likely affected by changes in forest management, increased development to accommodate population growth, and floodplain and wetland loss. Specific habitat and water quality related effects typically associated with land use activities are listed in Table 1.5.

1.9 Channel Habitat Types

Stream channel geomorphology is the result of the complex interaction of ecosystem conditions and processes including geology, climate, terrain, disturbance and biological factors. Stream channels can be categorized and grouped based on their geomorphologic characteristics. Differences in geomorphology produce different responses to similar watershed processes such as changes in discharge or sediment loading (Naiman and Bilby 1998). Stream channels with similar geomorphology will have a similar response to changes in land use and ecosystem structure. Classifying stream channels by geomorphology allows us to predict the response for watershed changes.

Table 1.4 Land use in the Youngs Bay watershed calculated from the refined land use coverages.

	Grand Total	Agriculture	Developed	Estuarine Wetland	Grassland	Industrial Forest	Non-Industrial Forest	Palustrine Wetland	Shoreline	State Forest	Unknown Forest	Water
	mi^2	%	%	%	%	%	%	%	%	%	%	%
Subwatershed												
Lower Lewis & Clark River	14.3	13.09	1.77	0.14	7.38	48.82	23.17	4.71	-	0.62	0.03	0.27
N Fork Klaskanine River	26.3	0.48	0.21	-	0.00	47.32	16.00	0.35	-	35.63	-	0.00
S Fork Klaskanine River	23.2	0.62	0.16	-	-	79.34	7.91	0.26	-	11.72	-	-
Upper Lewis & Clark River	47.2	1.34	0.29	-	0.27	86.26	11.34	0.40	-	-	-	0.09
Upper Youngs River	36.6	0.66	0.16	-	0.13	85.29	8.51	0.52	-	4.70	-	0.03
Youngs Bay East	23.9	7.13	1.59	0.85	2.82	40.64	33.64	2.28	-	10.96	-	0.09
Youngs Bay Mouth	2.7	3.22	14.75	3.10	26.34	1.23	37.72	12.55	-	-	-	1.09
Youngs Bay West	9.2	21.38	0.88	0.58	7.56	35.33	30.04	3.83	-	-	-	0.41
Total	183.5	3.69	0.77	0.20	1.81	66.92	16.17	1.33	0.00	9.00	0.00	0.10

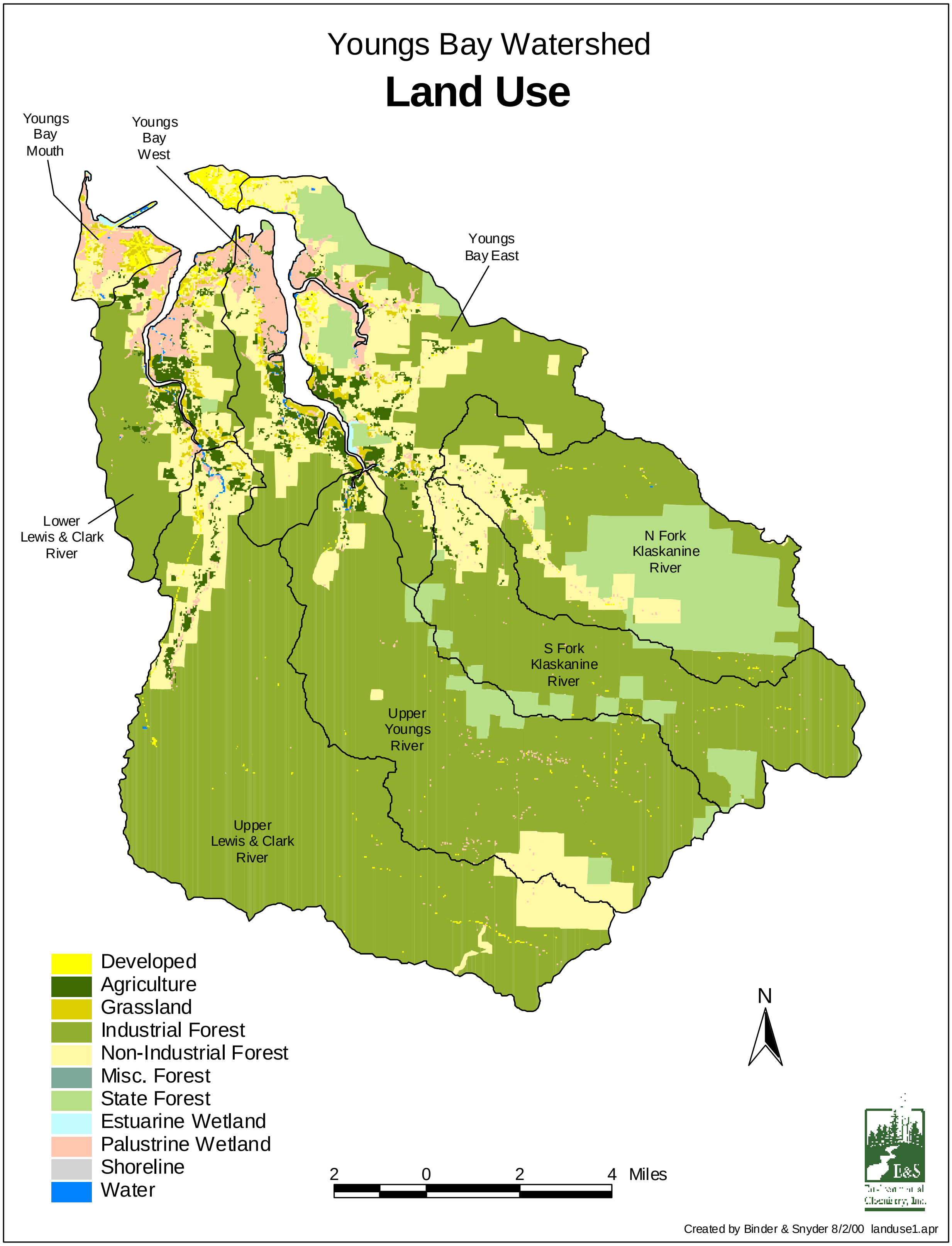


Figure 1.5. Land use in the Youngs Bay watershed. Data displayed is from the refined land use coverage.

Table 1.5. Typical watershed issues organized by major land use activity (WPN 1999)

Land Use Category	Habitat-Related Effects	Water Quality Effects
Forestry	Channel modification Pool quantity and quality Large wood abundance Shade and canopy Substrate quality Flow alteration Passage barriers	Temperature Turbidity Fine sediments Pesticides and herbicides
Crop-land grazing	Channel modification Pool quantity and quality Large wood abundance Shade and canopy Substrate quality Flow alteration	Temperature Dissolved oxygen Turbidity Fine sediments Suspended sediments Nutrients, bacteria Pesticides and herbicides
Feedlots and dairies	Channel modification	Suspended sediments Nutrients Bacteria Pesticides and herbicides
Urban areas	Flow alteration Channel modification Pool quantity and quality Large wood abundance Shade and canopy Substrate quality Passage barriers	Temperature Dissolved oxygen Turbidity Suspended sediments Fine sediments Nutrients Organic and inorganic toxics Bacteria
Mining	Channel modification Pool quantity and quality Substrate quality	Turbidity Suspended sediments Fine sediments Nutrients Organic and inorganic toxics
Dams and irrigation works	Flow alteration Channel modification Pool quantity and quality Substrate quality Passage barriers	Temperature Dissolved oxygen Fine sediments
Road networks	Flow alteration Channel modification Pool quantity and quality Substrate quality Passage barriers	Turbidity Suspended sediments Fine sediments

Stream channels were separated into channel habitat type (CHT) categories using the OWEB protocol. Categories were based on stream geomorphic structure including stream size, gradient, and side-slope constraint (Table 1.6). By identifying current channel forms in the watershed, we can understand how land use activities may have affected the channel form as well as identify how different channels may respond to particular restoration efforts. Ultimately, changes in watershed processes will affect channel form and produce changes in fish habitat.

Table 1.6. Channel habitat types and their associated channel geomorphologic conditions (WPN 1999)

Code	CHT Name	Channel Gradient	Channel Confinement	Channel Size
ES	Small Estuary	<1%	Unconfined to moderately confined	Small to medium
EL	Large Estuary	<1%	Unconfined to moderately confined	Large
FP1	Low Gradient Large Floodplain	<1%	Unconfined	Large
FP2	Low Gradient Medium Floodplain	<2%	Unconfined	Medium to large
FP3	Low Gradient Small Floodplain	<2%	Unconfined	Small to medium
AF	Alluvial Fan	1-5%	Variable	Small to medium
LM	Low Gradient Moderately Confined	<2%	Moderately confined	Variable
LC	Low Gradient Confined	<2%	Confined	Variable
MM	Moderate Gradient Moderately Confined	2-4%	Moderately confined	Variable
MC	Moderate Gradient Confined	2-4%	Confined	Variable
MH	Moderate Gradient Headwater	1-6%	Confined	Small
MV	Moderately Steep Narrow Valley	3-10%	Confined	Small to medium
BC	Bedrock Canyon	1 - >20%	Confined	Variable
SV	Steep Narrow Valley	8-16%	Confined	Small
VH	Very Steep Headwater	>16%	Confined	Small

Channel response to changes in ecosystem processes is strongly influenced by channel confinement and gradient (Naiman and Bilby 1998). For example, unconfined channels possess floodplains that mitigate peak flow effects and allow channel migration. In contrast, confined channels translate high flows into higher velocities with greater basal shear stress. Ultimately, these characteristics control stream conditions such as bedload material, sediment transport, and fish habitat quality. Generally, more confined, higher gradient streams demonstrate little response to watershed disturbances and restoration efforts (Figure 1.6). By grouping the channels into geomorphologic types, we can determine which channels are most responsive to disturbances in the watershed as well as those channels most likely to respond to restoration activities.

Low gradient streams with extensive floodplains tend to be especially sensitive to the effects of watershed disturbance. Approximately 48 percent of the channels in the Youngs Bay watershed occurred in the lower elevations of the Youngs Bay watershed (Figure 1.7; Table 1.7) and demonstrate a high sensitivity to both watershed disturbance and restoration activities. Those channel habitat types with moderate sensitivity generally have small floodplains with moderate gradients. Channels with moderate sensitivity to watershed disturbance accounted for 25 percent of the stream channels, with the majority of these channels exhibiting a moderately steep narrow valley channel form (MV; 24 percent). Channel geomorphologies in the Youngs Bay watershed suggest that most streams demonstrate a high sensitivity to watershed disturbance and restoration activities and occur in the lower and mid elevations of the watershed.

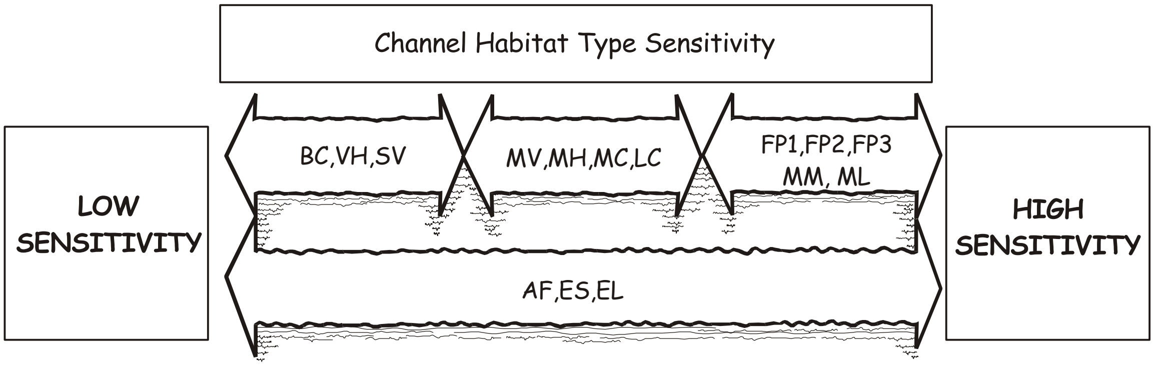


Figure 1.6. Different channel types respond differently to adjustment in channel pattern, location, width, depth, sediment storage, and bed roughness. Such changes may not only result in alteration of aquatic habitat, but the more responsive areas are most likely to exhibit physical changes from land management activities and restoration efforts. (WPN 1999)

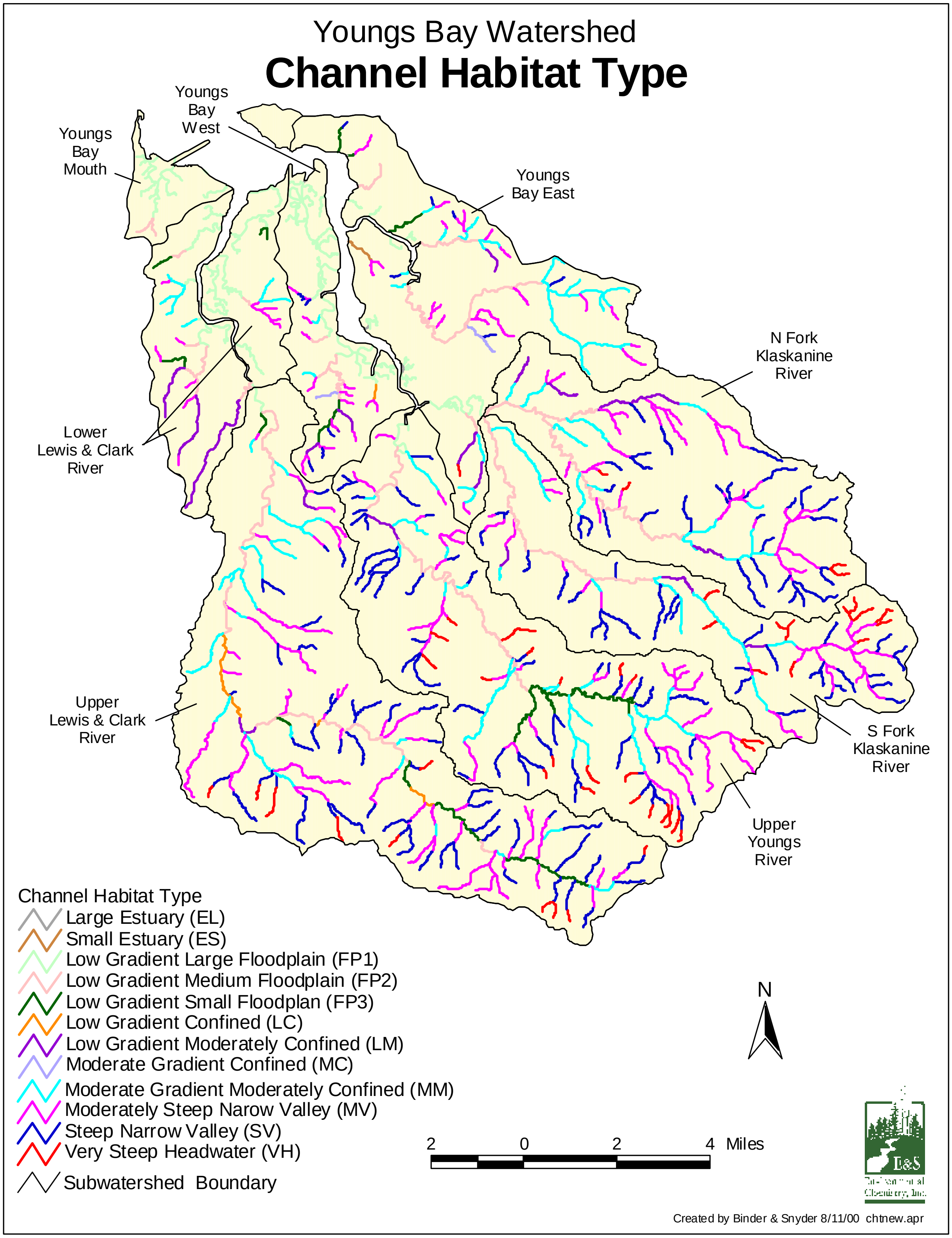


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Figure 1.7. Channel habitat types in the Youngs Bay watershed. Stream reaches were classified by slope, size, and side-slope according to OWEB protocols (WPN 1999).

Table 1.7. Channel habitat types in the Youngs Bay watershed. Channel habitat types are grouped by their sensitivity to watershed disturbance.

		PERCENT CHANNEL HABITAT TYPE													
Channel Sensitivity		High					Moderate						Low		
Subwatershed	Stream Length	% FP1	% FP2	% FP3	% LM	% MM	% EL	% ES	% LC	% MC	% MH	% MV	% BC	% SV	% VH
Lower Lewis & Clark River	32	46	10	5.2	18	10	0.4	-	-	-	-	10	-	-	-
N Fork Klaskanine River	57	0.04	17	-	7.7	16	-	-	-	-	-	28	-	30	2.3
S Fork Klaskanine River	50	-	15	-	3.9	17	-	-	-	-	-	24	-	31	9.9
Upper Lewis & Clark River	99	0.7	12	5.7	1.5	14	-	-	3.2	-	-	31	-	29	3.7
Upper Youngs River	84	1.6	10	6.9	1.1	17	0.1	-	-	-	-	24	-	29	9.5
Youngs Bay East	44	17	20	3.6	4.7	27	1.5	1.6	-	2.0	-	19	-	3.5	0.5
Youngs Bay Mouth	7	88	12	-	-	-	0.2	-	-	-	-	-	-	-	-
Youngs Bay West	28	57	9.7	4.2	3.7	2.3	0.6	-	1.2	1.9	-	15	-	4.0	-
Total	401	11.6	13.0	4.0	4.4	15.3	0.3	0.2	0.9	0.4	0.0	23.6	0.0	21.9	4.5

1.10 History

The history of a watershed is an important part of any watershed assessment because it provides information on how conditions have changed over time and provides a reference point for current conditions. The history of the Youngs Bay watershed has been compiled by the watershed council (Lisa Heigh) and included in the Appendices of this document (Appendix A). The history section provides insight on issues that relate to landscape features such as aquatic/riparian habitat, fish populations, and water quality. Having information on these prior conditions will allow local stakeholders to develop appropriate reference conditions when conducting restoration activities.

CHAPTER 2 FISHERIES

2.1 Introduction

The OWEB assessment process focuses on watershed processes that affect salmonids and their associated habitats. Understanding the current condition of salmonid populations in a watershed is vital to identifying the effects of the spatial and temporal distribution of key habitat areas on salmonids. Additionally, salmonids are often used as indicator species under the assumption that salmonids are the most sensitive species in a stream network (WPN 1999, Bottom et al. 1998, Tuchmann et al. 1996). Habitat conditions that are good for salmon reflect good habitat conditions for most aquatic species. Understanding the complex life cycles, spatial distribution, and current status of salmonids in a watershed is key to evaluating watershed management practices and their effects on watershed health.

2.2 Fish Presence

There are numerous fish species that occur in the Columbia River Estuary that may use resources in the Youngs Bay watershed. A 1967 report on fish species occurring in the Columbia River Estuary and tributaries identified 28 families and 77 species of fish (Reimers and Bond 1967). Excluding marine and introduced fish, six families and 17 species of freshwater fish remain. Sculpins (*Cottus* spp.) were found to be the most widely distributed species in lower Columbia tributaries. Selected species occurring in the lower Columbia River tributaries are listed in Table 2.1.

2.3 Species of Concern

The National Marine Fisheries Service (NMFS) has listed several anadromous fish species that exist, or could potentially exist, in the watershed as threatened under the Endangered Species Act (Table 2.2). Chum and chinook are listed as threatened and steelhead is listed as a candidate by NMFS. Coho has been listed as a candidate for listing while coastal cutthroat is proposed to be listed as threatened. Listing occurs for entire Evolutionarily Significant Units (ESU) which is a genetically or ecologically distinctive group of Pacific salmon, steelhead, or sea-run cutthroat trout (Appendix B).

The Endangered Species Act requires that any land providing habitat for endangered species must be properly managed. Relationships between land cover and rare species decline has been

Table 2.1 Selected species occurring in lower Columbia River tributaries.

Common Name	Species	Source
Coho	*Oncorhynchus kisutch*	ODFW 1995
Coastal Cutthroat	*Oncorhynchus clarki clarki*	ODFW 1995
Chum	*Oncorhynchus keta*	ODFW 1995
Chinook	*Oncorhynchus tshawytscha*	ODFW 1995
Steelhead	*Oncorhynchus mykiss irideus*	ODFW 1995
Pacific Lamprey	*Lampetra tridentata* spp.	ODFW 1995
Northern Squawfish	*Ptychocheilus oregonensis*	ODFW 1995
Longnose Dace	*Rhinichthys cataractae*	ODFW 1995
Redside Shiner	*Richardsonius balteatus*	ODFW 1995
Sandroller	*Percopsis transmontana*	ODFW 1995
Sculpins	*Cottus spp.*	ODFW 1995; Reimers and Bond 1967
Leopard Dace	*Rhinichthys falcatus*	ODFW 1995

Table 2.2. Status of anadromous fish occurring in the lower Columbia River ESUs[1]. Listing status was obtained from the NMFS website (*http://www.nwr.noaa.gov/1salmon/salmesa/index.htm*).

Fish	ESU	Status
Coho	Lower Columbia River/Southwest Washington	Candidate
Coastal Cutthroat	Southwestern Washington/Columbia River	Proposed Threatened
Chum	Columbia River	Threatened
Chinook	Lower Columbia River	Threatened
Steelhead	Oregon Coast	Candidate

[1] An Evolutionarily Significant Unit or "ESU" is a distinctive group of Pacific salmon, steelhead, or sea-run cutthroat trout.

established. An understanding of the land patterns associated with the distribution of these species can lead to a better understanding of how to preserve these species. The OWEB process focuses on salmonids in the watershed.

In addition to provisions of the Endangered Species Act, private timber, federal, and state owned lands have their own mandates for the protection and conservation of the habitats related to these threatened and endangered species. Private timber practices are regulated by the Forest

Practices Act, which is designed to help protect important habitats. The Oregon Department of Forestry is developing an assessment and management plan to detail forest management practices within areas occupied by threatened species. Due to the complex interactions in watersheds, all of these practices must be coordinated with private landowners to manage the natural resources for the protection of the critical habitats associated with these species.

Many of the following paragraphs have been taken directly from ODFW's Biennial Report on the Status of Wild Fish in Oregon (ODFW 1995) or from the NMFS website (*http://www.nwr. noaa.gov/1salmon/salmesa/inde3.htm*).

2.4 Coho

2.4.1 Life History

Coho salmon (*Oncorhynchus kisutch*) is an anadromous species that rears for part of its life in the Pacific Ocean and spawns in freshwater streams in North America. Coho salmon may spend several weeks to several months in freshwater before spawning, depending on the distance they migrate to reach their spawning grounds (Table 2.3). Adults die within two weeks after spawning. Juveniles normally spend one summer and one winter in freshwater, although they may remain for one or two extra years in the coldest rivers in their range. They migrate to the ocean in the spring, generally one year after emergence, as silvery smolts about four to five inches long. Most adults mature at three years of age (ODFW 1995).

2.4.2 Listing Status

On July 25, 1995, NMFS determined that listing was not warranted for the Lower Columbia Coho ESU (Appendix B). However, the ESU is designated as a candidate for listing due to concerns over specific risk factors. This ESU includes all naturally spawned populations of coho salmon from Columbia River tributaries below the Klickitat River on the Washington side and below the Deschutes River on the Oregon side (including the Willamette River as far upriver as Willamette Falls), as well as coastal drainages in southwest Washington between the Columbia River and Point Grenville. Major river watersheds containing spawning and rearing habitat for this ESU comprise approximately 10,418 sq. mi. in Oregon and Washington. The following counties lie partially or wholly within these watersheds: Oregon - Clackamas, Clatsop,

Table 2.3. Life history patterns for species of concern in the Youngs Bay watershed.

Fish	Return	Spawn	Out-migration
Coho [1,2]	Aug-Dec	late Oct-Dec	spring
Chinook, fall [3]	Aug-Sep	fall	summer
Chinook, spring [2]	Apr-Jun	Sep	Hatchery Releases
Chinook, summer [2]	Jul-Sep	Sep-Nov	Hatchery Releases
Steelhead, winter [3]	Nov-Apr	Dec-Jun	Mar-June
Coastal Cutthroat[4]	Jul-Mar (Nov-Dec, peak)	Dec-June, Feb (peak)	Apr-Jun
Chum[3]	Oct-Nov	Nov-Dec	spring

[1] Status Review of Coho Salmon from Washington, Oregon, and California
[2] Joseph Sheahan, personal communication
[3] Status Report: Columbia River Fish Runs, 1938-1997
[4] Status Review of Coastal Cutthroat Trout from Washington, Oregon, and California

Columbia, Hood River, Marion, Multnomah, Wasco, and Washington; Washington - Clark, Cowlitz, Grays Harbor, Jefferson, Klickitat, Lewis, Mason, Pacific, Skamania, Thurston, and Wahkiakum (Source: *http://www.nwr.noaa.gov/1salmon/salmesa/inde3.htm*).

2.4.3 Population Status

Coastal watershed wild coho production has declined from approximately 1.5 million fish at the turn of the century to approximately 70,000 in the 1990s. Wild populations still occur in most coastal watersheds and in the Clackamas and Sandy Rivers in the Columbia River watershed, and may occur in some other tributaries of the lower Columbia River watershed. Remaining coho populations generally spawn and rear in small, low gradient (less than 3 percent) tributary streams, although rearing may also take place in lakes where available.

Populations have been monitored by ODFW and data has been compiled in the StreamNet database. Three methodologies for estimating fish abundance have been used in the Youngs Bay watershed: peak or index live fish (# sampled from index locations), total live fish (live fish trapped at a location), and sport counts (counts made from sport catches; Figure 2.1). Spawning

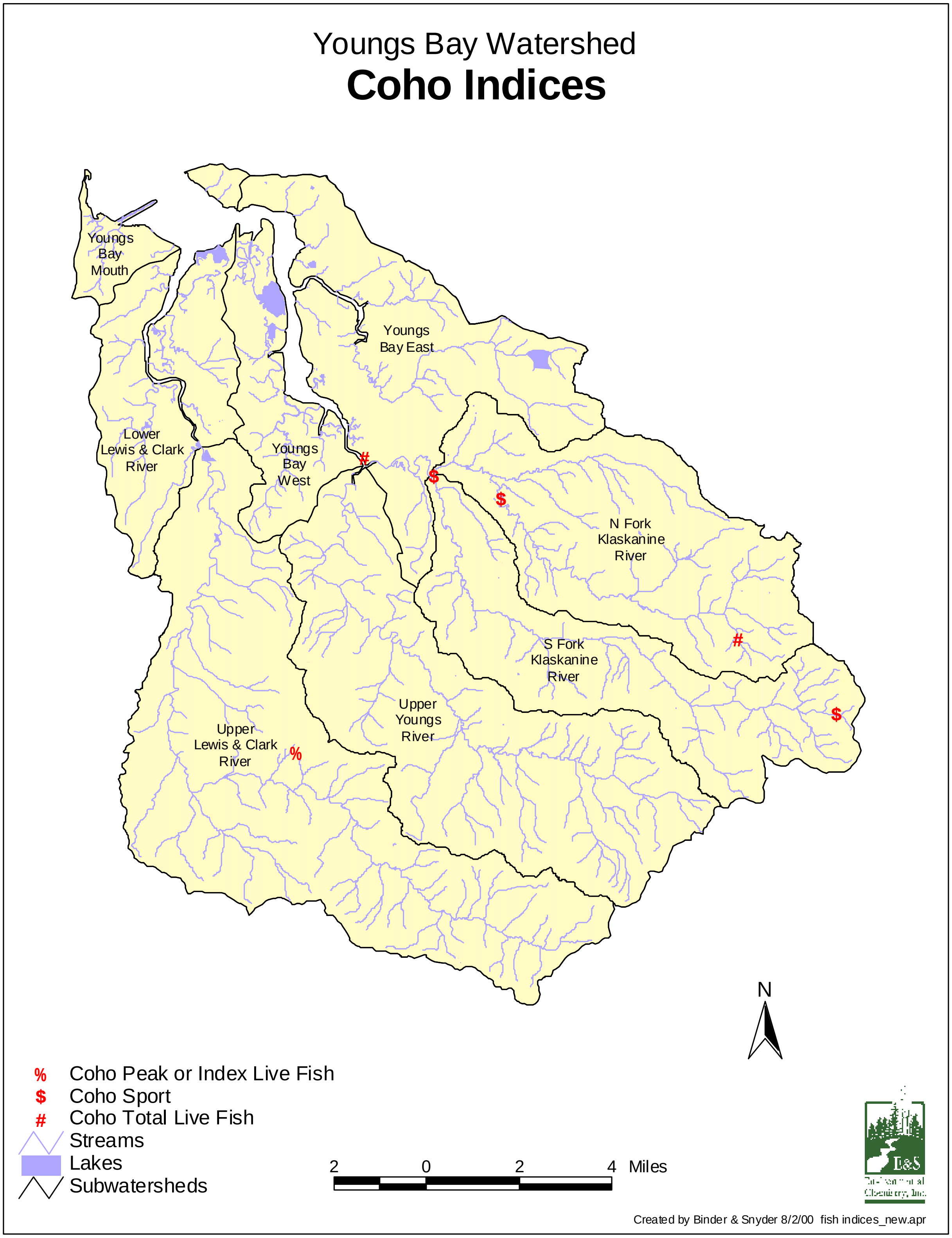

Figure 2.1. Locations and types of coho counts in the Youngs Bay watershed. Points represent the upper extent of the survey. Data were obtained from the StreamNet database.

surveys in the Youngs River show a diminishing population of wild coho (Figure 2.2). It is important to note that this observation is based on a general trend in the data and not a result of rigorous statistical analysis. Statistics would need to be used to identify actual trends in fish populations, which is beyond the scope of this analysis. Hatchery returns to the Klaskanine fish hatchery are shown in Figure 2.3.

2.4.4 Species Distribution

ODFW mapped current coho distribution by attributing 1:100,000 stream coverages based on survey data and best professional judgment of local fish biologists. Distributions identified spawning, rearing and migration areas. These coverages are dynamic data sets that are scheduled to be updated every two years. These data are available on ODFW's website (*ftp://ftpfw.state.or. us/pub/gis*).

Coho occur in the Lewis & Clark, Youngs, Klaskanine, and Wallooskee Rivers (Figure 2.4). The Lewis & Clark River is the river most heavily used by coho, with the distribution extending into the headwaters where a natural waterfall limits distribution. The lower portions of the South Fork Klaskanine are used by coho, extending to the 25 ft waterfall that limits upstream migration. Both the Wallooskee and Little Wallooskee Rivers are used by coho. It is generally believed that coho in the Youngs Bay watershed are hatchery returns.

2.4.5 Hatcheries

Hatchery influences on coho populations in the Youngs Bay watershed are widespread. The Klaskanine Fish Hatchery (run by ODFW) located about 22 mi from Fort Stevens State Park, raises both coho and steelhead. Releases of coho salmon in the Youngs Bay watershed have been conducted by ODFW, the Clatsop Economic Development Council (CEDC), and the United States Fish and Wildlife Service (USFWS). In 1983, approximately 100,000 coho were released in the Lewis & Clark River (Genovese and Emmett 1997). No other information was found for coho releases in the Lewis & Clark River although it was suggested that heavy releases of presmolt coho occurred in more than one year (Walt Weber pers. comm.). The Klaskanine River is the most heavily stocked river in the watershed. There are three historic release sites, including the upper reaches, a north fork site, and a lower site (Figure 2.5). Between 1982 and 1990, over 25 million coho yearlings were released in the Klaskanine River system, with

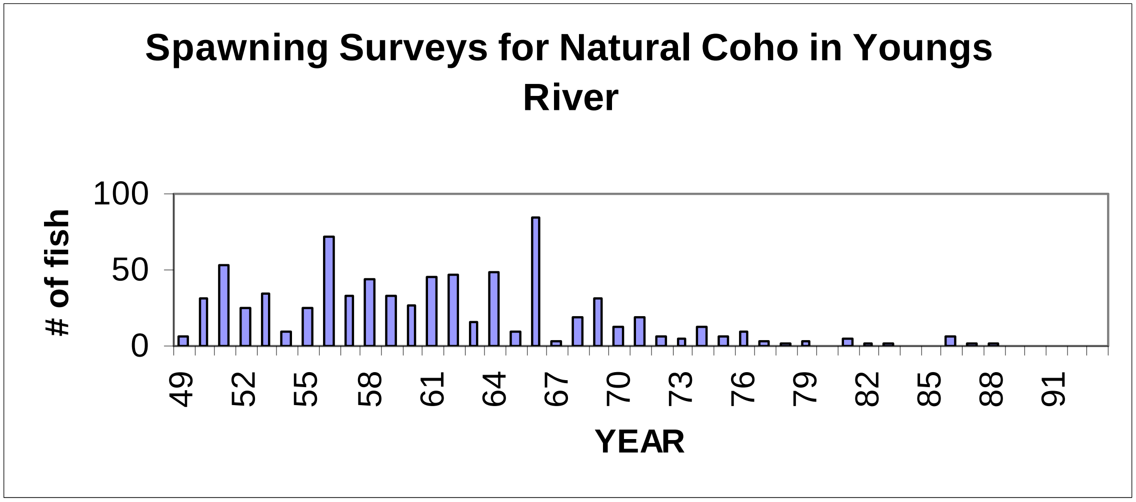

Figure 2.2. Spawning survey counts (peak or index live fish) for Coho in the Youngs River for the period 1949 to 1993. Data were obtained from the StreamNet database.

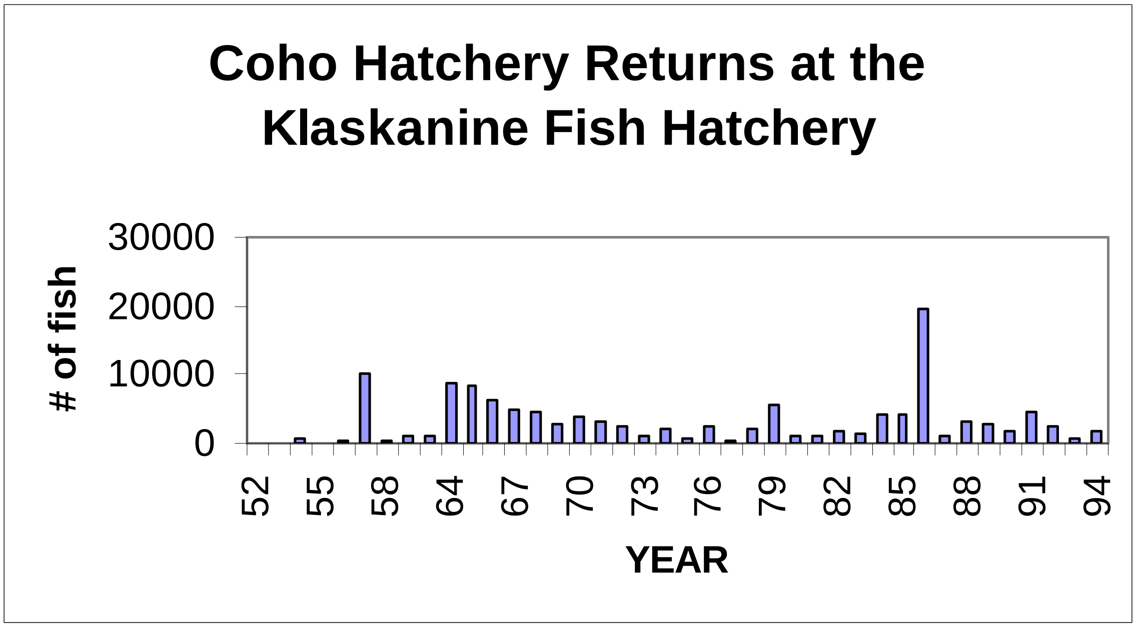

Figure 2.3. Coho hatchery returns for the Klaskanine hatchery for the period 1952 to 1994. Data were obtained from the StreamNet database.

