City of Monroe
Grant No. G0200041

November 2002

FINAL REPORT

Shoreline Master Program Inventory for the City of Monroe's Shorelines: Skykomish River and Woods Creek

Prepared for:

City of Monroe
806 West Main Street
Monroe, WA 98272

This report was funded in part through a cooperative agreement with the National Oceanic and Atmospheric Administration.

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1. INTRODUCTION

1.1 BACKGROUND

This document is intended to accomplish three objectives for the City of Monroe: 1) facilitate compliance with the State of Washington's Shoreline Management Act (SMA), 2) facilitate compliance with State of Washington's Growth Management Act (GMA), and 3) facilitate compliance with the federal Endangered Species Act (ESA).

On 29 November 2000, the Department of Ecology adopted a new set of guidelines implementing the state SMA of 1971. The state Shorelines Hearings Board invalidated Parts III and IV of the new shoreline management guidelines on 27 August 2001, leaving only Parts I and II (procedural rules for Shoreline Master Program [SMP] amendments) and the original SMA in place. Accordingly, the current standard for preparation of SMP amendments is guidance found in RCW 90.58.100(1):

> "(a) Utilize a systematic interdisciplinary approach which will insure the integrated use of the natural and social sciences and the environmental design arts;
>
> (b) Consult with and obtain the comments of any federal, state, regional, or local agency having any special expertise with respect to any environmental impact;
>
> (c) Consider all plans, studies, surveys, inventories, and systems of classification made or being made by federal, state, regional, or local agencies, by private individuals, or by organizations dealing with pertinent shorelines of the state;
>
> (d) Conduct or support such further research, studies, surveys, and interviews as are deemed necessary;
>
> (e) Utilize all available information regarding hydrology, geography, topography, ecology, economics, and other pertinent data;
>
> (f) Employ, when feasible, all appropriate, modern scientific data processing and computer techniques to store, index, analyze, and manage the information gathered."

The following inventory and analysis of the City of Monroe's shorelines, the Skykomish River and Woods Creek, was conducted using the above guidance and giving consideration to the expected performance-based standard of protecting and restoring ecosystem-wide processes and ecological functions.

In 1997, the City of Monroe incorporated the goals and policies of its Shoreline Management Master Program into its Comprehensive Plan (a GMA planning document) as a new element called "Shoreline Management." An amendment to the GMA (RCW

36.70A.172) requires use of “best available science” to develop policies and development regulations protecting functions and values of critical areas, and required that those policies and regulations “give special consideration to preserving or enhancing anadromous fisheries.” As this report supports future changes to the City’s Shoreline Management element, best available science criteria were used in the selection of reference materials and in the development of this report. The condition of habitat for anadromous fish (in particular, the ESA-listed species) is discussed extensively in Sections 3 and 4.

Chinook salmon and bull trout were listed as threatened under the federal ESA in March 1999 and November 1999, respectively. In June 2000, the National Marine Fisheries Service (NMFS) adopted a Section 4(d) Rule prohibiting “take” of chinook salmon (U.S. Federal Register, 10 July 2000). The U.S. Fish and Wildlife Service (USFWS) prohibited take of bull trout at the time of its listing. “Take” is defined as “harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or attempt to engage in any such conduct.” “Harass” has been further defined as “actions that create the likelihood of injury to listed species to such an extent as to significantly disrupt normal behavior patterns which include, but are not limited to, breeding, feeding or sheltering.” “Harm” has been further defined as “significant habitat modification or degradation that results in death or injury to listed species by significantly impairing behavioral patterns such as breeding, feeding, or sheltering” (NMFS 1999). The prohibition against take applies to federal, state, and local governments, as well as individuals and businesses. Any City of Monroe actions or programs that “take” listed fish put the City at risk for legal action. To reduce risk, the City must evaluate all programs and actions to determine their potential for take. Because the City borders the Skykomish River and Woods Creek, shorelines that contain listed fish, the potential for take is moderately high. Critical habitat designated for Puget Sound chinook salmon (U.S. Federal Register, 16 February 2000) was withdrawn as of 30 April 2002 as part of a settlement between NMFS and the National Association of Home Builders. Designation of critical habitat will be reevaluated with special emphasis placed on economic analysis. NMFS “expects this action will not significantly affect the protection of … chinook…” because “[t]he authorities of the Endangered Species Act (sections 4, 7, 9, and 10) that [NMFS] primarily relies on for its enforcement and protective actions remain in effect” (NOAA 2002). As mentioned above, the definition of take already includes habitat modification or degradation.

The following analysis of the Skykomish River and Woods Creek will provide the City with a foundation for reviewing its planning documents and activities, and making science-based modifications that will satisfy regulatory requirements, protect and restore the environment for the benefit of its residents and fish and wildlife, and reduce risk.

1.2 SHORELINE BOUNDARY

As defined by the Shoreline Management Act of 1971, shorelines include certain waters of the state plus their associated "shorelands." Shorelands are defined as:

> "those lands extending landward for 200 feet in all directions as measured on a horizontal plane from the ordinary high water mark; floodways and contiguous floodplain areas landward 200 feet from such floodways; and all wetlands and river deltas associated with the streams, lakes, and tidal waters which are subject to the provisions of this chapter…Any county or city may determine that portion of a one-hundred-year-floodplain to be included in its master program as long as such portion includes, as a minimum, the floodway and the adjacent land extending landward two hundred feet therefrom (RCW 90.58.030)"

The City of Monroe's current shoreline boundary (Figure 1[1]) appears to have been based partially on the floodway and partially on the floodplain as mapped by the Federal Emergency Management Agency (FEMA) (see Figure 8). However, significant areas of associated wetlands were not included in the formal map of the shoreline. The City's shoreline boundary has been updated concurrent with this assessment to include the entire 100-year floodplain, those areas landward 200 feet from the floodway that are not otherwise in the 100-year floodplain, and any associated wetlands. The revised shoreline boundary is illustrated on Figure 1. All calculations of land use and impervious surface areas conducted in the course of this assessment were made using the revised shoreline boundary.

1.3 METHODOLOGY

Per the guidance contained in the SMA, an attempt was made to "gather and incorporate all pertinent and available information, existing inventory data and materials from state agencies, affected Indian tribes, watershed management planning, and other appropriate sources." A list of potential information sources was compiled and an information request letter was distributed (Appendix B). Collected information was supplemented with other resources such as City documents, scientific literature, personal communications, aerial photographs, internet data, and a physical inventory of the City's shorelines. The Skykomish River and Woods Creek were divided into segments, and the condition of each segment was described qualitatively. The aquatic habitat was characterized using the categories listed in the NMFS Matrix of Pathways and Indicators (1999), although the matrix labels were not applied as NMFS definitions are not necessarily appropriate for the City's shoreline and streams.

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[1] **Note: all figures are located in Appendix A at the end of this report.**

2. LAND USE AND "ALTERED" CONDITIONS

The City of Monroe is located approximately 25 miles northeast of Seattle, on the right bank of the Skykomish River. State Route (SR) 2, which has its western terminus in Everett, passes through Monroe and follows the Skykomish eastward towards Stevens Pass. Woods Creek is the largest tributary to the Skykomish in Monroe, and meets the river at the western edge of Al Borlin Park, at approximately river mile[1] 25 on the Skykomish.

The City of Monroe encompasses 4.33 square miles. An additional 2.67 square miles around Monroe has been designated as Urban Growth Area, yielding a total planning area of 7.00 square miles. Most of this area is situated on alluvium, soils deposited by river processes, and is relatively flat, ranging in elevation from approximately 40 to 60 feet. The higher land to the north (rising to 200 feet and above) is underlain by a combination of glacial outwash (material deposited by glacial meltwater) and glacial till (material directly deposited by glaciers). The southwestern portion of the City, in the vicinity of the Washington State Department of Corrections facility, is also situated on glacial till.

Before 1960, the population of Monroe remained small and relatively constant at under 2,000. Exponential growth has occurred since 1980. By 1990, the population had grown to almost 4,300, and by 2000, well over 13,000 people lived in Monroe (Figure 2).

The shoreline jurisdiction of Monroe includes the land bordering the Skykomish River and Woods Creek. The total length of shoreline is over 3.5 miles, and while only one side of the Skykomish is within the City limits, both sides of Woods Creek are within the City. This creates a total shoreline area of approximately 446 acres. The shoreline area is divided between two subbasins: the lower mainstem Skykomish subbasin and the lower Woods Creek subbasin (Figure 3).

2.1 HISTORIC LAND USE AND WATERSHED CONDITIONS

The Skykomish River drains 842 square miles, originating high in the Cascades, including some glacially fed tributaries, and flowing west to the Puget Lowlands, where it meets the Snoqualmie River. The confluence of the Skykomish and Snoqualmie rivers form the Snohomish River, the second largest river entering Puget Sound.

The two primary tributaries of the Skykomish are the North Fork and the South Fork, which join the mainstem near Index, approximately 24 river miles upstream of Monroe. Both forks of the Skykomish originate in steep bedrock valleys, composed primarily of Tertiary granitic rock. From the confluence of the North and South Forks, the Skykomish

[1] The river mile gives the distance along a river or stream, measured from its mouth along the course of the channel, following all of its bends and turns.

continues through a relatively narrow valley for approximately four miles, where it enters a broad, glacially carved valley.

The Skykomish carries approximately 21,000 cubic yards of sediment annually (Collins and Dunne 1990, cited in DOE 1999). This sediment load is not transported in a smooth, continuous process; instead, some areas are dominated by erosion, and others by deposition. From the confluence of the North and South Forks to Startup in the glacially carved valley, the river is lacking in sediment and erodes the banks and bed of the channel. Further downstream, between Startup and Sultan, the river is no longer competent to carry its sediment load, and deposition occurs. From Sultan to Monroe, flood control projects have altered the sediment regime, with the result that there is neither excess erosion nor deposition. From Monroe to the Snohomish, deposition again dominates, and the river is considered unstable (Collins and Dunne 1987, cited in DOE 1999).

The gradient of the Skykomish has been described as “relatively steep” for a river its size, steeper than either the mainstem Snoqualmie or the mainstem Snohomish. The combination of steep gradient and high sediment load produces excellent spawning habitat for chinook and steelhead (Pentec Environmental, Inc. [Pentec] and NW GIS 1999). An abundance of side channels and alcoves produces good rearing and refuge habitat. The relatively steep gradient increases the power of the stream, so that woody debris generally only becomes stable if it forms into jams.

The path of the Skykomish within Monroe is relatively straight, but large abandoned meander loops indicate that the river once had a much more sinuous pattern. An 1888 survey map shows a much more sinuous channel in the Monroe area, including several side channels and large islands (Northwest Hydraulic Consultants inc. [NHC] 2001). However, the river had shifted to a pattern similar to its current one by 1917. Since 1917, various side channels have opened or been abandoned, but the primary channel has remained relatively stable.

Non-native American usage of the basin began over 100 years ago. In the late 1800s, woody debris was removed from the river to improve navigation, and wood and agricultural products were transported down the river to Port Gardner in Everett. The primary land use in the Snohomish basin has been forestry, with agriculture and urban development following well behind (Pentec and NW GIS 1999). The Culmback Dam on the Sultan river, which impounds Spada Lake, is the only dam upstream of Monroe.

Most of the riparian forest that once dominated the broad Skykomish floodplain near Monroe was cleared. While the basin is currently considered to be recovering from some of these past impacts (Pentec and NW GIS 1999), human activity continues to have an effect on the river.

Given the high rate of population growth in the Skykomish Basin, especially in Monroe, urbanization is becoming an increasingly important factor. Urbanization can increase peak flow rates and durations, introduce pollutants to surface waters, eliminate forested riparian vegetation, disturb stream channel structure, reduce groundwater recharge, and reduce low flow levels in streams (Booth and Jackson 1997).

Levee construction, draining and clearing began in the late 1800s, using dredged river material, local earth fill, and waste wood chips (hog fuel) (Snohomish County 1991). Such projects were generally small scale, and designed to protect individual property owners. In the early 1900s, diking districts were formed, and are still active today. The diking districts pool money from a number of property owners, and use this money to build and maintain larger scale structures. Most dikes in the Snohomish River valley are now maintained by one of nine public diking districts.

According to a map produced by Pentec and NW GIS (1999), 21 dikes/levees exist on the Skykomish between Index (on the North Fork) and Monroe. Additionally, eight significant bank hardening projects have been installed on the mainstem Skykomish, as well as a few small projects on various tributaries. Finally, SR 2, which parallels the Skykomish and the South Fork Skykomish towards Stevens Pass, has undoubtedly been associated with several bank-hardening projects not shown on the map.

2.2 CURRENT LAND USE AND PLANNING DESIGNATIONS

The City maintains several planning documents and maps that facilitate management of appropriate and desired growth within the City limits and the Urban Growth Area. Primary current land use, zoning (Figure 4), and preferred future land use (Figure 5) favor residential development (24% of City's area including UGA), and maintenance of special regional uses (e.g., Evergreen State Fairgrounds and Washington State Department of Corrections facility) (14%) and public parks/open space (18%) (City of Monroe 1998a).

The following sections describe current land use, zoning, preferred land use, and shoreline designations within the shoreline zones of the Skykomish River and Woods Creek. Tables 1 and 2 show comprehensive plan designations and zoning as a percent of total shoreline area. Because of the modifications to the original shoreline boundary, percentages of land area are not provided for SMP environment designations.

SKYKOMISH RIVER

In the shoreline zone, the current uses are primarily undeveloped (portions of Al Borlin Park and Skykomish River Centennial Park, protected wetlands and vegetated stream and wetland buffers), mineral extraction, and active park. Although portions of Al Borlin

Table 1. Summary of planning designations [1] in the Shoreline Zone of the Skykomish River.

Bank	Comp Plan	%	Zoning	%	SMP Environment Designation
Right	Limited Open Space	58.7	Limited Open Space	58.7	Rural
	Special Regional Use	1.2	Public Open Space	40.9	None assigned
	Public Facilities - Schools	0.3			None assigned
	Parks/Open Space	39.4			Rural / None assigned
	Industrial	0.4	Light Industrial	0.4	None assigned

Park are technically in the shoreline zone of both the Skykomish River and Woods Creek, all of Al Borlin Park was included in the Skykomish River planning designation summary to avoid double-counting.

The majority of the Skykomish River shoreline is zoned for limited open space (primarily Cadman Inc. gravel operation) and public open space (Skykomish River Centennial Park, Al Borlin City Park, and Washington State Department of Corrections facility) (City of Monroe 1999) (see Figure 4, Table 1). These zoning designations are consistent with the City's future land use designations contained in the Comprehensive Plan (City of Monroe 1998a). The primary comprehensive plan designations in the shorelands are limited open space (which corresponds directly to the limited open space zone), and parks/open space and public facilities-school (which corresponds directly to the public open space zone) (see Figure 5). A small area north of the Cadman operation is currently zoned and projected for future land use as light industrial and industrial, respectively. The current Shoreline Master Program (City of Monroe 1998a) identifies Rural, Conservancy, and Suburban shoreline areas along the Skykomish River.

WOODS CREEK

In the shoreline zone, the current uses are undeveloped (portions of Lewis Street Park, protected wetlands and vegetated stream and wetland buffers), single-family and multi-family residential areas, active park, and a small industrial area (see Table 2). As previously mentioned, the portion of Al Borlin Park that is technically within the Woods Creek shoreline are excluded from this discussion to avoid double-counting with the Skykomish River shoreline.

[1] Existing land use was determined using digital planimeter measurements taken from a 2001 aerial photograph produced at a 1"=157' scale (approximate, photos not ortho-corrected). Planning designations were transferred to the 2001 aerial photograph for measurement.

Table 2. Summary of planning designations[1] in the Shoreline Zone of Woods Creek (non-Skykomish River floodplain sections).

Bank	Comp Plan	%	Zoning	%	Current SMP Environment Designation
Right	Parks/Open Space	13	Public Open Space	13	Suburban
	Residential (R5-7)	23.1	Urban Residential (UR 6000)	28.8	Suburban
			Multi-Family (MR 6000)	8.4	Urban
	Industrial	26.2	General Industrial	26.2	Urban
	General Commercial	34.8	General Commercial	34.8	Conservancy
Left	Residential (R3-5)	40.2	Urban Residential (UR 9600)	40.2	Conservancy
	General Commercial	59.8	Public Open Space	33.3	
			General Commercial	26.5	

The Woods Creek shoreline is zoned for public open space (Lewis Street Park), urban residential, multi-family residential, general industrial, and general commercial (City of Monroe 1999) (see Figure 4). These zoning designations are generally consistent with the City's future land use designations contained in the Comprehensive Plan (City of Monroe 1998a). The comprehensive plan designations in the shoreline zone are residential (R3-5, R5-7), parks/open space, general commercial, and industrial (see Figure 5). The current Shoreline Master Program (City of Monroe 1998a) identifies Urban, Conservancy, and Suburban shoreline areas along Woods Creek.

2.3 PARKS AND OPEN SPACE/PUBLIC ACCESS

As noted above in Tables 1 and 2, a substantial portion of the City's shoreline zone is occupied by City parks and open space (Figure 6). Figure 7 shows only City parks. The total shoreline length of the City (including both banks of Woods Creek) is approximately 4.5 miles, of which 2.3 miles is park (almost 51%). Skykomish River Centennial Park, Lewis Street Park, and Al Borlin Park border approximately 1.3 linear miles of the in-City portion of the Skykomish River. Lewis Street Park and Al Borlin Park border approximately1.03 miles of the in-City portion of Woods Creek. Therefore, a detailed discussion of the City's shoreline parks is necessary as fish and wildlife use and habitat function has and can be significantly impacted by past, current, and future

[1] Existing land use was determined using digital planimeter measurements taken from a 2001 aerial photograph produced at a 1"=157' scale (approximate, photos not ortho-corrected). Planning designations were transferred to the 2001 aerial photograph for measurement.

management of the parks. Because the park lands are owned by the City, the opportunities for restoration are greater and the obstacles for implementation are fewer than on private land.