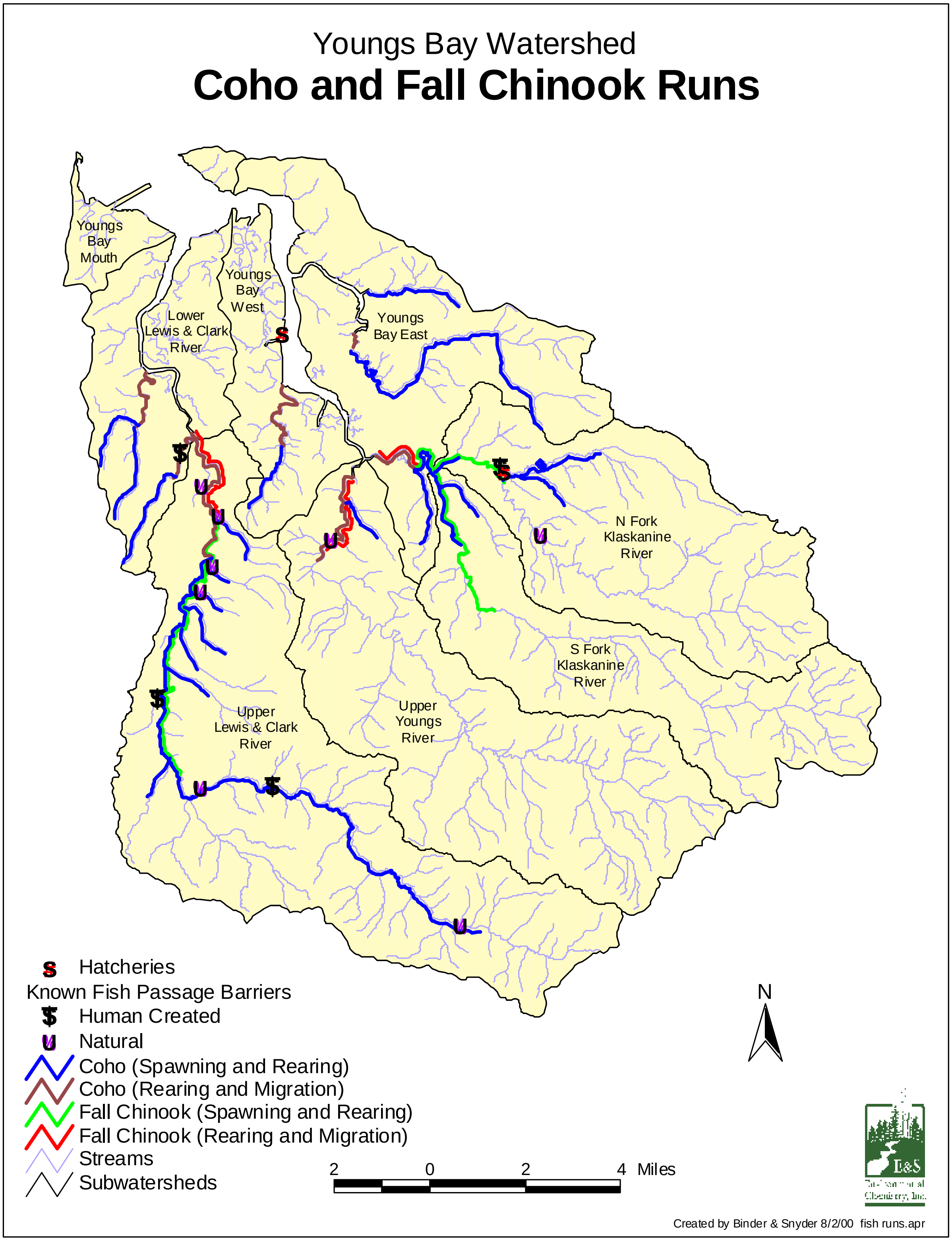

Figure 2.4. Coho and fall chinook distribution in the Youngs Bay watershed showing the location of fish barriers and hatcheries. Distribution data were obtained from ODFW and based on local fish surveys and best professional judgement of local fish biologists. Fish barriers were identified by local watershed council members.

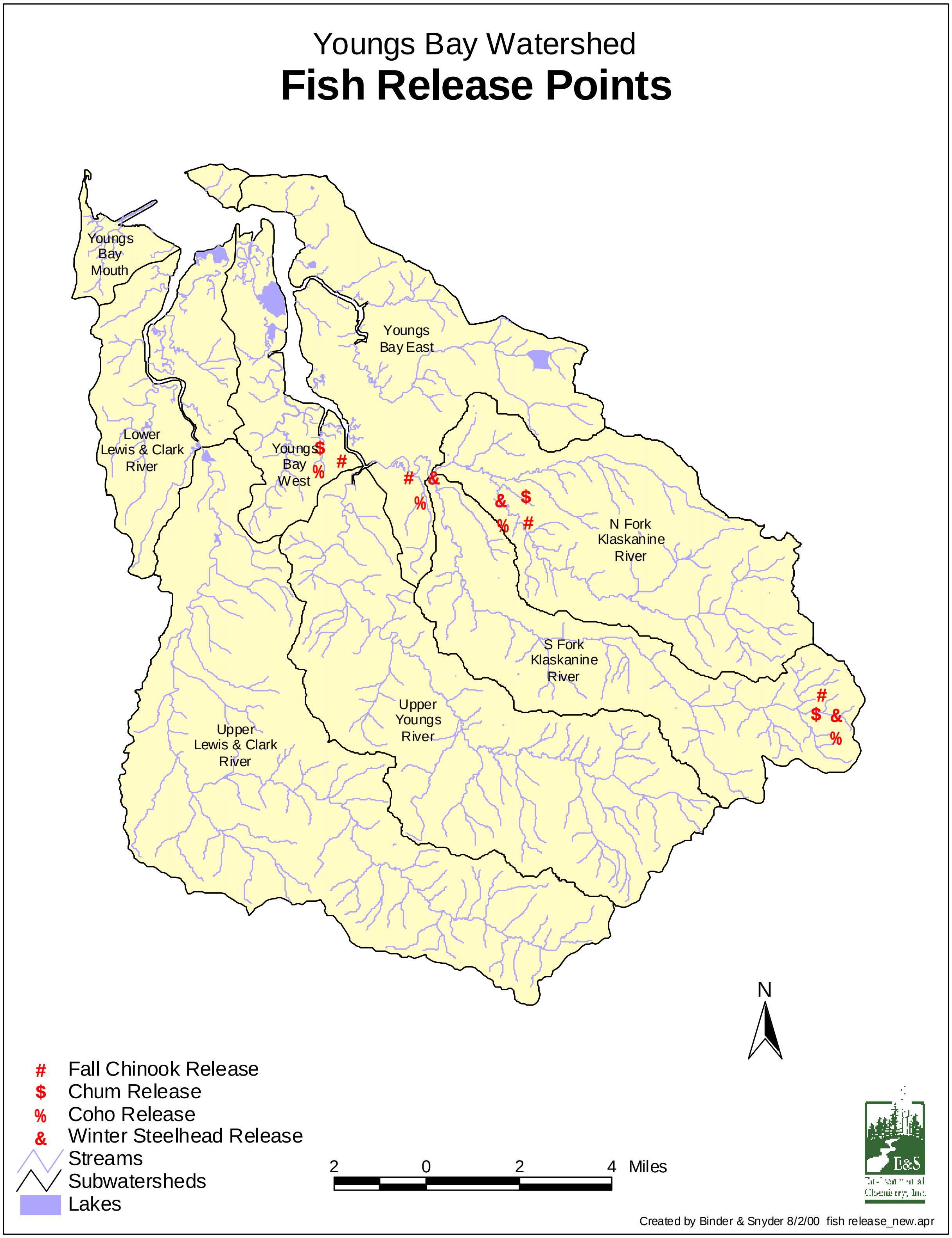

Figure 2.5. Coho, chinook, chum, and steelhead release locations in the Youngs Bay watershed. Data were obtained from the StreamNet database.

765,000 stocked in 1988 alone. More recently, the North Fork Klaskanine River received over 1 million coho and 800,000 coho in 1995 and 1996, respectively. In the early 1980s, over 2 million fish were stocked in Tucker Creek. Many releases occur in Youngs Bay itself as a result of net pen operations in the Youngs Bay estuary. Approximately 2 to 3 million coho were released from the net pens annually between 1992 and 1999.

Broodstocks for the hatchery raised fish were from varied locations with many of these coming from outside of the Youngs Bay watershed. The most common broodstock released in the Youngs Bay watershed is from the Big Creek hatchery, located just east of the watershed. Other early Columbia River stocks include Sandy, Tanner Creek, and Klaskanine stocks. The most varied broodstocks are released from the Youngs Bay net pen facilities. Coho broodstocks released from this site include Eagle Creek, Oxbow, Klaskanine, and Sandy broodstocks.

Hatchery coho may have contributed to the decline of wild coho salmon. Hatchery programs supported historical harvest rates in mixed-stock fisheries that were excessive for sustained wild fish production. Hatchery coho have also strayed to spawn with wild fish, which may have reduced the fitness and therefore survival of the wild populations through outbreeding depression (Hemmingsen et al 1986; Flemming and Gross 1989, 1993; ODFW 1995), and which lowered effective population sizes. Finally, hatcheries may have reduced survival of wild juveniles through increased competition for limited food in streams, bays, and the ocean in years of low ocean productivity; through attraction of predators during mass migrations; and through initiation or aggravation of disease problems (Nickelson et al. 1986).

2.5 Chinook

2.5.1 Life History

Oregon chinook salmon populations exhibit a wider range of life history diversity than coho or chum salmon, with variation in the date, size and age at juvenile ocean entry; in ocean migration patterns; and in adult migration season, spawning habitat selection, age at maturity and size (Table 2.3; Nicholas and Hankin 1989, Healey 1994). Generally, subyearling juveniles rear in coastal streams from three to six months and rear in estuaries from one week to five months. Nearly all Oregon coastal chinook salmon enter the ocean during their first summer or fall. Columbia River fall chinook show a similar rearing pattern, but Columbia River spring chinook (and a small percentage of fish in coastal chinook populations) spend one summer and one winter in freshwater. However, there are no naturally spawning spring chinook in these watersheds. Juvenile chinook salmon with this life history of prolonged freshwater rearing tend to move downstream from the area where they hatched into larger rivers during their first spring. Migration to the ocean occurs during the second spring with variation in outmigration depending on amount and timing of spring runoff and individual population differences.

2.5.2 Listing Status

Chinook salmon was listed as a threatened species on March 24, 1999. The ESU includes all naturally spawned populations of chinook salmon from the Columbia River and its tributaries from its mouth at the Pacific Ocean upstream to a transitional point between Washington and Oregon east of the Hood River and the White Salmon River. It includes the Willamette River to Willamette Falls, Oregon, exclusive of spring-run chinook salmon in the Clackamas River (Source: *http://www.nwr.noaa.gov/1salmon/salmesa/inde3.htm*).

2.5.3 Population Status

Lower Columbia Fall Chinook are chinook that enter the Columbia River as mature fish and spawn in small tributaries in the lower watershed. No wild populations have been sampled for allozyme (genetic) variation in this group, although Big Creek hatchery fish, founded from this group, were analyzed (Marshall 1993). The fish are distinctive from all other Columbia Watershed chinook in that they are mature upon river entry, have a short migration more similar to coastal populations, and spawn soon after arrival on the spawning grounds. Their ocean distribution is somewhat south of north coast populations extending along the coasts of Washington and British Columbia. Scattered naturally spawning fish are still observed in the lower Clackamas River and in small streams such as Plympton Creek, Gnat Creek, Big Creek, Clatskanie River, Hood River, and in the Youngs Bay and Columbia Gorge areas. Observations by ODFW district staff indicate that these fish generally spawn from September to early November.

Most spawning has been observed in September, although fresh adults have been observed in late October and dead fish have been found in late November. Harvest management staff have concluded, based on expansions of coded-wire tag recoveries from these fish, that a huge proportion of the fish in these tributaries have been strays from Big Creek hatchery "tules" along with some strays of Rogue River "brights" released into Big Creek. The Plympton Creek "tules" were collected for hatchery broodstock in 1990, 1991 and 1994, with most of the females removed from the watershed in 1990. The information that is available indicates that the fall chinook populations in the lower Columbia Watershed are reduced from historical numbers, with much of the natural spawning dominated by hatchery fish from the 11 Oregon and Washington fall chinook hatcheries located in the lower Columbia.

Populations have been monitored in the Youngs Bay watershed by ODFW and data have been compiled in the StreamNet database. Three methodologies for estimating fish abundance were used in the Youngs Bay watershed: peak or index live fish, total live fish, and sport counts (Figure 2.6). Data for naturally-occurring fall chinook abundance are lacking. Peak or index live fish surveys or total live fish surveys have not been included in the StreamNet database since 1986. Hatchery returns of fall chinook have been monitored in the Youngs Bay tributaries and show poor returns over the last five years.

2.5.4 Species Distribution

ODFW mapped current chinook distribution by attributing 1:100,000 stream coverages based on survey data and best professional judgment of local fish biologists. Distributions identified spawning, rearing and migration areas. These coverages are dynamic data sets that are scheduled to be updated every two years. These data are available on ODFW's website (*ftp://ftp.dfw.state. or.us/pub/gis*).

Fall chinook occur in the Lewis & Clark, Youngs, Klaskanine, and Wallooskee Rivers (Figure 2.4). These chinook are most likely hatchery strays or from direct hatchery releases. There may be some natural production from these hatchery fish. The Lewis & Clark River is the river most heavily by fall chinook, with the distribution extending midway up the river. The lower portions of the South Fork Klaskanine are used by fall chinook, extending to the 25 ft waterfall that limits upstream migration.

2.5.5 Hatcheries

Releases of "tule" fall chinook from Oregon facilities included 13-14 million smolts below Bonneville Dam,10 million smolts in the Big Creek and Youngs Bay area, and 1-8 million smolts and fry in the lower Willamette in 1992 and 1993. Less than 5 percent of the fish are marked so the number of returning hatchery adults straying to natural spawning areas must be estimated from limited tag recoveries. Based on increases in coded-wire tags recovered in

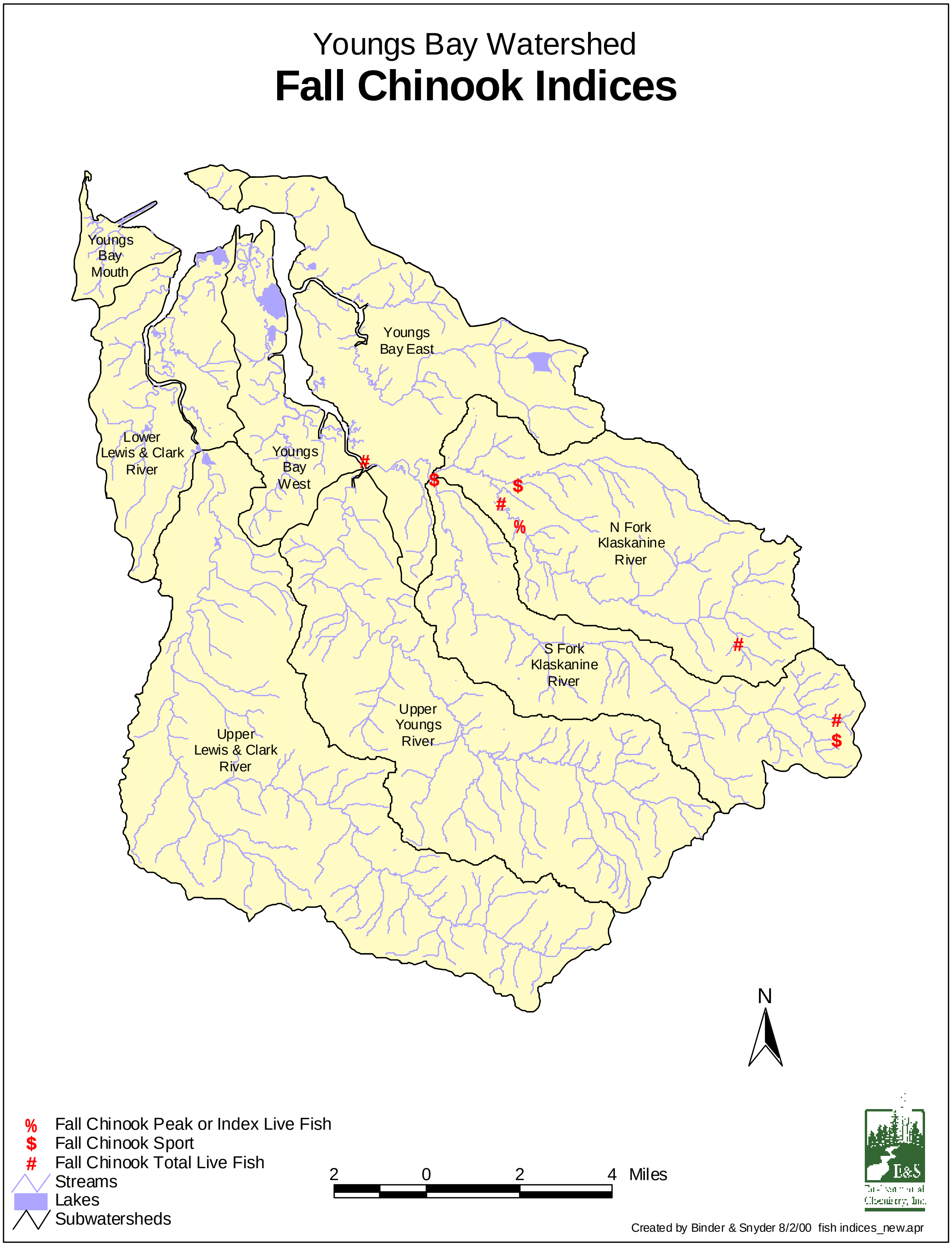

Figure 2.6. Location and types of fall chinook counts in the Youngs Bay watershed. Points represent the upper extent of the survey. Data were obtained from the StreamNet database.

streams, most of the natural spawning can be attributed to hatchery strays. This straying pattern probably dates to the 1960s.

Fall chinook from the Rogue River were historically introduced into the lower Columbia River and were released into Big Creek and the Youngs Bay area. The purpose of this program was to provide a south migrating fall chinook for harvest along the Oregon coast and a "brighter" fall chinook in the lower river harvest. About 500,000 to 700,000 Rogue River smolts were released in 1992 and 1993. The fish are adapted to a long migration up the Rogue River and so enter the Columbia River "brighter" than the local populations. All Rogue River "brights" have been marked and straying is being monitored. There has been some straying into natural spawning areas and into lower Columbia hatcheries. Their spawning time does not overlap with the later part of the natural spawning distribution of the local "tules." And, based on their marks, they are removed from the hatchery tule spawning escapement.

The Klaskanine River is the most heavily stocked for fall chinook in the Youngs Bay watershed. Between 1974 and 1981, 2.9 million fall chinook were released in the lower reaches of the Klaskanine River (Figure 2.5). In the north fork Klaskanine River, 4.4 million fall chinook were released from 1980 and 1988. Between 1996 and 1999, anywhere from 200,000 to 700,000 fall chinook were released in the Klaskanine River, and in the headwaters of the Klaskanine River, 17.7 million fall chinook were released between 1981 and 1990. There were also significant releases from the Youngs Bay net pen operations. From 1986 to 1994, almost 1 million fall chinook were released from the net pens. Currently, fall chinook are heavily released from the net pen facilities. Anywhere from 56,000 to 1.5 million fall chinook were released annually from the net pen facilities for the period of 1992 to 1999.

Hatchery spring chinook from the Willamette River are also released into the Youngs Bay area to provide fish for sport and commercial harvest in the bay. About 400,000 smolts were released into the bay in 1992. Spring chinook releases range from 375,000 to about 450,000 spring chinook annually from the Youngs Bay net pen facilities. These fish enter the lower Columbia River in the spring, long before "tule" populations are present. Potential impacts of these fish are unknown, but they probably do not survive through the summer to spawn in the lower river tributaries near their release sites due to a lack of adult holding habitat in the lower Columbia River Watershed. They have not been found to stray into other areas.

2.6 Coastal Cutthroat

2.6.1 Life History

Coastal cutthroat trout exhibit diverse patterns in life history and migration behaviors. Populations of coastal cutthroat trout show marked differences in their preferred rearing environments (river, lake, estuary, or ocean); size and age at migration; timing of migrations; age at maturity; and frequency of repeat spawning (Table 2.3). Anadromous or sea-run populations migrate to the ocean (or estuary) for usually less than a year before returning to freshwater. Anadromous cutthroat trout either spawn during the first winter or spring after their return or undergo a second ocean migration before maturing and spawning in freshwater. Anadromous cutthroat are present in most coastal rivers. Nonmigratory (resident) forms of coastal cutthroat trout occur in small headwater streams and exhibit little instream movement. They generally are smaller, become sexually mature at a younger age, and may have a shorter life span than many migratory cutthroat trout populations. Resident cutthroat trout populations are often isolated and restricted above waterfall barriers, but may also coexist with other life history types.

2.6.2 Listing Status

Coastal cutthroat trout were proposed for listing as a threatened species on April 5, 1999. The Upper Columbia River ESU includes populations of coastal cutthroat trout in the Columbia River and its tributaries downstream from the Klickitat River in Washington and Fifteenmile Creek in Oregon (inclusive) and the Willamette River and its tributaries downstream from Willamette Falls. The ESU also includes coastal cutthroat trout populations in Washington coastal drainages from the Columbia River to Grays Harbor (inclusive). Major river watersheds containing spawning and rearing habitat for this ESU comprise approximately 12,136 sq. mi. in Oregon and Washington. The following counties lie partially or wholly within these watersheds: Oregon - Clackamas, Clatsop, Columbia, Hood River, Marion, Multnomah, Wasco, and Washington; Washington - Clark, Cowlitz, Grays Harbor, Jefferson, Klickitat, Lewis, Mason, Pacific, Skamania, Thurston, Wahkiakum, and Yakima (Source: *http://www.nwr.noaa.gov/1salmon/salmesa/inde3.htm*).

2.6.3 Population Status

The abundance of sea-run cutthroat trout in the lower Columbia River watershed appears to have significantly declined in recent years (ODFW 1995). Although these populations are not routinely monitored, angler surveys conducted in the lower mainstem Columbia during the 1970s typically observed annual catches of up to 5,000 fish. Similar data in the late 1980s estimate the annual catch as low as 500 fish. Effective in 1994, all wild cutthroat trout caught by anglers in the Columbia River must be released unharmed (ODFW 1995).

Systematic abundance estimates also are not available for most resident, fluvial (migrate to spawning tributaries) or adfluvial (migrate between spawning tributaries and lakes) cutthroat populations. However, anecdotal observations indicate that they remain relatively abundant, even in streams where the abundance of sea-run fish has sharply declined. This pattern suggests that anadromous populations are most impacted by problems occurring along migration corridors, in estuaries, or in near-shore marine environments (ODFW 1995).

2.6.4 Species Distribution

Anadromous cutthroat trout have not been mapped by ODFW. The 1995 biennial report on the status of wild fish (ODFW 1995) reported a distribution including the Lewis & Clark (below falls), Youngs River (below falls), Klaskanine River, and the Wallooskee River. All of the rivers in the Youngs Bay watershed were reported to contain resident cutthroat populations.

2.6.5 Hatcheries

The effects of long-term hatchery releases of sea-run cutthroat trout on wild stock abundance in this group is unknown. The hatchery broodstock used in most programs was developed from the wild population in Big Creek on the lower Columbia River. Legal size hatchery releases that were annually made into the Lewis and Clark River (10,000–15,000) were discontinued in 1990, and annual releases into the Klaskanine River (5,000), Big Creek (5,000), Gnat Creek (3,000), and Scappoose Creek (4,000) were discontinued after 1993. Starting in 1994, remaining lower Columbia River cutthroat trout releases have been switched to standing water bodies.

2.6.6 Species Interactions

Cutthroat trout populations with different life history patterns may be sympatric (able to exchange genetic information) in the same river. The level of genetic exchange between cutthroat trout of different life history types, for example, between sea-run and resident forms, is poorly understood. A single population may be polymorphic for several life histories; or the life histories may form separate breeding populations through assortative mating, but still exchange low levels of gene flow; or the life history types may form completely reproductively isolated gene pools. Extensive genetic and life history surveys will be needed to clarify these relationships.

2.7 Chum

2.7.1 Life History

The chum salmon is an anadromous species that rears in the Pacific and Arctic oceans and spawns in freshwater streams in North America. Most of the chum salmon life span is spent in a marine environment. Adults typically enter spawning streams ripe, promptly spawn, and die within two weeks of arrival. Most spawning runs are over a short distance, although exceptionally long runs occur in some watersheds in Asia and Alaska. Adults are strong swimmers, but poor jumpers and are restricted to spawning areas below barriers, including minor barriers that are easily passed by other anadromous species. Juveniles are intolerant of prolonged exposure to freshwater and migrate to estuarine waters promptly after emergence. A brief residence in an estuarine environment appears to be important for smoltification and for early feeding and growth. Movement offshore occurs when the juveniles reach full saltwater tolerance and have grown to a size that allows them to feed on larger organisms and avoid predators. Chum salmon mature at 2 to 6 years of age and may reach sizes over 40 pounds.

2.7.2 Listing Status

Chum salmon were listed as a threatened species on March 25, 1999. The ESU includes all naturally spawned populations of chum salmon in the Columbia River and its tributaries in Washington and Oregon (Source: *http://www.nwr.noaa.gov/1salmon/salmesa/inde3.htm*).

2.7.3 Population Status

Oregon currently has 55 populations on its provisional list, including 23 in the Columbia Watershed and 32 in coastal watersheds. The species in Oregon requires typical low gradient, gravel-rich, barrier-free freshwater habitats and productive estuaries. In Oregon most chum mature at 3 to 4 years and weigh 10–15 pounds as adults (Table 2.3).

Chum salmon populations are very depressed to extinct in Oregon subwatersheds of the lower Columbia River. Small numbers of scattered adults are still observed and might provide the means for naturally recolonizing the area if conditions permitted. However, conditions on the Oregon side of the river are poorly suited to the natural production of chum. Spawning habitat is poor or inaccessible (ODFW 1995). Large numbers of hatchery coho and chinook are released into some of the potential juvenile chum rearing areas, such as the Youngs Bay area, where 3 to 5 million coho were released in 1992 and 1993. Gill-net fisheries can intercept adult chum salmon in October. The 1992 Columbia River commercial harvest landed about 700 chum salmon, most of which are thought to have come from Washington rivers (ODFW and WDF 1993). In comparison, Columbia River harvests prior to the 1940s landed 100,000 to 600,000 fish annually.

2.7.4 Species Distribution

ODFW mapped current chum distribution by attributing 1:100,000 stream coverages based on survey data and best professional judgment of local fish biologists. Distributions identified spawning, rearing, and migration areas. Theses coverages are dynamic data sets that are scheduled to be updated every two years. These data are available on ODFW's website (*ftp://ftp.dfw.state.or.us/pub/gis*).

Currently, chum salmon do not occur in the Youngs Bay watershed. Historically, chum were found in almost all of the subwatersheds in the Youngs Bay watershed including the Lewis & Clark, Youngs, Klaskanine, and Wallooskee Rivers. However, many of these areas are considered poor chum habitats due to competition with large numbers of hatchery coho and chinook (ODFW 1995). Additionally, these areas have poor or inaccessible spawning areas (ODFW 1995).

2.7.5 Hatcheries

Oregon has never had a large chum salmon hatchery program, and there are currently no state hatchery programs for the species. The Klaskanine fish hatchery had a limited chum program that has been discontinued. One private hatchery has operated in the Nehalem estuary over the past few years. The objective at this hatchery has been to collect all returning hatchery adults; however some straying has occurred. Chum salmon are probably impacted by coho salmon hatchery programs that release large numbers of hatchery smolts into estuaries that are used by rearing juvenile chum. Coho salmon juveniles have been shown to be a major predator on chum juveniles in the Northwest (Hargreaves and LeBrasseur 1986). Juvenile chum salmon may also be affected by large releases of fall chinook salmon hatchery fish, particularly presmolts, since fall chinook juveniles also rear in estuaries and may compete with chum juveniles.

2.8 Steelhead

2.8.1 Life History

Most coastal steelhead in Oregon are winter-run fish and summer steelhead are present only in a few large watersheds. The subspecies (*Oncorhynchus mykiss irideus*) includes a resident phenotype (rainbow trout) and an anadromous phenotype (coastal steelhead). The steelhead express a further array of life histories including various freshwater and saltwater rearing strategies and various adult spawning migration strategies. Juvenile steelhead may rear one to four years in freshwater prior to their first migration to salt water. Saltwater residency may last one to three years. Adult steelhead may enter freshwater on spawning migrations year around if habitat is available for them, but generally spawn in the winter and spring. Adults that enter between May and October are called "summer-run" fish. These hold several months in freshwater prior to spawning. Adults that enter between November and April are called "winter-run" fish. These fish are more sexually mature upon freshwater entry and hold for a shorter time prior to spawning. Rainbow trout are thought to spawn at three to five years of age, generally in the winter or spring, although some populations vary from this pattern. Both rainbow and steelhead may spawn more than once. Steelhead attempt to return to salt water between spawning runs. There are no natural steelhead populations in the Youngs Bay watershed.

2.8.2 Listing Status

On March 19, 1998, NMFS determined that listing was not warranted for the Oregon Coast ESU. However, the ESU is designated as a candidate for listing due to concerns over specific risk factors. The ESU includes steelhead from Oregon coastal rivers between the Columbia River and Cape Blanco. Major river basins containing spawning and rearing habitat for this ESU comprise approximately 10,604 sq. mi. in Oregon. The following counties lie partially or wholly within these basins: Benton, Clatsop, Columbia, Coos, Curry, Douglas, Jackson, Josephine, Lane, Lincoln, Polk, Tillamook, Washington, and Yamhill (Source: *http://www.nwr.noaa.gov/1salmon/salmesa/index.htm*).

2.8.3 Population Status

Most of the winter steelhead populations in the lower Columbia Watershed are small. Observations of sport catch in the Lewis & Clark River, and the South Fork Klaskanine River indicate these populations have more than 300 adults each, although no comprehensive populations surveys have been done. Currently, ODFW is collecting adult spawning populations in the Lewis & Clark River (Joe Sheahan pers. comm.).

2.8.4 Species Distribution

ODFW mapped current steelhead distribution by attributing 1:100,000 stream coverages based on survey data and best professional judgment of local fish biologists. Distributions identified spawning, rearing and migration areas. These coverages are dynamic data sets that are scheduled to be updated every two years. These data are available on ODFW's website (*ftp://ftp.dfw.state.or.us/pub/gis*).

Winter steelhead occur in the Lewis & Clark and Klaskanine Rivers (Figure 2.7). Distribution in the Klaskanine River is shown to extend beyond the fish hatchery. ODFW is currently allowing adult steelhead to pass above the fish hatchery (Joe Sheahan pers. comm.).

2.8.5 Hatcheries

Most of the lower Columbia River watershed steelhead populations were planted with a winter steelhead broodstock founded from Big Creek in the lower Columbia River watershed. Releases of Big Creek stock were discontinued in the Lewis & Clark, South Fork Klaskanine and Hood Rivers, effective in 1993. Historical stocking of winter steelhead in the Klaskanine River included around 250,000 winter steelhead released in the NF Klaskanine and around 200,000 released in the lower portions of the watershed. More recently, the North Fork Klaskanine River was stocked with 50,000 to 60,000 winter steelhead annually between 1995 and 1999. Between 1982 and 1991, more than 380,000 winter steelhead were released in the Lewis & Clark River. However, stocking of winter steelhead has been discontinued in the Lewis & Clark River.

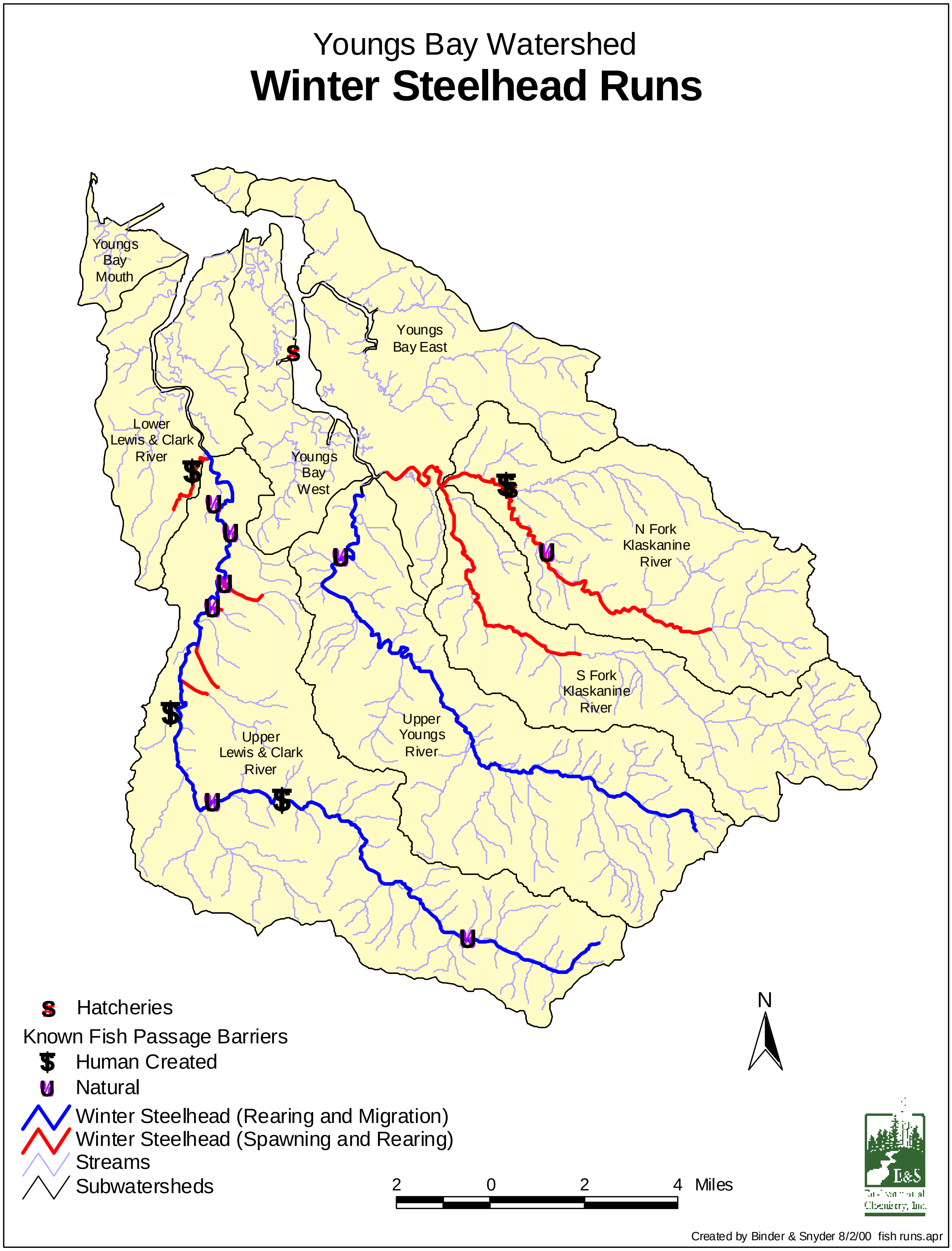

Figure 2.7. Winter steelhead distributions in the Youngs Bay watershed. Distribution data were obtained from ODFW and based on local fish surveys and best professional judgement of local fish biologists. Fish barriers were identified by local watershed council members.

2.9 Conclusions

The National Marine Fisheries Service (NMFS) has listed several anadromous fish species that exist, or could potentially exist, in the watershed as threatened. Chum and chinook were listed as threatened and steelhead was listed as a candidate by NMFS. Coho has been listed as a candidate for listing, while coastal cutthroat is proposed to be listed as threatened.

Fisheries in the Youngs Bay watershed lack self-sustaining anadromous fish populations. Native coho, chum, and chinook have been eliminated (if there ever were any). Sea-run cutthroat trout appear to be at very low levels. Native winter steelhead are present in moderate numbers only in the Lewis & Clark River. Consequently, even if significant improvements were made in habitat and ocean conditions, anadromous fish levels in the Youngs Bay watershed would most likely remain low (Walt Weber pers. comm.). To improve fisheries in the Youngs Bay watershed, it is imperative that brood stock development programs be developed that provide fish stocks capable of using improved habitats to become self-sustaining populations. Possible brood stock sources include late spawning Cowlitz River hatchery coho, Washington lower Columbia River chum, Lewis & Clark River winter steelhead, and Clatskanie River or Lewis & Clark River sea-run cutthroat trout. The list is not all inclusive and establishment of these broodstocks must take into account current local terminal fishery programs and local gill-net fisheries. Potential issues include over-harvest of developing broodstocks, competition, predation, and attraction of avian predators.

An additional problem exists in that fish are excluded from some of the better fish habitat available due to the North Fork Klaskanine ODFW fish hatchery. This barrier has led to the virtual elimination of native steelhead and sea-run cutthroat populations in the Youngs Bay watershed (Walt Weber pers. comm.) and has limited the expansion of introduced coho broodstock. Removal of the hatchery would eliminate this problem; however, this hatchery may be needed for broodstock development.

CHAPTER 3 AQUATIC AND RIPARIAN HABITATS

3.1 Introduction

Distribution and abundance of salmonids within a given watershed varies with habitat conditions such as substrate and pool frequency, as well as biological factors such as food distribution (i.e. insects and algae). In addition, salmonids have complex life histories and use different areas of a watershed during different parts of their life cycle. For example, salmonids need gravel substrates for spawning but may move to different stream segments during rearing. The interactions of these factors in space and time make it difficult to determine specific factors affecting salmonid populations. Consequently, entire watersheds, not just individual components, must be managed to maintain fish habitats and(Garano and Brophy 1999).

Understanding the spatial and temporal distribution of key aquatic habitat components is the first step in learning to maintain conditions suitable to sustain salmonid populations. These components must then be linked to larger scale watershed processes that may control them. For example, a stream that lacks sufficient large woody debris (LWD) often has poor LWD recruitment potential in the riparian areas of that stream. By identifying this link, riparian areas can be managed to include more conifers to increase LWD recruitment potential. Also, high stream temperatures can often be linked to lack of shade as a result of poorly vegetated riparian areas. By linking actual conditions to current watershed-level processes, land mangers can better understand how to manage the resources to maintain these key aquatic habitat components.

3.2 Aquatic Habitat Inventory Data

To assess current habitat conditions within the Youngs Bay watershed, we have compiled fish habitat survey data collected according to the ODFW protocol (Moore et al. 1997). Stream survey data is like a snapshot in time of current stream conditions. Streams are dynamic systems, and channel conditions may change drastically from year to year depending on environmental conditions. Nevertheless, these data are useful in describing trends in habitat conditions that may be linked to larger watershed processes. Through understanding these habitat distribution patterns, land managers can identify and address problem areas or processes.

To interpret the habitat survey data, ODFW has established statewide benchmark values as guidelines for an initial evaluation of habitat quality (Table 3.1). The benchmarks rate conditions as desirable, moderate, or undesirable in relation to the natural regime of these streams. These values depend upon climate, geology, vegetation and disturbance history, and

Table 3.1. ODFW Aquatic Inventory and Analysis Habitat Benchmarks.

	Undesirable	Desirable
Pools		
Pool Area (percent total stream area)	<10	>35
Pool Frequency (channel widths between pools)	>20	5-8
Residual Pool Depth (meters)		
Low Gradient (slope<3%)or small (<7m width)	<0.2	>0.5
High Gradient (slope >3%) or large (>7m width)	<0.5	>1
Riffles		
Gravel (percent area)	<15	>35
Large Woody Debris		
Pieces (per 100m)	<10	>20
Volume (m^3 per 100m)	<20	>30
"Key" Pieces (>60cm dia. & >10cm long per 100m)	<1	>3
Shade (reach average %)		
Stream Width <12 m	<60	>70
Stream Width >12 m	<50	>60
Riparian Conifers (30 m from both sides)		
Number > 20-in dbh/1,000-ft stream length)	<150	>300
Number > 35-in dbh/1,000-ft stream length)	<75	>200

can help to identify patterns in habitat features that can lead to a better understanding of the effects of watershed processes on the current conditions of the stream channel.

Since 1990, nine creeks and rivers have been surveyed in the Youngs Bay watershed (Figure 3.1; Table 3.2). There was a major flood in February of 1996 that may have significantly changed stream channel conditions. However, these surveys may still provide some insight into current habitat condition patterns. For example, streams that lacked large woody debris before the flood may have been affected by poor recruitment potential in the riparian zone. Although the flood may have brought in some large woody debris, most likely the channels still lack LWD. All sites must be field verified for conditions before on-the-ground restoration is planned.

3.2.1 Stream Morphology and Substrates

Stream morphology describes the physical state of the stream including features such as channel width and depth, pool frequency, and pool area (Garano and Brophy 1999). Pools are important features for salmonids providing refugia and feeding areas. Substrates are also an important channel feature since salmonids use gravel beds for spawning. These gravel

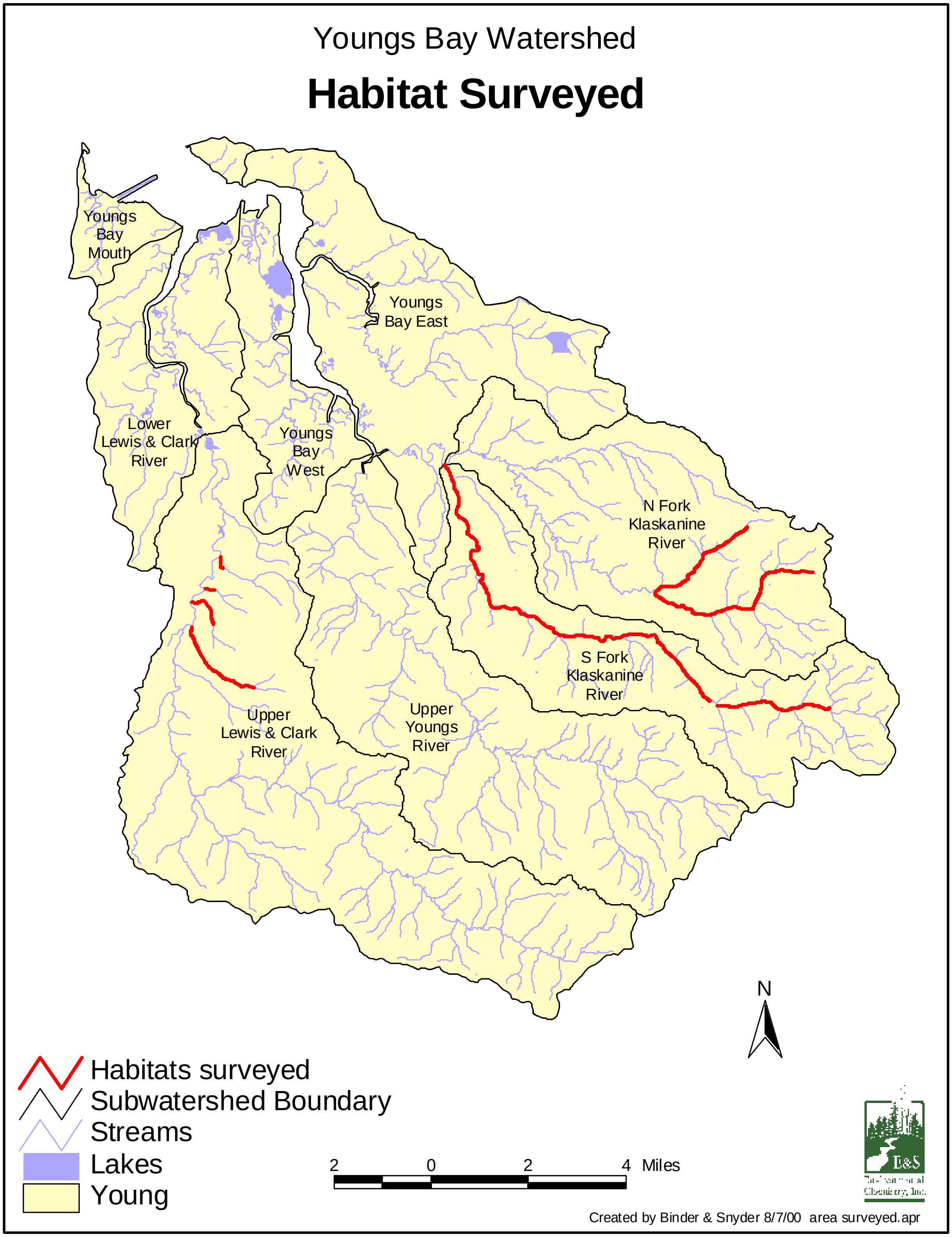

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Figure 3.1. Streams surveyed for habitat conditions by ODFW. Survey dates are listed in Table 3.2.

Table 3.2. Stream surveys conducted in the Youngs Bay watershed.

Reaches Surveyed	Year Surveyed
Hartill Cr., Klickatat Cr., Loowit Cr., Speelyai Cr.	1990
SF Klaskanine R., Mainstem Klaskanine	1992
NF Klaskanine R., MF of NF Klaskanine R.	1995

beds can be buried by heavy sedimentation, resulting in loss of spawning areas as well as reduced invertebrate habitat. For streams that were surveyed, stream morphology and substrates were compared against ODFW benchmarks to evaluate current habitat conditions.

In the streams surveyed, pool frequency and percent pools were generally between moderate and desirable conditions (Table 3.3). Residual pool depth had the greatest variability with desirable conditions in the Klaskanine River and Undesirable conditions in Hartill, Klickitat, and Loowit Creeks.

Gravel beds are important channel features since they provide spawning areas for salmonids. Gravel conditions in riffles demonstrated generally moderate to desirable conditions, with only Klickitat Creek having undesirable conditions (Table 3.3). The majority of reaches have moderate gravel conditions, suggesting there could be some improvement.

3.2.2 Large Woody Debris and Riparian Conditions

Large woody debris is an important feature that adds to the complexity of the stream channel. LWD in the stream provides cover, produces and maintains pool habitat, creates surface turbulence, and retains a small woody debris. Functionally, LWD dissipates stream energy, retains gravel and sediments, increases stream sinuosity and length, slows the nutrient cycling process, and provides diverse habitat for aquatic organisms (Bischoff 2000, BLM 1996). LWD is most abundant in intermediate sized channels in third and fourth-order streams. In fifth-order and larger streams, the channel width is generally wider than a typical piece of LWD, and therefore, LWD is not likely to remain stable in the channel. In wide channels LWD is more likely to be found along the edge of the channel.

Table 3.3. Stream morphology and substrate conditions in the Youngs Bay watershed as compared to ODFW benchmark values. Benchmark values for stream habitat conditions have been provided in Table 3.1. Data were collected by ODFW.

Stream	Reach	Stream Miles	Gradient (%)	Pool Frequency (Channel Width Between Pools	Percent Pools	Residual Pool Depth (m)	Gravel in Riffles (% area)
Hartill Creek	1	0.6	0.5	░ 5.9	░ 33.8	▓ 0.1	33.0
	2	0.2	11.2	8.6	▓ 9.6	▓ 0.1	░ 44.0
Klickitat Creek	1	0.7	7.0	▓ 27.5	16.6	▓ 0.0	▓ 0.0
Loowit Creek	1	0.6	0.8	11	24.8	▓ 0.1	░ 46.0
	2	0.3	1.4	4.3	17.6	0.2	░ 51.0
M. Fk. Of N. Fk. Klaskanine	1	2.7	3.6	░ 6.1	18.0	▓ 0.3	░ 41.0
	2	5.1	9.6	11.2	13.9	▓ 0.3	░ 46.0
North Fork Klaskanine	1	4.3	1.5	4	░ 45.5	░ 0.7	░ 63.0
	2	3.6	2.0	4.4	░ 39.2	░ 0.7	░ 53.0
	3	2.9	4.5	9.6	26.4	0.5	░ 40.0
	4	0.9	1.6	▓ 48	░ 54.3	0.3	28.0
	5	1.5	9.8	0	▓ 0.0	▓ 0.0	24.0
S Fk S Fork Klaskanine	1	4.4	3.3	4.4	25.3	▓ 0.4	17.0
	2	1.1	2.7	1.3	░ 38.6	░ 0.5	23.0
	3	2.6	4.0	░ 5.3	17.2	▓ 0.4	19.0
South Fork Klaskanine	1	5.6	0.9	2.4	░ 75.9	░ 0.6	░ 38.0
	2	6.2	1.4	1.8	░ 51.8	░ 0.7	33.0
	3	4.6	1.7	4.6	34.4	░ 0.6	28.0
	4	3.5	2.7	4.9	░ 37.7	░ 0.8	▓ 12.0
	5	4.2	1.9	3.9	28.5	░ 0.6	15.0
	6	6.0	2.7	3.5	33.9	░ 0.6	22.0
Speelyai Creek	1	0.4	1.1	3.2	22.3	░ 0.8	░ 73.0
	2	2.3	1.6	░ 5.1	29.5	0.3	33.0

░ = Desirable ▓ = Undesirable □ = Moderate

In general, most surveyed streams lacked LWD pieces, volume and key pieces (Table 3.4). The Middle Fork of the North Fork Klaskanine had desirable LWD conditions despite a generally undesirable riparian conifer condition. Riparian conditions followed this trend of poor LWD conditions, with most streams not having sufficient conifers in the riparian zones (Table 3.5). Surveyed streams in the Youngs Bay watershed had poor instream large woody debris most likely as a result of very few old conifers growing in the riparian areas.

Table 3.4. Large woody debris conditions in the Youngs Bay watershed as compared to ODFW habitat benchmark values. Benchmark values for stream habitat conditions have been provided in Table 3.1. Data were collected by ODFW.

				Woody Debris		
Stream	Reach	Stream Miles	Gradient (%)	# Pieces / 100m	Volume (m^3/100m)	# Key Pieces / 100m
Hartill Creek	1	0.6	0.5	0.0	0.0	0.0
	2	0.2	11.2	0.0	0.0	0.0
Klickitat Creek	1	0.7	7.0	0.0	0.0	0.0
Loowit Creek	2	0.3	1.4	0.0	0.0	0.0
	1	0.6	0.8	0.0	0.0	0.0
M. Fk. Of N. Fk. Klaskanine	1	2.7	3.6	23.9	39.1	1.1
	2	5.1	9.6	28.0	51.6	2.4
North Fork Klaskanine	1	4.3	1.5	10.9	11.1	0.5
	2	3.6	2.0	14.6	15.5	0.5
	3	2.9	4.5	18.2	36.8	0.9
	4	0.9	1.6	9.9	15.9	0.0
	5	1.5	9.8	23.8	84.3	0.9
S Fk S Fork Klaskanine	1	4.4	3.3	26.5	39.3	0.0
	2	1.1	2.7	18.4	15.1	0.0
	3	2.6	4.0	25.0	21.3	0.0
South Fork Klaskanine	1	5.6	0.9	14.8	14.5	0.0
	2	6.2	1.4	26.9	30.3	0.0
	3	4.6	1.7	14.0	18.9	0.0
	4	3.5	2.7	11.5	30.9	0.0
	5	4.2	1.9	14.4	22.8	0.0
	6	6.0	2.7	20.8	43.3	0.0
Speelyai Creek	1	0.4	1.1	0.0	0.0	0.0
	2	2.3	1.6	0.0	0.0	0.0

░ = Desirable ▓ = Undesirable □ = Moderate

3.2.3 Shade

Shade conditions in the streams surveyed were generally desirable with only 1 out of the 23 reaches surveyed showing less than desirable conditions (Table 3.5). Riparian conifer conditions were undesirable in most reaches, suggesting that much of the shading may coming from hardwood stands such as alder or other vegetation.

Table 3.5. Riparian conifer conditions in the Youngs Bay watershed as compared to ODFW habitat benchmark values. Benchmark values for stream habitat conditions have been provided in Table 3.1. Data were collected by ODFW.

Stream	Reach	Stream Miles	Gradient (%)	Width (m)	Shade (%)	# Conifers > 20 in dbh per 1,000 ft stream length	# Conifers > 35 in dbh per 1,000 ft stream length
Hartill Creek	1	0.6	0.5	2.1	74	0	0
	2	0.2	11.2	2.7	80	0	0
Klickitat Creek	1	0.7	7.0	1.2	81	0	0
Loowit Creek	1	0.6	0.8	3.0	91	0	0
	2	0.3	1.4	3.1	96	0	0
M. Fk. Of N. Fk. Klaskanine	1	2.7	3.6	3.4	91	81	71
	2	5.1	9.6	2.8	91	88	88
North Fork Klaskanine	1	4.3	1.5	5.3	81	17	8
	2	3.6	2.0	4.0	92	15	0
	3	2.9	4.5	3.0	90	24	12
	4	0.9	1.6	1.4	84	0	0
	5	1.5	9.8	0.7	83	244	244
S Fk S Fork Klaskanine	1	4.4	3.3	4.2	85	0	0
	2	1.1	2.7	4.2	73	0	0
	3	2.6	4.0	4.0	77	0	0
South Fork Klaskanine	1	5.6	0.9	6.0	74	0	0
	2	6.2	1.4	5.1	80	0	0
	3	4.6	1.7	6.4	68	0	0
	4	3.5	2.7	7.3	78	0	0
	5	4.2	1.9	5.6	89	0	0
	6	6.0	2.7	4.6	86	0	0
Speelyai Creek	1	0.4	1.1	3.4	80	0	0
	2	2.3	1.6	3.5	93	0	0

░ = Desirable ▓ = Undesirable □ = Moderate

3.3 Riparian Conditions

The riparian zone is the area along streams, rivers and other water bodies where there is direct interaction between the aquatic and terrestrial ecosystems. The riparian zone ecosystem is one of the most highly valued and highly threatened in the United States (Johnson and McCormick 1979; National Research Council 1995, in Kauffman et al. 1997). Riparian vegetation is an important element of a healthy stream system. It provides bank stability, controls erosion, moderates water temperature, provides food for aquatic organisms and large woody debris to increase aquatic habitat diversity, filters surface runoff to reduce the amount of sediments and pollutants that enter the stream, provides wildlife habitat, dissipates flow of energy, and stores water during floods (Bischoff 2000). Natural and human degradation of riparian zones diminishes their ability to provide these critical ecosystem functions.

The Clatsop County GIS office provided digital orthophotos taken in 1994 for all of Clatsop County. The riparian assessment was performed using ArcInfo software. A stream channel data layer was overlayed on the orthophotos and a buffer was drawn on each side of the streams. The vegetation composition and continuity were assessed within this buffer.

The riparian zone is the primary source of natural large woody debris (LWD). The riparian assessment used two buffer widths for the evaluation of streamside vegetation. These two widths (RA1 and RA2) were based on ecoregion and side slope constraint and represent the area most likely to deliver large woody debris into the stream channel. The RA2 width was always 100 feet. RA1 widths are shown in Table 3.6.

Table 3.6 RA1 widths based on channel constrainment and ecoregion (WPN 1999).

	RA1 Width (ft)		
Constraint	Coastal Lowlands	Coastal Uplands	Willapa Hills
Unconstrained	25	75	75
Moderately Constrained	25	50	50
Constrained	25	25	25

3.3.1 Large Woody Debris Recruitment Potential

Riparian vegetation was categorized as having a high, moderate, and low potential for large woody debris recruitment. Vegetation classes defined as coniferous or mixed in the large class (>24 inch dbh) had a high potential for LWD recruitment. Coniferous or mixed vegetation in the medium size class (12-24 inch dbh), and hardwoods in the medium to large class, had moderate potential for LWD recruitment .

Almost half of all the subwatersheds in the Youngs Bay watershed were considered inadequate for LWD recruitment, with the remaining half typically in the moderate category (Table 3.7). None of the riparian areas in the Youngs Bay watershed demonstrated an adequate potential to contribute LWD to the stream channel. These conditions are likely the result of heavy historical clearcutting for timber in the watersheds, generally leaving the forests in a

Table 3.7. Potential Wood Recruitment in the Youngs Bay watershed, based on aerial photo interpretation conducted by E&S.

	Total Stream Miles	Inadequate (%)	Moderate (%)	Adequate (%)	Estuarine Wetlands (%)	Palustrine Wetlands (%)
Lower Lewis & Clark River	32	59.5	24.8	0.0	0.09	15.6
N Fork Klaskanine River	57	36.4	61.8	0.0	0.00	1.8
S Fork Klaskanine River	50	48.5	50.6	0.0	0.00	1.0
Upper Lewis & Clark River	99	57.1	40.7	0.0	0.00	2.2
Upper Youngs River	84	56.2	40.9	0.0	0.00	2.9
Youngs Bay East	44	43.8	43.7	0.0	3.58	8.9
Youngs Bay Mouth	7	50.9	0.0	0.0	3.05	46.1
Youngs Bay West	28	68.7	14.1	0.0	0.21	17.0
Total	401	52.4	41.4	-	0.47	5.79

regenerative state (small to medium conifers; Table 1.2). Several of the lower elevation subwatersheds (Lower Lewis & Clark, Youngs Bay Mouth, Youngs Bay East) had riparian wetlands accounting for 16 to 46 percent of the riparian areas (Figure 3.2). Although wetlands may or may not contribute LWD to the stream channel depending on the wetland type, they do provide several important habitat features such as back channels and cover. Many of these wetlands are diked and disconnected from the stream limiting access to this habitat. Diking and wetlands is further discussed below in the wetland section (Section 3.6)

3.3.2 Stream Shading

Riparian vegetation provides shade that helps control stream temperature in the summer. While shade will not actually cool a stream, riparian vegetation blocks solar radiation before it reaches the stream and prevents the stream from heating (Bischoff 2000, Beschta 1997, Boyd and Sturdevant 1997, Beschta et al. 1987). The shading ability of the riparian zone is determined

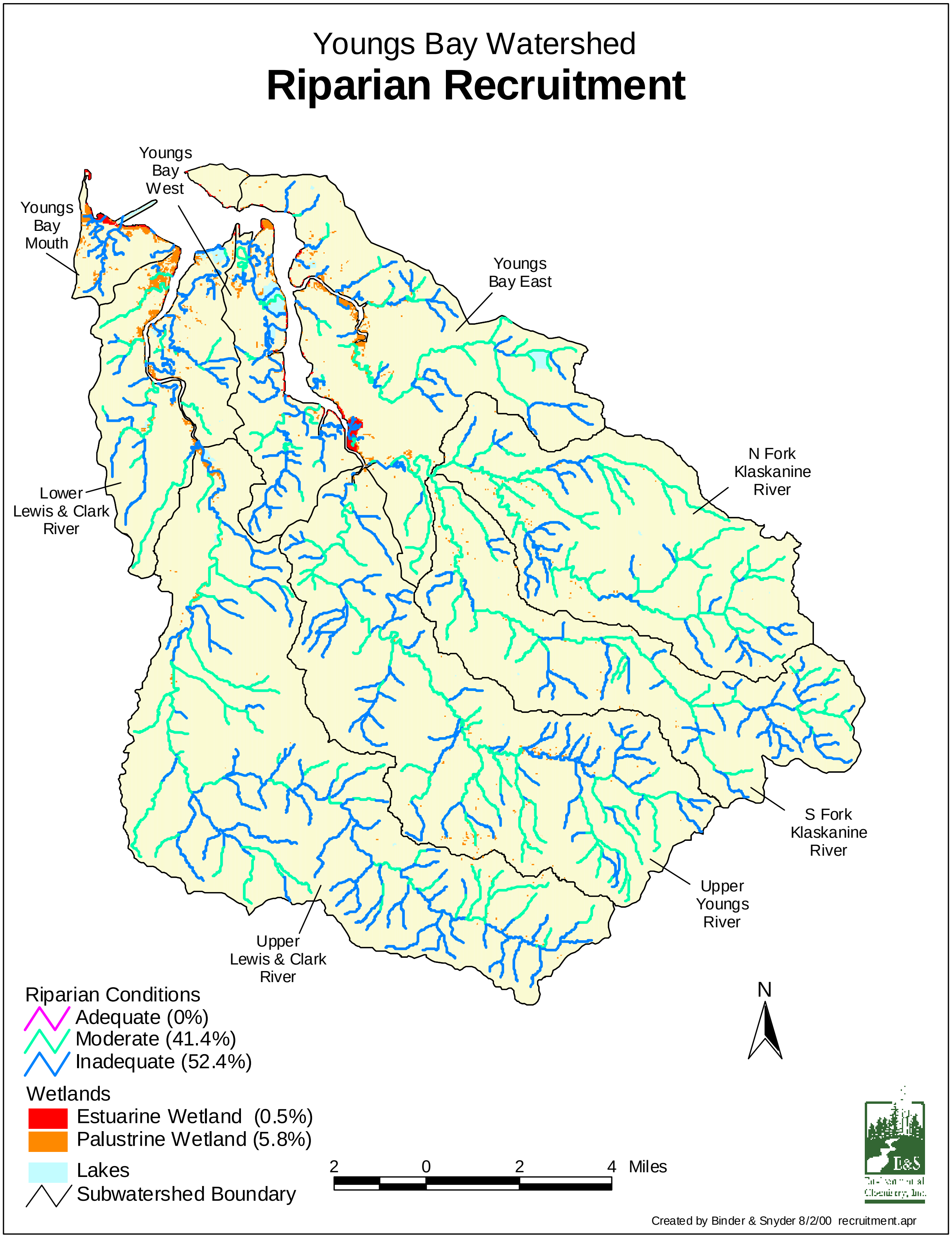

Figure 3.2. Large woody debris recruitment potential in the Youngs Bay watershed. Data were developed from aerial photo interpretation conducted by E&S Environmental Chemistry, Inc. Photos used were black and white and taken in 1994.

by the quality and quantity of vegetation present. The wider the riparian zone and the taller and more dense the vegetation, the better the shading ability (Beschta 1997, Boyd and Sturdevant 1997). Current shade conditions for the Youngs Bay watershed were estimated from the aerial photo interpretation.

Stream shading conditions were generally moderate to good across the watershed (Table 3.8). High shading conditions ranged from 0 to 72 percent of the total stream lengths in the subwatersheds. The lower elevation subwatersheds (Youngs Bay West, Youngs Bay Mouth, Youngs Bay East) had large proportions of wetlands in the riparian areas, ranging from 16 to 46 percent (Figure 3.3). Wetlands can provide shade from vegetation, although many of these wetlands are diked and disconnected from the stream as a result of development and agriculture. Shading values of wetlands need to be evaluated on a wetland by wetland basis.

Table 3.8. Current stream shading conditions in the Youngs Bay watershed, based on aerial photo interpretation conducted by E&S.

	Total Stream Miles	% Low	% Medium	% High	Estuarine Wetlands (%)	Palustrine Wetlands (%)
Lower Lewis & Clark River	32	26	19	39	0.09	15.6
N Fork Klaskanine River	57	10	16	72	-	1.8
S Fork Klaskanine River	50	12	23	64	-	1.0
Upper Lewis & Clark River	99	12	19	67	-	2.2
Upper Youngs River	84	12	26	59	-	2.9
Youngs Bay East	44	23	14	51	3.58	8.9
Youngs Bay Mouth	7	37	14	0	3.05	46.1
Youngs Bay West	28	47	14	21	0.21	17.0
Total	401	17	19	58	0.47	5.8

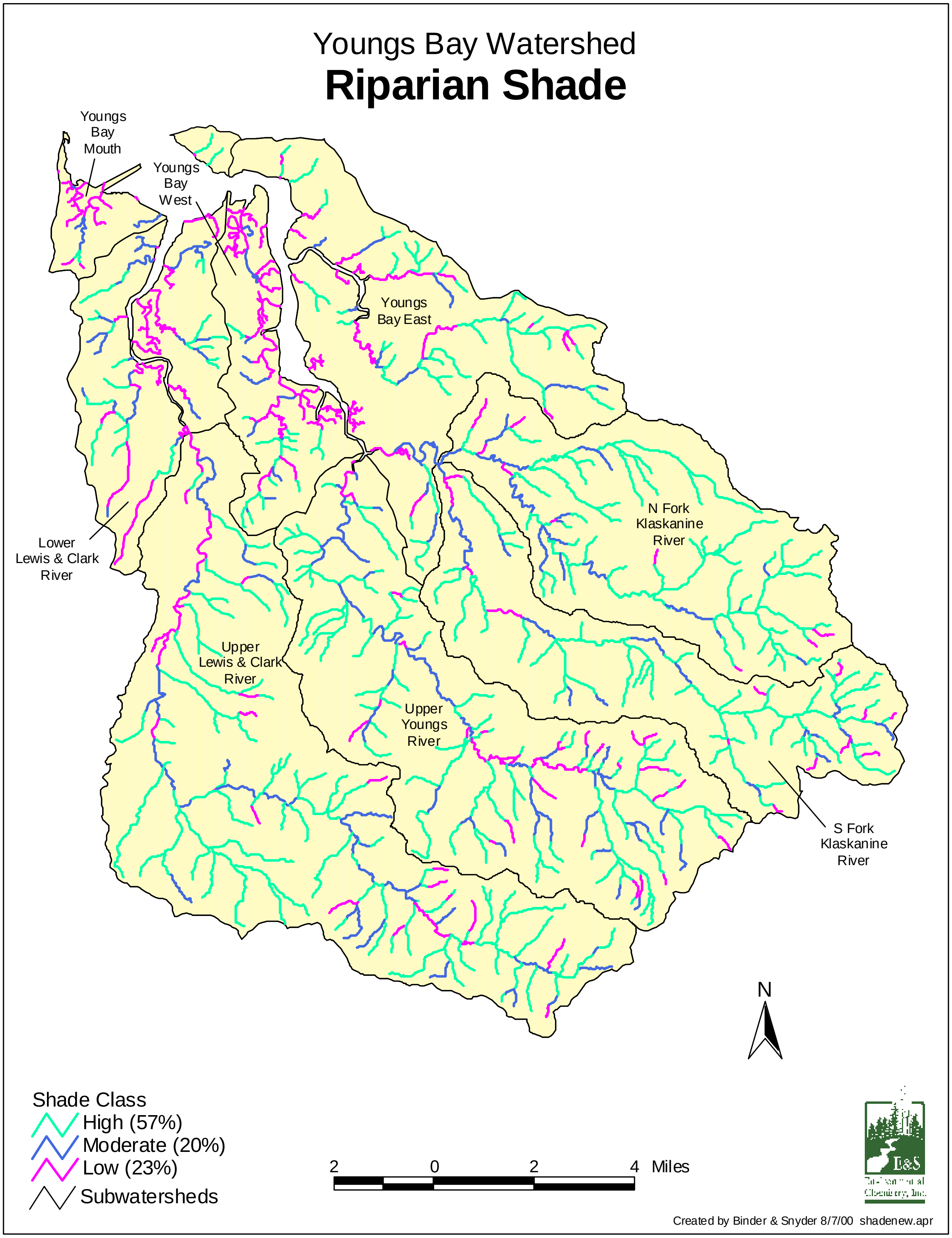

Figure 3.3. Riparian shade conditions in the Youngs Bay watershed. Data were developed from aerial photo interpretation conducted by E&S Environmental Chemistry, Inc. Photos used were black and white and taken in 1994.

3.4 Fish Passage Barriers

Stream channels are often blocked by poorly designed road culverts at road crossings. This has resulted in significant loss of fish habitat. Anadromous fish migrate upstream and downstream in search of food, habitat, shelter, spawning beds, and better water quality. Fish populations can be significantly limited if they lose access to key habitat areas. One study estimated the loss of fish habitat from forest Roads to be 13 percent of total coho summer rearing habitat (Beechie et al. 1994). Another study reported as many as 75 percent of culverts in some forested drainages are either impediments or outright blockages to fish passage based on surveys completed in Washington State (Conroy, 1997). Surveys of County and State Roads in Oregon have found hundreds of culverts that at least partially block fish passage. Potential effects from the loss of fish passage include loss of genetic diversity by isolation of reaches, loss of range for juvenile anadromous and resident fish and loss of resident fish from extreme flood or drought events (prevents return).

3.4.1 Culverts

Culverts can pose several types of problems including excess height, excessive water velocity, insufficient water depth in culvert, disorienting flow patterns and lack of resting pools between culverts. Culverts can also limit fish species during certain parts of their life cycles and not others. For example, a culvert may be passable to larger adult anadromous fish and not juveniles. Culverts may also act as passage barriers only during particular environmental conditions such as high flow events. Because of these variable efforts, it is important to understand the interactions of habitat conditions and life stage for anadromous fish.

There are 638 stream/road crossings in the Youngs Bay watershed (Table 3.9). ODFW conducted a survey of culverts for state and county roads. Of the 36 culverts surveyed by ODFW, 29 did not meet standards, suggesting that they block access to critical habitat areas. Many of these impassable culverts occurred in the lower portions of the watershed blocking access to rather large areas of the watershed (Figure 3.4). The data did not identify whether the culverts were impassable under all environmental conditions (i.e. low flow, high flow). Current data suggest that impassable culverts are a widespread problem in the Youngs Bay watershed. Culverts blocking access to critical fish habitat areas need to be upgraded to improve fish passage. Culverts on Willamette Industry land are currently being evaluated and either repaired or replaced under their 10 year road plan (see section 6.4.1).

Table 3.9. Culverts and road/stream crossings in the Youngs Bay watershed. Road/ stream crossings were generated using GIS. Culvert data were provided by ODFW.

Subwatershed	Area (mi^2)	Surveyed Culverts*		Road-Stream Crossings	
		# Surveyed	# impassable		
Lower Lewis & Clark River	14	3	2	41	2.9
N Fork Klaskanine River	26	9	8	87	3.3
S Fork Klaskanine River	23	7	7	79	3.4
Upper Lewis & Clark River	47	1	1	137	2.9
Upper Youngs River	37	1	1	154	4.2
Youngs Bay East	24	9	6	77	3.2
Youngs Bay Mouth	2.8	1	1	17	6.1
Youngs Bay West	9.2	5	3	46	5.0
Total		36	29	638	

*Culverts surveyed by ODFW for county and state roads

3.4.2 Natural Barriers

Most of the natural fish passage barriers that occur in the Youngs Bay watershed are water falls. Many of the tributaries to the Lewis & Clark River have falls including Stavebolt Creek, Hartill Creek, and Klickitat Creek. There is a possible fish passage barrier at low flows on the mainstem Lewis & Clark River just above the confluence with the Little South Fork and the South Fork Lewis & Clark Rivers. There is also a large falls on the mainstem Lewis & Clark River near the headwaters (Figure 3.4). There is a falls on the Youngs River a little over a mile upstream from where the river flows into the bay. There is also a 25 ft falls on the South Fork Klaskanine River.