The *Park and Recreation Element* of the City of Monroe's Comprehensive Plan has specific policies for improving environmental conditions in the City's parks and open space areas. The relevant policies are as follows:

> *PR-4.5* – The city shall look toward increased mitigation of sensitive natural areas by using PRD codes in developments where sensitive natural areas exist.
>
> *PR-4.6* – The city wetland open space areas shall be preserved and where possible, a net increase in wetlands classifications shall be pursued.
>
> *PR-4.7* – The city shall strive to control non-indigenous plants or weeds that are proven harmful to native and/or beneficial vegetation or habitats.
>
> *PR-4.8* – The city shall make efforts to meet and maintain state and county water quality standards in the city's lakes and streams.

According to the City of Monroe's Parks Department, Monroe has more park and open space acreage than any other city in Snohomish County (City of Monroe 2001). As previously mentioned, approximately 18 percent of the City's area (including the UGA) consists of public parks and limited open space. A substantial portion of that area is located along the City's shorelines. There are three shoreline parks in the City: Skykomish River Centennial Park, Lewis Street Park, and Al Borlin Park (also known as Buck Island Park). These three parks are described briefly below:

> <u>Al Borlin Park</u>: The 90-acre Al Borlin Park is located between Woods Creek and the Skykomish River, and extends northwest from the mouth of Woods Creek to the Burlington Northern – Santa Fe Railroad, which is south of and roughly parallel to U.S. Highway 2. The majority of the park is forested, except for a landscaped picnic area at the mouth of Woods Creek, a parking area and gravel road near the north end of the park, and the network of formal and informal trails. Pedestrians and bicyclists frequently use the trails, and formal and informal trails are used often for fishing access. The park, essentially a low-elevation island no more than 15 feet above the normal water level, occasionally closes during winter floods (City of Monroe 1998a).
>
> According to Steve Crueger, Parks Superintendent (pers. comm., 25 January 2002), maintenance of Al Borlin Park typically consists of mowing in the parks small lawn area, placement of gravel on formal trails once per year, garbage removal, and vegetation clearing within 3 to 4 feet of formal trails. Gravel replacement is necessary due to losses during floods and losses to trail fringes or embeddedness as a result of pedestrian traffic. Any trees that fall in the park are left intact, except for

those portions of the tree that fall across the trail. Live or snag tree removal only occurs when the tree poses a safety hazard; hazard trees are cut and left on site. The Parks Department does not use any chemicals to control vegetation, nor does it have a formal invasive plant control program (e.g., for Himalayan blackberry or Japanese knotweed). Additional efforts appear necessary in Al Borlin Park to control Himalayan blackberry and Japanese knotweed as directed by PR-4.7.

The Parks Department has recently solidified a relationship with the Stillaguamish-Snohomish Fisheries Enhancement Task Force. The Task Force has completed several small vegetation enhancement projects in the past, most recently clearing a few patches of the invasive non-native Japanese knotweed along Woods Creek and planting western red cedar and other native trees. The Task Force submitted a report to the City, which included background information on the physical and biological character of Al Borlin Park; recommendations to enhance vegetation, increase public education efforts, and stabilize eroding Skykomish River bank at the southwest end of the island; and a proposed vegetation management schedule through 2004 (Ward, pers. comm., 28 March 2001; Appendix C). This timeline would likely be accelerated and additional activities added now that Monroe and the Task Force are committed to working together to improve Al Borlin Park.

Bank erosion is allowed to occur naturally, and no bank areas have been armored since the Parks Department has been managing the park. The only areas of significant erosion have occurred on the Skykomish River at the end of a dirt access road, and at the southwest tip of the island. Approximately 10 feet of bank at the access road has been lost during the past 12 years (Crueger, pers. comm., 25 January 2002).

Future plans for the Park include preparation of a Master Park Plan that would be consistent with the existing natural environment. New developments would likely be limited to minor improvements to existing parking and restroom facilities, placement of barriers to prevent vehicle access to the shoreline, and additional trails. Prevention of vehicle access to the waterfront is consistent with the following public access policies contained in the Shoreline Management Element of the Comprehensive Plan:

2. Locate, design and maintain public access development so as to protect the natural environment and natural processes.

6. Control and regulate public access on the public-owned shorelines to insure that the ecology shall not be unduly damaged by public use.

<u>Lewis Street Park</u>: The 5-acre Lewis Street Park is located between Lewis Street and Woods Creek, bounded to the south by the Skykomish River. The park includes parking areas, restroom facilities, play equipment, lawn area, and picnic benches (City of Monroe 1998a). Except on the steep slopes to the east along Woods Creek and to the south along the Skykomish, there are no natural vegetated areas. Century-old

cedar trees in the park have been retained (City of Monroe 1998a). A pedestrian bridge connects Lewis Street Park to Al Borlin Park.

According to Steve Crueger, Parks Superintendent (pers. comm., 25 January 2002), maintenance of Lewis Street Park typically consists of mowing, restroom upkeep, and weed control. Weeds are usually pulled by hand, but occasionally spot applications of Roundup® are used in the compacted gravel parking area. These rare occasions of chemical use do not occur when rain seems imminent.

<u>Skykomish River Centennial Park</u>: The 32-acre Skykomish River Centennial Park is located east of the Cadman, Inc. property with approximately 1,330 feet of Skykomish River frontage. Skykomish River Centennial Park is the only active use park in the City's shoreline, although most of the active-use facilities such as baseball and soccer fields are located more than 200 feet from the river near the north end of the park. The fields are treated with a granular fertilizer and liquid weed control at appropriate times of year and during appropriate weather conditions (Crueger, pers. comm., 1 March 2002). No chemicals are applied within 200 feet of the Skykomish River. The waterfront portion of Skykomish River Centennial Park allows for limited vehicle parking, and is frequently used for fishing access. A pedestrian shoreline trail starting in the Cadman, Inc. property continues east across the park.

Public access is provided at each of the parks discussed above. In addition, Cadman, Inc. allows access to the Skykomish River via its property for recreational fishing and other waterfront enjoyment uses. Cadman has an informally designated parking area on the south side of the facility, with a pedestrian trail leading to the gravel bar. A narrow dirt trail extends east along the Skykomish River through the Cadman, Inc. property to Skykomish River Centennial Park. Public access is also provided at a WDFW boat ramp on the Skykomish River just east of Skykomish River Centennial Park. Access is limited during low flow periods; Search & Rescue operations during low-flow periods launch from the Cadman site. A list of public access points is provided in Appendix D.

2.4 IMPERVIOUS SURFACE

The total impervious area (TIA) is a combination of areas that have had their infiltration capacity reduced through human activity and those areas that naturally contribute to surface water. Although portions of Al Borlin Park are technically in the shoreline zone of both the Skykomish River and Woods Creek, all of Al Borlin Park was included in the Skykomish River impervious surface calculation to avoid double-counting. This artificially inflates the impervious surface percentage calculated for Woods Creek. The net impervious surface percentage for the collective shoreline is approximately 19 percent.

SKYKOMISH RIVER

The shoreline jurisdiction of the Skykomish River has a very low impervious surface percentage due to the large area of natural park land and the characteristics of the Cadman gravel operation. TIA estimated from aerial photographs is only about 5.5 percent in the shoreline area (Table 3). Note that all areas are on the right bank of the Skykomish. According to *The Snohomish County Land Cover Project* (Purser and Simmonds 2001), the Lower Mainstem Skykomish Subbasin has a total impervious surface area of 7.5 percent (high impervious 3% plus medium impervious 7%*0.5, plus open water 1%).

Table 3. Impervious surface within the Shoreline Zone of the Skykomish River.

	Area (acres)[1]	**Runoff Coefficient (Avg)**	**Equivalent impervious surface (acres)**
Building	1.92	0.85	1.63
Road – paved	2.89	0.825	2.39
Road – gravel	8.49	0.8	6.79
Parking lot – paved	0.39	0.825	0.33
Parking lot - gravel	0.16	0.8	0.13
Open Gravel	39.66	0.05	1.98
Open Water	50.43	0.0	0.00
Undeveloped	301.85	0.2	60.37
Total	**405.8**		**73.62**
			TIA = 5.5%

WOODS CREEK

As previously mentioned, the portion of Al Borlin Park (which falls under the "undeveloped" category) that is technically part of the shoreline of Woods Creek was excluded from the calculation of impervious area so the value reported below is substantially inflated. TIA estimated from aerial photographs is about 27 percent in the shoreline area (Table 4). According to *The Snohomish County Land Cover Project* (Purser and Simmonds 2001), the Lower Woods Creek Subbasin has a total impervious surface area of 12.5 percent (split between high impervious 6% and medium impervious 13%*0.5).

2.5 FILLED AREAS

Significant shoreline fill areas are relatively limited in the City's shorelands. The most significant fill areas are primarily associated with an old railroad bed through Al Borlin Park, and shoreline hardening and minor flood-protection areas along the Skykomish

[1] Impervious surface was determined using digital planimeter measurements taken from 2001 aerial photographs printed at a 1"=157' scale. The aerial photographs were not ortho-corrected.

Table 4. Impervious surface within the Shoreline Zone of Woods Creek (non-Skykomish River floodplain sections).

	Area (acres)[1]	Runoff Coefficient (Avg)	Equivalent impervious surface (acres)
Building	2.59	0.85	2.20
Road – paved	1.01	0.825	0.83
Road – gravel	0.71	0.8	0.57
Parking lot – paved	0	0.825	0
Parking lot - gravel	0	0.8	0
Open Gravel	0	0.05	0
Open Water	0	0.0	0
Undeveloped	35.52	0.2	7.1
Total	**40.23**		**10.7**
			TIA = 27%

River and Woods Creek. Minor fills related to buildings, paved and gravel roads, and paved and gravel parking lots cover approximately 4 percent of the shoreline area (using the impervious surface areas reported in Tables 3 and 4). The Cadman operation is currently a network of substantial cuts and fills, which is expected to ultimately result in net cut. The volume of fill at this operation varies as roads and stockpiles change configuration, but is primarily derived from material excavated elsewhere on-site. One notable exception is approximately 375,000 tons of off-site material that has been or will be used as fill in the deepest portions of the main gravel pit.

2.6 ROADS AND BRIDGES

Several paved and unpaved roads are within the City's shoreline jurisdiction. SR 2, a heavily traveled two lane highway leading to one of the primary routes over the Cascades, parallels the Skykomish at the upstream end of Monroe. In Al Borlin Park, an unpaved road leads to a parking lot on an actively eroding bank of the Skykomish. Near the SR 203 bridge, a park maintenance road and walking trail (unpaved) crosses Woods Creek and meanders within the shoreline jurisdiction, at two points intersecting actively eroding banks of the Skykomish. The boat ramp and associated parking lot maintained by WDFW just west of the SR 203 bridge are largely unpaved (though the ramp itself is concrete). In Skykomish River Centennial Park, west of the boat ramp, a paved maintenance road between the Waste Water Treatment Plant (WWTP) and the Skykomish appears to have captured flow from the most recent flood event, estimated to have a recurrence interval of approximately two years. A feature on the south side of the gravel pit may have once been an unpaved road, but is now a high flow channel. Finally, 177th Avenue SE, on the west side of Monroe, is a paved road built on top of a revetment.

[1] Impervious surface was determined using digital planimeter measurements taken from 2001 aerial photographs printed at a 1"=157' scale. The aerial photographs were not ortho-corrected.

The shoreline zone of Woods Creek includes part of the downtown core of Monroe, on the northwest bank of the creek. Roads in the area are typical of older downtown residential neighborhoods – a grid of north-south and east-west oriented, relatively narrow paved streets. None of the residential streets cross the creek. On the opposite bank of Woods Creek, a few park access roads exist in Al Borlin Park, most of which are unpaved. Upstream of the downtown area, the roads in the Woods Creek shoreline include SR 2, a five-lane highway that narrows to two lanes in the eastern portion of the shoreline area, and Old Owen Road, a heavily traveled, two-lane, residential road. A short access road also connects a motel and cabins to Old Owen Road on the southeast bank of Woods Creek.

Only two bridges exist over the Skykomish in Monroe. The SR 203 bridge is a single span that carries a two-lane highway, with an abutment very near to the mouth of Woods Creek. Approximately two-thirds of a mile upstream of SR 203, an abandoned railroad spur crosses, supported by two piers built on artificial islands.

A total of four bridges cross Woods Creek within the city limits. The uppermost is a concrete bridge with a wooden center pier at Old Owen Road, on the northern edge of the City. Moving downstream, the next bridge is at SR 2, a single span bridge, followed by the Burlington Northern railroad, supported by two mid-channel piers, the abandoned railroad spur, and finally a small single-span bridge on an access road in Al Borlin Park.

2.7 FLOOD CONTROL STRUCTURES

SKYKOMISH RIVER

Two primary flood control structures exist on the Skykomish River in Monroe (Figure 8). At the upstream end of the City's jurisdiction, a rip-rap revetment protects the railroad track that runs between SR 2 and the Skykomish. The entire revetment is approximately 3,000 feet long, but only approximately 1,000 feet of it is within the City limits. The revetment affects little floodplain, since it is placed at the base of a hill that rises approximately 150 feet above the floodplain.

Further downstream, another rip-rap revetment begins at the base of the SR 203 bridge and extends downstream approximately 1,500 feet. Much of the land protected by the revetment is a parking lot managed by WDFW, and is associated with the boat ramp located immediately downstream from the bridge. The Monroe WWTP also has an outlet to the Skykomish in this revetment, and the rip-rap near the outlet appears to be much newer than the remainder of the revetment. At one time, the entire segment of river between the WDFW parking lot and the southern boundary of the current gravel pit was protected by a revetment. However, a 1960 flood removed much of this revetment, leaving only the revetment described above (City of Monroe 1994).

In addition to these two primary revetments, a few other structures should be addressed. One is located along the southern boundary of the gravel pit, where unvegetated gravel deposits mark the boundary between the floodplain and the pit. Hence, the southern boundary of the pit may be considered a revetment. However, this gravel does not appear to be piled higher than the rest of the gravel mining operation area, and was therefore probably not placed to prevent floodwater from entering the pit. This boundary may be a more or less natural feature that has simply been cleared of vegetation.

On the north and west sides of the pit is a tributary channel. According to Pentec and NW GIS (1999), a revetment exists on the portion of the channel that is oriented east-west. This tributary channel appears to be in a similar location to an old channel of the Skykomish (NHC 2001), and may be considered part of the ordinary high water mark of the Skykomish. However, the volume of flow from this channel indicates that it functions as a tributary, and it may be that the tributary has captured an abandoned channel of the mainstem river. Regardless of its genesis, the revetment on this channel has little or no practical influence on the mainstem of the Skykomish.

WOODS CREEK

Significant flood control structures on Woods Creek exist near Old Owen Road (see Figure 8). Viewed from Old Owen Road and looking downstream, Woods Creek makes a bend to the left. On this bend, the left bank has been built up several feet with rip-rap and soil to prevent flooding of a motel and cabins. The right bank is armored with rip-rap, but the rip-rap is generally flush with the top of the bank. This protection ends at the end of the motel property. Four bridges cross Woods Creek: SR 2, the Burlington Northern railroad track, the old railroad spur, and an access road in Al Borlin Park. Each of these bridges has some bank protection associated with them, but only enough to protect the bridge abutments. Further downstream in Al Borlin Park, a few minor areas of bank protection exist. These are minor in scope, encompassing only 10 to 20 feet of bank, and their original purpose is unknown.

2.8 DOCKS, PIERS, AND OVER-WATER STRUCTURES

With the exception of the bridges discussed in Section 2.6, no dock, piers or over-water structures exist along the Skykomish shoreline. The WDFW boat ramp west of the SR 203 bridge is the only boat access to the Skykomish in the City. Several old pilings were noted along the shoreline, but whatever structures they might have been used for no longer exist, with the exception of the railroad bridge.

2.9 STORM WATER AND SEWER OUTFALLS, AND OTHER UTILITIES

There are a total of seven documented outfalls to Woods Creek and the Skykomish River in Monroe (see Figure 7). The WWTP discharges its treated water to the Skykomish

River. It is currently capable of treating up to 3.229 million gallons per day, but in June of 2002, its capacity will be increased to 5.686 million gallons per day. Treated water generally leaves the plant via gravity flow, but pumps can be employed when water levels in the river are high. While some storm water does go through the WWTP to be discharged with the treated water, there is also a separate WWTP outfall that discharges only storm water (Feilberg, pers. comm., 6 March 2002).

The outfalls on Woods Creek are all stormwater outfalls. Three of these (Ann Street, McDougal and Lewis Street) drain primarily older residential and mixed-use neighborhoods. Water collected from SR 2 east of approximately Kelsey Street outfalls to Woods Creek near the overpass. A retail area and parking lot between Woods Creek Road and Old Owen Road drains via an outfall to Woods Creek north of SR 2.

While there are no major utility facilities in the shoreline zone, the residential and commercial properties in the shoreline area are serviced by various utilities, including water, sewer, electric, gas, phone and cable.