3.4.3 Other Barriers

A reservoir with an “adequate” fish ladder is located a few miles upstream from the South Fork confluence on the Lewis & Clark River. The Klaskanine fish hatchery blocks the North Fork of the North Fork Klaskanine.

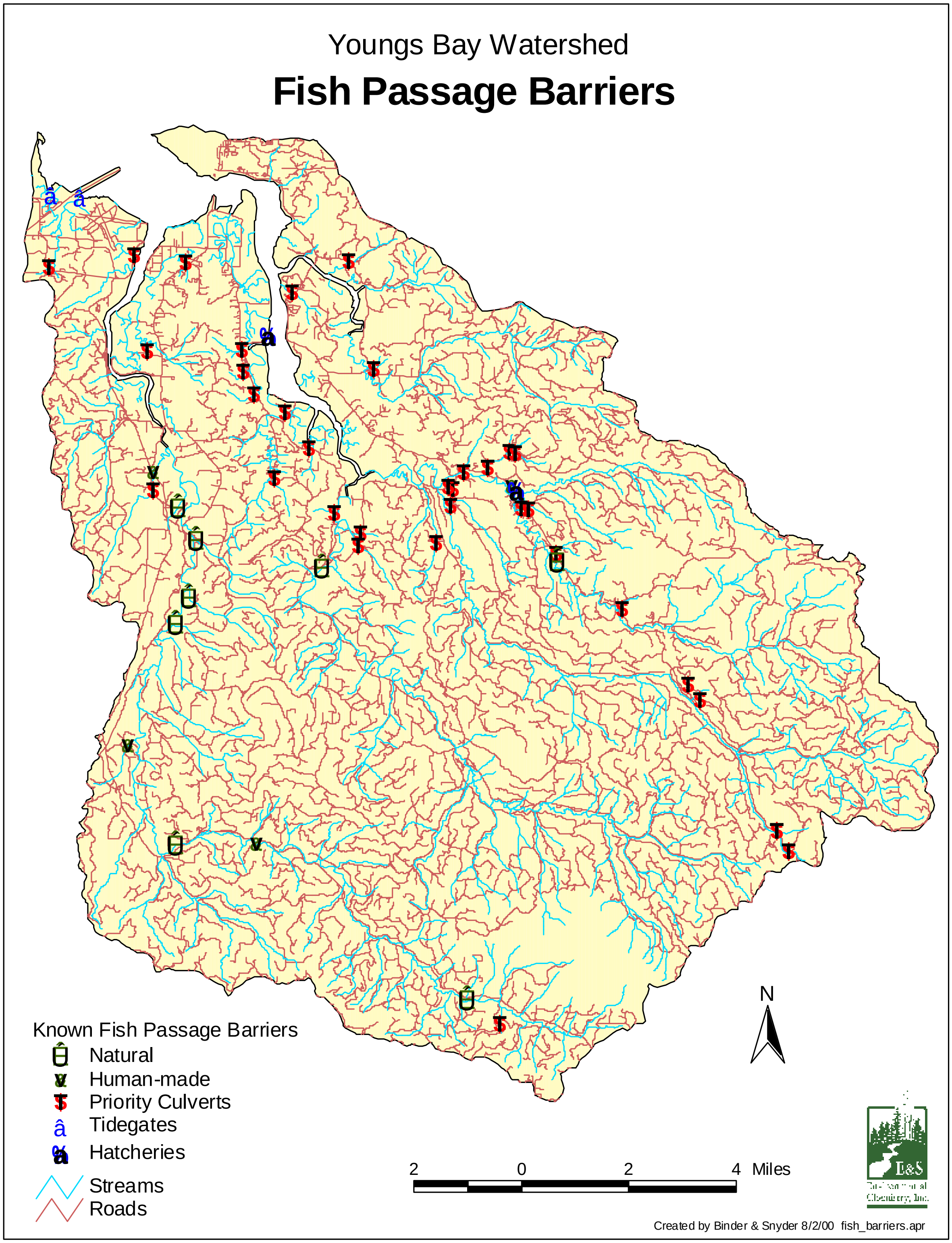

Figure 3.4. Road/stream crossings and known fish passage barriers in the Youngs Bay watershed. Road/stream crossings were generated using GIS. Culvert data were provided by ODFW.

3.5 Channel Modifications

In-channel structures and activities such as dams, dredging or filling can adversely affect aquatic organisms and their associated habitats by changing the physical character of the stream. These changes can ultimately lead to a change in the community composition of instream aquatic biota. Identifying channel modification activities can address how human-created channel disturbances affect channel morphology, aquatic habitat, and hydrologic functioning.

3.5.1 Channelization and Dredging

Youngs Bay has a long history of dredging to maintain navigability for the Port of Astoria. The lower 4.5 mi of the Lewis & Clark River were dredged in 1973 with dredge spoils being placed on diked areas along the river (ACOE 1973). Historically, the Lewis & Clark River has been dredged to maintain navigability, including dredging in 1956 and 1962. The history of dredging is too extensive to list here. However, Youngs Bay has been historically altered to maintain channel navigability which has led to losses in aquatic habitats. The only known Dredged Material Disposal Site for Columbia River dredged material is located on the spit between Youngs Bay and the entrance to the Skipanon River (ACOE 1999).

3.5.2 Diking

Disconnecting the floodplain from the stream can lead to stream simplification and downcutting due to increased water velocities, resulting in deteriorated habitat conditions. Additionally, disconnection from the floodplain can lead to changes in the biotic structure of the stream by limiting nutrient and organic material exchanges between the stream and floodplain.

By far, the most significant alteration to Youngs Bay has been from diking for flood protection. Substantial portions of the lower Youngs Bay watershed have been drained and diked (Figure 3.5). Between 1917 and 1939, extensive diking occurred in the Youngs Bay watershed extending throughout the south portion of the bay along the entire stretch of the Lewis & Clark River as well as the Youngs River. Many of the original levees were reconstructed under the 1936 Flood Control Act (Leach 1980). Current dikes in the Youngs Bay watershed are shown in Figure 3.5. Diking and wetland loss will be further discussed in the Wetlands section (section 3.6).

Pile dikes are also found in Youngs Bay as well as along the south jetty of the Clatsop Spit. These pilings indicate that tugs and log booms have operated on these rivers almost to the

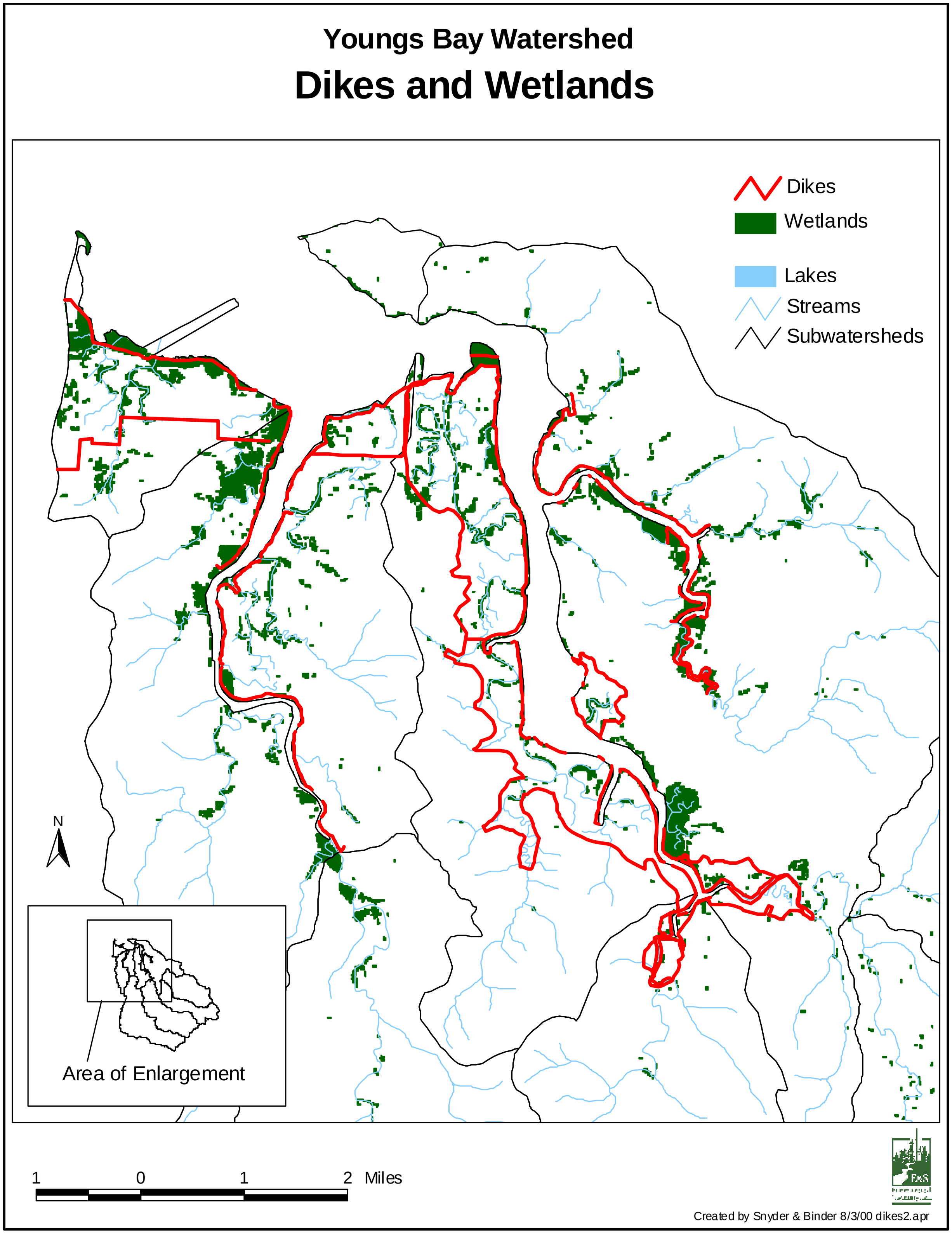

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Figure 3.5. Location of dikes and wetlands in the Youngs Bay watershed. Dike data were provided by the Army Corps of Engineers.

present day tide head. The tide head for the Youngs River is at river mile 4.3 and for the Lewis & Clark River at river mile 8.

3.5.3 Log Storage

Historically, log storage was a common occurrence in the Columbia River Estuary. Youngs Bay was used for in-water log handling and storage since it was protected from wind and waves (Envirosphere Company 1981). Logs were rafted within Youngs Bay and upriver on the Youngs, Lewis and Clark, Wallooskee and Klaskanine Rivers. Logs were stored in the backwater areas and sloughs and extended up into the Youngs River and Lewis and Clark arms of Youngs Bay. In fact, it was reported that the logs were taken over the 69 ft falls on the Youngs River during high waters (Farnell 1981). Only the Lewis & Clark River was used above the tide head for storage of logs. Log dump sites with a floating saw mill preceding the Palmer Rail Road were found on the Wallooskee near where the river narrows and the railroad ends at about river mile two. On the Klaskanine River, a log dump area was located between Grant Island and the confluence of the Wallooskee. On the Lewis and Clark a log dump site was located on the west bank, below tidal extent and just upriver from the winter camp site of Lewis and Clark (Fort Clatsop National Memorial). Log storage can lead to losses of benthic habitats due to physical destruction as a result of log grounding and water quality degradation as a result of log leachate and debris. Currently, logs are no longer stored in Youngs Bay.

3.5.4 Splash Damming

A splash dam was erected in 1894 by the Olson brothers on the Lewis & Clark River, just above the canyon at River Mile 17. This dam was constructed to assist the logs in getting through the canyon. From miles 8-16 the log drives were unassisted to tidewater.

3.5.5 Railroads

Railroads were used extensively throughout Clatsop County, to move logged timber to processing centers. Many of these railroads would follow the rivers and streams. Consequently, construction of the railroads led to dikes, bridges and other channel modifications that have impacted the habitats of the Youngs Bay watershed. More detailed information on the railroads in Clatsop County can be found in Appendix A.

3.6 Wetlands

Wetlands contribute critical functions to a watersheds health such as water quality improvement, flood attenuation, groundwater recharge and discharge, and fish and wildlife habitat. Because of the importance of these functions, wetlands are regulated by both State and Federal agencies. Determining the location and extent of wetlands within a watershed is critical to understanding watershed processes.

3.6.1 National Wetlands Inventory

The primary source for wetland information used in this assessment was National Wetlands Inventory maps created by the U.S. Fish and Wildlife Service. Very few of the NWI quads were digitized for the Youngs Bay watershed, so information was generally derived from hard copy NWI maps. NWI Maps were created from interpretation of 1:58,000-scale aerial photos that were taken in August of 1981. It is important to note that NWI wetland maps are based on aerial photo interpretation and not on ground based inventories of wetlands. On-the-ground inventories of wetlands often identify extensive wetlands that are not on the NWI maps.

3.6.2 Wetland Extent and Types

Because digital NWI data were not available, wetland extent was calculated from the refined land use coverage generated as a part of this study. Wetlands were identified from a 1991 LANDSAT image obtained from CREST and C-CAP. The image was classified and field verified by C-CAP using local wetland inventories and hard copy NWI data. Where NWI data were available in digital form, it was used to update the refined land use map.

Wetlands are an important landscape feature in the Youngs Bay watershed, representing a little more than one percent of the total watershed (Table 3.10). The predominant wetland type is palustrine wetlands. Palustrine wetlands are defined as all non-tidal wetlands dominated by trees, shrubs, and persistent emergents and all wetlands that occur in tidal areas with a salinity below 0.5 parts per thousand (Mitsch and Gosselink 1993, Cowardin et al. 1979). Estuarine wetlands represent less than 0.2 percent of the watershed and are concentrated in the Youngs Bay Mouth subwatershed. Estuarine wetlands are defined as deepwater tidal habitats and adjacent tidal wetlands that are usually semiclosed by land but have open, partially obstructed, or sporadic access to the ocean and in which ocean saltwater is at least occasionally mixed with freshwater (Mitsch and Gosselink 1993, Cowardin et al. 1979).

Table 3.10. Wetland area in the Youngs Bay watershed. Wetland area was calculated from the refined land use cover (see Chapter 1).

	Grand Total mi^2	Estuarine Wetland %	Palustrine Wetland %
Lower Lewis & Clark River	14.3	0.14	4.71
N Fork Klaskanine River	26.3	-	0.35
S Fork Klaskanine River	23.2	-	0.26
Upper Lewis & Clark River	47.2	-	0.40
Upper Youngs River	36.6	-	0.52
Youngs Bay East	23.9	0.85	2.28
Youngs Bay Mouth	2.7	3.10	12.55
Youngs Bay West	9.2	0.58	3.83
Total	183.5	0.20	1.33

The Cowardin classification system is used by the NWI and others in classifying wetlands based on wetland type, vegetation or substrate type, and hydrology. The classification system is a hierarchical approach where the wetland is assigned to a system, subsystem, class, subclass, and water regime. Common types and characteristics of wetlands in the Youngs Bay watershed are shown in Table 3.11.

Wetland types are dominated by palustrine emergent wetlands generally located in the lower elevations of the watershed. The lowlands are characterized by emergent palustrine wetlands generally in the floodplains of Lewis & Clark, Youngs, and Wallooskee Rivers. Some higher elevation wetlands do exist and generally are forested and emergent wetlands. Palustrine scrub-shrub wetlands are generally scattered throughout the watershed.

3.6.3 Wetlands and Salmonids

Wetlands play an important role in the life cycles of salmonids (Lebovitz 1992, Shreffler et al. 1992, MacDonald et al. 1987, Healey 1982, Simenstad et al. 1982). Estuarine wetlands provide holding and feeding areas for salmon smolts migrating out to the ocean. These estuarine wetlands also provide an acclimation area for smolts while they are adapting to marine environments. Riparian wetlands can reduce sediment loads by slowing down flood water, allowing sediments to fall out of the water column and accumulate (Mitsch and Gosselink 1993). Wetlands also provide cover and a food source in the form of a diverse aquatic invertebrate

Table 3.11. Common NWI wetland types listed in the Youngs Bay watershed. Wetland codes are from the Cowardin Wetland Classification used by NWI (Cowardin 1979).

Code	System	Class	Water Regime
E2USN	E=estuarine	US=Unconsolidated shore	N=Regularly Flooded
E2EMN	E=estuarine	EM=emergent	N=Regularly Flooded
PSSW	P= palustrine	SS=Scrub/Shrub	W=Intermittently Flooded
PSSC	P= palustrine	SS=Scrub/Shrub	C = Seasonally flooded
PEMF	P= palustrine	EM=emergent	F= Semipermanently flooded
PEMC	P= palustrine	EM=emergent	C = Seasonally flooded
PEMCh	P= palustrine	EM=emergent	C = Seasonally flooded h=Diked/impounded
PEMFb	P= palustrine	EM=emergent	F= Semipermanently flooded b= beaver
PFOA	P= palustrine	FO=Forested	A=Temporarily Flooded
PSSR	P= palustrine	SS=Scrub/Shrub	R=Seasonal/Tidal
PEMT	P= palustrine	EM=emergent	T=Semipermanent -tidal
PEMR	P= palustrine	EM=emergent	R=Seasonal/Tidal
PEMA	P= palustrine	EM=emergent	A=Temporarily Flooded
PUBH	P= palustrine	UB=Unconsolidated Bottom	H=Permanently Flooded
PUBHh	P= palustrine	UB=Unconsolidated Bottom	H=Permanently Flooded h=Diked/impounded
PSSY	P= palustrine	SS=Scrub/Shrub	Y=Saturated/Semipermanent/ Seasonal
PFOW	P= palustrine	FO=Forested	W=Intermittently Flooded
PFOY	P= palustrine	FO=Forested	Y=Saturated/Semipermanent/ Seasonal

community. Backwater riparian wetlands also provide cover during high flow events, preventing juvenile salmon from being washed downstream.

Wetlands that intersect streams represent important salmonid habitats (WPN 1999, Lebovitz 1992). Stream lengths that ran through both estuarine and palustrine wetlands were calculated using GIS. Of the 810 mi of streams in the Youngs Bay watershed, 47 mi (5.8 percent) passed through or are a part of palustrine wetlands (Figure 4,6; Table 3.12). Most of these wetlands are concentrated in the lower elevations of the watershed including the Youngs Bay Mouth and lower Lewis & Clark subwatersheds. These wetlands are of particular importance to salmonids in that they are connected to streams and are accessible for habitat utilization. It is important to note that wetland locations were generated from a LANDSAT image in GIS and need to be field verified to determine actual location. Additionally, it is unclear as to the current function of the wetlands, i.e., are they modified or disconnected from the stream.

3.6.4 Filling and Diking of Wetlands

Wetlands have been one of the landscape features most impacted by human disturbances. In the Pacific Northwest, it is estimated that 75 percent of wetlands have been lost to human disturbances (U.S. Fish and Wildlife Service and Canadian Wildlife Service 1990). Somewhere between 50 and 90 percent of tidal marshes in individual Oregon estuaries have been lost, most as a result of agricultural activities (Frenkel and Morlan 1991, Boule and Bierly 1987). Loss of wetlands connected to the stream system can lead to salmonid habitat loss and loss of flood attenuation.

Wetlands in the lower elevations of the watershed have been diked and disconnected from the streams (Figure 3.5). Almost the entire west bank of the Youngs River arm of Youngs Bay has been diked. Extensive diking has occurred in the tidal portions of the Lewis & Clark River as well as the Wallooskee River. Many of these wetlands may have once been tidal estuarine wetlands that have been disconnected as a result of draining from tidegates and dike construction. These practices remove the tidal influence, resulting in the loss of saltwater influences and leading to changes in the structure of the wetland.

3.6.5 Wetlands and Future Development

Development is generally restricted to the urban growth boundary which extends around the cities of Astoria and Warrenton. The urban growth boundary encompasses an area of approximately 4 sq. mi. in the lower elevations of the watershed. Almost 15 percent of the land within this urban growth boundary is occupied by wetlands, according to the land use cover. In fact, this is most likely an under representation of wetland extent in the urban growth boundary, since local wetland inventories tend to identify many more wetlands than are on the NWI maps

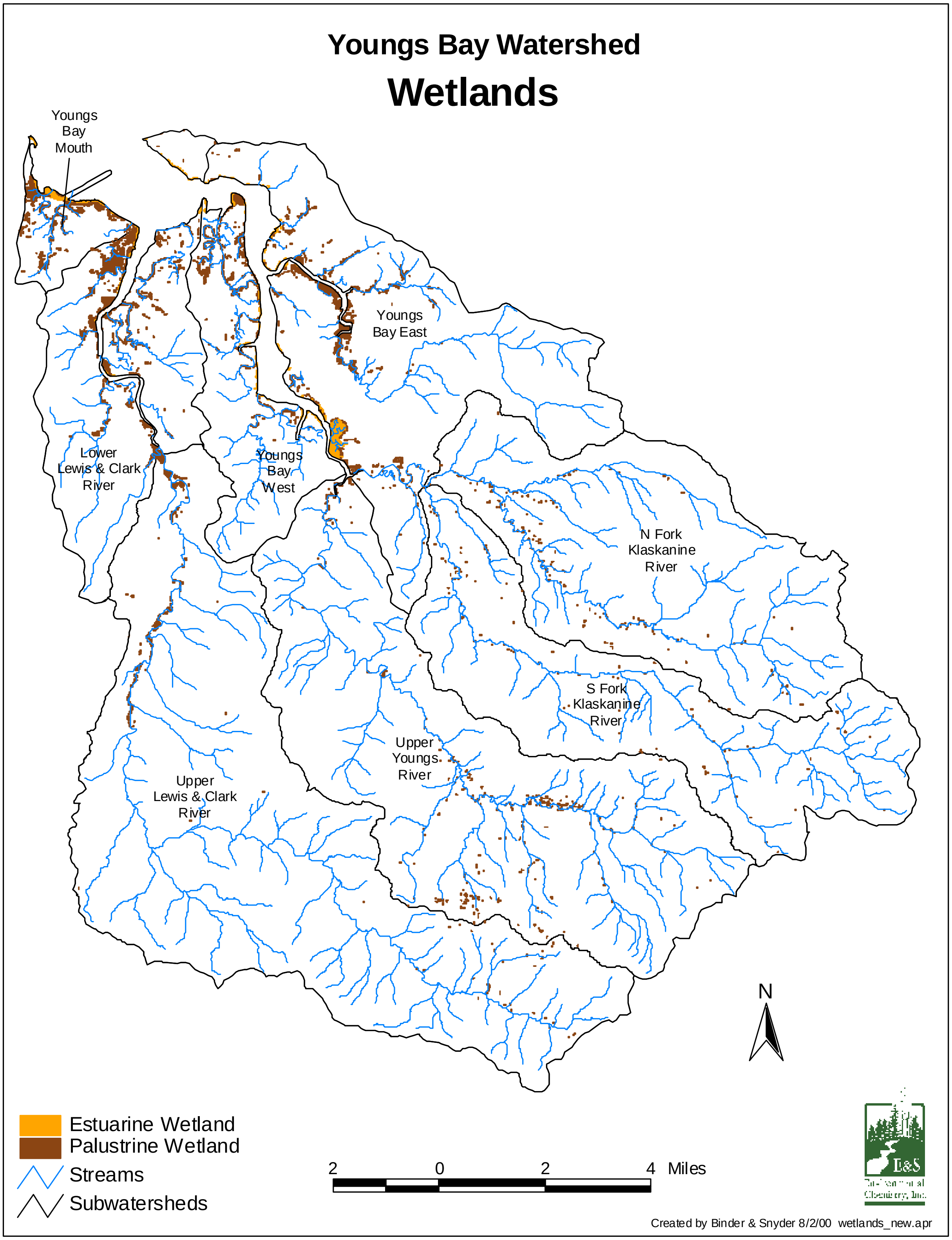

Figure 3.6. Wetlands and streams in the Youngs Bay watershed. Data shown are from the refined land use coverage (see Chapter 1).

Table 3.12. Percent stream channel length that intersect wetlands in the Youngs Bay watershed.

	Total Stream Miles	Estuarine Wetlands (%)	Palustrine Wetlands (%)
Lower Lewis & Clark River	32	0.09	15.6
N Fork Klaskanine River	57	0.00	1.8
S Fork Klaskanine River	50	0.00	1.0
Upper Lewis & Clark River	99	0.00	2.2
Upper Youngs River	84	0.00	2.9
Youngs Bay East	44	3.58	8.9
Youngs Bay Mouth	7	3.05	46.1
Youngs Bay West	28	0.21	17.0
Total	401	0.47	5.79

or identified from the LANDSAT image. Consequently, development has the potential to greatly impact wetlands within the urban growth boundary which may lead to the loss of important wetland functions. Wetlands are regulated so that any filling of wetlands must be mitigated by either wetland construction or restoration. However, it is unclear as to whether the mitigation wetland can replace the lost functions of a filled wetland.

3.7 Conclusions

Overall, data were insufficient to evaluate current fish passage problems in the Youngs Bay watershed. Only a small number of culverts have been evaluated. ODFW conducted a survey of culverts for state and county roads. Of the 36 culverts surveyed by ODFW, 29 did not meet standards, suggesting that they block access to critical habitat areas. Of 50 culverts on fish bearing or unknown streams, Willamette Industries identified and prioritized 35 culverts that may act as fish passage barriers. These data need to be combined and mapped in a GIS data base. Culverts should be prioritized according to fish usage or need to be evaluated. A good starting point is the road /stream crossing coverage developed as a part of this assessment.

Other fish passage barriers block large amounts of fish habitat. There is a falls on the Youngs River a quarter mile above tidewater. There is also a 25 ft falls on the South Fork Klaskanine River. A reservoir with an “adequate” fish ladder (downstream passage of steelhead is at least delayed) is located a few miles upstream from the South Fork confluence on the Lewis

& Clark River. The Klaskanine fish hatchery blocks the north fork of the North Fork Klaskanine. There is a possible fish passage barrier at low flows on the mainstem Lewis & Clark River just above the confluence with the Little South Fork and the South Fork Lewis & Clark Rivers.

In general, data were lacking to evaluate current stream morphology. Overall, the upper reaches of the Klaskanine River had desirable geomorphologic conditions. Gravel beds were generally desirable in these areas. These areas are could provide good spawning grounds for salmonids, especially coho, fall chinook, and winter steelhead. Access to these habitat areas are currently blocked by the Klaskanine River Falls. Both coho and fall chinook use the Lewis & Clark River, which has desirable morphologic characteristics except for residual pool depths.

Streams generally lacked instream LWD including key pieces, volume, and number of pieces. Much of this is probably a result of poor riparian recruitment. Streams within current fish distributions would benefit from instream LWD placement especially in the Lewis & Clark River. Coho are found in the Wallooskee River, although there is no data available on current instream conditions. Riparian recruitment was moderate in this watershed. Further investigation is needed to evaluate habitat in the Wallooskee River.

Estuarine wetlands were once common in the Columbia River estuary, including Youngs Bay. Many of these wetlands have been diked, disconnecting them from saltwater influences and changing the structure of the wetland. All existing estuarine wetlands currently accessible to salmonids need to be protected or restored. Those wetlands disconnected by dikes need to be evaluated for potential restoration.

Palustrine wetlands are a dominant feature in the Youngs Bay watershed. Stream side wetlands need to be protected especially those that are in current salmonid distributions. Streamside wetlands that have been disconnected due to diking need to evaluated for restoration opportunities. Other wetlands should be protected for their roles in maintaining water quality, flood attenuation, and habitat.

CHAPTER 4 HYDROLOGY

4.1 Introduction

Human activities in a watershed can alter the natural hydrologic cycle, potentially causing changes in water quality and aquatic habitats. These types of changes in the landscape can increase or decrease the volume, size, and timing of runoff events and affect low flows by changing groundwater recharge. Some examples of human activities that can affect watershed hydrology are timber harvesting, urbanization, conversion of forested land to agriculture, and construction of road networks. The focus of the hydrologic analysis component of this assessment is to evaluate the potential impacts from land and water use on the hydrology of the watershed (WPN 1999). It is important to note that this assessment only provides a screening for potential hydrologic impacts based on current land use activities in a watershed. Identifying those activities that are actually affecting the hydrology of the watershed would require a more in-depth analysis and is beyond the scope of this assessment.

4.2 General Watershed Characteristics and Peak Flow Processes

Peak flows occur as water moves from the landscape into surface waters. Peak flows are a natural process in any stream and are characterized by the duration and volume of water during the rise and fall of a hydrograph. The primary peak flow generating process for the Coast Range and its associated ecoregions is rain events. The Coast Range generally develops very little snow pack. Snow pack that does develop in the coastal mountains is only on the highest peaks and is of short duration. Rain-on-snow events are infrequent in the Coast Range although these events have contributed to some of the major floods, including the floods of 1964 and 1996. These large floods are rare events, and it is unlikely that current land use practices have exacerbated the flooding effects from rain-on-snow events. Additionally, none of the subwatersheds have mean elevations above 1,000 ft in the rain-on-snow zone (Table 4.1). This hydrologic analysis focuses on the effects of land use practices on the hydrology of these watersheds using rain events as the primary hydrologic process.

Table 4.1. Topographic features and precipitation amounts for the Youngs Bay watershed based on GIS calculations. Annual precipitation was estimated from the PRISM model (Daly 1994).

	Subwatershed Area (mi^2)	Mean Elevation (feet)	Minimum Elevation (feet)	Maximum Elevation (feet)	Mean Annual Precipitation (inches)
Upper Lewis & Clark River	47	745	0	3290	118
Upper Youngs River	37	780	0	3280	122
N Fork Klaskanine River	26	800	23	2650	118
Youngs Bay East	24	215	0	1160	91
S Fork Klaskanine River	23	880	23	2740	117
Lower Lewis & Clark River	14	90	0	415	78
Youngs Bay West	9.2	100	0	1125	84
Youngs Bay Mouth	2.8	15	0	270	74
Warren Slough	2.5	90	0	340	79
TOTAL	186	415	0	3290	98

4.3 Hydrologic Characterization

Discharge data are limited and there is currently no stream gage in the Youngs Bay watershed. Historically, both the Youngs River and the North Fork Klaskanine River were gaged (Table 4.2). At least a ten year period of record is needed for a gage to be considered representative (WPN 1999), and the North Fork Klaskanine River was gaged for only five years. Consequently, only the Youngs River data will be used in this analysis.

Table 4.2 USGS gaging stations in the Youngs River watershed.

Station Number	Station Name	Drainage Area (mi^2)	Datum (ft above NGVD)	Period of Record	Data Available
14251500	Youngs River near Astoria, OR	40	63	1927-1958	Mean Daily Flow; Peak Flow
14252000	NF Klaskanine R. near Olney, OR	14	214	1950-1955	Peak Flow

The Youngs River gage is located near Astoria, Oregon and represents approximately 40 sq. mi. of land. Discharge patterns for the Youngs River are typical of Oregon coastal watersheds, with the majority of high flows and storm events occurring between the months of October and

May (Figure 4.1). The summer season consists of base flow conditions with very few storm events.

Annual peak flow events range between 2,000 and 4,000 cfs, with the largest event on record reaching 4,750 cfs, occurring on February 10, 1946. Although no flood stage was established for this gaging station, the Nehalem River (gaged near Foss) exceeded floodstage by 100 cfs (21,600 cfs) during this time period. The smallest annual peak flow event was 1,280 cfs which occurred during a two year dry period in 1928 and 1929.

4.4 Potential Land Use Impacts on Peak Flows

Increased peak flows can have deleterious effects on aquatic habitats by increasing streambank erosion and scouring (ODFW 1997). Furthermore, increased peak flows can cause downcutting of channels, resulting in a disconnection from their floodplain. Once a stream is

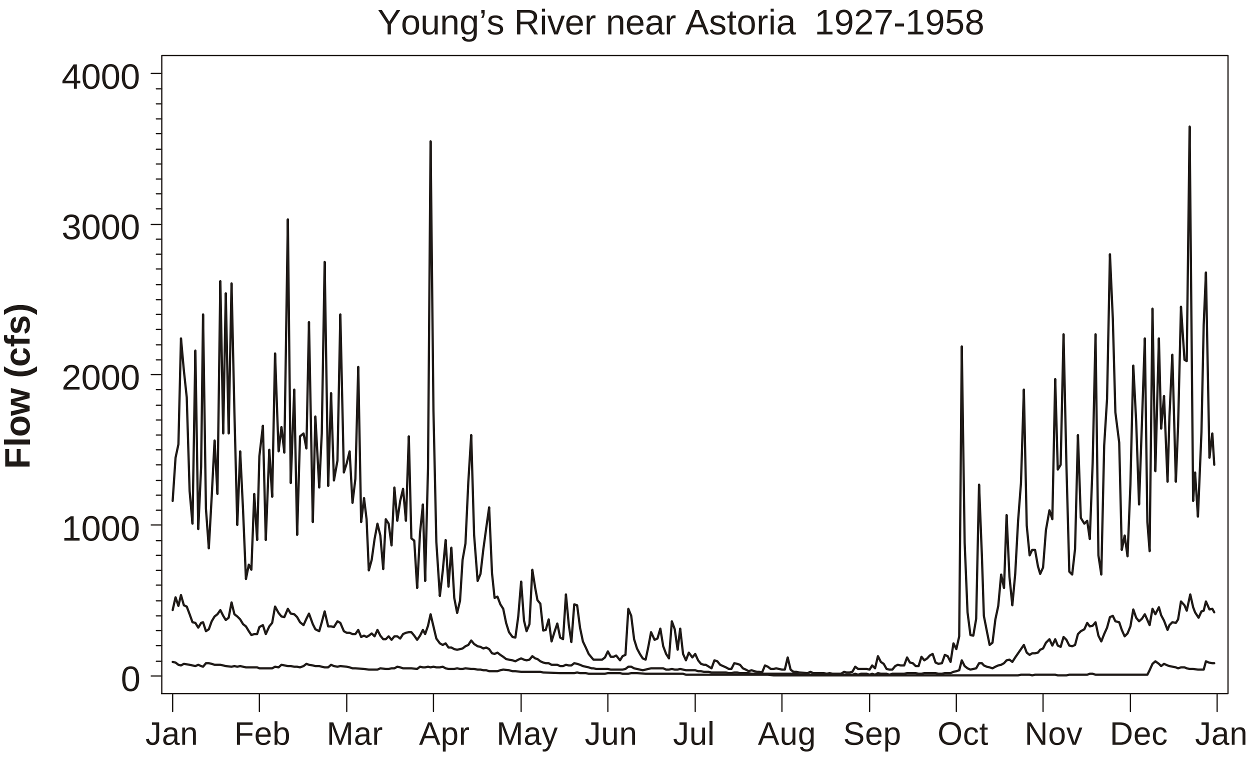

Figure 4.1. River discharge for the period of record. The top line is maximum mean daily flow, the center line is mean daily flow, and the bottom line is minimum mean daily flow. (Data from USGS)

disconnected from its floodplain, the downcutting can be further exacerbated by increased flow velocities as a result of channelization.

All subwatersheds in this component were screened for potential land use practices that may be influencing the hydrologic process associated with these watersheds (WPN 1999). This screening process only deals with the most significant processes affected by land use (i.e runoff). There are four potential land use practices that can affect the hydrology of a watershed: forestry, agriculture and rangeland, forest and rural roads, and urban or rural residential development.

4.4.1 Forestry Practices

The forestry portion of this analysis focuses heavily on the effects of forestry practices, such as timber harvest, on the peak flows in a watershed. These effects are generally most noticeable during either spring snowmelt events or rain-on-snow events (WPN 1999, Naiman and Bilby 1998). Since the Youngs Bay watershed is dominated by rain events, it is unlikely that forest harvest practices are influencing the peak flows of this watershed by increasing the effects of rain-on-snow events. However, because forest harvest practices are common in the watershed, there may be other effects on the watershed’s hydrology such as reductions in evapotranspiration, increased infiltration and subsurface flow, and increased overland flow (Naiman and Bilby 1998). These changes may result in modified peak and low flows.

4.4.2 Agriculture and Rangeland

The largest impact on the hydrology of the Youngs Bay watershed from agricultural land use is the draining and diking of wetlands. Agricultural land use is concentrated in the lower elevations of the watershed, generally in the old floodplain of the Lewis & Clark and Youngs Rivers. Historically, these floodplains were wetland areas that trapped rich sediments and accumulated plant material, resulting in rich fertile soils. Recognizing the economic value of these soils, these floodplains were drained and diked for agricultural purposes. Disconnecting the floodplain from the rivers has resulted in the loss of flood attenuation that is naturally provided by the floodplains ability to store and impede peak flows which can result in the downcutting of channels and increased flow velocities. Further discussion of disconnection of the floodplain and wetland loss can be found in Chapter 3 (Aquatic and Riparian Habitats).

4.4.3 Forest and Rural Roads

Road construction associated with timber harvest and rural development has been shown to increase wintertime peak flows of smaller floods in Oregon Coast Range watersheds (Harr 1983, Hicks 1990). This assessment uses a roaded area threshold of 8 percent to screen for potential impacts on peak flows (discharge increase >20 percent; WPN 1999). Watersheds with a greater than 8 percent roaded area are considered to have a high potential hydrologic impact, 4 to 8 percent have a moderate potential, and less than 4 percent have a low potential.

All of the subwatersheds except for one in the Youngs Bay watershed have a forest roaded area less than 4 percent (Table 4.3). Consequently, all of these subwatersheds were categorized as a having a low potential for increasing peak flows as a result of road construction. The Youngs Bay Mouth subwatershed had greater than 8 percent of its forested area roaded, resulting in a high potential for peak flow enhancement as a result of road construction. Channel forms in the Youngs Bay Mouth subwatershed are all unconfined suggesting that peak flow enhancement may be mitigated by flood attenuation as a result of significant floodplain areas. Further investigation is warranted.

Table 4.3. Forest road summary for the Youngs Bay watershed based on GIS calculations. The roads coverage data used for this analysis were obtained from the BLM (fire roads).

Subwatershed	Subwatershed Area (mi^2)	Area Forested (mi^2)	Forest Roads (mi)	Roaded Area (mi^2)*	Percent Forested Area in Roads	Relative Potential Impact
Lower Lewis & Clark River	14.3	10.4	83	0.39	3.8	low
N Fork Klaskanine River	26.3	26.0	129	0.61	2.3	low
S Fork Klaskanine River	23.2	23.0	134	0.63	2.7	low
Upper Lewis & Clark River	47.2	46.1	249	1.17	2.5	low
Upper Youngs River	36.6	36.1	199	0.93	2.6	low
Youngs Bay East	24.0	20.4	140	0.66	3.2	low
Youngs Bay Mouth	2.8	1.1	20	0.09	8.9	high
Youngs Bay West	9.2	6.0	47	0.22	3.7	low
Total	184	169	1001	4.70	2.8	low

* Width used to calculate roaded area was 25 ft.

Both the North and South Fork Klaskanine subwatersheds had a moderate potential for enhancing peak flows as a result of rural road densities (Table 4.4). However, it is important to note that rural areas (including agriculture) represent less than one percent of their respective watersheds. Consequently, it is unlikely that rural roads in the North and South Fork Klaskanine subwatersheds are increasing peak flows.

Table 4.4. Rural road summary for the Youngs Bay watershed based on GIS calculations. The roads coverage data used for this analysis were obtained from the BLM (fire roads).

Subwatershed	Subwatershed Area (mi^2)	Rural Area (mi^2)	Rural Roads (mi)	Roaded Area (mi^2)*	Percent Rural Area in Roads	Relative Potential for Peak-Flow Enhancement
Lower Lewis & Clark River	14	1.87	7.74	0.051	2.7	low
N Fork Klaskanine River	26	0.13	0.89	0.006	4.7	moderate
S Fork Klaskanine River	23	0.14	0.88	0.006	4.1	moderate
Upper Lewis & Clark River	47	0.63	2.05	0.014	2.1	low
Upper Youngs River	37	0.24	0.57	0.004	1.6	low
Youngs Bay East	24	1.71	7.77	0.051	3.0	low
Youngs Bay Mouth	3	0.09	0.45	0.003	3.4	low
Youngs Bay West	9	1.96	5.15	0.034	1.7	low
Total	184	7	26	0.2	2.5	low

* Width used to calculate roaded area was 25 ft.

4.4.4 Urban and Rural Residential Areas

Urban and rural residential areas are concentrated around the city of Astoria, which is located on a small peninsula between Youngs Bay and the Columbia River. Only two small streams run through the city of Astoria. Road densities are high within the city limits; however, their impact on peak flows is low due to the lack of streams within the city limits and the physical location of the city. Identifying potential hydrologic effects on Youngs Bay is beyond the scope of this analysis.

4.5 Conclusions

Current land use practices in the Youngs Bay watershed do not demonstrate a high potential for enhancing peak flows as a result of forest harvesting, establishment of agriculture and range lands, construction of forest and rural roads, or establishment of urban and suburban areas.

Because rain events are the predominant form of precipitation, there is only a small chance for forestry practices to enhance peak flows. Rain-on-snow events that do occur are large and rare events, and it is unlikely that forest practices are increasing the magnitude of these events. It is generally believed that forest harvest practices have the greatest effect on moderate peak flows, and not these large rare events (Naiman and Bilby 1998; Dunne 1983). Because forest harvest practices are common in the watershed, it is possible that there are other impacts to the watershed's hydrology, such as reductions in evapotranspiration, increased infiltration and subsurface flow, and increased overland flow. Both forest and rural road densities are low or occupy such small proportions of the watershed that the potential for enhancing peak flows is low.

Urban, suburban, and agricultural development is concentrated in the lower elevations of the watershed, often occurring in the floodplains of the Youngs and Lewis & Clark Rivers. These land management activities often result in the channelization and diking of the rivers for flood protection. By channelizing and disconnection the rivers from their floodplains, downcutting of the channel can occur, increasing flow velocities and changing peak flows. Determining the level of impact from diking and channelization warrants further investigation.

CHAPTER 5 WATER USE

Under Oregon law, all water is publicly owned. Consequently, withdrawal of water from surface and some groundwater sources requires a permit, with a few exceptions. The Oregon Water Resources Department administers state water law through a permitting process that issues water rights to many private and public users (Bastasch 1998). In Oregon, water rights are issued as a 'first in time; first in right' permit, which means that older water rights have priority over newer rights. Water rights and water use were examined for each of the water availability watersheds (watersheds defined by the Oregon Water Resources Department for the assessment of flow modification).

Water that is withdrawn from the stream has the potential to affect instream habitats by dewatering that stream. Dewatering a stream refers to the permanent removal of water from the stream channel, thus lowering the natural instream flows. For example, a percentage of the water that is removed from the channel for irrigation is permanently lost from that watershed as a result of plant transpiration and evaporation. Instream habitats can be altered as a result fo this dewatering. Possible effects of stream dewatering include increased stream temperatures and the creation of fish passage barriers.

Water is appropriated at a rate of withdrawal that is usually measured in cubic feet per second (cfs). For example, a water right for 2 cfs of irrigation allows a farmer to withdraw water from the stream at a rate of 2 cfs. Typically, there are further restrictions put on these water rights including a maximum withdrawal amount allowed and the months that the water right can be exercised. Identifying all of these limits is a time-consuming and difficult task, which is beyond the scope of this assessment. However, for subwatersheds identified as high priority basins this should be the next step.

5.1 Instream Water Rights

Instream water rights were established by the Oregon Water Resources Department for the protection of fisheries, aquatic life, and pollution abatement; however, many remain junior to most water rights in these watersheds. Both the Youngs and Lewis & Clark Rivers have instream water rights to protect aquatic life as well as anadromous and resident fish (Table 5.1). The North and South Forks of the Klaskanine River also have instream water rights protecting anadromous and resident fish.

Table 5.1. Instream water rights in the Youngs River watershed. Data were obtained from the Oregon Water Resources Department.

Water Availability Watershed	Priority	Purpose
Youngs River	5-9-73	Supporting Aquatic Life
Youngs River	11-30-90	Anadromous and Resident Fish Rearing
South Fork Klaskanine River	11-30-90	Anadromous and Resident Fish Rearing
North Fork Klaskanine River	11-30-90	Anadromous and Resident Fish Rearing
Lewis & Clark River	11-30-90	Anadromous and Resident Fish Rearing
Lewis & Clark River	5-9-73	Supporting Aquatic Life

5.2 Consumptive Water Use

5.2.1 Irrigation

Only small amounts of water are appropriated for irrigation and are typically associated with the lowland portions of the watershed (Table 5.2; Figure 5.1). Irrigation is defined as the artificial application of water to crops or plants to promote growth or nourish plants (Bastasch 1998). The lower reach of the Youngs River has more than 1 cfs appropriated for irrigation. This represents 75 percent of the relatively small (1.56 cfs) total withdrawals for this water availability basin (Youngs River @ mouth).

Table 5.2. Water use and storage in the Youngs Bay watershed. Numbers in parentheses are for water storage in acre-feet. Data were obtained from the Oregon Water Resources Department.

Water Availability Basin	Irrigation (cfs)	Municipal (cfs)	Domestic (cfs)	Fish/ Wildlife (cfs)	Other (cfs)	Total (cfs)
Lewis & Clark River above Heckard Creek	0.34	30.0	0.13	--	0.32	30.79
SF Klaskanine River @ mouth	0.24	--	0.01	16.5	--	16.75
Youngs River above Klaskanine River	--	27.00 (36,000)	2.01	--	2.02	31.03
Lewis and Clark River@ mouth	0.02	7.00	0.19	0.10	0.30	7.61
Youngs River @ mouth	1.17	--	0.36	--	0.03	1.56
NF Klaskanine River @ mouth	0.64	--	0.025	150	–	150.67

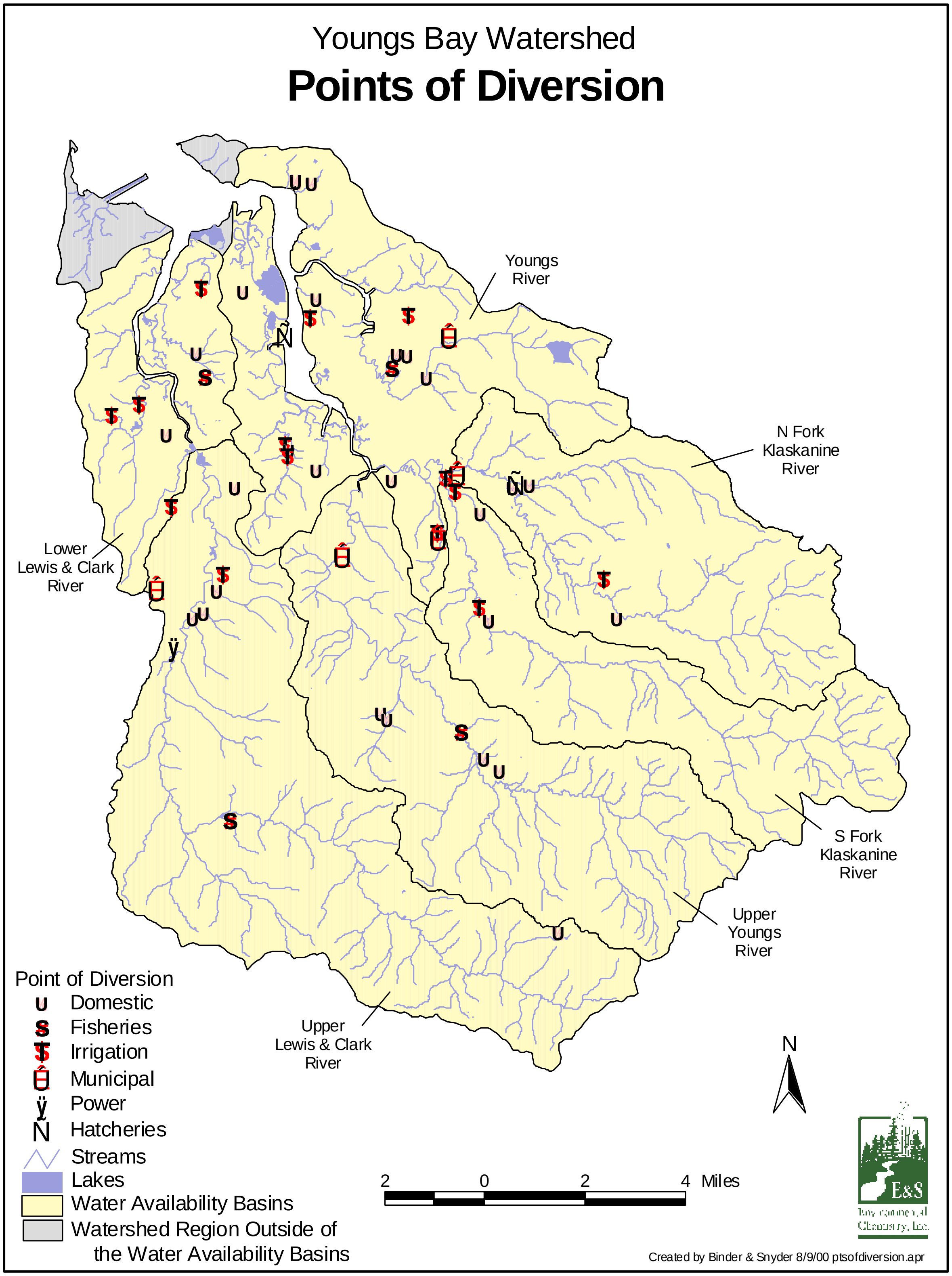

Figure 5.1. Water withdrawals in the Youngs Bay watershed. Data were obtained from the Oregon Water Resources Department.

5.2.2 Municipal and Domestic Water Supply

The Lewis & Clark River is the primary source of water for the city of Warrenton, with three of its tributaries (Big South Fork, Little South Fork, and Camp C Creek) serving as secondary sources (Woodward-Clyde 1997). Typically, water is diverted from the mainstem Lewis & Clark River (25 cfs appropriated) in the months of June through September, and all four streams are used in the winter, depending on water quantity and quality. Big and Little South Forks have 5 cfs of water appropriated for municipal water supply, while only 2 cfs are appropriated for Camp C Creek. The largest withdrawals on the Lewis & Clark River are for municipal and domestic uses, representing 97 percent of the total withdrawals (Table 5.2). These withdrawals represent a large interbasin transfer, since most of the city of Warrenton lies in the Skipanon River watershed.

The city of Astoria holds municipal water rights for the Youngs River (27 cfs; 36,000 ac-ft storage), although this site remains currently undeveloped (OSU-Extension 2000). These rights may become important in the future as the water demands for the city of Astoria grow. Currently, the majority of Astoria's water is drawn from the Bear Creek subwatershed (Nicolai-Wickiup watershed) .

5.3 Non-Consumptive Water Use

5.3.1 Fish and Wildlife

Significant amounts of water have also been appropriated for fish and wildlife purposes. The largest amount of appropriated water is associated with the Klaskanine Fish Hatchery (150 cfs; Table 5.2). The South Fork Klaskanine River also has 16.7 cfs appropriated for fish use, with 15 cfs being used for aquaculutre purposes. However, these rights can only be exercised January through May (10 cfs) and August and September (5 cfs). Generally, the water processed by these uses quickly reenters the stream, resulting in a non-consumptive use, although they may temporarily dewater a reach and act as a fish passage barrier.

5.4 Water Availability

Both the Lewis & Clark and Youngs Rivers exhibit a high potential for dewatering (Table 5.3). The Lewis & Clark River acts as the main source of municipal water for the city of Warrenton, which faces a potential water shortage (CH2M Hill 1997). In the near term, these

Table 5.3. Dewatering potential in the Youngs Bay watershed based on a 50 percent exceedence*. The dewatering potential is the percent of instream flows that are appropriated for consumptive use during the low flow months. In some cases water has been over-appropriated, resulting in a percentage greater than 100.

	Dewatering Potential (%)*					Overall Dewatering Potential	
Water Availability Watershed	Jun	Jul	Aug	Sep	Oct	Average Percent Withdrawal	Potential
Lewis & Clark River above Heckard Creek	57.6	109.6	181.9	128.7	52.4	106.04	High
Youngs River above Klaskanine River	17.1	35.1	61.9	45.8	17.6	35.5	High
Lewis and Clark @ mouth	8.2	15.2	24.8	17.9	7.7	14.76	Moderate
Youngs River @ mouth	6.1	12.3	19.6	13.3	5.6	11.38	Moderate
SF Klaskanine River @ mouth	0.7	3.9	5.3	0.5	0.0	2.08	Low
NF Klaskanine River @ mouth	0.7	3.2	4.0	0.4	0.1	1.68	Low

* A 50% exceedence represents the amount of water than can be expected to be in the channel 50% of the time or one out of every two years.

shortages are expected to last only a couple of days. However, if the projected water demands are reached, these shortages may extend longer than a month. This projection assumes that the city is allowed to capture 100 percent of stream flows, which is allowed under the current water right held by the city. The city's water system master plan (CH2M Hill 1997) suggests three alternatives to help meet Warrenton's water demands without increasing the current impacts on the Lewis & Clark River. These alternatives include adding more raw water storage in the watershed, developing a groundwater supply or implementing a rigorous and formalized water conservation program.

The city of Astoria owns an undeveloped water right on the Youngs River which accounts for the high dewatering potential. Since the city is not currently exercising this water right, dewatering in the Youngs River is not of immediate concern. However, as the water demands for the city of Astoria grow, this site may be developed to meet those water needs. Astoria has yet to develop a water management plan. Further details on the city's water rights can be found in the recent water supply study (CH2M Hill 1996).

5.5 Conclusions

The greatest demands on water in the Youngs Bay watershed are for municipal and fisheries uses. The Lewis & Clark River has the greatest potential for dewatering because it acts as the primary source of water for the city of Warrenton. The city of Astoria uses the Bear Creek subwatershed (Nicolai-Wickiup watershed) as its primary source of water and also owns two undeveloped water rights for Big Creek and the Youngs River. Municipal water rights have a number of preferences under Oregon water law (Bastasch 1998). First, a municipality can get a water right certificate for part of its permit and keep the remainder in permit status. This allows the municipality to hold the remainder in a type of permit reserve for future use. Thus, a municipality can hold undeveloped water rights, such as the Big Creek and Youngs River water rights, without fully developing those rights and save them for future needs. Additionally, municipal water rights can override more senior water rights if it is deemed in the public interest. Although not an immediate concern, the Youngs River may develop a high dewatering potential if the city of Astoria decides to develop its water rights for the Youngs River as the city's demand for water increases.

Although the Klaskanine fish hatchery uses a large percentage of flows from the North Fork Klaskanine River, these flows are quickly returned to the river. Other potential problems associated with this practice include fish passage barriers and water quality degradation.

CHAPTER 6 SEDIMENT SOURCES

6.1 Introduction

Landslides are a natural watershed process in the Oregon Coast Range. However, most experts agree that land use practices have increased landslide frequency and magnitude (WPN 1999, Naiman and Bilby 1998). Separating landslide activity into natural and human-induced events is difficult. It is perhaps even more difficult to identify the amount of sediment that is "too much" for fish and aquatic organisms. In general, the more a stream deviates from natural sediment levels, the greater the chance for adverse affects on aquatic communities (WPN 1999, Newcombe and MacDonald 1991).

There were several assumptions made about the nature of sediment in this watershed (WPN 1999). First, sediment is a normal and critical component of stream habitat for fish and other aquatic organisms. The more that sediment levels deviate (either up or down) from the natural pattern in a watershed, the more likely it is that aquatic habitat conditions will be altered. Second, human-caused increases in sediment occur at a limited number of locations within the watershed that can be identified by a combination of site characteristics and land use practices. Third, sediment movement is often episodic, with most erosion and downstream soil movement occurring during infrequent and intense runoff events.

Knowledge of current sources of sediment can provide a better understanding of the locations and conditions under which sediment is likely to be contributed in the future. These sources can then be evaluated and prioritized based on their potential affects on fish habitat and water quality to help maintain natural ecosystem functioning.

6.2 Screening for Potential Sediment Sources

Eight potential sediment sources have been identified by OWEB that have significant impacts on watershed conditions (WPN 1999). Not all are present in every watershed, and they vary in influence depending on where and how often they occur. The potential sediment sources include slope instability, road instability, rural road runoff, urban area runoff, crop land, range or pasture lands, burned areas, and other identified sources.

In this watershed, slope instability, road instability, and rural road runoff were determined to be the most significant sediment sources based on the location of the watersheds (Oregon Coast Range) and the local land use. This screening process is outlined in the OWEB watershed assessment manual (WPN 1999). Shallow landslides and deep-seated slumps are common in the

Oregon Coast Range. Streamside landslides and slumps can be major contributors of sediment to streams, and shallow landslides frequently initiate debris flows. Rural roads are a common feature of this watershed, and many are present on steep slopes. Washouts from rural roads contribute sediment to streams, and sometimes initiate debris flows. The density of rural roads, especially unpaved gravel and dirt roads, indicates a high potential for sediment contribution to the stream network.

Urban runoff and surface erosion from crop and range or pasture lands were not analyzed in this assessment. Agricultural lands account for less than four percent of the watershed and are mostly located in the valley bottoms of the watersheds or floodplains of the Columbia River. Developed lands currently occupy less than one percent of the Youngs Bay watershed. There have been no large wildfires in the watershed in the past five years, so burned areas are not a significant sediment source.

6.3 Slope Instability

Slope instability is evaluated by collecting information about recent landslide activity and high risk areas that are likely to be active in the future (WPN 1999). Data on recent landslide activity are relatively scarce and no comprehensive on-the-ground inventories of landslides have been conducted in this watershed. The Department of Geological and Mineral Industries (DOGAMI) has created debris flow hazard maps to characterize the future potential for landslide activity based on watershed features such as slope, soils, and geology.

According to potential debris flow hazard maps created by DOGAMI, less than one fifth of the Youngs Bay watershed is in the debris flow activity zone (Figure 6.1). Eighty-eight percent of the debris flow risk area is in the moderate risk category, while high risk accounts for only 12 percent (Table 6.1). The higher elevation subwatersheds (North and South Fork Klaskanine River, Upper Youngs River, and Upper Lewis and Clark) have similar proportions in the debris flow zone, ranging from 23-26 percent of the total subwatershed area. The lower elevation subwatersheds (Youngs Bay West, Lower Lewis and Clark) have a more moderate proportion of debris flow area ranging from 2 to 11 percent of the subwatershed area. Only the Youngs Bay Mouth subwatershed lies completely outside the potential debris flow zone.

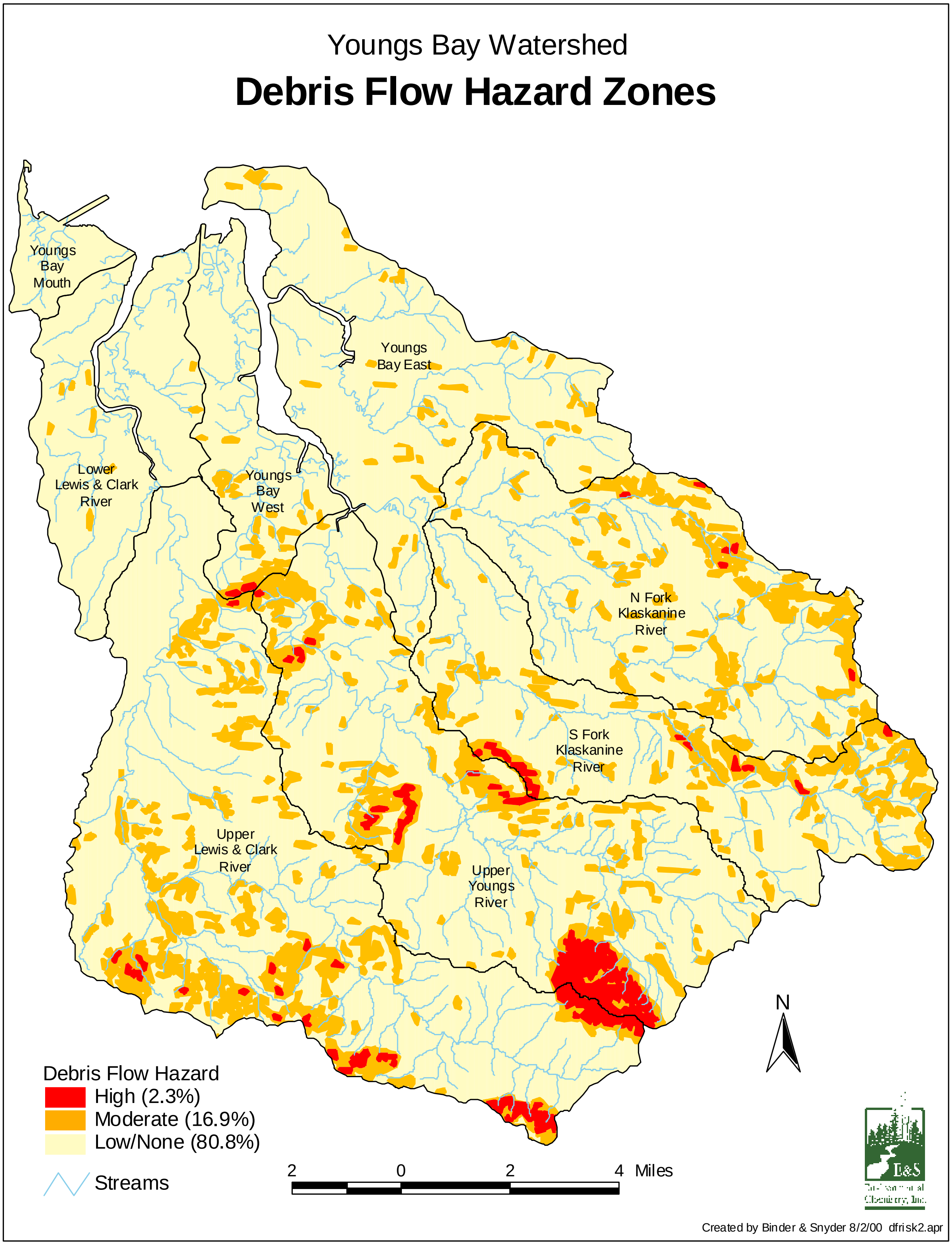

Figure 6.1. Debris flow hazard zones for the Youngs Bay watershed. Data were obtained from DOGAMI.

Table 6.1. Potential debris flow hazard zones in the Youngs Bay watershed (DOGAMI 1999).

Subwatershed	Watershed Area (sq. mi.)	High (%)	Moderate (%)	High + Mod. (%)
Upper Youngs River	37	5.9	19.8	25.7
S Fork Klaskanine River	23	1.8	23.5	25.4
Upper Lewis & Clark River	47	3.3	20.2	23.5
N Fork Klaskanine River	26	0.5	22.9	23.4
Youngs Bay West	9.2	0.8	10.5	11.3
Youngs Bay East	24	-	6.7	6.7
Lower Lewis & Clark River	14	-	2.1	2.1
Youngs Bay Mouth	2.8	-	-	-
TOTAL	184.0	2.3	16.9	19.2

The limited amount of landslide information makes it difficult to determine the significance of landslide contributions of sediment to the stream network. An inventory of landslides in the Youngs Bay watershed is recommended to elucidate naturally and human-induced landslides.

6.4 Road Instability

Road construction, especially on steep slopes, can lead to slope failure and result in increased landslide activity (WPN 1999, Sessions et al. 1987). Road stability can be affected by the type of construction. For example, sidecast roads are built by using soil from the inside portion of a road to build up the outside, less stable portion of the road. Sidecast roads work well in moderately steep terrain, but can lead to problems on steep terrain. Road crossings with poorly designed culverts can fail and wash out, create gullies, and deliver large pulses of sediment to the channel. To quantify rural road instability requires data about recent road washouts, including the factors that may have led to these events, and high risk situations that may lead to future washouts.

Road inventories are the primary source of data used to evaluate the current conditions of roads in the watersheds. The road inventory conducted by ODF is not up-to-date, and is only available in the form of field notebooks (Rick Thoreson pers. comm.). ODF is currently in the process of updating their road inventory. Willamette Industries has conducted an extensive road inventory on their lands, which has been summarized below. Remaining roads have either not been assessed or were unavailable at the time of this assessment.

6.4.1 Willamette Industries 10-Year Legacy Road Improvement/Decommissioning Plan

In 1997 Willamette Industries Inc. developed a forest road inventory in conjunction with the Oregon Department of Forestry (ODF) and the Oregon Forest Industries Council (OFIC). The North Coast Resource Area inventoried approximately 1700 miles of road on company managed forestland in Tillamook, Columbia, and Clatsop Counties. Road features were given a priority class from one to five, with one being highest priority for repair and five being no action needed.

In 1999 the road inventory had been completed and a legacy road improvement and decommissioning plan was developed. The plan has all road segments identified as needing action either repaired or decommissioned within the next 10 years. The plan breaks the road inventory priorities into subclasses. The subclasses in order of singular impact or concern are safety, sedimentation into live streams, mass wasting, sedimentation depositing outside of live streams, fish passage. An example of this system is that a priority one with a safety concern will be repaired/decommissioned before a priority one that has fish passage issues.

Under the North Coast Resource Area 10-year road plan, all priority one road segments will be repaired/decommissioned by the fall of 2001, and all road segments requiring action will be repaired/decommissioned by the fall of 2008.

Recent concern about sediment from road systems entering waters of the state has prompted Willamette Industries, Inc. to adopt new specifications for forest road location, construction and reconstruction, maintenance and erosion control. Whenever possible existing roads that parallel stream channels are relocated or bypassed and new roads are located near ridge tops to minimize the number of stream crossings. This method of road location helps minimize the possibility of sediment entering waters of the state. Ditch relief culverts or ditchouts are placed with a minimum spacing of 300-500’ and are located to allow any runoff to filter through vegetation on the forest floor prior to entering flowing water. Ditch relief culverts are placed 50’to100’ ahead of all stream crossing culverts. This allows ditch water to filter through vegetation on the forest floor prior to entering flowing water. Stream crossing culverts are required to be designed to pass a 50 year flood event but all crossing installed by the North Coast Resource Area will pass a 100 year event. Side-cast material in steeper terrain that has the potential to fail is pulled back and the road is set into the hillside. All waste material in these steeper areas in now hauled to stable waste areas.

All weather haul roads are now surfaced with quarried rock and the top lift is usually a finer grade crushed rock that has been processed with a grader and vibratory roller. By processing the rock the road surface is sealed and water cannot saturate the subgrade. This helps prevent the "pumping" of mud onto the road surface. Roads with natural surfaces have haul restrictions placed on them and active haul is allowed only during periods of dryer weather. All active haul roads are continually monitored and maintained, if a road begins to show signs of failing active hauling will be suspended until the road can be repaired. All non-active haul roads are monitored on an annual basis and during periods of high flows, with routine maintenance preformed as needed.

Where there is a potential for erosion, a variety of erosion control methods are used. Silt fences and straw bales are used along with settling basins to help slow water and allow suspended sediment to settle out of the water. Seeding and hand mulching or hydro mulching are used to vegetate surfaces to prevent erosion.

6.4.2 Landslide Data

In 1999, DOGAMI compiled and mapped landslide information on state and federal lands for all of western Oregon, however this database does not contain any landslides in the Youngs Bay watershed. It is important to note that this survey was not a planned comprehensive inventory of road-related landslides, but rather reflects an ad-hoc collection of known landslide events. More than likely, there are many landslide events in the Youngs Bay watershed that have not been inventoried.

6.4.3 Culverts

Both the Oregon Department of Transportation and Willamette Industries have assembled databases of culverts that are in need of repair or are at risk of causing damage to the stream network. The Lower Lewis & Clark subwatershed has the highest density of these high-priority culverts (3.2 culverts/sq. mi.). The Upper Lewis & Clark (1.5/sq. mi.) and Upper Youngs River (1.3/sq. mi.) subwatersheds have the second-highest densities of high-priority culverts, with and, respectively.

Analysis of high priority culverts that are on fish-bearing streams, or potential fish-bearing streams, provides similar results. The Lower Lewis & Clark subwatershed has the highest density, at 1/sq. mi. Higher elevation subwatersheds (North and South Fork Klaskanine River, Upper Youngs River, and Upper Lewis & Clark) have densities ranging 0.2 to 0.4/sq. mi. Youngs Bay Mouth has 0.1/sq. mi.

Table 6.2. Stream/road crossings in the Youngs Bay watershed. Data were calculated using GIS.

Subwatershed	Area (sq. mi.)	Road-Stream Crossings (#)	(#/sq mi)
Lower Lewis & Clark River	14	41	2.9
N Fork Klaskanine River	26	87	3.3
S Fork Klaskanine River	23	79	3.4
Upper Lewis & Clark River	47	137	2.9
Upper Youngs River	37	154	4.2
Youngs Bay East	24	77	3.2
Youngs Bay Mouth	2.8	17	6.1
Youngs Bay West	9.2	46	5.0

GIS-based analysis of road stream crossings reveals that the highest density of crossings is in the Youngs Bay Mouth subwatershed, with 6.1 crossings/sq. mi. (Table 6.2). Youngs Bay West has approximately 5.0 crossings/sq. mi. The lowest density of road-stream crossings is found in the Lower Lewis and Clark subwatershed, with 2.9 road-stream crossings/sq. mi. The remainder of the watershed has approximately 3 to 4 crossings/sq. mi.

6.5 Road Runoff

The water draining from roads can constitute a significant sediment source into streams. However, the amount of sediment potentially contained in road runoff is difficult to quantify because road conditions and the frequency and timing of use can change rapidly. Poor road surfaces that are used primarily in dry weather may have a smaller impact on sediment production than roads with high quality surfaces that have higher traffic and are used primarily in the rainy season. ODF fire-road data were used to assess potential sediment contribution from road runoff. Road density within 200 ft of a stream and on slopes greater than 50 percent was calculated using GIS.

The density of roads within 200 ft of a stream in the Youngs Bay watershed ranged from 0.25 to 0.40 miles of road per mile of stream (Table 6.3). The density of roads near streams suggests that roads are potentially a significant sediment source. In addition, the most common road surface in the Youngs Bay watershed is gravel, accounting for 86 percent of all the roads in the watershed (Table 6.3). Predominantly rock road surfaces can exhibit a broad range of conditions depending upon the timing and frequency of use.

Roads with steeper side slopes tend to accumulate more sediment in their associated drainage ditches, resulting in greater loading of sediments to surface waters (WPN 1999). Road failure often ensues if these ditches become plugged.. Based on GIS analysis, less than four percent of the roads in the Youngs Bay watershed were constructed on both slopes steeper than 50 percent in gradient and within 200 ft. of a stream (Table 6.3). Many of these roads are currently being upgraded by the installation of cross culverts to reduce sediment loading into the stream (see section 6.4.1).

Table 6.3. Current road conditions in the Youngs Bay watershed. The ODF fire roads coverage was used to calculate these numbers in GIS (see GIS data evaluation).