2.10 CULVERTS AND OTHER FISH PASSAGE BARRIERS

No fish passage barriers occur along the Skykomish River adjacent to the City of Monroe. A bridge carrying SR 203 and an unused railroad bridge cross the river, entering the City from unincorporated Snohomish County from the south, but neither poses a barrier or hindrance to fish migration. A backwater area off of the river, including beaver pond and oxbow areas, is located between 177th Avenue SE and the west side of the Cadman gravel mining area. The beaver dams may or may not hinder the upstream movements of adult and juvenile fish depending on the condition of the dams at any given time, the stage of the river, and the amount of flow coming out of the backwater area into the river. The Cadman access road crosses the backwater area, but the culvert under the road is not expected to impede fish passage either upstream or downstream due to the low gradient through the area. Juvenile salmonid fish utilizing the backwater areas for rearing or as refuge during periods of high river flow should be able to work their way back downstream to the river at will.

Within the City, Woods Creek is crossed by a number of bridges including a park pedestrian/vehicle access road bridge, two railroad bridges, the SR 2 bridge, and the Old Owen Road bridge at the City limits. No fish migration barriers or hindrances due to these bridges or other possible causes occur along Woods Creek within the City. There are no culverts present along the creek in this section. As mentioned previously, a small unnamed tributary, # 07-0827, enters Woods Creek through a piped section on the right (west) bank immediately upstream of SR 2. This piped section is likely not entirely fish passable, and the feasibility of restoring the lower sections of this creek to an open, fish-passable channel should be investigated.

3. BIOLOGICAL RESOURCES AND CRITICAL AREAS

3.1 WETLANDS

Information on wetlands in the shoreline zone was provided by: 1) National Wetlands Inventory (as shown on WDFW Priority Habitats and Species maps) (WDFW 2001a), 2) 2001 aerial photographs provided by the City, 3) the *Draft Supplemental Environmental Impact Statement – Skykomish River Pit – Cadman Inc*. (City of Monroe 1994), and 4) the City of Monroe Comprehensive Plan (1998a). Numbers have been assigned to the wetlands known to be located within the shoreline zone. These numbered wetlands are listed and briefly described in Table 5 and illustrated on Figure 9. Additional information about wetlands in the shoreline zone is provided in Section 3.3.3 (*Sensitive Wildlife Use and Habitats in the Monroe Area*) and the *Priority Habitat* discussions under each segment description in Section 4 (*Existing Conditions in the City of Monroe*). Additional site-specific review would be required to determine the presence of any additional associated wetlands, and to locate the exact boundaries of the following known wetlands.

Existing regulatory standards for wetlands are described in the City of Monroe Sensitive Area Guidelines (1990). However, the City is currently reviewing and revising these standards and plans to adopt revised sensitive area regulations in 2002/2003. In the existing guidelines, wetlands are classified into three classes based on size, plant and animal associations, vegetation type, and on the number of wetland subclasses within the wetland.

3.2 AQUIFER RECHARGE AREA

The shoreline areas of Monroe are underlain primarily by recessional outwash (deposits left by meltwater rivers as glaciers retreated at the end of the Ice Age) and younger alluvium (river deposits developed from more recent deposits not effected by continental glaciation), with some glacial till (dense, clay-rich material deposited and compacted by glaciers) in the vicinity of the Washington State Department of Corrections facility at the far western portion of the shoreline area (City of Monroe 1998b).

Glacial till is relatively impervious, and is therefore a poor aquifer. Outwash deposits are much better aquifers due to their much higher permeability. Since the outwash deposits tend to be at a higher elevation than their surroundings in Monroe, they are recharged primarily by downward percolation of precipitation. As water percolates through the outwash deposits, it commonly intersects areas of lower permeability and is forced to migrate laterally. As the laterally migrating water reaches the edge of the outwash, it is either passed to the neighboring deposit or emerges as a spring or seep and becomes

Table 5. Wetlands within the Shoreline Zone of the Skykomish River and Woods Creek.

Wetland	General Location	Wetland Class	Water Regime	Functions	Approximate Size	DOE Wetland Category
1	Cadman Pit	Palustrine Forested, Scrub/ Shrub, Aquatic Bed, Emergent, and Open Water	Some portions are seasonally flooded, some are semi-permanently flooded, and some are permanently flooded.	Moderate to high functions for wildlife habitat and food chain support; moderate functions for flood storage and water quality protection; and low functions for recreation and esthetic values.	40 acres	I[1]
2	Cadman Pit	Palustrine Forested, Scrub/Shrub, Emergent, Aquatic Bed, and Open Water; Riverine Lower Perennial Unconsolidated Shore	Some portions are temporarily flooded, some are seasonally flooded, some are semi-permanently flooded, and some are permanently flooded.	Moderate to high functions for wildlife habitat, food chain support, shoreline protection, flood storage, groundwater recharge, and water quality.	20 acres	I[1]
3, 3a, and 3b	Cadman Pit	Palustrine Open Water Excavated	Permanently flooded.	Low functions for wildlife habitat; moderate functions for flood storage and water quality.	38 acres total	III
4	Between Cadman and Centennial Park	Palustrine Scrub/Shrub and Emergent	Seasonally flooded.	Moderate functions for wildlife habitat, flood storage, groundwater recharge, and water quality.	1 acre	III

[1] Classification as Category I is based primarily on potential use by listed fish (chinook or coho salmon, bull trout) and/or wildlife (bald eagle).

Wetland	General Location	Wetland Class	Water Regime	Functions	Approximate Size	DOE Wetland Category
5	Confluence of Woods Creek and Skykomish River	Riverine Upper Perennial Unconsolidated Shore	Seasonally flooded	Moderate functions for wildlife habitat, flood storage, and water quality.	3 acres	I[1]
6	Al Borlin/Buck Island Park	Palustrine Forested	Temporarily flooded	High functions for wildlife habitat and food chain support; moderate to high functions for flood storage, groundwater recharge, and water quality.	35 acres	II
7	Woods Creek	Palustrine Forested, Scrub/ Shrub and Emergent	Seasonally flooded	Moderate to high functions for wildlife habitat, food chain support, shoreline protection, flood storage, groundwater recharge, and water quality (discontinuous along stream).	15 acres	I[1]
8a and 8b	Al Borlin/Buck Island Park on the Skykomish River	Riverine Upper Perennial Unconsolidated Shore	Seasonally flooded	Moderate to high functions for wildlife habitat and food chain support; high functions for shoreline protection, flood storage, groundwater recharge, and water quality.	1.5 acres total	I[1]

Wetland	General Location	Wetland Class	Water Regime	Functions	Approximate Size	DOE Wetland Category
9	Adjacent to the Skykomish River	Palustrine Forested, Scrub/ Shrub, Emergent; Riverine Upper Perennial Unconsoli-dated Shore	Seasonally flooded	Moderate to high functions for wildlife habitat and food chain support; high functions for shoreline protection, flood storage, groundwater recharge, and water quality.	8 acres	I[1]

surface flow. Younger alluvium is also highly permeable and constitutes the primary aquifer recharge area for Monroe (Figure 10). It is recharged by precipitation, by infiltration of surface runoff from surrounding higher-elevation areas, or by sub-surface lateral migration of water from surrounding deposits.

Aquifers are important for maintaining base summer flows in streams. During hot dry summer months, groundwater reaching the river provides not only higher flows, but also helps to keep the water cooler and carries nutrients and oxygen into the stream. Therefore, it is important that aquifers be allowed to store water during the winter months, so it will be available to the stream in the summer months.

Under the Growth Management Act, one of the five designated critical areas is "critical aquifer recharge area" which is defined as "[a]reas … that are determined to have a critical recharging effect on aquifers used for potable water …" Prior to 1969, the City received its water from local wells, including one on Buck Island (City of Monroe 1997). The City of Monroe currently purchases all of its water from the City of Everett; therefore, no drinking water is supplied by any aquifers in the City itself and groundwater recharge of local aquifers is not an issue from a drinking water perspective. The Washington State Department of Corrections facility obtained its water from two wells adjacent to the Skykomish River prior to 1996. The Department of Corrections has developed a plan to close the wells (City of Monroe 1997), and they are not currently in use.

3.3 SENSITIVE HABITATS AND SPECIES

A list of sensitive habitats and species in Monroe's shoreline zone was compiled from information provided by local, state, and federal sources. Sensitive species and habitats include those designated by the state as "Priority"[1]; those listed, proposed for listing, or candidates for a proposal to list under the federal ESA; and those that provide actual or potential habitat for sensitive species. Local sources include the City of Monroe and Snohomish County; state sources include WDFW and DNR; and federal sources include NMFS and USFWS. This information was supplemented with field data collected by The Watershed Company. In general, the Skykomish River and Woods Creek shorelines include the following sensitive habitats and species: state and federal sensitive fish and wildlife; wetlands; and riparian areas (potential habitat for priority wildlife and an important component of ESA-listed fish habitat). The vegetation attributes of terrestrial wildlife habitat and riparian aquatic habitat overlap significantly; as much as possible, vegetation discussions in the aquatic and terrestrial habitat sections will focus on those specific elements critical to fish and wildlife habitat, respectively. Prior to a discussion of habitat and species on a City-specific basis, however, is a discussion about the basin as a whole and its processes that will help lay the groundwork for a meaningful discussion of Monroe.

3.3.1 Basin-Wide Ecological Functions/Ecosystem-Wide Processes

"Ecological" or "shoreline" functions are defined as "the physical, chemical, and biological processes that contribute to the proper maintenance of the aquatic and terrestrial environments that constitute the shoreline system." Related "ecosystem-wide processes" are the naturally occurring physical and geologic processes (including erosion, sediment transport, and deposition) and certain chemical processes that shape the landforms of a specific shoreline ecosystem, thereby largely determining the habitat types and functions present. The functioning of fish and other wildlife habitat throughout the Skykomish Basin has been significantly altered, and in most cases degraded, subsequent to European settlement during the last approximately 150 years. Land uses throughout the basin have been altered over time, converting most of the basin area, originally in an old-growth forested condition, to younger forests, agriculture, residential, urban, and industrial uses. These land use changes have ultimately affected terrestrial and aquatic wildlife alike.

Aquatic Habitat

The following sections summarize the status of salmonid fish habitats in the Skykomish basin Six overall pathways are included (consistent with NMFS Matrix of Pathways and Indicators): 1) water quality, 2) habitat access, 3) habitat elements, 4) channel conditions and dynamics, 5) flow/hydrology, and 6) watershed conditions. Each pathway is further subdivided into indicators. These conditions are summarized in Table 6.

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[1] "*Priority species* include State Endangered, Threatened, Sensitive, and Candidate species; animal aggregations considered vulnerable; and those species of recreational, commercial, or tribal importance that are vulnerable. *Priority habitats* are those habitat types or elements with unique or significant value to a diverse assemblage of species. A *priority habitat* may consist of a unique vegetation type or dominant plant species, a described successional stage, or a specific structural element" (WDFW 2001b).

Table 6. Environmental Baseline – completed at scale of Snohomish Basin Watershed.

PATHWAYS INDICATORS	**ENVIRONMENTAL BASELINE**
Water Quality	
Temperature	High temperatures result of reduction in streamside vegetation, by channel widening associated with increased sediment loads, and reduced summertime low flows
Sediment/Turbidity	Variable throughout watershed
Chem. Contam./Nut.	Turbidity, fecal coliform, temperature, runoff from both commercial and "hobby" farms, land clearing, and construction are problems at specific locations and/or in specific tributaries; several 303(d) listed segments
Habitat Access	
Physical Barriers	Most barriers natural, except for seasonal hatchery-related blockage on Wallace River, the Sultan River dam, and culverts on small tributaries
Habitat Elements	
Substrate	Spawning habitat abundant, but substrate at risk for degradation related to sedimentation
Large Woody Debris	Large conifer recruitment potential low
Pool Frequency Pool Quality	Low frequency and quality is result of reduced LWD and vegetative cover, and sediment inputs
Off-Channel Habitat	Abundant
Refugia	Compromised
Channel Cond. & Dyn.	
Width/Depth Ratio	High width/depth ratio, result of sediment mobilization, reduction in pool size/frequency, reduced bank vegetation, and reduced LWD
Streambank Cond.	Stable for the most part – few areas of instability have large effect
Floodplain Connect.	Compromised - roads and railroads paralleling river and stream channels
Flow/Hydrology	
Peak/ Base Flows	Increased peak flows and reduced base flows, result of forest practices and an increase in other land uses
Drainage Network	Increased drainage network, result of roads
Watershed Conditions	
Road Dens. & Loc.	Numerous roads in valley bottoms
Disturbance History	Disturbances located in unstable and riparian areas, large reductions in old-growth forest
Riparian Reserves	Variable – still a high percentage of forest in the watershed

Temperature

High water temperatures pose a potentially significant problem with respect to the functioning of salmonid fish habitat in the Skykomish basin, more so in some of the tributaries than in the mainstem river itself. With some variations, the optimal temperature range for salmonid fish is 12-14^{o} C (54-57^{o} F). Lower temperatures are typically preferred for spawning, particularly for bull trout. Lethal temperatures for adults are in the range of 20-25^{o} C (68-77^{o} F) (MacDonald et al. 1991). In the Skykomish River at Monroe, summer temperatures usually meet standards, with only three measurements between 18 and 20^{o} C recorded during regular sampling during the last 10 years. Water temperatures farther downstream in the lower Snohomish and estuary areas exceed the standards more frequently. Over 50 percent of the July and August temperature readings measured there over the last 10 years have exceeded the standard (Thornburgh and Williams 2000). The Wallace River has been placed on the 1998 list of impaired and threatened water bodies by the Department of Ecology (the 303(d) list) solely on the basis of high temperatures. French Creek also exceeds water temperature standards frequently during the summer months.

Increases in stream temperatures beyond those that would be observed in the pristine or pre-European settlement state are believed to be primarily affected by a reduction in streamside vegetation and by channel widening associated with increased sediment loads. Reduced summertime low flows due to forest practices, clearing, increases in impervious surfaces, and other land use changes are also a factor.

<u>Sediment/Turbidity</u>

Excessive fine sedimentation is problematic for the habitat of salmonid fish in that it reduces water flow through gravel, thereby reducing or cutting off the supply of dissolved oxygen needed by incubating eggs. Cemented or clogged gravels can also prevent fry from emerging from the gravel, entombing them in the streambed. Excessive fine and coarser sediments can reduce pool habitat and cause channels to widen, contributing to increased water temperatures (Pentec and NW GIS 1999; WSCC 1999).

The Skykomish River transports an annual bed and sediment load of approximately 21,000 cubic yards. The main river channel is sediment-limited between Index and Startup, eroding terraces. Between Startup and Sultan, the gradient is less, allowing sediment to deposit and resulting in a wide and braided channel. Between Sultan and Monroe, erosion and deposition are in relative balance. Between Monroe and the confluence with the Snoqualmie River, the Skykomish deposits much of its sediment load, resulting in an unstable channel and frequent channel changes (Collins and Dunne 1990, cited in Pentec and NW GIS 1999). The sediment regime was listed as “at risk” for most of the Skykomish River reaches in the *Snohomish River Basin Chinook Salmon Habitat Evaluation Matrix* (SBSRTC 2000) with the lower mainstem listed as “not properly functioning” and the lower South Fork listed as “properly functioning.”

<u>Chemical Contamination/Nutrients</u>

Maintaining overall good water quality, including control of fine sediment and temperature, as well as toxic substances and nutrients, is crucial for the survival, growth, and reproduction of salmonid fish. However, the nonpoint nature of the sources of many pollutants, environmental variation, and the interrelatedness of many water quality parameters make it difficult to isolate specific water quality factors which might be directly responsible for reduced salmon returns. In the Skykomish basin, water quality issues include turbidity, fecal coliform, temperature, runoff from both commercial and “hobby” farms, land clearing, and construction (Pentec and NW GIS 1999). Overall water quality in the basin is generally good, with exceptions at specific locations and/or in specific tributaries (SBSRTC 1999). Toxic chemicals that may be problematic for fisheries resources are often associated with urban land uses (WSCC 1999). A number of streams and stream segments in the Skykomish basin have appeared on the "303(d) list," including the lower Skykomish River, the Wallace River, and Woods Creek (Thornburgh and Williams 2000). The 303(d) lists contains stream sections or water bodies not expected to meet water quality standards even after implementation of technology-based pollution controls (DOE 1997).

Chemical contaminant and nutrient levels for the Skykomish lower mainstem would probably fall in the "not properly functioning" category, the lower South Fork is "properly functioning," and the remaining Skykomish River sections are all "at risk" (SBSRTC 2000). The lower mainstem of the Skykomish was 303(d) listed in 1998 for copper, fecal coliform, lead, silver, and temperature. Overall, the Skykomish basin as a whole would probably be considered to be "at risk" for this category.

<u>Physical Barriers</u>

Williams et al. (1975) indicated that most of the barriers to anadromous fish passage in the Skykomish basin were natural in origin. As mentioned previously, a combination ladder-trap and haul facility has been operated by WDFW and its predecessors since 1958 at Sunset Falls on the South Fork of the Skykomish just upstream of the confluence with the North Fork. This facility opened up approximately 54 miles of additional stream length for anadromous fish usage (Williams et al. 1975). The Wallace River, a Skykomish River tributary, is blocked by impassable falls 8 miles upstream of its mouth. The state salmon hatchery at river mile 4 of the Wallace River also has a barrier weir in place from approximately June 1 through October1 for the trapping of summer chinook, although a goal of 500 summer chinook are not kept for hatchery use and are passed upstream. Coho salmon and other fish passing by the weir location generally have unrestricted access upstream during the October through May period when the barrier weir is not in place. Some pink salmon may be precluded or hindered from passing upstream since the barrier weir remains in place during the month of September, which is part of their migration and spawning season (Mills, pers. comm., 10 June 2002). The primary man-made fish migration barrier in the Skykomish basin is the storage and diversion dam complex on the Sultan River, tributary to the Skykomish. The diversion dam blocks anadromous fish at river mile 9.7, and operation of the facilities affects stream flow, in turn affecting migration, spawning and rearing in the Sultan River.