Subwatershed	Stream Length mi	Road Length mi	Gravel %	Dirt %	Paved %	Roads <200' from Stream	mi/mi*	Roads <200' from Stream and >50% Slope %
Lower Lewis & Clark River	32	83	69	2.3	29	8.1	0.25	3.3
N Fork Klaskanine River	57	129	89	5.5	5.4	16	0.29	2.0
S Fork Klaskanine River	50	134	91	3.0	6.3	18	0.35	3.3
Upper Lewis & Clark River	99	249	92	1.9	6	30	0.31	4.8
Upper Youngs River	84	199	96	2.0	1.9	34	0.40	1.9
Youngs Bay East	44	140	77	2.9	20	15	0.33	3.8
Youngs Bay Mouth	7	18	29	0.0	71	2.2	0.30	0.00
Youngs Bay West	28	47	71	0.3	29	8.1	0.29	3.0
Watershed Total	401	998	86	3.0	11	131	0.13	3.1

6.6 Streambank Erosion

Twenty-one miles of streams (5 percent of total stream length) were surveyed by ODFW in the Youngs Bay watershed. Of these, 24 percent of the surveyed length had experienced streambank erosion. The Upper Lewis & Clark subwatershed experienced the highest proportion of streambank erosion (31 percent), followed by South Fork of the Klaskanine River (25 percent), and finally North Fork of the Klaskanine River (17 percent). No low-elevation floodplain reaches were surveyed. However, high rates of streambank erosion commonly occur in valley bottoms and floodplain areas due to stream channelization and draining of wetlands, so it is possible that these rates are not representative of the watershed as a whole.

6.7 Conclusions

Sediment sources are highly variable across the Youngs Bay watershed. Although it is difficult to differentiate between human-induced and natural landslide events at this level of analysis, it is likely that land use practices are increasing sediment loading into surface waters (WPN 1999). Many culverts have been identified to be at risk of causing damage to the stream network. High-risk culverts that exist on Willamette Industries land have been prioritized and are currently being replaced under the 10-year legacy road plan. Additionally, road densities within 200 ft of the stream are high, although very few of these are on slopes greater than 50 percent. Considering the overall lack of information regarding the contribution of sediment to the stream network, additional studies of landslides and potential road-associated sediment sources are warranted.

CHAPTER 7 WATER QUALITY

7.1 Introduction

The purpose of the water quality assessment, according to the OWEB manual (WPN 1999), is to complete a screening-level analysis of water quality. A screening-level analysis serves to identify obvious areas of water quality impairment by comparing selected measurements of water quality to certain evaluation criteria. The screening-level analysis uses existing data obtained from a variety of sources. This assessment does not include statistical evaluation of seasonal fluctuations or trends through time, and does not evaluate specific sources of pollution through upstream/downstream comparisons.

7.1.1 Assessment Overview

The water quality assessment proceeds in steps. The first step is to identify uses of the water that are sensitive to adverse changes in water quality, and identify potential sources of pollution in the watershed. The second step establishes the evaluation criteria. The third step examines the existing water quality data in light of the evaluation criteria. Conclusions can then be made about the presence of obvious water quality problems in the watershed, and whether or not additional studies are necessary.

Water quality is evaluated by comparing key indicators against evaluation criteria. Indicators are selected to represent pollution categories. Some aspects of water quality, such as fine sediment and temperature processes, are addressed in other sections of this watershed assessment. Although there are many constituents that contribute to the “water quality” of a stream, the watershed assessment focused on seven that are most often measured, and that may have the most direct effect on aquatic organisms: temperature, dissolved oxygen, pH, nutrients, bacteria, turbidity, and chemical contaminants. Evaluation criteria, discussed in Section 7.4, have been determined based on values of these constituents that are generally protective of aquatic life.

7.1.2 Components of Water Quality

Temperature

Cool water temperatures are necessary for the survival and success of native salmon, trout, and other aquatic life. Excessively warm temperature can adversely affect the survival and growth of many native species. Although there is some debate about which specific temperatures should apply, and during which part of the year, standards have been set that can be used to determine if the waters in the stream are too warm. Because temperature in the stream varies throughout the day and among the seasons, multiple measurements throughout the day and in different seasons are needed to adequately assess water temperature conditions.

Dissolved oxygen

Aquatic organisms need oxygen to survive. Oxygen from the air dissolves in water in inverse proportion to the water temperature. Warmer water contains less dissolved oxygen at saturated conditions. Organisms adapted to cool water are also generally adapted to relatively high dissolved oxygen conditions. If the dissolved oxygen is too low, the growth and survival of the organisms is jeopardized. As with temperature, dissolved oxygen can vary throughout the day and among the seasons, so multiple measurements, both daily and seasonally, are required for an adequate analysis of water quality conditions.

pH

The pH is a measure of the acidity of water. The chemical form and availability of nutrients, as well as the toxicity of pollutants, can be strongly influenced by pH. Pollutants can contribute to changes in pH as can the growth of aquatic plants through photosynthesis. Excessively high or low pH can create conditions toxic to aquatic organisms.

Nutrients

Nitrogen and phosphorus, the most important plant nutrients in aquatic systems, can contribute to adverse water quality conditions if present in too great abundance. Excessive algae and aquatic plant growth that results from excessive nutrient concentration can result in excessively high pH and low dissolved oxygen, can interfere with recreational use of the water, and in some cases, can produce toxins harmful to livestock and humans.

Bacteria

Bacterial contamination of water from mammalian or avian sources can cause the spread of disease through contaminated shellfish, contact recreation or ingestion of the water itself. Bacteria of the coliform group are used as an indicator of bacterial contamination.

Turbidity

Turbidity is a measure of the clarity of the water. High turbidity is associated with high suspended solids, and can be an indicator of erosion in the watershed. At high levels, the ability of salmonids to see their prey is impaired. As discussed elsewhere, high suspended sediment can have a number of adverse effects on fish and aquatic organisms.

Chemical contaminants

Synthetic organic compounds, pesticides, and metals can be toxic to aquatic organisms. The presence of such contaminants in the water suggests the presence of sources of pollution that could be having an adverse effect on the stream ecosystem.

7.2 Beneficial Uses

The Clean Water Act requires that water quality standards be set to protect the beneficial uses that are present in each water body. The Oregon Department of Environmental Quality (ODEQ) has established the beneficial uses applicable to the 18 major river basins in the State. The Youngs Bay watershed is in the North Coast–Lower Columbia Basin. The beneficial uses established for all streams and tributaries in the basin are (OAR 340-41-202):

Public domestic water supply[1]
Private domestic water supply[1]
Industrial water supply
Irrigation
Livestock watering
Anadromous fish passage
Salmonid fish rearing
Salmonid fish spawning
Resident fish and aquatic life
Wildlife and hunting
Fishing
Boating
Water contact recreation
Aesthetic quality

In addition, the Columbia River supports a beneficial use of commercial navigation and transportation. Estuaries and adjacent marine waters are considered to support the above beneficial uses as well, not including public or private water supply, irrigation, or livestock watering. Water quality must be managed so the beneficial uses are not impaired.

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[1] With adequate pretreatment (filtration and disinfection) and natural quality to meet drinking water standards.

7.2.1 Water Uses Sensitive to WQ

Not all beneficial uses are equally sensitive to change in water quality. For example, use of the water body for domestic water supply would be impaired long before its use for commercial navigation. In general, water quality is managed to protect the most sensitive beneficial use. In the case of the Youngs Bay watershed, the most sensitive beneficial use is probably salmonid fish spawning. It is assumed that if the water quality is sufficient to support the most sensitive use, then all other less sensitive uses will also be supported.

7.3 Pollutant Sources

7.3.1 Point Sources

NPDES permitted discharges

The Clean Water Act prohibits discharge of waste to surface water. In order to discharge any waste, a facility must first obtain a permit from the State. ODEQ issues two primary types of discharge permit. Dischargers with Water Pollution Control Facility (WPCF) permits are not allowed to discharge to a water body. Most WPCF permits are issued for on-site sewage disposal systems. Holders of National Pollutant Discharge Elimination System (NPDES) permits are allowed to discharge wastes to waters of the state, directly or indirectly, but their discharge must meet certain quality standards as specified in their permits. Permits set limits on pollutants from industrial and municipal dischargers based on the ability of the receiving stream to absorb and dissipate the pollutants. Industries, municipal wastewater treatment facilities, fish hatcheries, and similar facilities typically have NPDES permits. The current discharge permits for the Youngs Bay watershed are listed in Table 7.1.

7.3.2 Non-point Sources

The largest current source of pollutants to Oregon’s waters is not point sources such as factories and sewage treatment plants. The largest source of water pollution comes from surface water runoff, often called “non-point source” pollution. Rainwater, snowmelt, and irrigation water flowing over roofs, driveways, streets, lawns, agricultural lands, construction sites, and logging operations carries more pollution, such as nutrients, bacteria, and suspended solids, than discharges from industry.

Table 7.1. Permitted facilities that have discharges in the Youngs Bay watershed (ODEQ 2000).

Facility Name	Category	Type	Stream	River Mile
Adamonis, Charles	C	WPCF	Youngs River	1
Astoria, City of	I	NPDES	Youngs River	0.3
Astoria, City of	I	NPDES	Youngs Bay	NA
Brugh, George D.	D	WPCF	Youngs River	1.2
Chadsey, Betty A. and others DBA	D	WPCF	John Day River	1
Clatsop Economic Development Council	A	NPDES	Youngs Bay	3
Clatsop Transfer and Disposal Co.	D	WPCF	Youngs River	0.5
Junes, Warren	D	WPCF	Lewis & Clark River	1.2
Meiners, Darwin L.	D	WPCF	Lewis & Clark River	5
Morisee, Steve	D	WPCF	Youngs Bay	0.9
Northwest Ready Mix, Inc.	I	NPDES	Youngs River	0.5
Nygaard, David — DBA	I	NPDES	Klaskanine River	NA
Port of Astoria	I	NPDES	Youngs Bay	2.5
Schock, Donald Duane	D	WPCF	Lewis & Clark River	0.5
Svensen, Tom	D	WPCF	John Day River	2
Thompson, Barbara L.	D	WPCF	Lewis & Clark River	1
Three D Corp	D	NPDES	Youngs River	2
US Coast Guard	I	NPDES	Youngs Bay	2.5
Weber, Terry	D	WPCF	Lewis & Clark River	5.1

D = domestic, I = industrial, A = Agricultural, including fish hatcheries

Land use can have a strong influence on the quantity and quality of water flowing from a watershed. An undisturbed watershed with natural vegetation in and along streams and rivers and a diversity of habitats on the uplands provides clean water that supports the desirable beneficial uses of the waterway. As the watershed is affected by logging, agriculture, and urban development, the water quality in the waterways can become degraded. The percent of the land area of the Youngs Bay watershed affected by these land uses is shown in Table 7.2. Table 1.4 shows the distribution of all land use types in the watershed. Table 1.5 lists possible water quality effects from various types of land use.

Table 7.2. Percent area of the Youngs Bay watershed by selected land uses.

Land Use Type	Area (sq mi)	Percent of Total Area
Industrial Forest	122.82	66.9
Agriculture	6.77	3.7
Developed	1.41	0.8

The most prominent type of land use in the Youngs Bay watershed is forestry, with relatively little land in developed areas. This land use pattern suggests that water quality problems associated with toxic industrial chemicals may be of relatively little importance while problems associated with sediment, turbidity, temperature, and possibly bacteria are likely to be more important. To the extent that herbicides and pesticides are used in forestry and agriculture operations, these compounds may assume greater importance.

7.3.3 Water Quality Limited Water Bodies

Sometimes, applying the best available treatment technology to all the point sources in a basin does not bring the stream into compliance with water quality standards. The combination of pollutants from all sources, point and non-point, within the watershed may contribute more pollution than the stream can handle. Under this circumstance, when a stream consistently fails to meet water quality standards for a particular pollutant, it is declared by ODEQ to be “water quality limited” as required by the Clean Water Act Section 303(d). Water bodies on the “303d List” must be analyzed to determine the total amount of pollutant that can be accommodated by the stream (the total maximum daily load – TMDL). This load is then allocated to all the dischargers, including non-point. Dischargers must then take the steps necessary to meet their allocated load.

The water quality limited water bodies in the Youngs Bay watershed are listed in Table 7.3.

Table 7.3. Water quality limited water bodies in the Youngs Bay watershed (DEQ 1999).

Water Body	Segment	Parameter	Season
Klaskanine River	Mouth to north/south confluence	Dissolved oxygen	May 1 — September 30

Although the 303(d) list identifies water bodies that are known not to meet current water quality standards, the list is not necessarily a complete indicator of water quality in a particular basin. For many stream reaches there is not enough data to make a determination. In addition, the 303(d) listing is tied to the total amount of monitoring done, which is influenced by the number of special monitoring studies completed by ODEQ. Because special studies are frequently concentrated where water quality degradation is a concern, the list is weighted toward poorer quality waters. Consequently the ODEQ has developed the Oregon Water Quality Index (OWQI) as a water quality benchmark that is keyed to indicator sites monitored regularly by ODEQ.

The OWQI integrates measurements of eight selected water quality parameters (temperature, dissolved oxygen, biochemical oxygen demand, pH, ammonia+nitrate nitrogen, total phosphates, total solids, fecal coliform) into a single index value that ranges from 10 (the worst) to 100 (the best). In the Youngs Bay watershed Youngs River at Youngs River Loop Road (RM 8.9) has an index value of 92 and is ranked in the "Excellent" category. The Lewis & Clark River at Stavebolt Lane (RM 7.6) has an index value of 81 and is ranked in the "Fair" category. The Klaskanine River at Youngs River Loop Road (RM 1.3) has an index value of 59 and is ranked in the "Very Poor" category.

In order to assess more adequately the water quality conditions in the Youngs Bay watershed, we assembled available data from a variety of sources.

7.4 Evaluation Criteria

The evaluation criteria used for the watershed assessment are based on the Oregon Water Quality Standards for the North Coast Basin (ORS 340-41-205) and on literature values where there are no applicable standards, as for example, for nutrients (WPN 1999). They are not identical to the water quality standards in that not all seasonal variations are included. The evaluation criteria are used as indicators that a possible problem may exist. The evaluation criteria are listed in Table 7.4.

Table 7.4. Water quality criteria and evaluation indicators (WPN 1999)

Water Quality Attribute	Evaluation Criteria
Temperature	Daily maximum of 64° F (17.8° C) (7-day moving average)
Dissolved Oxygen	8.0 mg/L
pH	Between 6.5 to 8.5 units
Nutrients	
Total Phosphorus	0.05 mg/L
Total Nitrate	0.30 mg/L
Bacteria	<u>Water-contact recreation</u> 126 E. coli/100 mL (30-day log mean, 5 sample minimum) 406 E. coli/100 mL (single sample maximum) <u>Marine water and shellfish areas</u> 14 fecal coliform/100 mL (median) 43 fecal coliform/100 mL (not more than 10% of samples)
Turbidity	50 NTU maximum
Organic Contaminants	Any detectable amount
Metal Contaminants	
Arsenic	190 µg/L
Cadmium	0.4 µg/L
Chromium (hex)	11.0 µg/L
Copper	3.6 µg/L
Lead	0.5 µg/L
Mercury	0.012 µg/L
Zinc	32.7 µg/L

The water quality evaluation criteria are applied to the data by noting how many, if any, of the water quality data available for the assessment exceed the criteria. If sufficient data are available, a judgement is made based on the percent exceedence of the criteria as shown in Table 7.5. If insufficient, or no, data are available, it is noted as a data gap to be filled by future monitoring. If any water quality parameter is rated as “moderately impaired” or “impaired”, water quality in the stream reach in question is considered impaired. The condition that caused the impairment should be addressed through stream restoration activities.

Table 7.5. Criteria for evaluating water quality impairment (OWEB 1999).

Percent of Data Exceeding the Criterion	Impairment Category
Less than 15 percent	No impairment
15 to 50 percent	Moderately impaired
More than 50 percent	Impaired
Insufficient data	Unknown

7.5 Water Quality Data

7.5.1 STORET

Data were obtained from the EPA STORET[2] database for the period 1965 through 1999. There were 277 sites in the ODEQ North Coast basin that had water quality data in the STORET database. Of these 277 sites, 85 were from ambient stream or lake stations. The remaining sites were from such locations as point discharges, wells, sewers, pump stations, and similar locations. The ambient water quality sites were distributed among the three watersheds in the North Coast basin as shown in Table 7.6.

Table 7.6. The distribution of STORET water quality sampling sites in the Oregon North Coast basin.

Description	Skipanon River Watershed	Youngs Bay Watershed	Nicolai-Wickiup Watershed
Total ambient sites	38	38	9
Number of sites sampled more than once	7	8	7
Number of sites sampled more than once since 1989	3	3	1

Sites sampled only once over a period of 30 years do not provide adequate data to make judgements about water quality. Likewise data from more than ten years ago may not be representative for current conditions. For these reasons only data since 1989 from sites that had been sampled multiple times were used in this analysis. This is consistent with the practice of ODEQ in establishing the Oregon Water Quality Index.

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[2] STORET data are available on CD-ROM from Earth Info, Inc. 5541 Central Ave., Boulder, CO 80301; (303) 938-1788.

The ambient sites sampled more than once in the Youngs Bay watershed are listed in Table 7.7 and displayed in Figure 7.1.

Table 7.7. Ambient water quality sampling sites used for water quality assessment in the Youngs Bay watershed (EPA 2000).

Station Number	N Latitude	W Longitude	Location	First	Last	No. Of Samples	No. Of Analyses
402494	46:04:00	123:50:00	Lewis & Clark River at Stavebolt Lane	1/1/01	12/11/97	46	1089
404599	46:05:00	123:45:00	Klaskanine River at Youngs River Loop Rd. (Olney)	1/1/01	12/11/97	24	578
404921	46:04:00	123:47:00	Youngs River at Youngs River Loop Road	1/1/01	12/11/97	22	506
402495	46:05:00	123:43:00	North Fork Klaskanine River above Fish Hatchery	7/28/65	9/11/73	12	172
402496	46:05:00	123:40:00	North Fork Klaskanine River below Fish Hatchery	7/28/65	8/27/68	10	88
402493	46:06:00	123:51:00	Lewis & Clark River .5 Mi above Peterson Slough	6/3/69	8/8/72	8	126
412269	46:09:00	123:51:00	Lewis & Clark River at Old Hwy 101 Bridge	3/5/74	7/17/84	4	45
412272	46:08:00	123:47:00	Wallooskee River at Hwy 202	3/5/74	7/17/84	4	44
405065	46:00:00	123:42:00	Fox Creek	8/25/94	8/25/94	2	46
404109	46:05:00	123:44:00	South Fork Klaskanine River at Mouth	5/8/73	9/11/73	2	32

7.5.2 ODEQ Sites

ODEQ currently maintains three sites in the Youngs Bay watershed as part of their ambient water quality monitoring network. The sites are 1) the Lewis & Clark River at Stavebolt Lane, 2) the Youngs River at Youngs River Loop Road, and 3) the Klaskanine River at Youngs River Loop Road. As can be seen from Table 7.7, these three sites are the most frequently sampled, and are the only STORET sites with recent data.

Table 7.8 shows a numerical summary of grouped data from all the STORET sites with more than one sample in the Youngs Bay for the parameters under consideration in this assessment.

Figure 7.1. Sampling sites in the Youngs Bay watershed with more than one sample since 1965. Site descriptions are provided in Table 7.7.

Table 7.8. Numerical data summary for water quality parameters: Youngs Bay Watershed STORET sites.

Descriptors	Temperature (ºC)	Turbidity (NTU)	Dissolved oxygen (mg/L)	pH (units)	Total Nitrate (mg/L)	Total Phosphorus (mg/L)	Fecal coliform (no/100 mL)	E. coli (no/100 mL)
Number of observations	94	73	94	93	85	164	38	38
Minimum	4	1	5.4	6.6	0.03	0.01	10	2
Maximum	22	93	13	8.2	0.99	0.22	400	400
Mean	11.15	6.37	10.45	7.08	0.37	0.04	146.92	102.39
Std. dev.	4.22	12.62	1.80	0.23	0.24	0.03	98.79	88.96
1st quartile[1]	7.60	2.00	9.53	6.90	0.19	0.02	65.00	37.00
Median[2]	10.00	3.00	11.00	7.00	0.31	0.03	124.00	74.00
3rd quartile[3]	14.43	6.00	11.90	7.20	0.52	0.05	210.00	143.75
Std dev of mean	0.43	1.48	0.19	0.02	0.03	0.00	16.03	14.43

[1] 25 percent of values were less than or equal to the 1st quartile value
[2] 50 percent of values were less than or equal to the median value
[3] 75 percent of values were less than or equal to the 3rd quartile value

7.5.3 Other Data Sources

Staff and volunteers from the Youngs Bay watershed council collected temperature data from four sites on the Lewis & Clark River (Table 7.9). Temperature data collected by the watershed council has been collected at hourly intervals so it is especially useful for water quality assessment. Additional data collected by the watershed council for the parameters under consideration have included grab samples for pH and dissolved oxygen. The National Park Service has collected water quality data for a number of years from sites in the vicinity of the

Table 7.9. Sites with water quality data in addition to those listed in the EPA STORET database.

Site ID	Agency	Period of Record	Number of Samples	Location	N Latitude	W Longitude
Lewis & Clark River	NPS	1994-1999	134	Fort Clatsop	46:07:55	123:52:36
YBLCW1	YBWC	July-Nov 1999	5	Bridge at Saddle Mt. Park	46:57:04	123:42:51
YBLCW2	YBWC	July-Nov 1999	6	400 Main Line	46:00:49	123:51:27
YBLCW3	YBWC	July-Nov 1999	6	Burkhardt’s	46:03:57	123:50:27
YBLCW5	YBWC	July-Nov 1999	14	Fort Clatsop	46:07:52	123:52:39

[1] NPS = National Park Service
[2] YBWC = Youngs Bay watershed council

Fort Clatsop National Monument, including one site on the Lewis & Clark River. The National Park Service data includes more parameters and is taken more frequently than the data collected at the ambient monitoring sites by ODEQ. The water quality data collected on the Lewis & Clark River by the National Park Service is summarized in Table 7.10. Water quality data collected by the watershed council is summarized in Table 7.11.

Table 7.10. Numerical data summary Lewis & Clark River near Fort Clatsop.

Descriptors	Temperature (°C)	Turbidity (NTU)	pH (units)	Dissolved Oxygen (mg/L)
Number of observations	135	119	114	104
Minimum	4.0	0.6	4.7	5.3
Maximum	24.0	364.0	8.5	12.3
Mean	14.1	23.2	6.6	9.7
Standard dev.	5.1	43.8	0.7	1.5
1st quartile[1]	10.0	8.1	6.3	8.5
Median[2]	13.0	12.7	6.7	9.4
3rd quartile[3]	19.0	18.4	7.0	11.1
Std dev of mean	0.44	4.02	0.07	0.15

[1] 25 percent of values were less than or equal to the 1st quartile value
[2] 50 percent of values were less than or equal to the median value
[3] 75 percent of values were less than or equal to the 3rd quartile value

Table 7.11. Numerical summary of water quality measured on grab samples collected in July-November 1999 by the Youngs Bay watershed council from various sites in the Youngs Bay watershed.

Descriptors	Water Temperature (ºF)	Air Temperature (ºF)	Turbidity (NTU)	pH (units)	Dissolved Oxygen (mg/L)
Number of observations	35	14	35	35	28
Missing Values	0	21	0	0	7
Minimum	48.5	51	0.4	6.5	7.5
Maximum	69.8	74	168	7.3	11.3
Mean	59.2	61.2	9.6	6.9	9.9
Standard deviation	6.4	7.1	28	0.2	0.9
1st quartile[1]	55	55	1.1	6.8	9.4
Median[2]	58.6	63.2	3.6	6.9	10.1
3rd quartile[3]	65.3	66.3	6.4	7.0	10.5

[1] 25 percent of values were less than or equal to the 1st quartile value
[2] 50 percent of values were less than or equal to the median value
[3] 75 percent of values were less than or equal to the 3rd quartile value

7.6 Water Quality Constituents

7.6.1 Temperature

Available temperature data are shown in Figures 7.2, 7.3, and 7.4. Figures 7.2 and 7.3 show instantaneous measurements taken during daytime. Figure 7.4 shows the 7-day moving average of the daily maximum temperature. Quite a number of the temperature data points exceed the salmonid spawning criterion of 12.8° C. A seasonal analysis of the data would be required to determine if these exceedences occur during the period when spawning would be likely to occur and in locations where spawning takes place. There are data points that exceed the salmonid rearing evaluation criterion, but the frequency differs considerably among the sites on the Lewis & Clark River. Relatively few (5.4 percent) of the data points at the DEQ ambient monitoring sites exceed 17.8° C, but many more (31.6 percent) exceed the criterion at the site near Fort Clatsop. This probably a function of location in the watershed. The ODEQ ambient sites are farther upstream (Figure 7.1), and thus subjected to less warming. The data collected by the watershed council (Figure 7.4) is of particular interest. It shows that in the Lewis & Clark River at Logan Bridge, the 7-day moving average of the maximum daily water temperature, which is the basis for the Oregon water quality standard for temperature, did not exceed the salmonid rearing criterion in 1999. It also shows that the temperature stays below the spawning criterion from early September until early to mid July.

These data suggest that the rivers in the Youngs Bay watershed are not impaired in their upper reaches, but show moderate impairment in the lower reaches. High temperatures in the lower reaches may adversely affect cold water species.

7.6.2 Dissolved Oxygen

Dissolved oxygen data are presented in Figures 7.5 and 7.6. For all the sites with data, with the exception of the Youngs River at Youngs River Loop Road, at least one data point fell below the evaluation criterion of 8.0 mg/L dissolved oxygen. For the pooled data, 12.8 percent of the values from the STORET sites, and 14.4 percent of the values from the Fort Clatsop site fell below the criterion. At the screening level of this assessment, these reaches are not impaired with respect to dissolved oxygen.

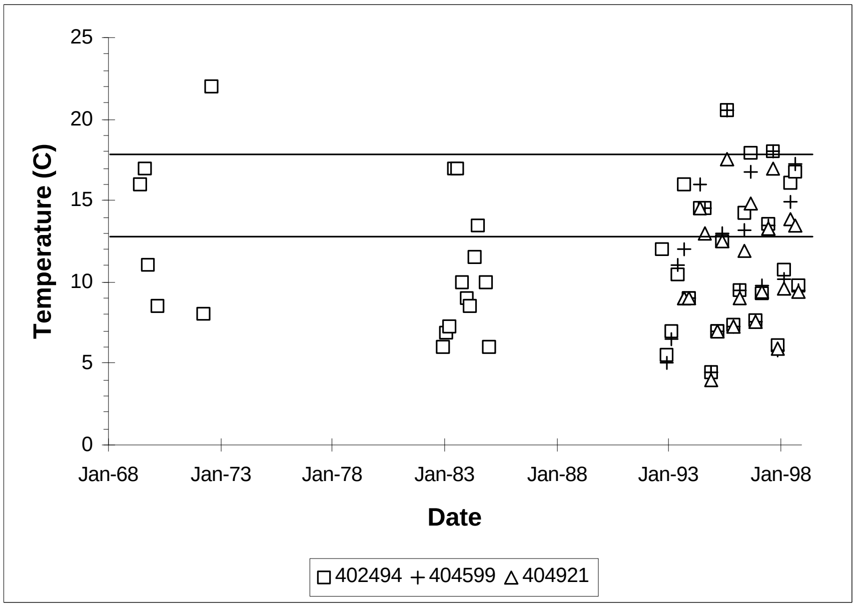

Figure 7.2. Temperature data collected at ODEQ ambient monitoring sites in the Youngs Bay watershed. (402494 = Lewis & Clark River at Stavebolt Lane, 404599 = Klaskanine River at Youngs River Loop Rd., 404921 = Youngs River at Youngs River Loop Rd.). Horizontal lines mark evaluation criteria of 12.8° C (spawning) and 17.8° C (salmonid rearing).

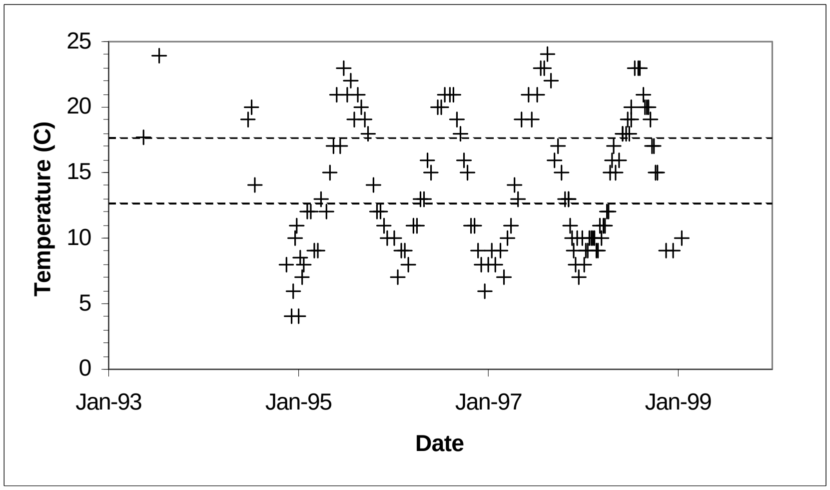

Figure 7.3. Temperature data collected by the National Park Service from the Lewis & Clark River near Fort Clatsop. Horizontal lines mark evaluation criteria of 12.8° C (spawning) and 17.8° C (salmonid rearing).

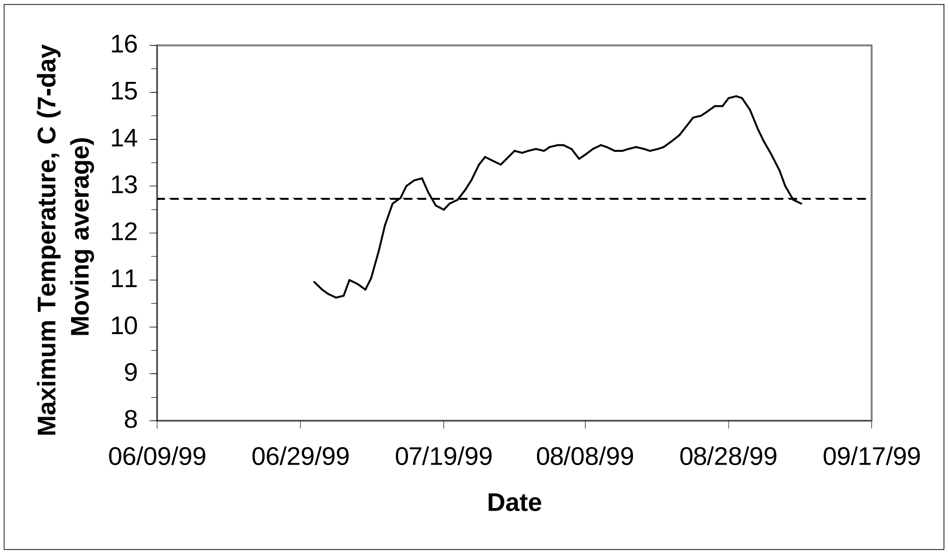

Figure 7.4. 7-day moving average of daily maximum temperature measured in the Lewis & Clark River near Logan Bridge. Horizontal line marks evaluation criterion for salmonid spawning (12.8° C).

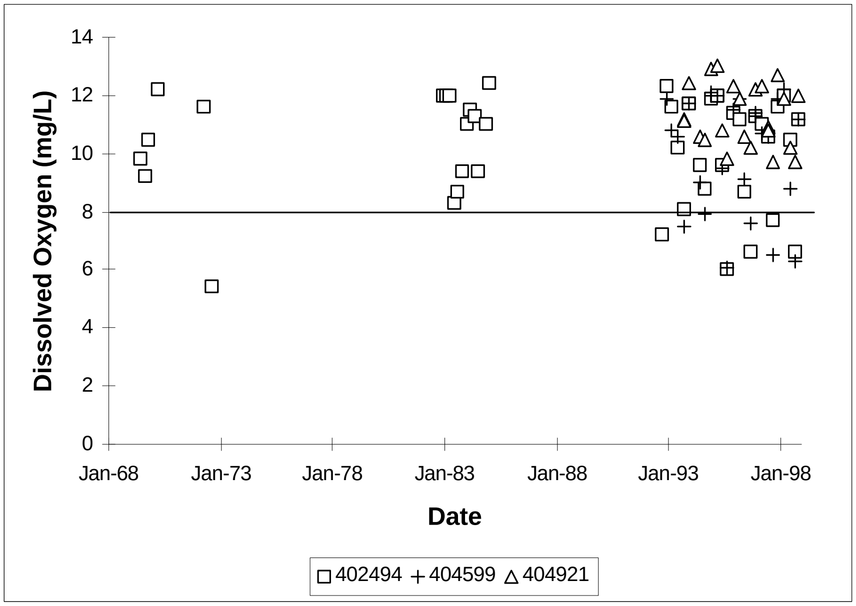

Figure 7.5. Dissolved oxygen data collected at the ODEQ ambient water quality sampling sites in the Youngs Bay watershed. (402494 = Lewis & Clark River at Stavebolt Lane, 404599 = Klaskanine River at Youngs River Loop Rd., 404921 = Youngs River at Youngs River Loop Rd.). Horizontal line marks evaluation criterion of 8.0 mg/L.

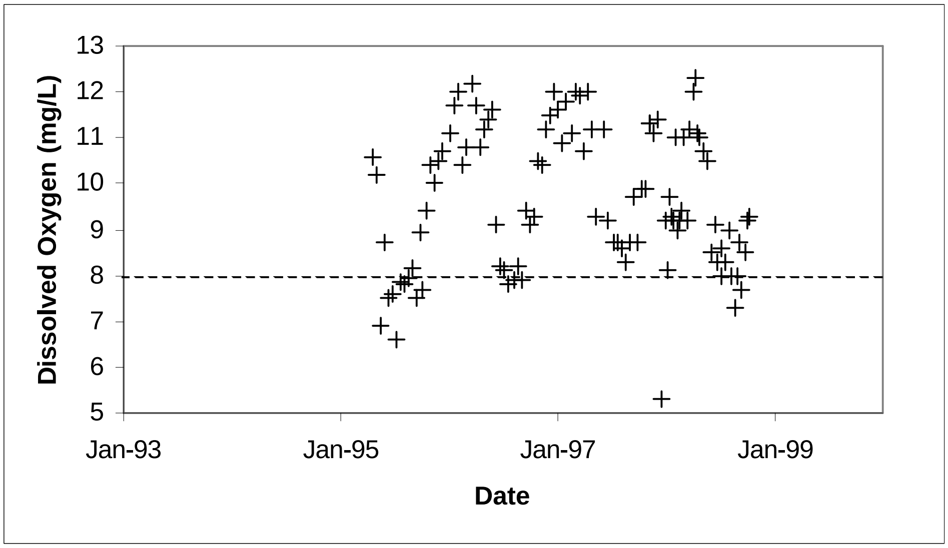

Figure 7.6. Dissolved oxygen data collected by the National Park Service from the Lewis & Clark River near Fort Clatsop. Horizontal line marks evaluation criterion of 7.0 mg/L.

7.6.3 pH

Data for pH are presented in Figures 8.7 and 8.8. All the available data points for pH fell within the evaluation criteria. Based on these data, there is no reason to suspect that water quality in the major streams of the watershed are impaired for pH.

7.6.4 Nutrients

Phosphorus

Data for total phosphorus, measured at the STORET sites, are presented in Figure 7.9. A number of the data points exceed the evaluation criterion. For the pooled data for all sites, 28 percent exceeded the evaluation criterion of 0.05 mg/L total P.