Additional natural upstream migration barriers also exist along many of the small and moderately sized tributary streams, but these block a minor proportion of potential fish use area (Williams et al. 1975). Traditionally, the focus on providing fish passage at culverts and other structures has been on providing upstream passage for adults. More recently, however, the importance of providing upstream passage through culverts for juveniles has been recognized as an important factor that could adversely affect carrying capacity. Overwintering use of tributaries by juvenile coho and chinook is important, and the lack of access to existing such habitat within the basin is widespread (SBSRTC 1999).

Clearly, salmonid fish need access to habitat in order to make use of it. Improperly designed and installed road culverts can block such access to both adult and juvenile fish, affecting the productivity of fish populations. Problem culverts can entirely block upstream migrations, or less severe cases can block the migration of some species at some life history stages and/or some flows. Culverts tend to more negatively impact salmonid fish species such as coho, cutthroat, and steelhead which tend to use smaller tributary streams than those species such as pink, chum and chinook which tend to use larger stream channels (WSCC 1999).

Substrate

In general, the Skykomish River system provides large amounts of excellent spawning habitat for chinook and steelhead because of its relatively steep gradient and abundance of coarse, gravelly sediments (Pentec and NW GIS 1999). However, given that the sediment/turbidity indicator for the Skykomish basin is typically “at risk” (SBSRTC 2000), the substrate may be compromised in certain areas also. Though numerous individual channel and stream sections are likely in good condition, and certain others are degraded, the substrate conditions for the basin as a whole are at risk for degradation.

Large Woody Debris

In-stream large woody debris, i.e. stumps and logs, are important for the proper function of a number of in-stream natural processes, including those by which log jams are created. Large woody debris dissipates overall stream energy, while at the same time promoting the localized scour which forms pools. Wood also provides some nutrients and serves as a basis for aquatic food webs (WSCC 1999). Wood is generally recruited to streams and rivers when forested banks erode or channels migrate through forested riparian areas. Wood can also be recruited when landslides or debris flows containing wood reach stream channels. Old-growth conifers are commonly believed to be the best source of woody debris for the purpose of contributing to the formation and maintenance of salmonid fish habitat. Prior to floodplain timber harvest along the major river channels in the late 19^{th} century, 20 percent of the riparian forest was coniferous, including trees up to 4 meters (12 feet) in diameter. Today, the remaining riparian forest is made up almost entirely of cottonwood with only 2 percent conifers, and few trees are larger than 1 meter (3 feet) in diameter (Haas and Collins 2001). Due to the gradient and power of the Skykomish, woody debris is usually effective at creating habitat only by forming debris jams (Pentec and NW GIS 1999).

Pool Frequency/Quality

Abundant, high quality pool habitat is important to salmonid fish, providing rearing areas for juveniles and cool resting areas for adults. Both summer steelhead and chinook require deep holding pools to rest and reach sexual maturity in, because they spend a comparatively long time in fresh water before spawning. Abundant large woody debris in such pools is also critical, both to provide protective cover for the fish, adults and juveniles alike, and because such large woody debris is often instrumental in the formation and maintenance of such pools (STAG 2000; WSCC 1999).

The reduction of pool area in the basin is associated with a reduction in large woody debris, increases in sediment supply, and increased peak flows. Pool spacing generally decreases (number of pools increases) with decreasing channel slope and increasing woody debris (Pess et al. 1999).

While some portions of the Skykomish system may have appropriate pool frequencies, others probably do not. The basin also has low to moderate pool quality since the number of deeper pools is reduced, many pools lack adequate cover, and some pool volume reduction by sediment may have occurred.

Off-Channel Habitat

Rearing and refuge habitat is formed along the Skykomish River by its many side channels and alcoves. The upper Snohomish River, below the confluence of the Skykomish and Snoqualmie Rivers and extending to just upstream of the town of Snohomish, includes gravel bars and riffles, deep pools, side channels and backwater eddies. These features allow that section of river to provide excellent overall fish habitat (Pentec and NW GIS 1999).

Refugia

Refugia areas have also been subject to disturbances. Certain tributary basins are less disturbed overall than the basin as a whole; however, potential refugia have been compromised. These prospective refugia may not be adequately buffered and may lack the size and connectivity to maintain viable sub-populations.

Width/Depth Ratio

Given the increase in sediment mobilization and an overall decrease in the size and frequency of pools in the Skykomish basin, its channels in the lower segments probably exhibit a higher width/depth ratio than existed pre-settlement or than would be “ideal.” Also, channel widening commonly occurs due to reduced bank vegetation and reduced recruitment of large woody debris.

Streambank Condition

Unstable stream and river banks exist, but these likely comprise less than 10 percent of the total. However, a few areas of unstable bank may contribute a disproportionately large amount of sediment.

Floodplain Connectivity

There is a moderate reduction in hydrologic connectivity between off-channel, wetland, floodplain, and riparian areas. These disconnections have occurred partly due to roads and railroads paralleling river and stream channels; their embankments act to limit the extent that flood flows can spill out onto historic floodplain areas.

Peak and Base Flows

Much of the area in the Skykomish basin is in the rain-on-snow or “transient zone,” roughly between 1,000 and 3,000 feet in elevation. As such, the watershed would be somewhat sensitive to peak flows, even in its natural state. The rain-on-snow phenomenon occurs when warm, moisture-laden air passes over snow, causing condensation, releasing large amounts of latent heat energy, and melting large volumes of snow fairly rapidly. Combined with accompanying rainfall, this melting snow can cause river and stream flows to rise rapidly and result in flooding, erosion, and sedimentation. Timber harvest throughout the basin has likely accentuated the rain-on-snow phenomenon, contributing to flooding and channel scour. Scour due to high flows in gravel beds containing salmon eggs can cause the eggs to be displaced from the gravel. Alternatively, sedimentation due to high flows can bury and smother eggs at other locations. Salmon, which tend to spawn just prior to the fall and winter periods when flooding is most likely to occur, are most vulnerable to peak flow events, whether they are caused by rain-on-snow or other rainfall and weather patterns (WSCC 1999). High flows can also flush woody debris out of channels and make it difficult for overwintering juveniles to keep from being swept downstream.

On an annual hydrograph, high flows in the Skykomish are bimodal. The months of November through January have very high stream flows due to winter precipitation, much of which is rain but can include melting snow as the snow level rises and falls. The months of May and June also show elevated river flows due to the seasonal spring snowmelt. Lower-elevation tributaries do not show the springtime increases in flow because their basins do not accumulate a winter snowpack. The month with the lowest average flows in the Skykomish is typically August because most of the snow has already melted and little rainfall typically occurs during that month (Pentec and NW GIS 1999).

It is believed that both low and high flows in the Skykomish basin have been significantly affected by the removal of much of the old-growth forests in the basin over time and the accompanying increase in other land uses (STAG 2000; WSCC 1999).

There are likely "pronounced changes in peak flow, base flow, and/or low flow timing relative to an undisturbed watershed of similar size, geology, and geography."

Drainage Network

For the Skykomish basin as a whole, it is likely that there are significant (20-25%) increases in drainage network density due to roads.

Road Density and Location

At least within portions of the main river valley bottoms, including the mainstem, and portions of both Forks, road densities exceed 3 miles per square mile.

Disturbance History

Timber has been harvested from a high proportion of the watershed at some time. Much of the disturbance has occurred in riparian areas, and a number of landslides have been triggered or exacerbated by human activities such as road building and timber harvest.

Riparian Reserves

Functioning riparian reserves provide "adequate shade, large woody debris recruitment, and habitat protection and connectivity in all subwatersheds, and buffers or includes known refugia for sensitive aquatic species (>80% intact), and/or for grazing impacts; percent similarity of riparian vegetation to the potential natural community/composition >50%" (NMFS 1999).

The Skykomish Basin consists primarily of three vegetation zones: 1) western hemlock (0-2,297 ft. above sea level) (further subdivided into the Puget Sound area), 2) subalpine forest (further subdivided into silver fir and mountain hemlock zones), and 3) the timberline/alpine region (Franklin and Dyrness 1988). The lower Skykomish Basin, including the City of Monroe, is in the Puget Sound area of the western hemlock zone, which is dominated by western hemlock, Douglas-fir, western red cedar, and/or Sitka spruce. Deciduous tree species include red alder, black cottonwood, and bigleaf maple (Franklin and Dyrness 1988).

The Skykomish River Mainstem sub-basin, which includes the City of Monroe, is approximately 325 square miles, 75 percent of which is forested. In the remaining 25 percent of land area, residential land use is most common, followed by agriculture, particularly in the floodplain. The Skykomish River Forks sub-basin, upstream of the Skykomish River Mainstem sub-basin, is approximately 507 square miles, 98 percent of which is forested. Low-density residential land use is most common in the remaining two percent of land area (SBSRTC 1999). Pentec and NW GIS (1999) mapped riparian conditions along the Skykomish River from its confluence with the Snohomish River to a point between Gold Bar and the Forks, and portions of the Wallace and Sultan Rivers. The following table (Table 7) summarizes conditions in the mapped area.

Table 7. Summary of riparian conditions along 67.99 miles of river in the Skykomish Basin (both banks) (Pentec and NW GIS 1999).

Riparian Category	Total Miles	Percentage of Total
1 – grass or brush	2.92	4
2 – single line of trees	8.03	12
3 – 20- to 200-ft forested corridor	4.12	6
4 – 200- to 400-ft forested corridor	5.52	8
5 - >400ft forested corridor	40.10	59
6 – residences or farms, little forest	3.48	5
7 – residences or farms, significant forest	1.76	3
8 – roads or railroad	2.06	3
9 – industrial	--	--
10 - unforested wetland	--	--
TOTAL	**67.99**	**100**

Table 8 summarizes data collected in the Skykomish River Mainstem sub-basin; the Skykomish River Forks sub-basin is expected to have a substantially higher percentage of Category 5 condition. While these percentages appear favorable for fish (and wildlife), the data does not include information about vegetation species composition (native vs. non-native, conifer vs. deciduous) or forest age, which are the primary vegetation-related factors determining LWD recruitment (a non-vegetation-related factor is limitations on channel migration).

The *Initial Snohomish River Basin Chinook Salmon Conservation/Recovery Technical Work Plan* (SBSRTC 1999) identifies 21.25 miles of the Skykomish River Mainstem between Gold Bar and Monroe as a "priority critical habitat" due to the lack of shoreline hardening and the presence of a 200-foot-wide forested riparian corridor. Preservation of this area is considered essential to "preservation of key habitat-forming and habitat-maintaining processes" (SBSRTC 1999). The mapping of riparian condition conducted by Pentec and NW GIS (1999) supports that designation.

The following is a brief background discussion[1] of how shoreline vegetation can affect and can be affected by ecosystem-wide processes and functions related to aquatic habitat (summarized from Knutson and Naef 1997). It can be assumed that the contributions made by the historical riparian vegetation condition in the Skykomish Basin were optimized for each of these categories. The level of function of Monroe's current shoreline vegetation will be discussed in detail in Section 4.

<u>Delivery and routing of water</u>: Riparian vegetation affects stream flows in several ways, and to differing degrees depending on stream size. Vegetation directly intercepts rainfall, holding it on leaves and other plant structures for later evaporation and/or slowing the fall of water as it makes its way through several layers of vegetation. Rooting structures of

[1] This summary is greatly simplified. The inter-relationships between the processes and the physical features in the water and on land are complex; changes in any one process or physical feature commonly affect numerous other processes and physical features.

riparian vegetation also increase soil porosity, thereby increasing infiltration into the soil. Riparian vegetation also directly uses water that makes its way into the soil, losing it back into the atmosphere through evapotranspiration. All of these vegetation functions tend to reduce the overall quantity of water moving into the stream, and slow the movement of water into the stream, thereby reducing flow spikes and providing a source of water during the summer months to maintain base flows. Removal of significant amounts of riparian vegetation increases overall flow volumes and the intensity of flow spikes. Increased flow volumes and spike magnitude can adversely affect fish habitat through increased erosion, blowout of fish habitat structures (such as large woody debris), mobilization of spawning gravels and fine sediments, and mobilization or coverage of eggs (among others).

Delivery and routing of sediment: Sediment-laden water that moves through a vegetated riparian area before reaching a stream loses those sediments as it either infiltrates into the soil (whose porosity has been increased by rooting); filters through the surface layer of leaves, twigs, and other litter; or is trapped by downed wood and vegetation. The frictional resistance provided by vegetation, litter, and a loose organic humus layer slows the movement of water through the riparian area, allowing sediments to settle out. Vegetation on banks also helps regulate the input of sediment into streams by stabilizing soil. In unaltered watersheds, sediments mobilized by natural events that reach the stream can be trapped behind large woody debris; the presence of large woody debris is likewise a function of riparian vegetation condition. Removal of riparian vegetation eliminates much of the friction and filtering materials that slow water movement and strip muddy water of its sediment. Raindrop and streamflow energy are not dissipated by vegetation, and exposed soils in the riparian corridor and on the banks are more easily mobilized. Increased instream sedimentation can fill resting/rearing areas and spawning gravels, reduce production of food, damage fish gills, and adversely affect feeding and migration behaviors (among others).

Delivery and routing of nutrients/toxics: The vegetation and soil bacteria in healthy riparian areas together convert or store most of the nutrients (nitrates and phosphates primarily) and toxic compounds (e.g., pesticides) that move through the system. Nitrogen, for example, is either denitrified by soil bacteria or taken up by vegetation and turned into biomass. The decaying layer of sticks, leaves and other materials dropped on the soil by vegetation traps phosphates and heavy metals. Vegetation and soils can slow or halt the movement of toxics through the system, allowing time for decay and/or uptake. Removal of riparian vegetation speeds the flow of potentially harmful substances to the aquatic environment.

Delivery and routing of heat: Riparian vegetation plays a critical direct and indirect role in maintenance of cool water temperatures through shading. The ability of riparian vegetation to directly cool water temperatures is greater in narrow systems, decreasing as the system widens. In narrow systems, overhanging vegetation can completely shade a stream, while in wider systems, riparian vegetation can only influence the nearshore area, with centrally located portions of the waterbody receiving no shade at all. Wider systems depend on inputs of cool water from shaded tributaries and groundwater; in large systems, aquatic species needing cool water utilize shaded pools or backwaters. Indirectly, vegetation influences water temperature by shading and cooling soils and litter that water moves through on its way to the waterbody. Loss of riparian vegetation can result in high mid-day water temperatures, and increased year-round average temperatures, potentially exceeding aquatic species' temperature tolerances. Increased temperatures reduce availability of oxygen. The combination of increased temperature and reduced oxygen can adversely affect growth of aquatic species, immune system function, and control of bacteria and algae growth that deplete oxygen further (among others).

Delivery and routing of LWD/organic matter: According to several sources cited in Knutson and Naef's 1997 report on riparian habitat, "approximately 70% of structural diversity within streams is derived from root wads, trees, and limbs that fall into the stream as a result of bank undercutting, mass slope movement, normal tree mortality, or windthrow." Large conifers generally provide the best structure in a stream because of their longevity and size. Structures can significantly affect flow patterns that contribute to formation of a variety of habitat features (e.g., pools, side channels), store substantial quantities of sediment and other organic and inorganic materials, stabilize banks, and provide a substrate for invertebrate production (among others). Decomposing wood provides chemical and physical support to the food chain. Alteration of riparian vegetation either by selectively removing conifers during logging, wholesale clearing for agriculture or other development, or reduction in the width of the riparian corridor can reduce the quantity and size of LWD inputs. Changes in LWD size and quantity adversely affect instream food production, availability of suitable spawning and rearing habitats, and accessibility of upstream habitats (among others).

Terrestrial Habitat

The primary terrestrial or amphibian wildlife habitat adjacent to waterbodies is the riparian habitat area (RHA). As defined by WDFW (Knutson and Naef 1997), RHA is "the area adjacent to aquatic systems with flowing water…that contains elements of both aquatic and terrestrial ecosystems which mutually influence each other." The RHA is bounded by aquatic and upland habitats, but can include upland and certain aquatic habitats (wetlands) where those habitats directly influence the stream system. In human-altered landscapes, the historic RHA may now be isolated from the aquatic habitat by installation of dikes and other shoreline hardening structures. Because the designated shorelands in the City of Monroe encompass the floodplain, as well as areas 200 feet from the floodway that are not otherwise in the floodplain, the entire Monroe shorelands could be considered "RHA" as the floodplain lands, whether upland or wetland, influence and are influenced by the strictly aquatic habitat.

According to Knutson and Naef (1997) "approximately 85 percent of Washington's terrestrial vertebrate species use riparian habitat for essential life activities and the density of wildlife in riparian areas is comparatively high." Wildlife habitat functions can be assessed to a large extent by examining and interpreting the vegetation characteristics. The recently invalidated Shoreline Master Program Guidelines mandated that City Shoreline Master Programs should be directed toward achieving the vegetation characteristics described in *Management Recommendations for Washington's Priority Habitats: Riparian* (Knutson and Naef 1997) "…where applicable and based on scientific and technical information." These "characteristics" (connectivity, vegetation composition, multiple canopy layers, natural disturbance, snags, woody debris, shape, width, stream bank, associated wetlands) are part of one or more shoreline vegetation functions and contribute to the operation of various processes (see discussion above under "*Riparian Reserve*"). The "*Riparian Reserve*" section above also discusses the historical and current vegetation conditions in the basin as a whole. Existing wildlife habitat conditions along Monroe's shorelines are discussed in detail by segment in Section 4, and in general in Section 3.3.3.

<u>Vegetation/Habitat Characteristics</u>

The *Riparian Reserve* section above discusses the relationship of vegetation and aquatic species and habitat; the following discussion explains the relationship between vegetation and terrestrial/amphibian species and habitat.

<u>Structural Complexity</u>: Structural complexity in a forested riparian system is provided over a long period of time. Once a catastrophic event (flood or fire) clears an area of vegetation, the long process of succession begins. Over time, rapid colonizers that thrive on disturbed, exposed sites will be supplemented by shade-loving species such as conifers. As the community develops and ages, natural disturbances (e.g., windthrow, mortality) will create openings that harbor early-successional species. Across the forested landscape, patches of old and young forest support a wide diversity of plant species, provide multiple canopy layers through differences in species mature heights and the recruitment of young trees, supply snags and downed wood as age-related mortality or disease kills or injures trees, and creates edges at the interface of young and old forest. This structural complexity provides a broad range of foraging and breeding opportunities for reptiles, amphibians, small and large mammals, and birds. Reductions in structural complexity which occur when the natural disturbance frequency and/or magnitude is increased through human activities (e.g., clearing, selective harvest of conifers) can eliminate a forest feature that is specifically required by one or more wildlife species for some part of the species life history. Due to the complex interactions between species and their habitats, elimination of one species can result in the loss of numerous species.

<u>Connectivity with Other Ecosystems</u>: Most wildlife species are mobile and can move through relatively large areas on a seasonal (migration) or daily basis to locate suitable conditions for feeding, nesting, roosting, and/or denning. Different wildlife species have

difference tolerances for micro- and macroclimate on a seasonal or daily basis, and needs for cover to avoid predators. Healthy vegetated riparian corridors provide most species with a relatively convenient and safe way to move from one area to another. Riparian areas also provide routes for dispersal of young that would otherwise exceed the capacity of the habitat, and prevent genetic isolation of different communities of the same species (Knutson and Naef 1997). The importance of connectivity increases in developed landscapes, where the riparian corridor might be the only protected path to other habitats (Knutson and Naef 1997).

<u>Abundant Food Sources and Available Water</u>: As previously mentioned, healthy riparian areas are structurally complex, including a wide variety of plant species and therefore a wide variety of food. Conditions in the riparian environment enhance plant growth and also contribute to an abundance of bacteria, fungi, and “other lower organisms” which “are at the base of a complex and highly productive food web…” (Knutson and Naef 1997). Wildlife that do not otherwise need to be riparian-associated can utilize riparian areas heavily simply because of the food abundance. Water is also readily available in riparian areas, either directly from the aquatic habitat or in associated seasonal or permanent open-water wetlands.

<u>Moist and Moderate Microclimate</u>: Riparian areas are generally cooler in the summer and warmer in the winter, and more humid than surrounding areas because of the moderating effects of abundant water and vegetation. These microclimate conditions are attractive for many species, particularly amphibians and other wildlife escaping extreme weather conditions. Removal of riparian vegetation or reductions in the width of the riparian corridor can reduce or eliminate the value of the riparian corridor for year-round amphibian use or seasonal weather refuge.

<u>Habitat Condition in Skykomish Basin</u>

At the scale of the Skykomish Basin (sum of Skykomish River Mainstem sub-basin and Skykomish River Forks sub-basin as defined in SBSRTC 1999), 89 percent of the land area is forested. Although the area of forested land is high for the largely urban Puget Sound region, much of the remaining 11 percent of developed (residential and agricultural) land area is located along river valleys, in floodplains and former riparian areas. Wildlife habitat in riparian corridors does not consist solely of forests, which are typically either deciduous dominant or mixed conifer-deciduous. Other common riparian habitats include forested, scrub-shrub or emergent wetlands; and early-successional upland habitats developing in areas routinely or infrequently altered by natural disturbances such as windthrow, flooding, or age- and disease-related mortality.

The impacts of historic and current logging practices in the forested areas include reduced structural complexity, particularly as retention of existing snags and a percentage of living large trees for future snag recruitment and wildlife habitat is a relatively recent practice. Replanting of logged areas also tends to focus on the harvestable species, and does not result in the species and height diversity typical of undisturbed forests, at least in the short term. Logging practices tend also to favor establishment of non-native invasive species such as Scotch broom and Himalayan blackberry which can preclude future recruitment of native shrubs and groundcovers. Creation of edge along the margins of cleared and retained forest is favorable to some species, such as deer and coyotes, but can have substantial adverse affects on other wildlife species, such as certain birds and amphibians who are very sensitive to changes in microclimate and/or are subject to egg predation by edge-favored birds.

Connectivity between ecosystems has also been negatively impacted by forestry and development. Clearcutting practices can create islands of forest that many terrestrial wildlife species cannot migrate from due to lack of protective cover or other environmental factor. Retention of a corridor (of varying widths during the history of forest management) along rivers and streams and around wetlands has helped to maintain connectivity, although these corridors are interrupted at road crossings and almost absent along rivers in some areas where agriculture and urban development have extended to the waterline.

Food availability has also been negatively impacted in the basin by forestry, agriculture and development. Food diversity for herbivores drops in relation to the drop in plant species diversity related to harvest practices. Some foods increase in quantity, such as blackberries, with positive effects on some species, but other food items favored by a particular wildlife species can be reduced such that the species must either starve, switch to a food item that may be less favorable energetically and nutritionally, or migrate to a site that still has the favored food item. Further up the food chain, carnivores are affected by the availability of their herbivorous prey in a similar fashion. Water availability in the basin has likely also been affected, although to a lesser degree than food. Changes in hydrology from forest practices or development can affect flow patterns and volumes, change the water regime in seasonal or permanent wetlands, and affect the vegetation community (species composition, successional stage) in the riparian corridor. Water is important not only for drinking, but also for maintenance of microclimate and soil moisture, and for certain breeding patterns.

3.3.2 Sensitive Fish Use in the Skykomish Basin

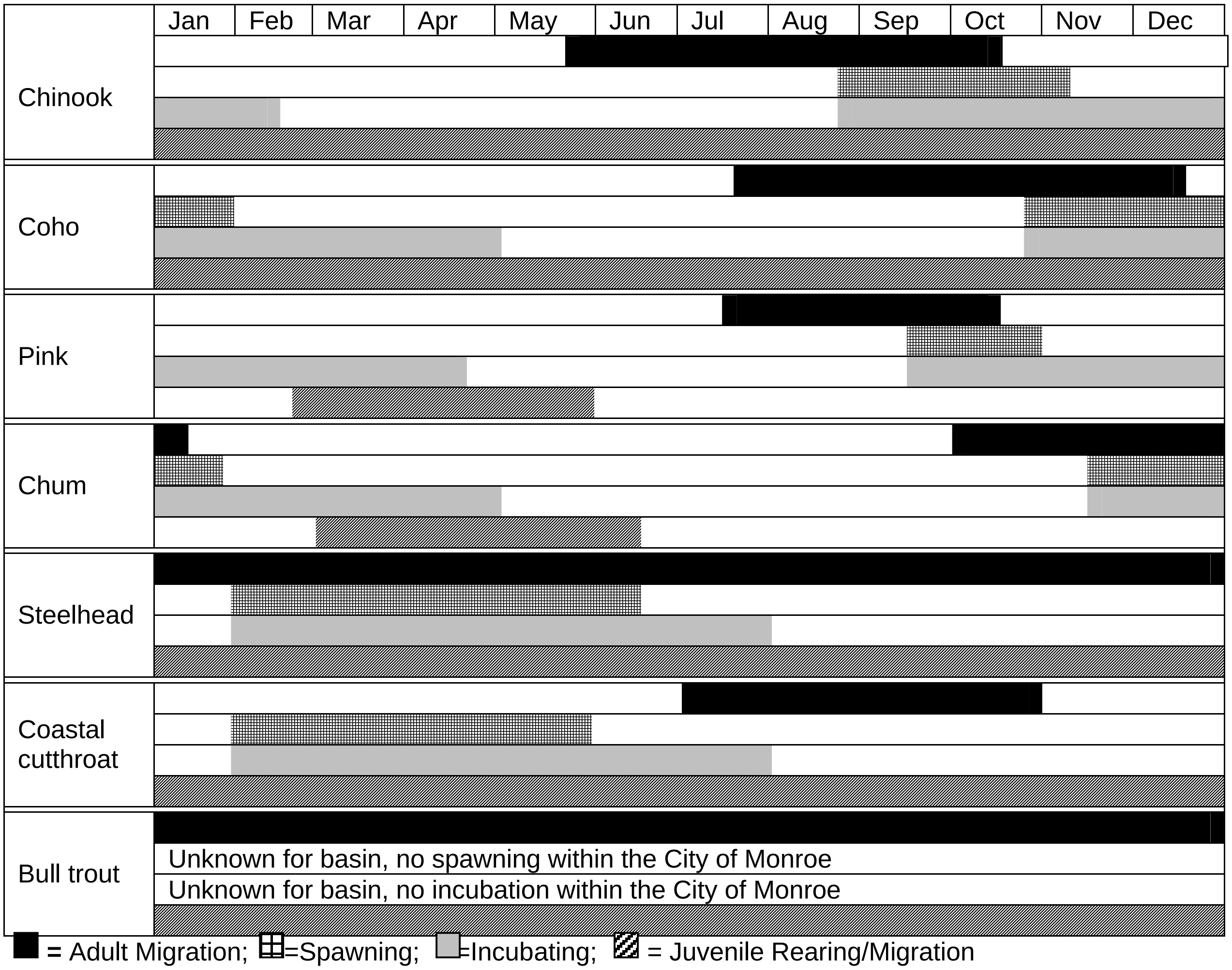
The Skykomish River and several of its tributaries are used by a number of salmonid fish species for various life-history stages (Tables 8 and 9). Certain of these species are divided into stocks as identified in the Washington State Salmon and Steelhead Stock Inventory (SASSI) (WDF at al. 1993; WDFW 1998). SASSI stocks in the Skykomish Basin presently include four chinook salmon stocks, two coho salmon stocks, two chum salmon stocks, two pink salmon stocks, three steelhead stocks, and one bull trout stock. In addition to the species and stocks identified in the SASSI, searun cutthroat trout make

Table 8. Fish Species with Special State or Federal Status in the Skykomish Basin.

Species	Federal Status	State Status	ESU/DPS[1]	Origin and Type
Chinook salmon *Oncorhynchus tshawytscha* Snohomish summer Wallace summer/fall Snohomish fall Bridal Veil Creek fall	Threatened March 1999	Candidate	Puget Sound ESU	Native w/ wild production Mixed w/ composite production Native w/ wild production Native w/ wild production
Coho salmon *Oncorhynchus kisutch* Skykomish South Fork Skykomish	Candidate July 1995	None	Puget Sound -Strait of Georgia ESU	Mixed w/ composite production Non-native w/ wild production
Chum salmon *Oncorhynchus keta* Skykomish Wallace	None	Priority		Native w/ wild production Native w/ wild production
Pink salmon *Oncorhynchus gorbuscha* Snohomish odd-year Snohomish even-year	None	Priority		Native w/ wild production
Steelhead trout *Oncorhynchus mykiss* North Fork Skykomish summer South Fork Skykomish summer Snohomish/Skykomish winter	None	Priority		Native w/ wild production Non-native w/ wild production Native w/ wild production
Coastal cutthroat trout *Oncorhynchus clarki clarki*	None	Priority		Presumed native w/ wild production
Bull trout *Salvelinus confluentus*	Threatened November 1999	None	Coastal-Puget Sound DPS	Native w/ natural production

[1] ESU = Evolutionarily Significant Unit, the species definition used by the National Marine Fisheries Service
DPS = Distinct Population Segment, the species definition used by the U.S. Fish and Wildlife Service

Table 9. Use and timing of Monroe's shorelines by sensitive fish species.



widespread use of most accessible streams in the basin (WSCC 1999). Isolated resident cutthroat populations likely inhabit some tributary sections upstream of migration barriers.

Chinook salmon (*Oncorhynchus tshawytscha*) stocks occurring in the Puget Sound Evolutionarily Significant Unit (ESU), which includes all of the Skykomish River stocks, are listed as Threatened under the Endangered Species Act (ESA) by the National Marine Fisheries Service (NMFS) (U.S. Federal Register, 24 March 1999). NMFS has also designated coho salmon (*O. kisutch*) stocks in the Puget Sound-Strait of Georgia ESU, including the Skykomish River stocks, as Candidates, which are eligible for listing under the ESA (U.S. Federal Register, 25 July 1995). The U.S. Fish and Wildlife Service (USFWS) has designated bull trout in the Coastal-Puget Sound Distinct Population Segment (DPS), including the Skykomish stock, as Threatened (U.S. Federal Register, 1 November 1999).

The Skykomish River system is presently managed for both wild and hatchery production of chinook salmon, coho salmon, and steelhead trout. Hatcheries within the Snohomish River basin account for some of the production of the above three species. Pink and chum salmon in the Skykomish basin both consist of native, wild stocks which are managed for natural production. An adult trapping and hauling facility to pass salmonid fish upstream is operated at Sunset Falls on the South Fork of the Skykomish just upstream of its confluence with the North Fork, opening up approximately 54 river miles of additional stream length for anadromous fish use (Williams et al. 1975). Under WDFW's current Wild Salmonid Policy, it is questionable whether or not similar facilities would be authorized for construction today. Allowing anadromous fish access above the falls may have adversely affected the native trout and other fish populations existing there; however, the additional accessible habitat may, to some degree, compensate for habitat losses for anadromous fish elsewhere throughout the basin. Coho salmon were introduced upstream of the falls in the late 1950's; chinook and pink runs above Sunset Falls have become established due to lower river native stocks colonizing upstream areas (Williams et al. 1975).

Due to the City of Monroe's location along the Skykomish River, all of the anadromous salmonid fish species described below utilize the in-river and shoreline areas in and near the City associated with the river and its side channels for migration, at least, with some spawning and rearing as well. These same species also utilize the lower sections of Woods Creek within the City (Williams et al. 1975).

Chinook Salmon

The SASSI identifies four stocks of chinook salmon utilizing the Snohomish watershed. The Snohomish summer chinook stock is described as a native stock with wild production, which is depressed due to chronically low escapements and a long-term negative trend. These fish are September spawners in the mainstem Skykomish and associated tributaries (see Table 10). The Wallace summer/fall chinook are a mixed stock with composite production whose status is healthy. This is the stock propagated at the Wallace River salmon hatchery, which spawn from late August through October. The Snohomish fall chinook is a native stock with wild production, which is depressed due to chronically low escapements and a long-term negative trend. These fish spawn from mid-September through October in portions of the Sultan River, Pilchuck River, Woods Creek, Elwell Creek, and the Snoqualmie River. The Bridal Veil Creek fall chinook spawn in Bridal Veil Creek, the South Fork Skykomish up to Sunset Falls, and the North Fork Skykomish up to Bear Creek. They are a native stock with wild production whose status is unknown. As mentioned, these, along with other Puget Sound chinook stocks, were designated by NMFS as Threatened under the federal Endangered Species Act in March of 1999.

Most juvenile chinook rear for a few months in fresh water and estuarine areas before migrating to sea (ocean type); however, a small percentage may rear in fresh water for a full year (stream type) (Williams et al. 1975).

Coho Salmon

Two distinct coho salmon stocks are also identified by the SASSI for the Skykomish Basin. These are the Skykomish and South Fork Skykomish stocks. The Skykomish coho stock is a mixed stock with composite production whose status is healthy. They spawn from November through January in the mainstem and North Fork Skykomish, the Sultan and Wallace Rivers, and other tributaries. The South Fork Skykomish stock is a non-native stock with wild production whose status is healthy. These coho spawn upstream of Sunset Falls and are (presumably) the descendants of coho planted upstream of the falls in the late 1950s. Their spawning timing has not been documented, but their run timing is earlier than the other coho stocks in the basin. Coho are small stream spawners and generally spawn throughout the basin in November through January, utilizing nearly every accessible tributary to some degree (Williams et al. 1975). Coho fry emerge in March and April, and typically spend a full year in fresh water, preferring low-gradient streams, side channels, and beaver ponds. Migrating to sea as yearlings, they are less dependent on estuarine areas for rearing than some of the other salmon species.

Chum Salmon

The SASSI (WDF et al. 1993) distinguishes two distinct chum salmon (*O. keta*) stocks in the Skykomish basin. The Skykomish chum stock is a native stock with wild production whose status is healthy. They spawn from mid-November through December in Skykomish side channels and larger tributaries. The run size has strong odd/even fluctuations, being more abundant in even years (when they do not have to compete with odd-year pinks). The Wallace chum stock spawns in the Wallace River from November through December. It is a native stock with wild production whose status is healthy. Escapement is lower during odd years due to competition with pink salmon (see below). Chum salmon fry typically emerge from March through May and migrate downstream to salt and estuarine waters immediately upon emergence. Some may spend several months rearing in the estuarine waters near the mouth of the Snohomish River, which are highly important to the survival of these young fish (Williams et al. 1975).

Pink Salmon

Two pink salmon (*O. gorbuscha*) stocks are listed in the SASSI for the Snohomish watershed, including the Skykomish basin. These are the Snohomish odd-year and the Snohomish even-year stocks. They are both listed as native, wild stocks whose status is healthy. Pink salmon spawn in large numbers in the Skykomish (and other Puget Sound Rivers where they are found) in odd-numbered years only. In addition to the more typical odd-year run, however, the Snohomish basin supports a relatively small, but healthy run of even-year pinks. Their escapement is listed in the SASSI as up to 2,200 fish which spawn in September, primarily in the mainstem Snohomish and lower Skykomish. The more numerous odd-year pinks spawn from late September through October in the mainstem Snohomish, Skykomish, Snoqualmie, Wallace, and Sultan Rivers, and other larger tributaries. Pink salmon fry typically emerge in March and migrate immediately downstream to estuarine and salt-water areas (Williams et al. 1975).