Nitrogen

Data for total nitrate-nitrogen (NO_3-B) measured at the STORET sites are presented in Figure 7.10. A number of the data points exceed the evaluation criterion. For the pooled data for all sites, 47 percent exceeded 0.50 mg/L.

The available data suggest that water quality in the major streams in the watershed is moderately impaired for nutrients.

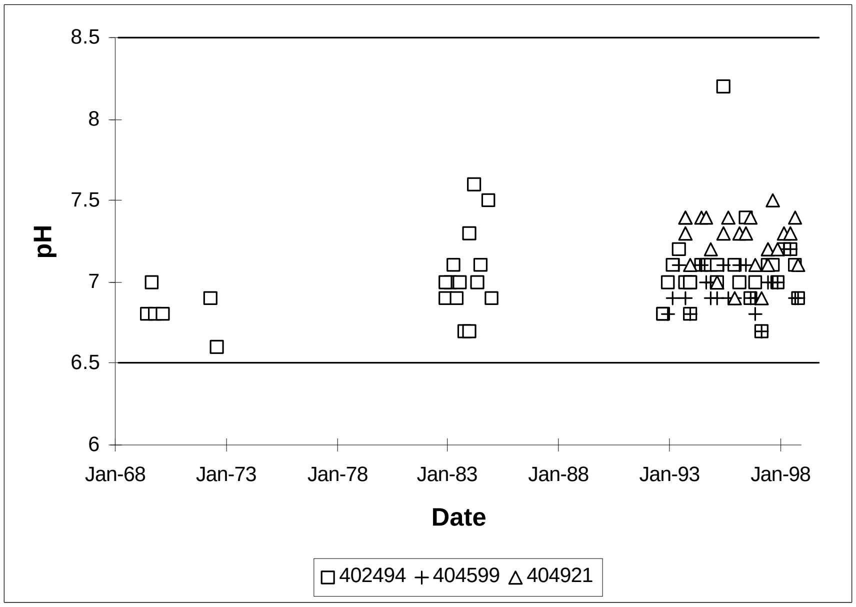

Figure 7.7. pH data collected at the ODEQ ambient water quality sampling sites in the Youngs Bay watershed. (402494 = Lewis & Clark River at Stavebolt Lane, 404599 = Klaskanine River at Youngs River Loop Rd., 404921 = Youngs River at Youngs River Loop Rd.). Horizontal lines mark evaluation criterion of 6.5 and 7.5.

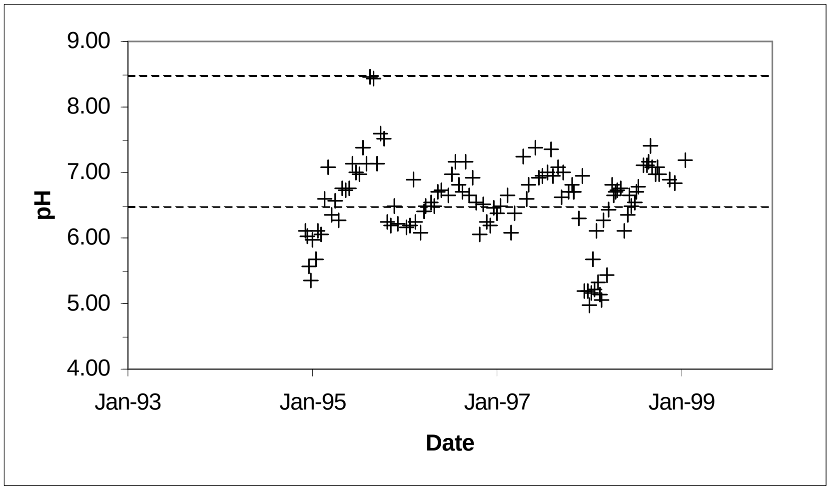

Figure 7.8. pH data collected by the National Park Service from the Lewis & Clark River near Fort Clatsop. Horizontal lines mark evaluation criterion of 6.5 and 7.5.

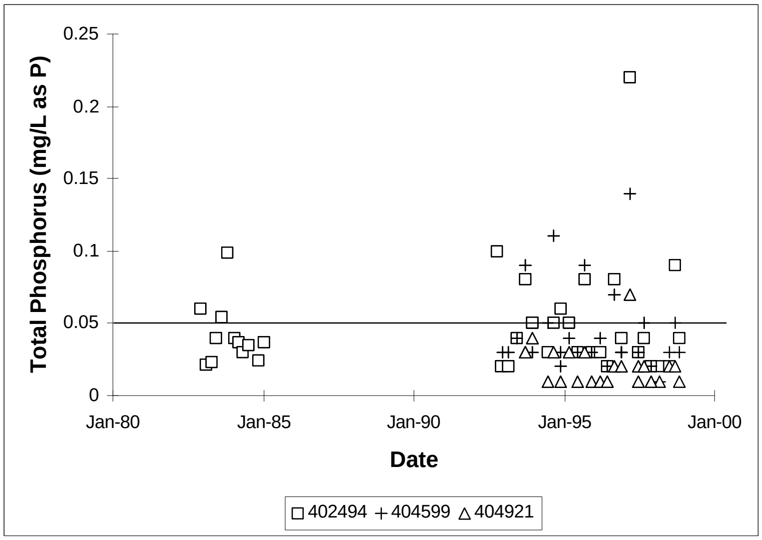

Figure 7.9. Total phosphorus data collected at the ODEQ ambient water quality sampling sites in the Youngs Bay watershed. (402494 = Lewis & Clark River at Stavebolt Lane, 404599 = Klaskanine River at Youngs River Loop Rd., 404921 = Youngs River at Youngs River Loop Rd.). Horizontal line marks evaluation criterion of 0.05 mg/L.

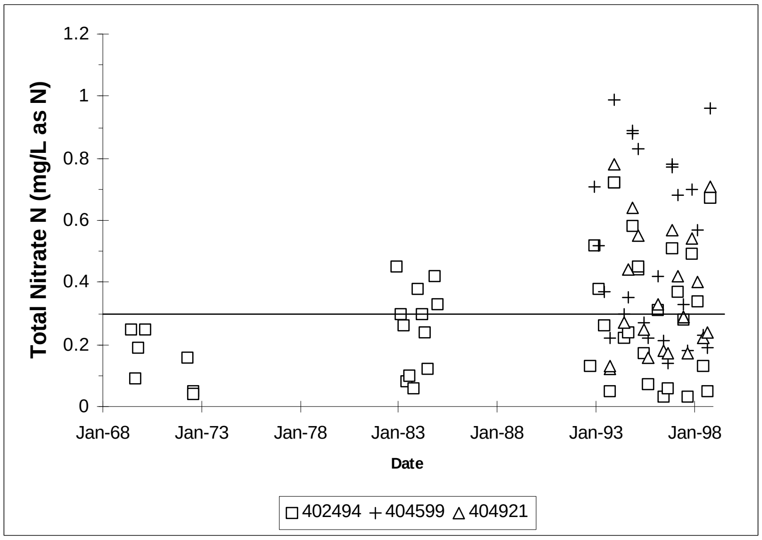

Figure 7.10. Total nitrate data collected at the ODEQ ambient water quality sampling sites in the Youngs Bay watershed. (402494 = Lewis & Clark River at Stavebolt Lane, 404599 = Klaskanine River at Youngs River Loop Rd., 404921 = Youngs River at Youngs River Loop Rd.). Horizontal line marks evaluation criterion of 0.30 mg/L.

7.6.5 Bacteria

Data for bacteria are presented in Figures 7.11 (Fecal coliform) and 7.12 (*E. coli*). In unimpaired waters not more than 50 percent of the samples should exceed 14 fecal coliform bacteria per 100 mL, and not more than 10 percent should exceed 43 per 100 mL. For the available STORET data, 86.1 percent exceeded 43 per 100 mL and nearly all exceeded 14 per 100 mL.

No sample for *E. coli* exceeds the single sample evaluation criterion of 406 per 100 mL. Fewer than 40 percent exceed the 30-day mean criterion of 126 per 100 mL. This number is of questionable relevance, however, because the data are from single samples, and the criterion is based on the average of at least 5 samples.

Based on the available data, water quality in the major streams of the watershed appears to be moderately impaired or impaired with respect to bacteria.

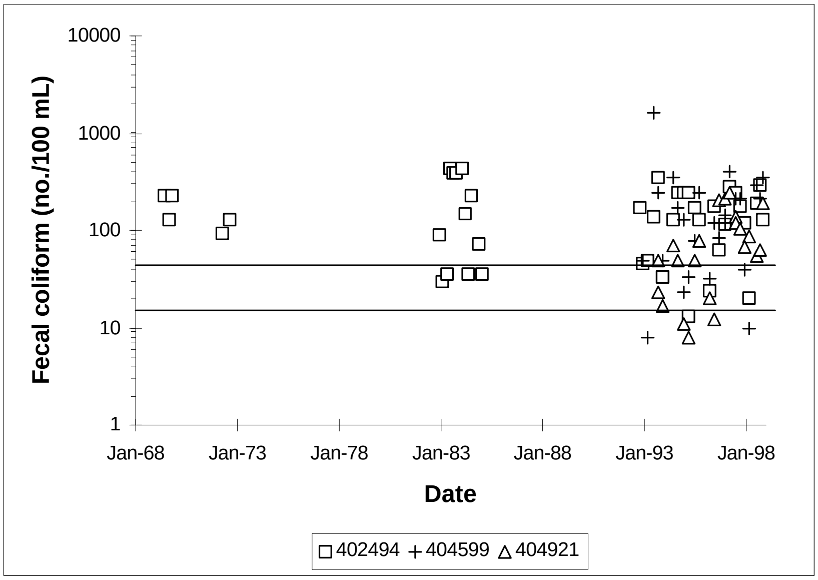

Figure 7.11. Fecal coliform data collected at the ODEQ ambient water quality sampling sites in the Youngs Bay watershed. (402494 = Lewis & Clark River at Stavebolt Lane, 404599 = Klaskanine River at Youngs River Loop Rd., 404921 = Youngs River at Youngs River Loop Rd.). Horizontal lines mark 90th percentile (43/100 mL) and 50th percentile (14/100 mL) evaluation criteria.

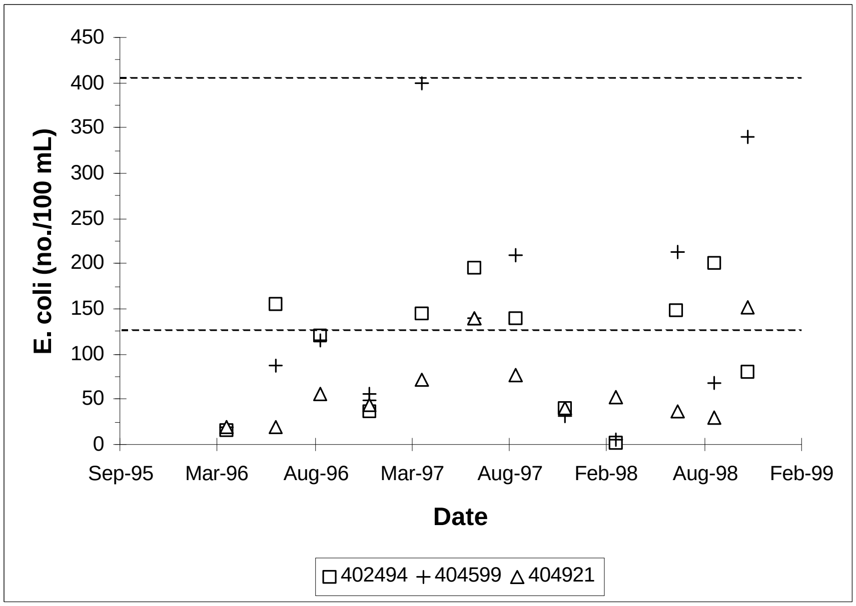

Figure 7.12. Bacteria (*E. coli*) data collected at the ODEQ ambient water quality sampling sites in the Youngs Bay watershed. (402494 = Lewis & Clark River at Stavebolt Lane, 404599 = Klaskanine River at Youngs River Loop Rd., 404921 = Youngs River at Youngs River Loop Rd.). Horizontal lines mark single sample (406/100 mL) and log-mean (126) evaluation criteria

7.6.6 Turbidity

Data for turbidity are presented in Figures 7.13 and 7.14. Only a few samples fall above the evaluation criterion of 50 NTU. This suggests that there is no impairment of water quality in regard to turbidity. However, it is likely that few of the samples considered in the assessment were taken during rainfall runoff events. It is probable, therefore that they do not represent the true range of values of turbidity. Additional sampling during rainfall events would be necessary to adequately evaluate water quality with regard to turbidity.

7.6.7 Contaminants

There are no data available to assess the water quality condition with regard to contaminants.

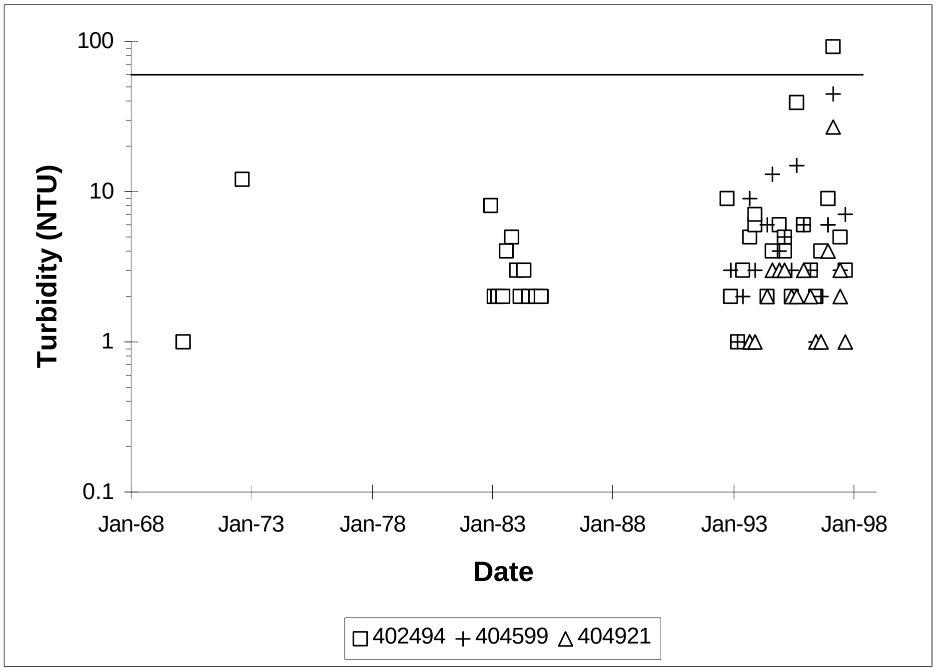

Figure 7.13. Turbidity data collected at the ODEQ ambient water quality sampling sites in the Youngs Bay watershed. (402494 = Lewis & Clark River at Stavebolt Lane, 404599 = Klaskanine River at Youngs River Loop Rd., 404921 = Youngs River at Youngs River Loop Rd.). Horizontal line marks evaluation criterion of 50 NTU.

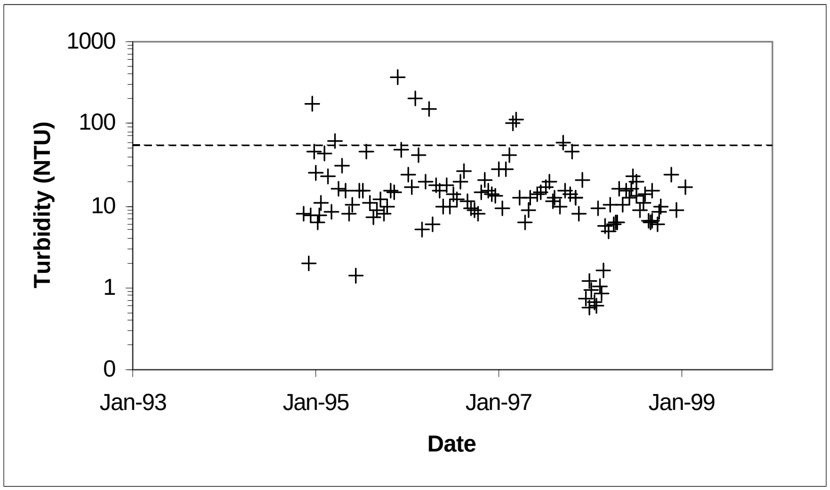

Figure 7.14. Turbidity data collected by the National Park Service in the Lewis & Clark River near Fort Clatsop. Horizontal line marks evaluation criterion of 50 NTU.

7.7 Water Quality Conditions

At the screening level of this assessment, water quality in the major streams of the Youngs Bay watershed would be considered impaired because of the frequency of exceedence of the evaluation criteria for nutrients (nitrogen and phosphorus) and bacteria. Temperature may also be a problem in the lower reaches of the streams near the mouth. These issues should be addressed through stream and watershed restoration activities. In order to adequately address the causes of impairment, additional data should be obtained through a carefully designed water quality monitoring program.

CHAPTER 8 WATERSHED CONDITION SUMMARY

8.1 Introduction

Summarizing current conditions and data gaps within a watershed will help to identify how current and past resource management is impacting aquatic resources. Through this summarization, we have attempted to create a decision-making framework for identifying key restoration activities that will improve water quality and aquatic habitats. Following is a summary of key findings and data gaps from the primary components of this watershed including fisheries, fish habitat, hydrology, water use, sediment sources, water quality and wetlands.

8.2 Important Fisheries

Fisheries within the Youngs Bay watershed have undergone significant changes during the twentieth century. The types of fish present and their locations have been altered from historical conditions in the watershed. Arguably, the most significant activities to affect the fisheries during the last one hundred years are habitat modifications, hatchery programs and harvest.

The National Marine Fisheries Service (NMFS) has listed several anadromous fish species that exist, or could potentially exist, in the watershed as threatened (Table 8.1), including chum and chinook. Steelhead and coho have been listed as candidates for listing, while coastal cutthroat are proposed to be listed as threatened. Listing occurs for entire Evolutionarily Significant Units (ESU), defined as a genetically or ecologically distinctive group of Pacific salmon, steelhead, or sea-run cutthroat trout.

Table 8.1. Status of anadromous fish occurring in the lower Columbia River ESU's.* Listing status was obtained from the NMFS website (*http://www.nwr.noaa.gov/lsalmon/salmonesu/index.htm*).

Fish	ESU	Status
Coho	Lower Columbia River/Southwest Washington	Candidate
Coastal Cutthroat	Southwestern Washington/Columbia River	Proposed Threatened
Chum	Columbia River	Threatened
Chinook	Lower Columbia River	Threatened
Steelhead	Oregon Coast	Candidate

* An Evolutionarily Significant Unit or "ESU" is a genetically or ecologically distinctive group of Pacific salmon, steelhead, or sea-run cutthroat trout.

Fisheries in the Youngs Bay watershed lack self-sustaining anadromous fish populations. Native coho, chum, and chinook have been eliminated (if there ever were any). Sea-run cutthroat trout appear to be at very low levels. Native winter steelhead are present in moderate numbers only in the Lewis & Clark River. Consequently, even if significant improvements were made in habitat and ocean conditions, anadromous fish levels in the Youngs Bay watershed would most likely remain low (Walt Weber pers. comm.). To improve fisheries in the Youngs Bay watershed, it is imperative that brood stock development programs be developed that provide fish stocks capable of using improved habitats to become self-sustaining populations. Possible brood stock sources include late spawning Cowlitz River hatchery coho, Washington lower Columbia River chum, Lewis & Clark River winter steelhead, and Clatskanie River or Lewis & Clark River searun cutthroat trout. This list is not all-inclusive and establishment of these broodstocks must take into account current local terminal fishery programs and local gill-net fisheries. Potential issues include over-harvest of developing broodstocks, competition, predation, and attraction of avian predators.

An additional problem exists in that fish are excluded from some of the better fish habitat available due to the North Fork Klaskanine ODFW fish hatchery. This barrier has led to the virtual elimination of native steelhead and sea-run cutthroat populations in the Youngs Bay watershed (Walt Weber pers. comm.) and has limited the expansion of introduced coho broodstock. Removal of the hatchery would eliminate this problem; however, this hatchery may be needed for broodstock development.

8.3 Hydrology and Water Use

8.3.1 Hydrology

Human activities in a watershed can alter the natural hydrologic cycle, potentially causing changes in water quality and aquatic habitats. These types of changes in the landscape can increase or decrease the volume, size, and timing of runoff events and affect low flows by changing groundwater recharge. Some examples of human activities that can impact watershed hydrology are timber harvesting, urbanization, conversion of forested land to agriculture, and construction of road networks. The focus of the hydrologic analysis component of this assessment is to evaluate the potential impacts from land and water use on the hydrology of this watershed (WPN 1999). It is important to note that this assessment only provides a screen for potential hydrologic impacts based on current land use activities in a watershed. Identifying those activities that are actually affecting the hydrology of the watershed would require a more in-depth analysis and is beyond the scope of this assessment.

Current land use practices in the Youngs Bay watershed do not demonstrate a high potential for enhancing peak flows as a result of forest harvesting, establishment of agriculture and range lands, construction of forest and rural roads, and establishment of urban and suburban areas (Table 8.2). Since rain events are the predominant form of precipitation, there is only a small chance for forestry practices to enhance peak flows. Rain-on-snow events that do occur are large and rare events, and it is unlikely that forest practices are increasing the magnitude of these events. It is generally believed that forest harvest practices have the greatest effect on moderate peak flows, and not these large rare events (Naiman and Bilby 1998, Dunne 1983). Since forest harvest practices are common in the watershed, it is possible that there are other impacts to the watershed's hydrology, such as reductions in evapotranspiration, increased infiltration and subsurface flow, and increased overland flow. Both forest and rural road densities are low or occupy such small proportions of the watershed that the potential for enhancing peak flows is low.

Table 8.2. Potential effects on peak flows from land use practices*. Impact ratings for forest and rural roads are based on calculations from the ODF fire roads coverage.

	Area (mi^2)	Forestry Impacts	Forest Road Impacts	Rural Road Impacts
Lower Lewis & Clark River	14.3	low	low	low
N Fork Klaskanine River	26.3	low	low	moderate
S Fork Klaskanine River	23.2	low	low	moderate
Upper Lewis & Clark River	47.2	low	low	low
Upper Youngs River	36.6	low	low	low
Youngs Bay East	24.0	low	low	low
Youngs Bay Mouth	2.8	low	high	low
Youngs Bay West	9.2	low	low	low
Total	184	low	low	low

*Impact ratings were based on standards set in the OWEB watershed assessment manual.

Urban, suburban, and agricultural development is concentrated in the lower elevations of the watershed, often occurring in the floodplains of the Youngs and Lewis & Clark Rivers. These land management activities often result in the channelization and diking of the rivers for flood protection. By channelizing and disconnecting the rivers from their floodplains, downcutting of the channel can occur, increasing flow velocities and changing peak flows (Naiman and Bilby 1998). Determining the level of impact from diking and channelization warrants further investigation.

8.3.2 Water Use

Water is withdrawn from both surface and subsurface water supplies within almost all the watersheds in Oregon. Much of this water is for beneficial uses, such as irrigation, municipal water supply, and stock watering. When water is removed from these stores, a certain percentage is lost through processes such as evapotranspiration. Water that is “consumed “ through these processes does not return to the stream or aquifer, resulting in reduced instream flows, which can adversely affect aquatic communities that are dependent upon this water. In fact, the dewatering of streams has often been cited as one of the major reasons for salmonid declines in the state of Oregon.

Water availability was assessed by ranking subwatersheds according to their dewatering potential (Table 8.3). Dewatering potential is defined as the potential for large proportions of instream flows to be lost from the stream channel through consumptive use.

Table 8.3. Dewatering potential and associated beneficial uses of water in the Youngs Bay watershed.

Water Availability Watershed	Fish Use[1]	Avg. Percent Withdrawn[2]	Dominant Water Use	Dewatering Potential[3]
Lewis & Clark R. above Heckard Cr.	C, FC, WS	106%	Municipal	High
Young’s R. above Klaskanine R.	C, FC, WS	36%	Municipal	High
Lewis and Clark @ mouth	C, FC, WS	15%	Municipal	Moderate
Young’s R. @ mouth	C, FC, WS	11%	Irrigation	Moderate
SF Klaskanine R. @ mouth	C, FC, WS	2%	Fisheries	Low
NF Klaskanine R. @ mouth	C, FC, WS	2%	Fisheries	Low

[1] C=coho, FC=fall chinook, WS=winter steelhead
[2] Average of low flow months (June, July, August, September, October).
[3] Greater than 30% is high, 10 to 30% is moderate, and less than 10% is low.

The greatest demands on water in the Youngs Bay watershed are for municipal and fisheries uses (Table 8.3). The Lewis & Clark River has the greatest potential for dewatering because it acts as the primary source of water for the city of Warrenton. The city of Astoria uses the Bear Creek watershed (Nicolai-Wickiup watershed) as its primary source of water and also owns two undeveloped water rights for Big Creek and the Youngs River. Although not an immediate concern, the Youngs River may develop a high dewatering potential if the city of Astoria decides to develop its water rights for the Youngs River as the city's demand for water increases.

Getting appropriated water back into the stream channel can be a difficult process. The Oregon Water Resources Board offers several programs, including water right leasing and conversion, in an attempt to put water back into the stream channel. However, much of this water has high economic value to its user, generating a demand for the water. Alternatives should be identified to conserve water, especially in streams with a high dewatering potential.

8.4 Aquatic Habitats

Distribution and abundance of salmonids within a given watershed varies with habitat conditions such as substrate and pool frequency as well as biological factors such as food distribution (i.e. insects and algae). In addition, salmonids have complex life histories and use different areas of a watershed during different parts of their life cycle. For example, salmonids need gravel substrates for spawning but may move to different stream segments during rearing. The interactions of these factors in space and time make it difficult to determine specific factors affecting salmonid populations. Consequently, entire watersheds, not just individual components, must be managed to maintain fish habitats (Garano and Brophy 1999).

The Endangered Species Act requires that forests providing habitat for endangered species must be properly (Tuchmann et al. 1996). An understanding of the land patterns associated with the distribution of these species can lead to a better understanding of how to conserve these species. The OWEB process focuses on salmonids in the watershed.

8.4.1 Fish Passage

Culverts can pose several types of problems including excess height, excessive water velocity, insufficient water depth in culvert, disorienting flow patterns and lack of resting pools between culverts. Culverts can also limit fish species during certain parts of their life cycles and not others. For example, a culvert may be passable to larger adult anadromous fish and not juveniles. Culverts may also act as passage barriers only during particular environmental conditions such as high flow events. Because of these variable effects, it is important to understand the interactions of habitat conditions and life stage for anadromous fish.

Overall, data were insufficient to evaluate current fish passage problems in the Youngs Bay watershed (Table 8.4). Only a small proportion of culverts have been evaluated. ODFW conducted a survey of culverts for state and county roads. Of the 36 culverts surveyed by ODFW, 29 did not meet standards, suggesting that they block access to critical habitat areas. Of 50 culverts on fish-bearing or unknown streams, Willamette Industries identified and prioritized 35 culverts that may act as fish passage barriers. These data need to be combined and mapped in a GIS database. Culverts should be prioritized according to fish usage or need to be evaluated. A good starting point is the road /stream crossing coverage developed as a part of this assessment.

Other fish passage barriers block large amounts of fish habitat. There is a falls on the Youngs River a quarter mile above tidewater. There is also a 25 ft falls on the South Fork Klaskanine River. A reservoir with an “adequate” fish ladder (downstream passage of steelhead is at least delayed) is located a few miles upstream from the South Fork confluence on the

Table 8.4. Fish passage conditions in the Youngs Bay watershed.

Subwatershed	Stream Miles	Salmonid Use*	Miles Salmonid Use	# Known Impassable Culverts	# Road/ Stream Crossings	Rank
Lower Lewis & Clark River	70	C, FC, WS	8.8	2	41	Insufficient data
N Fork Klaskanine River	113	C, FC, WS	12.5	8	87	Insufficient data
S Fork Klaskanine River	99	C, FC, WS	7.1	7	79	Insufficient data
Upper Lewis & Clark River	202	C, FC, WS	29.3	1	137	Insufficient data
Upper Youngs River	167	C, FC, WS	16.4	1	154	Insufficient data
Youngs Bay East	91	C, FC, WS	14.5	6	77	Insufficient data
Youngs Bay Mouth	13	C, FC, WS	0.0	1	17	Insufficient data
Youngs Bay West	55	C, FC, WS	4.2	3	46	Insufficient data

* C=coho, FC=fall chinook, WS=winter steelhead

Lewis & Clark River. The Klaskanine fish hatchery blocks the North Fork of the North Fork Klaskanine. There is a possible fish passage barrier at low flows on the mainstem Lewis & Clark River just above the confluence with the Little South Fork and the South Fork Lewis & Clark Rivers.

8.4.2 Fish Habitats

Understanding the spatial and temporal distribution of key aquatic habitat components is the first step in learning to maintain conditions suitable to sustain salmonid populations. These components must then be linked to larger scale watershed processes that may control them. For example, a stream that lacks sufficient large woody debris (LWD) often has poor LWD recruitment potential in the riparian areas of that stream. By identifying this linkage, riparian areas can be managed to include more conifers to increase LWD recruitment potential. Also, high stream temperatures can often be linked to lack of shade as a result of poorly vegetated riparian areas. By linking actual conditions to current watershed-level processes, land mangers can better understand how to manage the resources to maintain these key aquatic habitat components.

Stream Morphology

Pools are important features for salmonids, providing refugia and feeding areas. Substrates are also an important channel feature since salmonids use gravel beds for spawning. These gravel beds can be buried by heavy sedimentation resulting in loss of spawning areas as well as reduced invertebrate habitat. For streams that were surveyed, stream morphology and substrates were compared against ODFW benchmarks to evaluate current habitat conditions.

In general, data were lacking to evaluate current stream morphology. Overall, the upper reaches of the Klaskanine River had desirable geomorphologic conditions (Table 8.5). Gravel beds were generally desirable in these areas. These areas could provide good spawning grounds for salmonids, especially coho, fall chinook, and winter steelhead. Access to these habitat areas are currently blocked by the Klaskanine River Falls. Both coho and fall chinook use the Lewis & Clark River, which has desirable morphologic characteristics except for residual pool depths.

Table 8.5 Stream morphologic conditions in the Youngs Bay watershed. Data were collected by ODFW (1990-1995).

Subwatershed	Stream Miles	Fish Use[1]	Miles Surveyed [2]	Pool Frequency[2]	Percent Pools[2]	Residual Pool Depth[2]	Gravel[2]
Lower Lewis & Clark River	70	C, FC, WS	0	--	--	--	--
N Fork Klaskanine River	113	C, FC, WS	21 (7)	MOD (3)	MOD (3)	UND (3)	DES (5)
S Fork Klaskanine River	99	C, FC, WS	38.2 (9)	MOD (8)	DES (4)	DES (7)	MOD (7)
Upper Lewis & Clark River	202	C, FC, WS	5.1 (7)	MOD (4)	MOD (6)	UND (4)	DES (5)
Upper Youngs River	167	C, FC, WS	0	--	--	--	--
Youngs Bay East	91	C, FC, WS	0	--	--	--	--
Youngs Bay Mouth	13	C, FC, WS	0	--	--	--	--
Youngs Bay West	55	C, FC, WS	0	--	--	--	--

[1] C=coho, FC=fall chinook, WS=winter steelhead
[2] Number in parentheses is the number of reaches in that category from ODFW surveys

Large Woody Debris

Large woody debris is an important feature that adds to the complexity of the stream channel. LWD in the stream provides cover, produces and maintains pool habitat, creates surface turbulence, and retains a small woody debris. Functionally, LWD dissipates stream energy, retains gravel and sediments, increases stream sinuosity and length, slows the nutrient cycling process, and provides diverse habitat for aquatic organisms (Bischoff 2000, BLM 1996).

Streams generally lacked instream LWD including key pieces, volume, and number of pieces (Table 8.6). Much of this is probably a result of poor riparian recruitment. Streams within current fish distributions would benefit from instream LWD placement especially in the Lewis & Clark River. Coho are found in the Wallooskee River, however there is no data available on current instream conditions. Riparian recruitment was moderate in this watershed. Further investigation is needed to evaluate habitat in the Wallooskee River.

Wetlands

Wetlands contribute critical functions to a watershed’s health such as water quality improvement, flood attenuation, groundwater recharge and discharge, and fish and wildlife

Table 8.6 Riparian and instream LWD conditions in the Youngs Bay watershed.

Subwatershed	Stream Miles	Fish Use[1]	Riparian Recruitment[2]	Riparian Shade[2]	Instream LWD[3]
Lower Lewis & Clark River	70	C, FC, WS	Inadequate	High	--
N Fork Klaskanine River	113	C, FC, WS	Moderate	High	Undesirable (9)
S Fork Klaskanine River	99	C, FC, WS	Moderate	High	Undesirable (12)
Upper Lewis & Clark River	202	C, FC, WS	Inadequate	High	Undesirable (21)
Upper Youngs River	167	C, FC, WS	Inadequate	High	--
Youngs Bay East	91	C, FC, WS	Moderate	High	--
Youngs Bay Mouth	13	C, FC, WS	Inadequate	High	--
Youngs Bay West	55	C, FC, WS	Inadequate	Low	--

[1] C=coho, FC=fall chinook, WS=winter steelhead
[2] From aerial photo interpretation conducted by E&S Environmental Chemistry, Inc.
[3] Number in parentheses is the number of reaches in that category from the ODFW field surveys.

habitat (Mitsch and Gosselink 1993). Because of the importance of these functions, wetlands are regulated by both State and Federal agencies. Additionally, wetlands play an important role in the life cycles of salmonids (Lebovitz 1992). Estuarine wetlands provide holding and feeding areas for salmon smolts migrating out to the ocean. These estuarine wetlands also provide an acclimation area for smolts while they are adapting to marine environments. Riparian wetlands can reduce sediment loads by slowing down flood water, allowing sediments to fall out of the water column and accumulate. Wetlands provide cover and a food source in the form of a diverse aquatic invertebrate community. Backwater riparian wetlands also provide cover during high flow events, preventing juvenile salmon from being washed downstream. Wetlands need to be prioritized for restoration.

Estuarine Wetlands

Estuarine wetlands were once common in the Columbia River estuary, including Youngs Bay (Boulé and Bierly 1987). Many of these wetlands have been diked, disconnecting them from saltwater influences and changing the structure of the wetland. All existing estuarine wetlands currently accessible to salmonids need to be protected or restored. Those wetlands disconnected by dikes need to be evaluated for potential restoration.

Palustrine Wetlands

Palustrine wetlands are a dominant feature in the Youngs Bay watershed. Stream side wetlands need to be protected especially those that are in the current salmonid distribution. Streamside wetlands that have been disconnected due to diking need to be evaluated for restoration opportunities. Other wetlands should be protected for their roles in maintaining water quality, flood attenuation, and habitat.

8.5 Sediment Sources

In this watershed, slope instability, road instability, and rural road runoff were determined to be the most significant sediment sources. Shallow landslides and deep-seated slumps are known to be common in the Oregon Coast Range. Streamside landslides and slumps can be major contributors of sediment to streams, and shallow landslides frequently initiate debris flows. Rural roads are a common feature of this watershed, and many are present on steep slopes. Washouts from rural roads contribute sediment to streams, and sometimes initiate debris flows. The density of rural roads, especially unpaved gravel and dirt roads, indicates a high potential for sediment contribution to the stream network.