Steelhead Trout

Three steelhead trout (*O. mykiss*) stocks are identified by the SASSI as occurring in the Skykomish River and its tributaries. The North Fork Skykomish summer steelhead stock is a native, wild stock, sustained by natural production, whose status is unknown. These fish are geographically isolated from other stocks, spawning upstream of Bear Creek Falls on the North Fork Skykomish, and its tributaries. Their spawning period is likely February through April. The South Fork Skykomish summer steelhead stock also consists of a geographically isolated population, which spawns in the South Fork Skykomish River, the Beckler River, and other tributaries upstream of Sunset Falls. These fish are believed to be derived primarily from Skamania hatchery summer run stock which colonized the habitat upstream of Sunset Falls, made accessible by the fish passage facilities built in the 1950s and operated since. They are believed to spawn from February through April. This is a non-native, wild stock, sustained by natural production, whose status is healthy based on adult counts past Sunset Falls. The Snohomish/Skykomish winter steelhead stock is a native, wild stock, sustained by natural production, whose status is healthy based on spawner escapement. Fish making up this stock spawn from early March through late June in the Snohomish, Skykomish, Sultan, and Wallace Rivers, and their suitable tributaries. Steelhead juveniles may rear in fresh water for one to three years before migrating to salt water as smolts from March through late June (WSCC 1999).

Coastal Cutthroat Trout

Searun and resident stocks of coastal cutthroat trout (*O. clarki clarki*) are found in streams throughout the Snohomish watershed. Isolated, resident cutthroat populations commonly occur upstream of migration barriers. Searun cutthroat typically rear from two to four years in fresh water before migrating to salt water for the first time (WSCC 1999). Most of the anadromous cutthroat in the Skykomish basin are found downstream of Gold Bar. Woods Creek and the Wallace River are important producers of searun cuthroat within the basin. Mature anadromous cutthroat enter the river from July through October, and spawn from early February through May (WDFW 2000).

Bull Trout

The WDFW 1998 Bull Trout and Dolly Varden SASSI Appendix identifies a population of native char as using streams in the upper Skykomish River basin. Native char include both bull trout and Dolly Varden char (*Salvelinus malma*), which are often indistinguishable from each other. They are believed to be found throughout the watershed at various life history stages and to include resident, fluvial, and anadromous forms. Only resident forms are found in upper tributary reaches above fish-barrier falls, such as in Troublesome Creek. As mentioned previously, the Coastal-Puget Sound bull trout DPS, including the Snohomish/Skykomish stock, was listed as threatened by USFWS in November of 1999. Native char in the North and South Forks of the Skykomish are considered to be of the same, single stock. Skykomish char spawn in the upper North Fork Skykomish mainstem and its tributaries between Bear Creek Falls and Deer Creek Falls. South Fork Skykomish bull trout passing above Sunset Falls spawn primarily in the East Fork of the Foss River. Spawning typically occurs from October first through the first week in November, as temperatures drop to or below 8° C., but can occur as early as late August or as late as mid-November. Skykomish bull trout/Dolly Varden are native and maintained by natural production. Their stock status is healthy, and they have expanded their range within the watershed by utilizing habitat upstream of the Sunset Falls trap-and-haul fishway that was inaccessible to them prior to the mid-1950s.

3.3.3 Sensitive Wildlife Use and Habitats in the Monroe Area

The Washington Department of Fish and Wildlife (WDFW) maintains a Priority Habitats and Species program to inventory potential state or federal proposed, threatened, or endangered species as well as other “priority” species and habitats of state concern. Habitats and Species Maps were obtained from WDFW for the township/range areas that comprise the entire City of Monroe (WDFW 2001a). The priority habitats mapped along the Skykomish River and Woods Creek include several riparian zones and wetlands (discussed in greater detail in Section 3.1, *Wetlands*). Parts of the shoreline zone are also included in a bald eagle breeding territory, although the bald eagle does not nest within City limits.

The Washington Department of Natural Resources (DNR) was also contacted to obtain any information about “rare plants, select rare animal species, or high quality ecosystems” that might be listed in their Washington Natural Heritage Program. DNR does not have any records of rare plants, select rare animal species, or high quality ecosystems in the City of Monroe (Moody, pers. comm., 14 September 2001).

In addition, the U.S. Fish and Wildlife Service (USFWS) was contacted to obtain a list of any listed and proposed threatened and endangered species, candidate species, and species of concern that may be present within the City of Monroe (Berg, pers. comm., 11 February 2002) (Appendix E). The USFWS list included nesting and wintering bald eagle activity in the area. The USFWS list also included 14 Species of Concern that have been found in Snohomish County, although none of these species has an actual known occurrence within 1 mile of the City of Monroe. The Species of Concern will not be considered in this report, although many of the recommendations made in Sections 4.1.5 and 4.2.5 would incidentally benefit one or more of these species’ habitats.

Wildlife

The only sensitive wildlife species known to be present in the shorelands of Monroe is the bald eagle. No nesting locations have been mapped by WDFW (2001) in the City. Douglas-fir trees with the appropriate structure suitable for nesting were not observed in the shoreline zone; however, bald eagles are known to occasionally use cottonwood trees. Large cottonwoods are abundant in the shoreline zone, so it is possible that bald eagles may nest within City limits in the future. Currently, bald eagle use in the City is limited to frequent foraging on spawning salmon and salmon carcasses in the Skykomish River (and possibly in Woods Creek as well). Therefore, perch and potential nest trees are an important habitat element to retain in the City's shorelines. In addition to being close to water, one of several nest and perch tree selection criteria appears to be that the view and flight path from the tree to open water be unobstructed (Parson 1992; Johnsgard 1990; Chandler et al. 1995). Such a location allows an eagle to find food easily (Chandler et al. 1995; Parson 1992), protect the nest and young, and define its territory boundaries (Parson 1992). It is generally agreed that bald eagles select nest trees based on structure not species (Grubb 1980; Rodrick and Milner 1991). In western Washington, Douglas-fir trees tend to have the required structure: tall, strong branches, broken tops, and some protective foliage above and surrounding the nest location (Grubb 1980; Rodrick and Milner 1991). Most nest trees are codominant with other large trees in heterogeneous stands (Grubb 1980). Suitable nest trees are also within range of other topped or dead trees, with limbs suitable for perching (Rodrick and Milner 1991). These elements are used for perches, roosts and defense posts (Rodrick and Milner 1991).

Wildlife observed in the Cadman wetland complex include great blue heron, red-tailed hawk, double-breasted cormorant, belted kingfisher, bufflehead, spotted towhee, golden-crowned sparrow, coyote, beaver, black-tailed deer, and raccoon (Ebasco Environmental 1992). Of these species, only the breeding areas of the great blue heron and the bufflehead (a cavity-nesting duck) and "regular large concentrations" of bufflehead are considered "priority" by WDFW. Neither the Cadman wetlands nor any of the other shoreline areas in the City of Monroe are mapped by WDFW as containing great blue heron rookeries, or bufflehead nests or concentrations.

Wildlife Habitat

Terrestrial habitat in the shoreline zone consists of a matrix of uplands and wetlands, with the upland vegetated habitat areas further divided into native forest in various stages of succession (generally either park land or protected critical area buffer), pasture/agriculture, and residential or commercial landscape (e.g., lawn, ballfields) (Figure 11). Because these areas are all in the floodplain, they also provide very temporary habitat for Skykomish River and Woods Creek fish. The riparian corridors associated with waterbodies containing chinook salmon, a species listed as Threatened under the federal ESA, are designated as part of "critical habitat[1]." Further, vegetated

[1] See discussion of critical habitat on page 2.

riparian corridors and associated wetlands contain potential habitat for priority wildlife species and possibly undiscovered occurrences of priority species. Accordingly, all riparian areas along the Skykomish River and Woods Creek will be discussed in this section, regardless of whether they have been designated "Priority" by WDFW.

A field reconnaissance was conducted in October and November 2001 to identify four characters of the riparian vegetation: dominant cover type, average tree size, tree density, and presence of non-native species. Additional habitat features were noted in the field, such as presence of snags and downed wood, structural and species diversity, and food and water availability. Aerial photographs taken in September 2001 were used to note broad patterns related to habitat connectivity. The significant findings and general descriptions of the riparian areas are provided below, and segment-specific detailed descriptions are provided in Section 4.

As previously mentioned, vegetation characteristics provide one of the best indicators of the quality of wildlife habitat. In general, the shorelands in the City of Monroe provide structural complexity, limited connectivity with other ecosystems, abundant food sources and water, and moist and moderate microclimate. The two most significant habitat areas are located at the west end of the City (Cadman-area wetlands) and the east end of the City (Al Borlin Park). The Cadman-area wetlands are a huge (approximately 60 acres) complex of permanent open water, emergent, scrub-shrub, and forested wetlands. Al Borlin Park is 90 acres of predominately native upland and wetland forest. Both of these areas are described in greater detail in Section 4.1.3.

A variable-width band of upland riparian vegetation, primarily dominated by black cottonwood, along the Skykomish River connects these two habitat areas. The primary interruption in this otherwise continuous band of connecting vegetation is the SR 203 bridge over the Skykomish River and Woods Creek (which is a barrier to mammals unless they can swim or navigate the pedestrian bridge crossing Woods Creek). An informal pedestrian trail also runs through this corridor, and some other low-impact land uses are adjacent to the corridor. However, the corridor still provides adequate cover for most wildlife species that would move through the area.

Additional small habitat patches north of SR 2 along Woods Creek are separated from the Al Borlin Park habitat area by SR 2. SR 2 is likely a source of mortality for wildlife crossing the road between these two habitat areas, and is likely a complete barrier to some species that do not attempt road crossings.

3.4 GEOLOGICALLY HAZARDOUS AREAS

Geologically hazardous areas are defined by the City of Monroe as areas that are not suited to the siting of commercial, residential or industrial development consistent with public health or safety concerns because of their susceptibility to erosion, sliding, earthquake or other geological events. Erosion hazard areas are further defined as areas containing certain erosion-prone soils as determined by the USDA Soil Conservation Service (City of Monroe 1990; Soil Conservation Service 1983). Landslide hazard areas are further defined as areas with: a) a combination of slopes greater than 15 percent, interbedded permeable and impermeable soils, and springs or seeps; b) areas located on an historic landslide; or c) areas shown to be at risk of snow avalanches.

No comprehensive survey of geologic hazards has been completed for Monroe. The identification of specific geologic hazards is therefore speculative, and may be shown to be inaccurate when further data is developed.

SKYKOMISH RIVER

Steep slope areas that may be susceptible to sliding may exist in several portions of the Skykomish shoreline. On the eastern side of the City, portions of the ridge that separate Woods Creek from the Skykomish are within the Skykomish shoreline area. The City of Monroe Comprehensive Steep Slope map (City of Monroe 1998a) (see Figure 9) indicates that slopes in this area exceed 40 percent. Though the map indicates the steep slopes are outside the shoreline area, field observations clearly indicate that the steep slopes continue into the shoreline area of the Skykomish. On the western side of Monroe, along the western end of the gravel pit, slopes greater than 15 percent have been identified. Again, the steep slopes mapped are outside the shoreline zone, but field observations indicate that the slopes continue into the shoreline area. It has not been determined whether these areas have interbedded permeable and impermeable soils, nor whether seeps or springs exist in these areas.

Much of the shoreline area of the Skykomish is likely susceptible to erosion, though only a few areas of the listed erosion-prone soils exist. The proximity of the Skykomish increases the erosion potential of soils that otherwise would not be considered prone to erosion. On the eastern portion of town, in the triangle of land formed by the abandoned railroad spur, the active railroad tracks, and the Skykomish, numerous channels exist that appear to be active at high flows. Both railroads are protected from erosion by rip-rap. Approximately halfway between the abandoned railroad and the SR 203 bridge, another channel allows high flow water from the Skykomish to enter Woods Creek, and must be considered an erosion hazard. Near Woods Creek, the bridge abutment, boat launch and parking lot are all protected from erosion by rip-rap. The presence of protective armoring indicates that erosion hazards exist in the area. In the 1960s, the rip-rap armoring extended from the parking lot to the beginning of the side channel that forms the island immediately south of the gravel pit area. This armoring has since been destroyed by high flows. According to the draft supplemental EIS for the gravel pit (City of Monroe 1994), the pit itself is at risk of an avulsion, the sudden changing of a river channel to a new location. Early maps indicate that the Skykomish once flowed along the northern boundary of the current gravel pit, which may place the entire pit and its northern and western boundaries at risk of erosion hazard.

Earthquake hazards are potentially severe for Monroe. The South Whidbey Island Fault passes very near to Monroe (Figure 12) (University of Washington 1996). This fault is one of the longer faults in the Puget Sound region, and the maximum earthquake potential from a fault is generally correlated to the length of the fault.

A large earthquake has several hazards associated with it. The foremost is direct ground shaking. According to Noson et al. (1988), ground shaking can be intensified in areas underlain by soft sediments such as those found in the shoreline area of the Skykomish. Several types of ground failure are also associated with earthquakes. Of particular concern in this area are liquefaction, land spreading, and differential compaction.

Liquefaction occurs when saturated sand or silt is shaken violently enough to rearrange its individual grains. This rearrangement tends to compact the sediment, and if water stored in the sediment cannot escape fast enough, the load of any overlying structures (buildings, roads, etc) are temporarily transferred from the grains of sand or silt to the escaping water, and the saturated deposit becomes like “quicksand.” Depending on the circumstances, this may lead to catastrophic failure of structures.

By a similar process, land spreading can occur. Soil that experiences liquefaction can flow similar to water, and like water, will seek out and fill topographic depressions. This flow can undermine the foundation of structures and fill in creek channels.

Differential compaction, as the name implies, occurs when different soils compact at different rates or by different amounts. As mentioned earlier, the shaking of an earthquake tends to compact soils, and different soils behave differently. If a building or similar structure is built on more than one soil type (e.g. partly on native soil, partly on artificial fill, or soil with wood chips or sawdust in it), and these soils do not compact at the same rate or to the same extent, it can cause serious damage to the structure.

WOODS CREEK

Much of the Woods Creek shoreline area is at risk of geologic hazards. Downstream of SR 2, most of the right bank (north and west of the stream) and some of the left bank present possible steep slope hazards. These hazards are intensified by the potential erosion hazard presented by the Creek at the bottom of the slopes. Upstream of SR 2, the primary steep slope area is on the left bank. Erosion potential is underscored by the bank armoring on both sides of the channel.

Woods Creek flows in a valley it inherited from glacial activity, and historically has not moved as much as the Skykomish. The soils developed in the floodplain may be somewhat more stable than those along the Skykomish. However, by and large the same earthquake potential and the same associated hazards related to the Skykomish will likely apply to the shoreline area of Woods Creek.

3.5 CHANNEL MIGRATION ZONE

The channel migration zone (CMZ) is defined by WAC 173-26 as "the lateral extent of likely movement along a stream reach with evidence of active stream channel movement over the past one hundred years." Areas that are legally protected from bank erosion or stream avulsion are considered outside the CMZ, unless the structures are designed to less than the 100-year recurrence interval flood event.

No studies have been done to delineate the channel migration zone in Monroe. The following discussion is based on the best estimate of the channel migration zone as determined by historical and current maps, aerial photographs, and limited field observations. The actual CMZ may vary somewhat from that depicted in this report, especially in the area between SR 203 and the current gravel pit.

SKYKOMISH RIVER

The probable CMZ of the Skykomish within the City of Monroe is depicted on Figure 8. The channel was formed by a combination of glacial and fluvial processes, and the channel migration zone is largely a product of those processes. However, as with most large rivers in the Pacific Northwest, the channel is limited in its ability to migrate by anthropogenic features as well. In Monroe, these features include SR 2, SR 203, Great Northern railroad tracks, an abandoned railroad track, and various revetments.

Several historic channels were identified in a study of the stability of Haskell Slough, a slough in the floodplain on the opposite bank of the Skykomish from Monroe (NHC 2001). An 1888 survey map shows that the position of the river as it approaches the eastern edge of Monroe was approximately the same then as it is today. However, while the 1888 map showed the river bending sharply to the left, and meandering significantly as it flowed past what would become Monroe, by 1917 the Skykomish straightened considerably, cutting off at least three significant meander bends. This 1917 map shows the positions of the older channels that were observed at the time (Figure 13).

Other researchers have identified glacial outwash terraces on the north side of the Skykomish in Monroe (NHC 2001; City of Monroe 1994). These terraces serve as the northern limit of the channel migration zone, except in those places where anthropogenic structures limit the ability of the river to migrate. In addition, a hill on the eastern edge of Monroe is a natural barrier to migration, with SR 2 and the railroad track at the toe of the slope and possibly limiting the channel migration zone by a few hundred feet.

The abandoned railroad bridge and the SR 203 bridge also limit the channel migration zone, creating "hard points" through which the river must pass. The SR 203 bridge is situated on a point where the terrace on the north bank approaches close to the river, so the bridge abutment has a minor effect on the north bank CMZ. The abandoned railroad bridge and its approach from the north are more intrusive into the CMZ. NHC (2001) identifies an historic channel or slough approximately 500 feet north of the present channel, and the railroad approach cuts across this historic channel. However, the age of this historic channel has not been determined, and may well prove to be older than 100 years, which would preclude it from being part of the true CMZ.

Immediately downstream of the SR 203 bridge, a parking lot maintained by the WDFW is protected by rip-rap. The level of maintenance of this structure is unknown, but it is presently acting to prevent the channel from migrating, and its existing use as a boat ramp and parking indicate that it will likely be maintained in the foreseeable future. Hence, the rip-rap is considered the edge of the CMZ in this area.

The WWTP for Monroe has an outfall in the Skykomish downstream of the WDFW parking lot. Rip-rap has been placed to protect the outfall from scour, and this rip-rap will presumably be maintained. Therefore it is also considered the boundary of the CMZ.

In 1961, a revetment was built between the WDFW parking lot and approximately the south-east corner of the property now used to mine gravel (City of Monroe 1994). This revetment was destroyed during floods in 1990, and has not been replaced. Historic maps indicate that the Skykomish occupied portions of the present gravel pit in 1888, but had abandoned those areas by 1917. Because of the gap in the historic record, it is unclear whether this area meets the strict requirements of being within the CMZ, but clearly, without some structure to prevent it, the Skykomish could re-occupy that area under certain conditions. Therefore, the gravel pit is considered to be within the CMZ.

The western boundary of the CMZ is 177th Avenue SE and the revetment on which it is constructed. That road has existed since before 1917, when it was called Feller Road. It is unclear whether the revetment was built with the road, or if the revetment was built afterward. Aerial photographs and topographic maps provide evidence that the channel once flowed as much as 2,000 feet west of the current revetment, thought it is uncertain when the channel moved to its present position. Hence, while the revetment is the limit of the CMZ, clearly the channel at one time moved well beyond the revetment and road.

WOODS CREEK

Historic aerial photographs dating to 1933 indicate that the channel of Woods Creek has not migrated significantly within the City. Throughout Al Borlin Park, Woods Creek is confined to a relatively narrow channel, with high walls on the edge of the terrace on which most of Monroe is situated. The CMZ is likely quite small. Between SR 2 and Old Owen Road, channel confinement diminishes, and the potential for a larger channel migration zone exists. However, there is no evidence from photos or maps to indicate that the channel has migrated in the past 100 years, and therefore the CMZ is likely only slightly wider than the ordinary high water mark of the stream.

3.6 FREQUENTLY FLOODED AREAS

"Frequently flooded areas" is one of five categories of critical areas established under the Growth Management Act (WAC 365-195-200). Monroe defines flood hazard areas as those areas subject to inundation by the base flood. The base flood is defined as the flood that has a 1 percent chance of occurring in any given year, or the 100-year recurrence interval flood. The City of Monroe participates in the National Flood Insurance Program, which allows City residents to purchase flood insurance, and the Community Rating System, which qualifies City residents for reduced insurance premiums depending on the City's rating. The City began the CRS program in 1990 and since 2001 has been rated as Class 6, which yields a 20 percent reduction in insurance premiums for structures in the 100-year floodplain and a 10 percent reduction in premiums for structures located outside of the 100-year floodplain (City of Monroe *no date*; Feilberg, pers. comm., 1 November 2002). Activities that the City conducts to qualify as a Class 6 include providing Flood Insurance Rate Map information and flood insurance purchase requirement information to inquirers; preserving open space in the floodplain; enforcing floodplain management and stormwater provisions of local ordinances; and requiring new buildings to be elevated or otherwise protected, among others (City of Monroe 2002a).

SKYKOMISH RIVER

The 100-year floodplain maps produced by FEMA (1999) are a very good approximation of the flood hazard area (see Figure 8). It includes most of Centennial Park and the gravel pit area, Al Borlin Park, and the triangle of land between the active railroad, the railroad spur, and the Skykomish main channel.

WOODS CREEK

Frequently flooded areas of Woods Creek include the inside of the meander bend between Old Owen Road and SR 2, and Al Borlin Park. Woods Creek may not flood Al Borlin Park frequently enough to consider the park part of the Woods Creek flood hazard area. However, the park is flooded by the Skykomish River with sufficient frequency to qualify as part of the Skykomish River flood hazard area. To date, a "Repetitive Loss Update Worksheet" under the National Flood Insurance Program has only been completed for one property in the City of Monroe, located on Old Owen Road adjacent to Woods Creek. This property has made seven claims for damages over the past 20 years, totaling $128,217.73.

4. EXISTING CONDITIONS IN THE CITY OF MONROE

4.1 SKYKOMISH RIVER

Shoreline areas along the Skykomish River within the City of Monroe are those areas along the north (right) bank of the river within 200 feet of the ordinary high water mark (OHWM). This shoreline extends from along a short section of 177th Avenue SE at the downstream (west) end to along the BNSF railway line and SR 2 at the upstream (east) end, the far east end of the City's Al Borlin Park. The length of this shoreline is approximately 2.3 miles and extends between approximately river miles 23.7 and 26.0 as measured from the mouth of the Snohomish River at Possession Sound near Everett (Williams et al. 1975).

For survey purposes, the Skykomish shoreline within the Monroe City limits was broken down into three segments, which are shown on all figures. Segment A extends upstream along the river from City limits to the end of the active Cadman gravel mining operations, which lie at varying distances inland from (north of) the river. Segment B extends from the east end of the Cadman site to the mouth of Woods Creek, which lies immediately upstream of the SR 203/Lewis Street bridge over the river. Finally, Segment C extends from the mouth of Woods Creek upstream to the eastern extent of Al Borlin Park and the City Limits adjacent to where the river nears and flows along SR 2 and a paralleling railway line.

On 15 January 2002, Greg Johnston, fisheries biologist, and Mark Indrebo, fluvial geomorphologist, both of The Watershed Company, conducted a qualitative aquatic habitat survey of the shoreline areas in the City of Monroe along the right bank of the Skykomish River. The general purpose of the survey was to assess, where applicable, the level of functioning of the various indicators as listed on NMFS' Matrix of Pathways and Indicators, as described previously in *Basin-Wide Ecological Functions/Ecosystem-Wide Processes* under Section 3.3. Table 11 summarizes the conditions of each segment.

4.1.1 Segment A

Land Use

The Cadman operation and the on-site critical areas and their buffers comprise most of Segment A, which is designated as Limited Open Space in the current zoning and future land use maps. When gravel operations at the Cadman site are complete, the property will likely be redeveloped as a City park, providing even greater benefits to the public and the environment than currently exist. Very small portions of the segment are zoned as Public Space (Washington State Department of Corrections facility), Light Industrial, and Urban Residential. The portions of these land uses within the shoreline zone are mostly vegetated by lawn or pasture, with very few structures or impervious surface.

Future land use is not expected to change substantially, or have additional adverse impacts on shoreline function.

According to the Draft Supplemental Environmental Impact Statement (City of Monroe 1994), the gravel pit first began operations in 1961 under a prior owner and before the area was annexed into the City. Cadman purchased the site in 1989, two years after it was annexed. Historically, the site was mined using a combination of rubber-tired equipment to remove the gravel above the water table, followed by dredging using a bucket attached to cables and pulled towards a tower, similar to many logging operations. This method allows excavation to a depth of about 45 feet below ground surface. Under the present permit, a "clamshell" bucket may be used, capable of excavating to a depth of 100 feet. As mentioned earlier, the deepest portions of the pit will be back-filled with 375,000 tons of off-site material, yielding a final depth of approximately 40 feet. In total, Cadman expects to remove approximately 11 million (M) tons of material over the life of the operation, with a peak output of approximately 1 M tons per year.

The present operation plan calls for three phases, with different road and processing configurations for each phase. As portions of the site are closed, they are regraded, stabilized, and replanted. An attachment to the 2002 Master Plan (City of Monroe 2002b) includes conceptual grading and planting plans, the goals of which are to "create wildlife habitat and provide accessibility for future recreation" (City of Monroe 2002b). Once all mining is completed, the site (less 37 acres to serve as a base for "long-term site operations") will be deeded to the City for non-commercial public use and stewardship. Ten acres in the northeast portion of the site have already been conveyed to the City (City of Monroe 2002b). A concern that has been expressed regarding the mining operation is the potential for the Skykomish to change locations and flow through the pit. Historically, the river has occupied the area of the pit (NHC 2001), and through bank erosion or during a flood event, it could reoccupy the area. Such an occurrence would have significant impacts upstream and downstream of the site. If the river flowed over the pit, the pit would serve as a sediment trap, capturing most of the sediment load of the river. Downstream of the site, the river would be starved of sediment, leading to potential downcutting of the riverbed and an increase in bank erosion. Upstream of the site, downcutting and bank erosion would also be likely, as the river adjusted to the new base level dictated by the bottom of the pit and/or the downcut channel downstream of the pit. Such downcutting could have serious ramifications for the City, potentially creating bank instability which would threaten the parks, railroad and highway.

Cadman has addressed this concern by creating a 200-foot-wide, 1,400-foot-long armored buffer between the river and the pit. This buffer has been designed to withstand the 100-year recurrence interval flood, and prevent the channel from either slowly migrating or rapidly shifting into the pit area.

With the Skykomish River in its present location, the pit has little impact on the sediment regime of the river. Flow from the river only enters the pit during floods as overbank flow. Overbank flow carries relatively little sediment, and while some of this sediment likely gets deposited in the pit, the volume is insignificant compared to the volume of sediment carried by the main flow of the Skykomish during a flood. Turbidity is also a concern during floods, as flow from the pit is carried out to the Skykomish. However, this too is deemed insignificant, since at flood flows the Skykomish itself becomes quite turbid. The extra turbidity derived from the pit is unlikely to have a significant impact in overall turbidity of the Skykomish (City of Monroe 1994).

Aquatic Habitat

The following discussion of aquatic habitat conditions is summarized in Table 10.

Table 10. Environmental Baseline – completed at segment scale for Segment A, Skykomish River.

PATHWAYS INDICATORS	**ENVIRONMENTAL BASELINE**
Water Quality	
Temperature	Slightly elevated summer temperatures
Sediment/Turbidity	Sediment load and turbidity occasionally high
Chem. Contam./Nut.	Variable depending on the contaminant and nutrient – several parameters are 303(d) listed
Habitat Access	
Physical Barriers	No barriers in mainstem – off-channel beaver dams and Cadman facilities may hinder passage
Habitat Elements	
Substrate	Gravel and cobble with low embeddedness
Large Woody Debris	LWD is present, but recruitment potential in the segment is low
Pool Frequency/Quality	frequency and quality are low – pool cover and LWD limited
Off-Channel Habitat	Present, but compromised by Cadman operation
Refugia	NA
Riparian Vegetation	Developing deciduous forest – few conifers, abundant non-native shrubs
Channel Cond. & Dyn.	
Width/Depth Ratio	Naturally high ratio because it's a depositional reach – likely further increased due to human activity
Streambank Cond.	Banks stable with a few areas of armoring
Floodplain Connectivity	Good connectivity
Flow/Hydrology	
Peak/ Base Flows	Increased peak flows and reduced base flows, result of forest practices and an increase in other land uses
Drainage Network	Somewhat compromised by Cadman

Temperature

Though the Skykomish River was included on the 1998 303(d) listing of the river because of temperature and other water quality parameters, summer temperatures at Monroe usually meet state standards with only three measurements between 18 and 20^{o} recorded during the last 10 years (Thornburgh and Williams 2000). However, DOE's

Water Quality Index (WQI) scores, compiled from measurements taken at a station in Monroe for temperature in eight of nine years (1992-2001), indicate that this parameter "met expectations and [is] of lowest concern" (http://www.ecy.wa.gov/apps/ watersheds/riv/station.asp?sta=07C070). As noted on DOE's WQI website, "[t]he WQI may not be consistent with Ecology's 303(d) listing because the WQI and the 303(d) analyses use different data sources, different constituents (parameters), different time periods, and different evaluation techniques." In summary, the temperatures in the Skykomish River through Monroe are slightly elevated due to land use changes in the basin. Though there would be some benefit from steps that would reduce temperatures, the are generally within a range that will accommodate migrating and rearing salmonid fish.

<u>Sediment/Turbidity</u>

The sediment regime for the lower mainstem Skykomish as a whole is listed as "not properly functioning" in the *Snohomish River Basin Chinook Salmon Habitat Evaluation Matrix* (SBSRTC 2000), citing 14 percent total impervious surface as determined by Snohomish County (2000). A more recent study by Snohomish County (Purser and Simmonds 2001) reports total impervious surface area in the lower mainstem Skykomish subbasin at 7.5 percent. Because the performance standard given in the *Snohomish River Basin Chinook Salmon Habitat Evaluation Matrix* indicates that the sediment regime is "not properly functioning" if total impervious surface is greater than 12 percent, SBSRTC's 2000 sediment/turbidity designation should be updated to "at risk." DOE's WQI scores for suspended solids and turbidity, which are related, fluctuate between low and moderate concern over the nine-year period of record (http://www.ecy.wa.gov/apps/ watersheds/riv/station.asp?sta=07C070).

Of note, tributary water entering the river at the west boundary of Segment A through a series of ponds and beaver dams along a former river channel paralleling 177^{th} Avenue SE was noticeably more turbid than the receiving river water on 15 January 2002.

<u>Chemical Contamination/Nutrients</u>

Water quality for the lower mainstem of the Skykomish River, including Monroe, was reported as "not properly functioning" in the *Snohomish River Basin Chinook Salmon Habitat Evaluation Matrix* (SBSRTC 2000). This determination is based in large part on the 1998 303(d) listing of the lower Skykomish River for fecal coliform, dissolved oxygen, temperature, silver, copper, and lead (Thornburgh and Williams 2000). However, DOE's WQI scores for nitrogen, phosphorus and dissolved oxygen over a nine-year period indicate that these parameters "met expectations and are of lowest concern" (http://www.ecy.wa.gov/apps/watersheds/riv/station.asp?sta=07C070). During that same time period, fecal coliform was of low concern for eight out of nine years. Similarly to temperature, water quality along the mainstem Skykomish in Monroe could be improved to the benefit of salmonid fish, but is generally of high enough quality to meet basic requirements. Water quality is presumed to be comparable for all three river segments defined along the City's jurisdiction.

Physical Barriers

No fish migration barriers are present along the river. A series of beaver dams is present along a drainage that joins the main river at the west boundary of Segment A, which may hinder fish passage under certain conditions. However, the additional rearing habitat provided by beaver ponds is generally thought to more than compensate for any reduction in fish passability.

During flood flows, fish may be able to enter the Cadman pit area. One condition of the current operating permit for the Cadman mine is that open channels be maintained that allow any fish brought into the pit during flood flows to re-enter the Skykomish. Construction of the fish escapement channels should begin within the next three years (City of Monroe 2002b).

Substrate

The substrate along the entire length of the Skykomish River bordering the City of Monroe is dominated by gravel and cobbles with a relatively low level of embeddedness. As such, the substrate is considered to be generally adequate to provide spawning habitat, though sandy materials tend to fill interstitial spaces in some areas.

Large Woody Debris

In Segment A, a fair amount of wood has formed jams along the margin of a side channel and a cottonwood forest. There is some recruitment potential, but probably not enough to maintain suitable conditions without continued recruitment of wood from upstream. Such continued recruitment is possible if upstream sources are not eliminated or compromised.

Pool Frequency and Quality

For a river the width of the Skykomish, pool frequency should be approximately 20 pools per mile, pools should be greater than 1 meter deep with good cover, and the reach should have adequate woody debris recruitment potential. At the time of observation, no pools were apparent, but a minimal number could possibly be discerned at low flow. Little overhanging vegetation is present, and the wood present in this segment is primarily stranded in jams on bars or well up the banks where it cannot provide cover to any pools. The combination of few pools and a lack of woody debris make this segment less than ideal for fish habitat.

Off-Channel Habitat

Suitable off-channel habitat consists of backwaters with cover and low-energy, off-channel areas. Segment A features a series of beaver dams and ponds along an apparent former river channel at its downstream end plus several additional side channels and high-flow channels through the floodplain and riparian area.

Refugia

Refugia are areas of important remnant habitat for sensitive aquatic species. The concept of refugia is more applicable on a larger sub-basin or basin-wide scale and is not particularly applicable to the localized segments contained within the City of Monroe. No such refugia areas are contained within the City.

Riparian Vegetation

Riparian areas are well-vegetated with shrubs and maturing deciduous trees, mostly cottonwoods. Few or no conifers are present. Some Himalayan blackberry and a considerable amount of Japanese knotweed are present, reducing and interfering with the function of native vegetation. See detailed discussion under *Priority Habitat* below.

Width/Depth Ratio

The width of the Skykomish in Monroe varies between 350 and 700 feet. The depth of the Skykomish was not measured, so width/depth (W/D) ratio has not been determined. However, gravel bars are evident in all three segments, which may indicate channel widening. On a non-braided stream, a W/D ratio of grater than 12 is considered moderate to high (Rosgen 1996), and NMFS uses a W/D ratio of 18 as the maximum for a properly functioning stream. To achieve a W/D ratio of 18, the Skykomish would need to have an average depth of 20 to 40 feet through Monroe. While some pools may achieve these depths, it is unlikely that this is the average depth.

The Skykomish from Monroe to the confluence with the Snoqualmie is a depositional reach; it deposits much of the sediment that it carries (Pentec, 1999). Depositional reaches typically have a higher width/depth ratio than transport reaches, so the higher W/D ratio in Monroe is consistent with the downstream processes. However the volume of deposition between Monroe and the confluence with the Snoqualmie has likely been increased due to human activity over the last century. Therefore, the high W/D ratio in Monroe, while consistent with downstream process, may also be symptomatic of wider, watershed-scale disturbances.