Sediment sources are highly variable across the Youngs Bay watershed (Table 8.7). Although it is difficult to differentiate between human-induced and natural landslide events at this level of analysis, it is likely that land use practices are increasing sediment loading into surface waters (WPN 1999). Many culverts have been identified to be at risk of causing damage to the stream network. High risk culverts that exist on Willamette Industries land have been prioritized and are currently being replaced under the 10-year legacy road plan. Additionally, road densities within 200 feet of the stream are high, although very few of these are on slopes greater than 50 percent. Considering the overall lack of information regarding the contribution of sediment to the stream network, additional studies of landslides and potential road-associated sediment sources are warranted.

Table 8.7. Potential sediment source conditions in the Youngs Bay Watershed.

	Area (mi^2)	Slope Instability*	Road Instability	Road Runoff	Stream Bank Erosion
Lower Lewis & Clark River	14.3	High	Insufficient Data	Insufficient Data	--
N Fork Klaskanine River	26.3	High	Insufficient Data	Insufficient Data	Moderate
S Fork Klaskanine River	23.2	High	Insufficient Data	Insufficient Data	High
Upper Lewis & Clark River	47.2	High	Insufficient Data	Insufficient Data	High
Upper Youngs River	36.6	Moderate	Insufficient Data	Insufficient Data	--
Youngs Bay East	24.0	Low	Insufficient Data	Insufficient Data	--
Youngs Bay Mouth	2.8	Low	Insufficient Data	Insufficient Data	--
Youngs Bay West	9.2	Low	Insufficient Data	Insufficient Data	--

* High was >20% area in high and moderate categories from DOGAMI slope instability analysis. Moderate was 10 to 20% and low was < 10%.

8.6 Water Quality

Water quality is controlled by the interaction of natural and human processes in the watershed. Processes that occur on the hillslope can ultimately control instream water quality. Pollutants are mobilized through surface and subsurface runoff and can cause degradation of stream water quality for both human use and fish habitat. Consequently, many water quality parameters are highly episodic in nature and often associated with certain land use practices. The water quality assessment is based on a process that identifies the beneficial use of water, identifies the criteria that protects these benefits, and evaluates the current water quality conditions using these criteria as a rule set (WPN 1999).

Assessment of water quality by subwatershed is difficult because there is so little data available in the watershed. A summary of the water quality assessment is provided in Table 8.8. In the assessment, if any one of the parameters was judged impaired, or moderately impaired, water quality was judged impaired for that subwatershed. Additional data will be required to ascertain the causes of impairment and to devise restoration activities that might improve water quality.

Table 8.8. Water quality impairment summary for the Youngs Bay watershed.

Subwatershed	Temperature	Dissolved oxygen	pH	Nutrients	Turbidity	Bacteria	Toxics	Impairment Summary
Lower Lewis & Clark River	Moderately impaired	No data	Moderately impaired	No data	No data	No data	No data	Impaired
Klaskanine River	Not impaired	Not impaired	Not impaired	Moderately impaired	Not impaired	Moderately impaired	No data	Impaired
Upper Lewis and Clark River	Not impaired	Not impaired	Not impaired	Moderately impaired	Not impaired	Moderately impaired	No data	Impaired
Upper Youngs River	Not impaired	Not impaired	Not impaired	Moderately impaired	Not impaired	Moderately impaired	No data	Impaired
Youngs Bay East	Not impaired	Not impaired	Not impaired	Moderately impaired	Not impaired	Moderately impaired	No data	Impaired
Youngs Bay Mouth	Impaired	Not impaired	Not impaired	Moderately impaired	Not impaired	Moderately impaired	No data	Impaired
Youngs Bay West	Not impaired	Not impaired	Not impaired	Moderately impaired	Not impaired	Moderately impaired	No data	Impaired

CHAPTER 9 RECOMMENDATIONS

9.1 General

- Prioritize restoration and watershed management activities based on information in this assessment and any other assessment work conducted in the watershed. One example is the instream habitat restoration guide developed by ODFW (ODFW 1997). Prioritize areas with known salmonid use for both spawning and rearing. Focus on areas with sufficient water quality for salmonids (low temperature, low turbidity) and areas with good stream channel characteristics (responsive channel habitat type, good geomorphologic conditions, good riparian shade and recruitment potential).

- Maintain relationships and contacts with the Oregon Department of Forestry, the cities of Astoria and Warrenton, and private timber owners to keep up-to-date on data collection, further assessment, and restoration activities on their lands. Update assessment data sets accordingly.

- Develop an understanding of the Forest Practices Act (a copy is housed at the watershed council office). This will provide a better understanding of regulations and mitigation actions necessary for timber harvest.

9.2 General Data

- Use a standardized set of base maps. As a part of this assessment, a series of 1:24,000 base map layers were developed. We recommend that these layers be used as a base map and additional data be maintained at a scale of 1:24,000 or larger (i.e. 1:12,000). All of these layers will relate directly to the USGS 7.5 minute quadrangles which can be used to list later information and find locations in the field.

- Georeference all field data at a scale of 1:24,000 or better. This can be accomplished by using GPS to record latitude and longitude or by marking the location on the USGS quadrangle maps.

- Maintain data in an accessible location and format. The watershed council office is the best place for this. Most data should be maintained in a GIS format and updated annually Some coverages will be updated periodically by the agency that created the coverage (i.e. salmonid distribution data from ODFW). These data sets should remain current in the watershed council’s database.

- Collect additional data in priority areas. The decision-making framework provided with this document allows the user to select strategic locations for data collection based on features such as channel habitat type, known salmonid distribution, and water quality conditions.

- Get expert advice on data collection and processing. Consult with the Technical Advisory Committee, federal and state agencies, and consultants to develop appropriate sampling collection, quality control, and data analysis protocols.

- Evaluate the GIS data layers. Several of the data sets used to develop this assessment need to be evaluated and compared to on-the-ground conditions before restoration or final conclusions are made about ecosystem processes. Layers that need further evaluation or updating include:

  <u>Land Use and Wetlands</u>
  The land use was refined from a LANDSAT scene, zoning, National Wetlands Inventory (NWI), and ownership (see section 1.8) which have all been field verified. NWI data were not available digitally for the entire area and so were used only in the areas of digital coverage. Additional wetland data were derived from the LANDSAT scene. NWI data are much more accurate since NWI is derived from aerial photo interpretation. Consequently, some areas that have been classified as wetlands are really agricultural fields. As NWI data become more readily available in digital format, the land use coverage should be updated. All land use categories should be field verified before restoration actions occur.

  <u>Roads</u>
  The roads coverage is a key coverage used to evaluate potential sediment sources and changes in watershed hydrology associated with road construction. However, the roads coverage may not accurately represent on-the-ground conditions in this watershed. The road coverage was developed from the 1:100,000 USGS Digital Line Graphs (DLG) updated on an ad-hoc basis from aerial photos and other sources as they were discovered. Although this coverage represents the best available data for roads, its accuracy is suspect. A study needs to be developed to verify the accuracy of the roads coverage.

  <u>Channel Habitat Types</u>
  Channel habitat types were determined using GIS. Field verification of these data suggest that the data accurately represent actual on-the-ground conditions (through visual comparison). However, the channel habitat type should be further verified in the field before any restoration actions occur.

  <u>Riparian Vegetation and Shade</u>
  Riparian conditions need to be further evaluated before restoration actions occur. A visual comparison of field checks to the aerial photo interpretations found the data to be fairly consistent. After site selection using the GIS data, the stream reach identified should be field checked for actual on-the-ground conditions. A more rigorous analysis of the GIS data could also be performed (field data have been provided to the watershed council).

- Refine the land use layer. Continue to develop the land use layer to reflect changes in land use. Update the layer with digital NWI data as they become available.

9.3 Fisheries

- Develop and update a fish limits coverage. This process has been started by ODF.
- Work with ODFW to identify viable populations and distributions of sensitive species, particularly salmonids. These data are critical in developing watershed enhancement strategies.
- Identify and survey areas currently used by salmonids. Collect stream survey data according to ODFW protocols. These data will help identify habitat limitations and areas that may provide good habitat but are currently blocked by a barrier.
- Work with ODFW to establish a brood stock development program that will provide fish stocks capable of establishing self-sustaining populations of coho, chum, chinook, sea-run cutthroat, and steelhead. A brood stock development program will help provide fish capable of using improved habitats, leading to self-sustaining populations of fish.

9.4 Aquatic Habitats

9.4.1 Instream Habitat Conditions

- Field verify the channel habitat type GIS data layer (see section 9.2). Some data have already been collected and visually compared to the layers. A statistical approach should be applied to these data.

9.4.2 Riparian Zones

- Field verify the riparian GIS data layers (see section 9.2). Some data have already been collected and visually compared to the layers. A statistical approach should be applied to these data.
- Prioritize stream reaches for restoration of riparian vegetation. Start in areas currently used by salmonids and lacking in LWD recruitment potential, good shade conditions, or instream LWD.
- Plant riparian conifers and native species in areas lacking LWD recruitment potential. Start in areas of known salmonid use, and use the riparian vegetation map provided with this assessment and ODFW stream surveys to identify candidate reaches. Before any reaches are targeted for planting, they should be field verified for suitability and actual conditions. Vegetation planting should use only native species and mimic comparable undisturbed sites.
- Develop a riparian fencing strategy to maintain riparian vegetation.

9.4.3 Fish Passage

- Complete a culvert survey of all culverts that have not been evaluated for fish passage. Data should be maintained in a GIS. The road/stream crossing coverage is a good place to start. The culvert survey should begin in priority subwatersheds at the mouth of each of the streams. Establish priorities for culvert replacement.

- Replace priority culverts identified in the culvert survey.

- Install fish passages at known fish passage barriers that are caused by human influences.

9.4.4 Wetlands

- Prioritize estuarine wetlands for restoration options based on their value to salmonids for restoration, creation, or maintenance. Landowners with priority wetlands can then be contacted for possible wetland restoration.

- Prioritize for restoration, creation, or maintenance, palustrine wetlands that are connected to streams and provide back water rearing areas for salmonids. Start in areas with known salmonid rearing and spawning habitat.

- Create, restore, and maintain estuarine wetlands based on their prioritization.

- Create, restore, and maintain palustrine wetlands based on their prioritization.

9.5 Hydrology and Water Use

- Update and refine the roads layer (see section 9.2). Keep in contact with ODF and other groups (private land owners) as the roads layer is updated to evaluate its accuracy.

- Develop a strategy to collect continuous discharge data in the primary rivers that flow into Young’s Bay. One strategy may be to install a level logger on the Lewis & Clark River and model the other rivers based on these data. Discharge data are essential to evaluate current low flow and peak flow conditions on the watershed. Work with OWRD or the USGS to get stream gages installed.

- Collect meteorologic data and rainfall data to improve modeling capabilities for water availability and flooding. This could be accomplished through local high schools or volunteers.

- Develop an outreach program to encourage water conservation. One of the primary water withdrawals is for municipal use. Educate the public about dewatering effects and how water conservation will help salmonids in the watersheds.

- Identify water rights that are not currently in use and that may be available for instream water rights through leasing or conversion.

9.6 Sediment

- Update and refine the roads layer (see section 9.2). Keep in contact with ODF as the roads layer is updated. Check with other groups (private land owners) to update the roads layer and evaluate its accuracy.

- Identify roads that have not been surveyed for current conditions and fill these data gaps. Work with ODF to develop road survey methodologies.

- Map road failures in areas where data are lacking. Coordinate with watershed stakeholders that are currently collecting road data such as ODF and private timber companies. Develop a strategy to fill in the data gaps.

- Map culvert locations and conditions in conjunction with the culvert survey conducted for fish passage barriers. Check with ODF, ODFW, and local foresters for the best methodologies and data to collect.

- Map all debris flows and landslides. Begin in the areas most susceptible to landslide activity as identified in the DOGAMI debris flow hazard map.

- Where possible, conduct road restoration activities such as road reconstruction, decommissioning, and obliteration.

- Replace undersized culverts that are at risk of washing out. Prioritize these culverts from the culvert surveys.

9.7 Water Quality

- Develop a systematic water quality monitoring program for areas with high priority for restoration activity. Focus the water quality monitoring on constituents that are important for the specific area being restored. Use the water quality data to refine the restoration plans.

- Develop or expand the continuous temperature monitoring network with monitors at strategically located points such as the mouths of tributary streams, locations of known spawning beds, at the interface between major land use types, or downstream of activities with the potential to influence water temperature.

- Include a plan for long-term monitoring in any restoration plan to measure the effects of the restoration activity.

- Begin to develop the capacity within the watershed council to conduct high quality, long term water quality monitoring to document the success of restoration activities.

- Locate and map potential sources of nitrogen, phosphorus, and bacteria in the watershed.

- Conduct all water quality monitoring activities according to established guidelines such as those published by the Oregon Plan for Salmon and Watersheds (OPSW 1999), or EPA (1997, 1993).

- Cooperate with DEQ and other agencies to share data and expertise. Coordinate the council's monitoring activities with those of the agencies, including DEQ's efforts to develop Total Maximum Daily Loads for water quality limited stream segments.

CHAPTER 10 MONITORING PLAN

10.1 Introduction

There are several possible functions of a monitoring plan: to answer questions that arise as a result of the watershed assessment, to fill critical data gaps, and to measure the success of restoration efforts developed as a result of the watershed assessment. Procedures for developing a monitoring plan are provided in some detail in Component XI of the OWEB Assessment Manual (WPN 1999). Those procedures will be summarized here. For further information, refer to the OWEB Manual.

The monitoring plan describes what is being monitored, and why, and lays out an organized approach to the monitoring. It does not necessarily include detailed procedures for actually collecting data. Those procedures can be found in a number of references such as the Oregon Plan Technical Guide (OPSW 1999). Although trained volunteers can often implement all or part of a monitoring program once a plan is developed, developing the plan requires specific knowledge of the appropriate monitoring techniques, data analysis, statistics, and quality assurance. Watershed councils should obtain help from specialists such as agency resource scientists or monitoring consultants when developing a monitoring program.

Monitoring may be undertaken for a number of reasons: 1) to evaluate the existing condition or status of the resource (fill a data gap), 2) to identify cause-and-effect relationships within the watershed, and 3) to determine trends in conditions in response to specific activities. The first type is conducted when little or no information exists about a particular condition, to identify if a problem exists, or to clarify the magnitude of a particular problem. The second type is usually designed to pinpoint the particular cause of a problem and to devise corrective measures. The third type is undertaken to document the effects of a particular restoration action, and may require intensive monitoring over many years or several decades to detect a trend.

It is critical that the objective of any monitoring effort be clearly identified before data collection efforts are planned. The monitoring objective will determine the location, duration, and frequency of field observation or sample collection.

10.2 Filling Data Gaps

The watershed assessment has identified data gaps and other information needs. These needs should be addressed before costly restoration activities are undertaken. Some data gaps, such as riparian condition assessment or verifying wetland location, can be filled through field observation. Others, such as water quality monitoring, require sample collection and analysis following standardized procedures. Still others, such as evaluation of hydrologic impacts cannot be readily monitored and must rely on models and professional expertise.

Field observations to verify assumptions can often be conducted at relatively little expense by volunteers who have been trained by a resource professional in the proper protocols and documentation procedures. More intensive studies involving the collection and analysis of samples are more expensive, and may require the assistance of professional scientists to be successful.

10.3 Monitoring Restoration Activities

The first aspect of monitoring a restoration activity is to document that the activity or practice was implemented correctly. This should be part of every project and should be conducted during or shortly after the activity takes place. It usually consists of visual inspections, field notes, and photographs. Implementation monitoring is a simple and cost-efficient form of monitoring. Although it may seem obvious, complete documentation of what was actually completed is frequently overlooked.

The second aspect of monitoring a restoration activity is to document that the activity or practice was effective, that it actually achieved the desired outcome. This is more complex than implementation monitoring, and may require the commitment of resources for up to several decades in order to detect a trend in highly variable constituents such as stream temperature.

10.4 Developing a Monitoring Plan

The first step toward a monitoring plan is to identify data gaps and prioritize monitoring needs. Once this is done, the monitoring plan can be developed to answer specific questions or fill specific data gaps. The monitoring plan describes the objectives for the monitoring, identifies the resources needed to conduct the monitoring, and describes what activities will take place, at what times, and in what locations. Developing a monitoring plan is an iterative process, and proceeds in stages. Stages may be revisited as the plan is developed and refined.

10.4.1 Objectives

The objectives of a monitoring plan arise from the data gap or question that is being addressed. An example question is, “Does this stream meet the ODEQ water quality standard for temperature?” With the question in mind, the specific objective can be stated, and a preliminary monitoring strategy can be developed. An example of a preliminary strategy is provided in Table 10.1.

Table 10.1 An example of an initial monitoring strategy (WPN 1999)

Question or data gap	Does the stream meet state standards for temperature?
Objective	Measure temperature during critical seasons and times of day to detect exceedence of criteria.
Constituents	Temperature
Methods	TidBit temperature data loggers
Study design	Upstream and downstream of major canopy openings.
Locations	Based on access, study design, security, etc.
Duration	At least 6 months including summer
Frequency	Hourly

10.4.2 Resources

During this stage, all the resources needed to conduct the monitoring plan are identified. This includes people, money, field equipment, laboratory services, supplies, and any other resources that might be required for the successful completion of the plan.

10.4.3 Details

Identify the specific constituents or parameters that will be measured: the specific location of the monitoring sites; the frequency of sampling and the time of sampling (both seasonal and daily); and the individuals who will conduct the sampling, data reduction, and analysis.

10.4.4 Verification

Conduct a pilot study to ensure that the plan is workable, that all monitoring sites are safely accessible in all seasons that will be required, that all field procedures can be conducted properly, that all field equipment needed is available and is in working order, and that field personnel understand the protocols and can conduct them properly.

10.4.5 Refinement

Refine the monitoring plan based on the results of the pilot study. Use the data collected during the pilot study to determine if the information will meet the monitoring objective and the quality assurance requirements. Make any changes to the protocols, such as moving a sample site or changing a field method, that are necessary to obtain acceptable data.

10.4.6 Write the Plan

It is critical that a written plan be prepared that documents why, how, when, and where the monitoring will be conducted. This is necessary in order to maintain consistency throughout the life of the monitoring plan, and to document your efforts for the benefit of others. The components of a written monitoring plan are included below (WPN 1999).

10.5 Monitoring Protocols

A number of protocols have been developed for use by volunteer groups working in watersheds. The council should seek the help of resource professionals in selecting potential monitoring protocols, and should consider carefully what can actually be accomplished by volunteers before designing a monitoring plan.

Some useful reference materials are listed below.

MONITORING PLAN COMPONENTS

Background

This information can be summarized directly from the Watershed Condition Evaluation Assessment component. Describe the watershed and the previous studies and data available on the issue. This section, as does the rest of the monitoring plan, communicates to others about your monitoring project. The background section provides the basic content for the study and includes such facts as geology, soils, land uses, channel types, and historical content.

Problem Statement, Goals, and Objectives

Summarize the information derived from Stage 1 to document the statement of the data gap to be addressed or the question to be answered.

Site Description

The site description provides the context of the sampling sites in comparison to other sites in the watershed and provides comparability to potential reference sites in other watersheds. The site description can be based on the information from maps generated during the watershed assessment such as channel habitat type, adjacent riparian condition, and elevation. Monitoring sites need to be located specifically on a topographic map so that the exact location can be described using the latitude and longitude.

Methods

The methods section describes the technical portion of the monitoring project. It documents the techniques that will be used to collect samples or field measurements, equipment and equipment calibration, what specific parameters are to be collected, and target periods. This section documents the decisions made in Stage 3 of the planning process. Quality assurance and quality control (QA/QC) are essential elements of any monitoring plan. They provide you with evidence that your data is accurate and precise enough to address the questions being asked. These elements are addressed in detail in the OPSW Water Quality Monitoring Guidebook.

Data Storage and Analysis

Thinking through this section is critical early in the monitoring process so you have the support necessary to store, transport, or analyze the data. The Oregon Department of environmental Quality has developed a data storage template that can be used to format data records (see OPSW Water Quality Monitoring Guidebook for details). Planning ahead can save time and money, and spare the agony of lost data.

Timetable and Staff Requirements

Each monitoring project will have a unique schedule of activities that must occur for it to be successful. these planning and implementation activities take time. The OPSW Water Quality Monitoring Guidebook contains general examples of the sequencing of stages and time requirements for a monitoring project.

Reference Materials

Bauer, S.B. and T.A. Burton. 1993. Monitoring Protocols to Evaluate Water Quality Effects of Grazing Management of Western Rangeland Streams. U.S. Environmental Protection Agency, Region 10, Water Division, Surface Water Branch. EPA 910/R-93-017.

Bedell, T.E. and J.C. Buckhouse. 1994. Monitoring Primer for Rangeland Watersheds. U.S. Environmental Protection Agency. EPA 908-R-94-001.

Bureau of Land Management, Oregon Division of State Lands. 1998. Urban Riparian Inventory and Assessment Guide.

MacDonald, L.H., A.W. Smart, and R.C. Wissmar. 1991. Monitoring Guidelines to Evaluate Effects of Forestry Activities on Streams in the Pacific Northwest and Alaska. U.S. Environmental Protection Agency, Region 10, Water Division, Seattle, WA. EPA/910/9-91-001.

Moore, K.M.S., K.K. Jones, and J.M. Dambacher. 1997. Methods for Stream Habitat Surveys. Oregon Department of Fish and Wildlife, Portland.

Oregon Plan for Salmon and Watersheds. 1999. Water Quality Monitoring Guidebook.

Shuett-Hames, D., A. Pleus, L. Bullchild, and S. Hall. 1994. Ambient Monitoring Program Manual. Washington State Department of Natural Resources, TFW-AM9-94-001, Olympia.

U.S. Environmental Protection Agency. 1997. Monitoring Guidance for Determining the Effectiveness of Nonpoint Source Controls. U.S. EPA, Region 10, Water Division, Surface Water Branch. EPA 910/R-93-017.

U.S. Environmental Protection Agency. 1997. Volunteer stream monitoring: a methods manual. EPA841-B-97-003.

U.S. Environmental Protection Agency. 1996. The volunteer monitor's guide to quality assurance project plans. EPA440-4-91-002. http://www.epa.gov/owow/monitoring/volunteer/gapcover.html.

U.S. Environmental Protection Agency. 1993. Volunteer estuary monitoring: a methods manual. EPA842-B-93-004. http://www.epa.gov/owow/monitor/estusrvm.html.

U.S. Environmental Protection Agency. 1991. Volunteer lake monitoring: a methods manual. EPA440-4-91-002. http://www.epa.gov/owow/monitor/lakevm.html.

CHAPTER 11 REFERENCES

Andrus, C. 1988. Survey of Class I streams in the Big Creek watershed. Report prepared for Boise Cascade Timber and Wood Products Group, Monmouth, OR.

Bastasch, R. 1998. Waters of Oregon. A Source Book on Oregon's Water and Water Management. Oregon State University Press, Corvallis, OR

Beechie et al. 1994. Estimating coho salmon rearing habitat and smolt production losses in a large river basin, and implications for habitat restoration. North American Journal of Fisheries Management 14:797-811.

Beschta, R. L. 1997. Riparian shade and stream temperature: an alternative perspective. Rangelands. 19:25-28.

Beschta, R.L., R.E. Bilby, G.W. Brown, L.B. Holtby, and T.D. Hofstra. 1987. Stream temperatures and aquatic habitat: Fisheries and forestry interactions. p. 191-232 In: Streamside management: Forestry and fisheries interactions. Contribution No. 57, Institute of Forest Resources. University of Washington, Seattle.

Bischoff, J.M., editor. 1999. South Santiam Watershed Assessment. E&S Environmental Chemistry, Inc., Corvallis, OR.

Bottom, D.L., J.A. Lichatowich, and C.A. Frissell. 1998. Variability of Pacific Northwest Marine Ecosystems and Relation to Salmon Production. In McMurray, G.R. and R.J. Bailey (eds.). Change in Pacific Northwest Coastal Ecosystems. NOAA Coastal Ocean Program, Decision Analysis Series No. 11, Silver Spring, MD. pp. 181-252.

Boulé, M.E. and K.F. Bierly. 1987. The history of estuarine development and alteration: what have we wrought? Northwest Environmental Journal 3(1):43-61.

Boyd, M and D. Sturdevant. 1997. The scientific basis for Oregon's stream temperature standard: common questions and straight answers. Oregon Department of Environmental Quality. Portland, OR.

Bureau of Land Management (BLM). 1996. Thomas Creek Watershed Analysis. U.S. Department of the Interior, Bureau of Land Management, Salem District Office, Salem, OR.

CH2M HILL. 1997. Water System Master Plan, City of Warrenton, Oregon.

CH2M HILL. 1996. City of Astoria Water Supply Study.

CH2M HILL. 1996. City of Astoria Water Supply Study. Technical Supplement.

Conroy, S.C. 1997. Habitat lost and found. Washington Trout Report. Vol. 7:1.

Cowardin, L.M., V. Carter, F.C. Golet, and E.T. LaRoe. 1979. Classification of wetlands and deepwater habitats of the United States. U.S. Department of the Interior, Fish and Wildlife Service. FWS/OBS-79/31.

Daly, C., R.P. Neilson, and D.L. Phillips. 1994. A statistical-topographic model for mapping climatological precipitation over mountainous terrain. Journal of Applied Meteorology, 33, 140-158.

Dunne, T. 1983. Relation of field studies and modeling in the prediction of storm runoff. Journal of Hydrology 65:25-48.

Envirosphere Co. 1981. The Status of Knowledge on the Effects of Log Storage on the Columbia River Estuary. Report prepared for the Pacific Northwest River Basins Commission. Envirosphere Co., Bellevue, WA.

EPA. 2000. STORET. http://www.epa.gov/ODOW/STORET/

Farnell, J.E. 1981. Port of Astoria Rivers Navigability Study. Div. of State Lands, Salem, OR.

Flemming, I.A. and M.R. Gross. 1993. Breeding success of hatchery and wild coho salmon (*Oncorhynchus kisutch*) in competition. Ecol. Applic. 3:230-245.

Flemming, I.A. and M.R. Gross. 1989. Evolution of adult female life history and morphology in a Pacific salmon (coho: *Oncorhynchus kisutch*). Evolution 43:141-157.

Frenkel, R.E. and J.E. Morlan. 1991. Can we restore our salt marshes? Lessons from the Salmon River, Oregon. Northwest Environmental Journal 7:119-135.

Garono, R. and L. Brophy. 1999. Rock Creek (Siletz) Watershed Assessment Final Report. Earth Design Consultants, Inc., Corvallis, OR.

Genovese, P.V. and R.L. Emmett. 1997. Desktop geographic information system for salmonid resources in the Columbia River basin. U.S. Dept. of Commerce, NOAA Technical Memo NMFS-NWFSC-30. 130 pp.

Hargreaves, N.B. and R.J. LeBrasseur. 1986. Size selectivity of coho (*Oncorhynchus kisutch*) preying on juvenile chum salmon (*O. keta*). Can. J. Fish. Aquat. Sci. 43:581-586.

Harr, R.D. 1983. Potential for augmenting water yield through forest practices in western Washington and western Oregon. Water Resour. Bull. 19:383-393.

Healey, M.C. 1994. Variation in the life history characteristics of chinook salmon and its relevance to conservation of the Sacramento winter run of chinook salmon. Cons.Biol. 8:876-877.

Healey, M.C. 1982. Juvenile pacific salmon in estuaries: The life support system. In: Kennedy, V. (ed.). Estuarine Comparisons. New York, NY. pp. 315-341.

Hemmingsen, A.R., R.A. Holt, and R.D. Ewing. 1986. Susceptibility of progeny from crosses among three stocks of coho salmon to infection by *Ceratomyxa shasta*. Transactions of the American Fish. Soc. 115:492-495.

Hicks, B.J. 1989. The influence of geology and timber harvest on channel morphology and salmonid populations in Oregon Coast Range streams. Ph.D. thesis, Oregon State University, Corvallis.

Johnson, R. R. and J.F. McCormick. 1979. Strategies for protection and management of floodplain wetlands and other riparian ecosystems. Gen. Tech. Report WO-12. U.S. Forest Service, Washington, DC.

Johnson, O.W., M.H. Ruckelshaus, W.S. Grant, F.W. Waknitz, A.M. Garrett, G.J. Bryant, K. Neeley, and J.J. Hard. 1999. Status Review of Coastal Cutthroat Trout from Washington, Oregon, and California. NOAA Tech. Memorandum NMFS-NWFSC-37.

Kauffman, J. B., R. L. Beschta, N. Ottig, and D. Lytjen. 1997. An ecological perspective of riparian and stream restoration in the Western United States. Fisheries 22:12-23.

Kostow, K., editor. 1995. Biennial Report on the Status of Wild Fish in Oregon. Oregon Dept. of Fish and Wildlife.

Lebovitz, M.E.S. 1992. Oregon estuarine conservation and restoration priority evaluation. Opportunities for salmonid habitat and wetlands functions enhancement in Oregon's estuaries. Report prepared for Oregon Trout and U.S. Fish and Wildlife Service. Yale Univ., New Haven, CT.

Lund, E.H. 1972. Coastal landforms between Tillamook Bay and the Columbia River, Oregon. The ORE BIN. 34:173-195.

Marshall, A. 1993. Summary and analysis of the genetic data available for Oregon chinook populations. Washington Dept. of Fisheries, Olympia.

MacDonald, J.S., C.D. Levings, C.D. McAllister, U.H.M. Fagerlund, and J.R. McBride. 1988. A field experiment to test the importance of estuaries for chinook salmon (*Oncorhychus tshawytscha*) survival: Short-term results. Canadian Journal of Fisheries and Aquatic Sciences 45:1366-1377.

Mitsch, W.J. and J.G. Gosselink. 1993. Wetlands. 2nd ed. Van Nostrand Reinhold, New York.

Montagne-Bierly Associates. 1977. Description of Historical Shoreline Changes in Youngs Bay Estuary.

Moore, K., K. Jones, and J. Dambacher. 1997. Methods for stream habitat surveys. Aquatic inventory Project. Oregon Department of Fish and Wildlife, Natural Production Program, Corvallis, OR. 45 pp.

Naiman, R.J. and R.E. Bilby, editors. 1998. River Ecology and Management. Lessons from the Pacific Coastal Ecoregion. Springer, New York.

Newcombe, C.P. and D.D. MacDonald. 1991. Effects of suspended sediments on aquatic systems. North American Journal of Fisheries Management 11:72-82.

Nicholas, J.W. and D.G. Hankin. 1989. Chinook salmon populations in Oregon coastal river basins: description of life histories and assessment of recent trends in run strengths. 2nd ed. Oregon Dept. of Fish and Wildlife, Corvallis, OR.

Nickelson, T.E., M.F. Solazzi, and S.L. Johnson. 1986. Use of hatchery coho salmon (*Oncorhynchus kisutch*) presmolts to rebuild wild populations in Oregon coastal streams. Can. J. Fish. Aquat. Sci. 43:2443-2449.

NRCS. 1999. Draft Skipanon River Hydrologic Analysis.

Omernik, J.M. and A.L. Gallant. 1986. Ecoregions of the Pacific Northwest. U.S. Environmental Protection Agency, Corvallis, OR. EPA/600/3-86/033.

Oregon Department of Environmental Quality. 2000. Web Page. http://waterquality.deq.state. or.us/SISData/

Oregon Department of Environmental Quality. 1999. Final 1998 Water Quality Limited streams- 303(d) list. http://waterquality.deq.state. or.us/303dlist/303dpage.htm. Accessed 8/13/00.

Oregon Department of Fish and Wildlife. 1997. Summary of January 6, 1997 ODFW Comments to National Marine Fisheries Service Concerning the Listing of Steelhead under the Endangered Species Act. ODFW, Portland, OR.

Oregon Department of Fish and Wildlife. 1995. Biennial Report on the Status of Wild fish in Oregon. Oregon Dept. of Fish and Wildlife, Portland, OR.

Oregon Department of Fish and Wildlife, and Washington Department of Fisheries. 1993. Status of Columbia River fish runs and fisheries, 1938-92. Oregon Dept. of Fish and Wildlife, Portland, and Washington Dept. of Fisheries, Olympia.

Oregon State University. 2000. Bear Creek Watershed Evaluation. Oregon State University Extension, Astoria, OR.

Reimers, P.E. and C.E. Bond. 1967. Distribution of fishes in tributaries of the Lower Columbia River. Copeia 1967 No. 3, pp. 541-550.

Riedel, J.L. 1994. Hydrology and geomorphology of the canoe landing: Fort Clatsop National Memorial, Clatsop County, Oregon. National Park Service, North Cascades National Park, Marblemount, WA.

Sessions, J., J.C. Balcom, and K. Boston. 1987. Road location and construction practices: effects on landslide frequency and size in the Oregon Coast Range. Western Journal of Applied Forestry 2(4):119-124.

Shreffler, D.K., C.A. Simenstad, and R.M. Thom. 1992. Foraging by juvenile salmon in a restored estuarine wetland. Estuaries 15(2):204-213.

Simenstad, C.A., K.L. Fresh, and E.O. Salo. 1982. The role of Puget Sound and Washington coastal estuaries in the life history of Pacific salmon: An unappreciated function. In: Kennedy, V. (ed.). Estuarine Comparisons. New York, NY. pp. 343-364.

Swan Wooster Engineering. 1969. Land Use Study of the East side of the Skipanon River (in Relationship to the Northwest Aluminum Co.) for the Port of Astoria, Oregon. Portland, OR.

Taylor, G.H. and R.R. Hatton. 1999. The Oregon Weather Book - A State of Extremes. Oregon State Univ. Press, Corvallis. 242 pp.

Thom, B. and K. Moore. 1997. North Coast Stream Project. Guide to instream and riparian restoration sites and site selection. Phase II. Necanicum River, Nehalem River, Tillamook Bay, Nestucca River, Neskowin Creek, and Ocean Tributary drainages. Oregon Department of Fish and Wildlife.

Tuchmann, E., K.P. Cannaughton, L.E. Freedman, and C.B. Moriwaki. 1996. The Northwest Forest Plan: A Report to the President and Congress. U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 253 pp.

U.S. Army Corps of Engineers, Portland District. Maps of authorized projects.

U.S. Army Engineer District. 1973. Final Environmental Statement. Dredging of Lewis and Clark Connecting Channel, Clatsop County, Oregon. Portland, OR.

U.S. Fish and Wildlife Service and Canadian Wildlife Service. 1990. North American Waterfowl Management Plan: Pacific Coast Joint Venture; Pacific coast habitat: a prospectus. USFWS, Portland, OR.

Warrenton Dune Soil & Water Conservation District. 1970. Thirty-five years of progress, 1935-1970. USDA Soil Conservation Service, Portland, OR.

Washington Department of Fisheries. 1993. Review draft, fisheries resources in southwest Washington. Prepared for Washington Dept. of Ecology, Olympia.

Water Resources Division and Fort Clatsop National Memorial. 1994. Fort Clatsop National Memorial Water Resources Scoping Report. Tech. Rept. NPS/NRWRD/NRTR-94/19. U.S. Dept. of the Interior, National Park Service, Washington, DC.

Watershed Professionals Network. 1999. Oregon Watershed Assessment Manual. June 1999. Prepared for the Governor's Watershed Enhancement Board, Salem, OR.

Woodward-Clyde International-Americas. 1997. Water Management Plan for Coastal Clatsop County. Report prepared for Clatsop County Planning Dept. Portland, OR. Partial Draft.

WRD Infosheet No. 6. November, 1999.