Streambank Condition

Streambank condition is defined as a measure of bank stability. The banks of the Skykomish River are generally stable in all segments within the City. However, it should be mentioned that rip-rap lines the bank and its toe along 177th Avenue SE at the extreme downstream end of the City, along the railroad at the extreme upstream end, at a possible sewer outfall downstream of SR 203, and at the SR 203 and railroad bridges.

Floodplain Connectivity

On the right (north) bank of the river within the City's jurisdiction, there is good connectivity with the floodplain with clear evidence that the floodplain has been recently inundated.

Peak/Base Flows

Flows were not measured as a part of this survey, and their functioning along the City of Monroe will be the same as for the lower mainstem of the Skykomish River as a whole. The *Snohomish River Basin Chinook Salmon Habitat Evaluation Matrix* (SBSRTC 2000) lists this section of river as "not properly functioning" for both peak and base flows.

Increase in Drainage Network

Drainage patterns within the floodplain are functioning well, but have been disrupted by activities on the Cadman gravel mining site.

Priority Habitat

Segment A includes all the active Cadman facilities, the Cadman-area wetland complex, upland forest patches, and agricultural lands on the west side of 177th Avenue SE. The wetland complex is briefly described above in Table 5, and is mapped as a priority habitat by WDFW (WDFW 2001a). Vegetation on the west side of 177th Avenue SE is primarily characterized by pasture and lawn grasses associated with the Washington State Department of Corrections property. Wildlife value is primarily limited to small mammal habitat and raptor foraging.

Upland forest is present on the side slope between 177th Avenue SE and the wetland complex and in between lobes of the wetland complex. The size and width of these areas is variable. On the west side of the wetlands adjacent to the road, the buffer width ranges between approximately 75 and 150 feet wide. Although habitat west of the wetlands is limited by the proximity of road noise and noise from nearby Cadman facilities, vegetation is comprised of a native deciduous-dominant, mixed forested community with some snags and small- to medium-sized woody debris that provide some food, cover and/or nesting habitat for birds, small mammals and macroinvertebrates. Native bigleaf maple (*Acer macrophyllum*), red alder, bitter cherry (*Prunus emarginata*), and black cottonwood (*Populus balsamifera*) are found in the overstory. Understory vegetation in this forested community predominantly consists of native vine maple (*Acer circinatum*), red elderberry (*Sambucus racemosa*), snowberry (*Symphoricarpos albus*), hazelnut (*Corylus cornuta*), salmonberry (*Rubus spectabilis*), sword fern (*Polystichum munitum*) and nettle (*Urtica dioica*). Non-native Himalayan blackberry and Japanese knotweed are dominant in patches and along the along the road edge. Other upland forested patches in Segment A contain the same mix of species, and provide marginally better wildlife habitat because of their shape (generally non-linear with a lower edge to area ratio), the increased abundance of snags and downed wood, and distance from a major road (although the Cadman operation is still a major disturbance).

The wetlands themselves are a mix of permanent and seasonal open water, aquatic bed, streambed, emergent, scrub-shrub, and forested vegetation classes with some ponded areas too deep to meet wetland criteria. The wetland complex formed in seasonal secondary channels of the Skykomish, and in and along the pre-1920s river channel (City of Monroe 1994). The wetland assessment in the City's EIS (City of Monroe 1994) attributes moderate to high functions to the wetlands based on the following factors: "food chain production; general and specialized habitats; aquatic study areas, sanctuaries or refuges; hydrologic support functions; shoreline protection; storage for flood waters; natural groundwater recharge; water purification through natural water filtration; and habitat for rare, restricted, or relic flora or fauna." The shrub and tree species are primarily native, but the groundcover layer of the wetlands is dominated in many areas by the non-native invasive reed canarygrass. Tree species include black cottonwood, Pacific and other willows (*Salix lucida ssp. lasiandra, S. sitchensis, S. scouleriana*), red alder (*Alnus rubra*), and western red cedar (*Thuja plicata*). Salmonberry, red-osier dogwood (*Cornus sericea ssp. sericea*), soft rush (*Juncus effusus*), lady fern (*Athyrium filix-femina*), and reed canarygrass (*Phalaris arundinacea*) in the understory. Snags, downed wood, the multi-storied canopy, vegetation species diversity, and a matrix of uplands and wetlands combine to create an excellent habitat area that should be preserved.

Habitat opportunities in Segment A to the south of the active Cadman operation are more limited due to the proximity of adjacent Cadman facilities, limited vegetation diversity, and reduced presence of habitat structures such as snags and woody debris. The vegetated buffer in this part of Segment A ranges in width from approximately 100 feet wide to 160 feet wide. Buffer vegetation is characterized by an early-successional, deciduous, forested community. Black cottonwood, red alder and bigleaf maple dominate the overstory in this area with osoberry (*Oemleria cerasiformis*), hazelnut, snowberry, Nootka rose (*Rosa nutkana*), salmonberry and/or Himalayan blackberry found in the understory. Wetland areas near the river provide some added habitat niches with black cottonwood, red alder and Pacific willow in the overstory and salmonberry and bulrush (*Scirpus microcarpus*) in the understory. Invasive Himalayan blackberry, evergreen blackberry (*Rubus laciniatus*), and various grass and herbaceous weed species are common in the transitional buffer areas immediately adjacent to the Cadman facilities.

Priority Species

As previously mentioned, Segments A through C are included in a bald eagle territory mapped by WDFW (2001). Further, USFWS noted wintering bald eagle use and a bald eagle winter concentration area just east of the City limits (Berg, pers. comm., 11 February 2002). No other state or federally listed wildlife species are mapped in the area.

The nearest bald eagle nest is more than 1.5 miles west of the City. Bald eagles could be found during the breeding and winter foraging seasons feeding on salmon and/or waterfowl in the Skykomish River and the Cadman wetland complex. Salmon can be found spawning the entire length of the in-City portions of the Skykomish River, providing an excellent source of bald eagle prey. In addition, salmon carcasses from these areas and areas further upstream collect on the Skykomish River banks when deposited by high flows, are grounded on gravel bars, or are trapped in vegetation or pockets of the bank. Carcasses also provide an excellent source of forage for bald eagles, as well as a variety of other non-priority species such as gulls and raccoons. Perch trees, primarily cottonwoods, are abundant along the Skykomish River shoreline.

Recommendations

1. Planting, encouraging, and preserving stream and riverbank vegetation which shades or would shade the river and its tributary stream sections within the City during the summer months is the primary method by which the City could ensure that any elevated river temperatures were not being exacerbated by conditions within the City and under its control or influence.

2. The City should work to prevent or reduce accelerated or unnatural rates of erosion along the banks of the river and its tributaries, such as Woods Creek, within its jurisdiction, as well as to control the sediment loading of runoff water originating within its jurisdiction. The establishment and maintenance of native streambank vegetation, including both understory and overstory layers, would facilitate achievement of this goal.

3. In general, the City can reduce and limit water quality impacts to the river by addressing the quality of storm and sanitary sewage discharges within its jurisdiction to the river and its tributaries.

4. Runoff water from the Cadman area through beaver ponds was somewhat turbid during site visits. Review and possibly improve Cadman's water quality control measures to reduce turbidity as applicable.

5. Those areas within the shoreline zone disturbed through the gravel mining process should ultimately be restored to include an adequate topsoil layer planted with a diverse assemblage of native riparian trees and shrubs consistent with Alternative 1 as described in the Draft EIS for the gravel operation. In addition, a network of ponds and channels connecting to the river or existing channels should be created in the process.

6. The existing wetlands and their buffers should be preserved, and enhanced through removal of non-native vegetation such as Himalayan blackberry, morning glory, and Japanese knotweed. These generally upland areas should be replanted with native trees and shrubs, such as Douglas-fir, western hemlock, osoberry, snowberry,

hazelnut, and hawthorn. Reed canarygrass-dominated areas should be enhanced through addition of native shrubs, such as red-osier dogwood and willow stakes. As redevelopment allows, expand the area of forested buffer and restore previous wetland areas.

4.1.2 Segment B

Land Use

Segment B is primarily the Skykomish River Centennial Park. This land use will not change in the foreseeable future, although existing facilities in the park (such as ballfields) may be modified and expanded and new facilities may be constructed. Any expansions would not remove existing forested areas adjacent to the Skykomish, and are not expected to increase impervious surface.

Aquatic Habitat

The following discussion of aquatic habitat conditions is summarized in Table 11.

Table 11. Environmental Baseline – completed at segment scale for Segment B, Skykomish River.

PATHWAYS INDICATORS	**ENVIRONMENTAL BASELINE**
Water Quality	
Temperature	Slightly elevated summer temperatures
Sediment/Turbidity	Sediment load and turbidity occasionally high
Chem. Contam./Nut.	Variable depending on the contaminant and nutrient – several parameters are 303(d) listed
Habitat Access	
Physical Barriers	None present
Habitat Elements	
Substrate	Gravel and cobble with low embeddedness
Large Woody Debris	Several logs and a stump – low recruitment potential in segment
Pool Frequency/Quality	no pools – cover potential and LWD potential limited
Off-Channel Habitat	None present
Refugia	NA
Riparian Vegetation	Fairly mature cottonwood forest – few conifers, some non-native shrubs
Channel Cond. & Dyn.	
Width/Depth Ratio	Naturally high ratio because it's a depositional reach – likely further increased due to human activity
Streambank Cond.	Banks stable with a few areas of armoring
Floodplain Connectivity	Good connectivity
Flow/Hydrology	
Peak/ Base Flows	Increased peak flows and reduced base flows, result of forest practices and an increase in other land uses
Drainage Network	Somewhat compromised by SR 203 bridge and boat ramp

Temperature

See discussion under Segment A.

Sediment/Turbidity

See discussion under Segment A.

Chemical Contamination/Nutrients

See discussion under Segment A.

Physical Barriers

No barriers are present in this segment.

Substrate

See discussion under Segment A.

Large Woody Debris

One old-growth stump rests on the bank and several larger logs are embedded in it. In addition, two or three large logs are partially submerged in the channel out from the bank. However, sufficient wood is not present to provide adequate cover and pool-forming functions, nor is recruitment potential present to maintain it. A fairly mature cottonwood forest lines most of the bank, but only a very few small conifers (cedars) are present.

Pool Frequency and Quality

No pools are present along this segment. Little overhanging bank vegetation or in-channel woody debris. Bank vegetation is suppressed due to access by fishermen via City parks and a WDFW boat launch and parking area adjacent to SR 203. As with Segment A, the lack of pools and the lack of woody debris make this segment less than ideal for fish.

Off-Channel Habitat

This segment includes no off-channel habitat (with the qualifier that the mouth of Woods Creek at the boundary between Segments B and C could be considered such habitat, but has been assigned to Segment C).

Refugia

See discussion under Segment A.

Riparian Vegetation

The riparian forest along the north bank of the river within the City of Monroe consists mostly of a fairly mature cottonwood forest including salmonberry, snowberry, and a few young cedar trees. Though increased numbers and maturity of conifers would improve prospects for large woody debris recruitment, more than half of the riparian vegetation is similar to the potential natural community. See detailed discussion under *Priority Habitat* below.

Width/Depth Ratio

See discussion under Segment A.

Streambank Condition

See discussion under Segment A.

Floodplain Connectivity

Neither the right nor left banks of the river have levees, so the river is connected to its floodplain in a more or less natural fashion. The right bank is higher than the south bank, however, and so would flood less frequently.

Peak/Base Flows

See discussion under Segment A.

Increase in Drainage Network

Structures increasing the drainage network in this segment include the SR 203 bridge crossing of the river and a boat ramp with parking area.

Priority Habitat

Segment B includes a forested buffer along the Skykomish River, undeveloped portions of the Cadman property, and the Skykomish River Centennial Park. WDFW included the forested portion of Segment B as a riparian priority habitat because of its value as a "major migration corridor." This corridor is the only significant wildlife habitat in Segment B, because of its function as a migration corridor and as a connection between the high-quality habitats in Segments A and C.

A young, monotypic, black cottonwood-dominated community characterizes the southwestern part of Segment B where the buffer is limited to approximately 100 feet in width. Invasive, non-native Himalayan blackberry and Japanese knotweed (*Polygonum sachalinese*) are also present in the understory in this area and consequently reduce habitat opportunities for wildlife. In addition, few to no habitat structures, such as snags and woody debris, are present. However, further northeast, beyond Cadman's boundaries and southwest of the Skykomish River Centennial Park, the vegetated buffer width widens to 200^{+} feet wide and the vegetation community becomes more diverse. Black cottonwood trees still dominate the canopy, but they are larger in size and a few red alder, bigleaf maple and bitter cherry are also present in the overstory. The understory also becomes more diverse in this area with hazelnut, osoberry, salmonberry, Nootka rose, sword fern, piggy-back plant, and large-leaved avens present, in addition to a smaller component of non-native Himalayan blackberry. Medium to large-sized snags and woody debris are also more abundant in this forested area, providing added habitat features for wildlife.

The northeast portion of Segment B bounds the Skykomish River Centennial Park. In this area, the native forested buffer narrows to 100 feet wide. Otherwise, the vegetation community remains similar in character to the previously described section of Segment B. An exception to this includes a large gravel parking lot that is located in the northeast end. In this area, the vegetated buffer narrows to between 0 and 10 feet wide. Vegetation present in this narrowed buffer area is fairly sparse and consists primarily of weedy grasses and herbaceous plant species with some Himalayan blackberry, evergreen blackberry, and Nootka rose.

Priority Species

See discussion under Segment A.

Recommendations

1. The existing rip-rap bank protection adjacent to the WDFW parking area serving the boat ramp should be reduced and/or supplemented with soil and woody debris. If needed, alternative bank protection measures such as bank barbs or woody structures should be considered. A wider buffer of native vegetation should be provided between the parking area and the river.

2. Some of the fisherman trails along the river throughout this segment should be vegetated to control access. The existing density and type of vegetation is presently limited by the trails and foot traffic. Increased vegetation density would improve bank stability and provide other habitat functions including shade and terrestrial insect food supply.

3. Existing rip-rap at the location of a sewage outfall should be supplemented with soil and vegetated with native shrub species.

4. In conjunction with native planting along this segment, all non-native plant specimens within the shoreline area, such as Himalayan blackberry and Scotch broom, should be removed.

5. Secure large woody debris along the river bank.

6. When upgrading or otherwise modifying lawn sections of Skykomish River Centennial Park, consider incorporating as many of the recommendations in *Ecologically Sound Lawn Care for the Pacific Northwest: findings from the scientific literature and recommendations from turf professionals* (McDonald 1999, http://www.ci.seattle.wa.us/util/lawncare/docs/Grnlwn61.pdf). These recommendations address ways to increase lawn health, thereby reducing weeds,

water runoff quantities, and the need for chemical applications, and increasing the biofiltration abilities of the soil.

4.1.3 Segment C

Land Use

Segment C is entirely Al Borlin Park. This land use will not change in the foreseeable future, although existing facilities in the park may be modified and new facilities may be constructed. These are briefly discussed above in Section 2.3. Impervious surface increases would be minor, and would likely not result in loss of vegetation.

Aquatic Habitat

The following discussion of aquatic habitat conditions is summarized in Table 12.

Table 12. Environmental Baseline – completed at segment scale for Segment C, Skykomish River.

PATHWAYS INDICATORS	**ENVIRONMENTAL BASELINE**
Water Quality	
Temperature	Slightly elevated summer temperatures
Sediment/Turbidity	Sediment load and turbidity occasionally high
Chem. Contam./Nut.	Variable depending on the contaminant and nutrient – several parameters are 303(d) listed
Habitat Access	
Physical Barriers	None present
Habitat Elements	
Substrate	Gravel and cobble with low embeddedness
Large Woody Debris	Woody debris abundant – low recruitment potential within segment
Pool Frequency/Quality	pool frequency and quality low – cover potential and LWD potential limited
Off-Channel Habitat	Several side channels present through Al Borlin Park
Refugia	NA
Riparian Vegetation	Young to mature deciduous forest – few conifers
Channel Cond. & Dyn.	
Width/Depth Ratio	Naturally high ratio because it's a depositional reach – likely further increased due to human activity
Streambank Cond.	Banks stable with a few areas of armoring
Floodplain Connectivity	Fairly good connectivity – compromised by bridges and SR 2
Flow/Hydrology	
Peak/ Base Flows	Increased peak flows and reduced base flows, result of forest practices and an increase in other land uses
Drainage Network	Compromised by roads, bridges, and railroad

Temperature

See discussion under Segment A.

Sediment/Turbidity

See discussion under Segment A.

Chemical Contamination/Nutrients

See discussion under Segment A.

Physical Barriers

No barriers are present in this segment.

Substrate

See discussion under Segment A.

Large Woody Debris

Similar to Segment A, a large amount of wood has stranded to form jams near the upstream end of the segment at the margin of a gravel bar and a cottonwood forest of medium maturity. Though sufficient wood is likely present to provide adequate habitat function, recruitment potential within the segment is not sufficient to maintain the condition. The wood which is present has been recruited from upstream and has stranded in the segment during high flows.

Pool Frequency and Quality

At low flows, pools are likely present in the vicinities of the railroad and SR 203 bridges. Some wood has also accumulated near the bridge abutments to provide limited cover, though most wood is stranded on bars or high on the banks as jams and is unavailable to function as cover in pools. This segment does not provide adequate large woody debris potential, which limits the utility of the pools that do likely exist.

Off-Channel Habitat

Side channels extend from the head of the bar near the upstream end of the segment to the railroad bridge. The mouth of Woods Creek can also be considered to provide off-channel habitat, especially during times of flood when it is backwatered by the river.

Refugia

See discussion under Segment A.

Riparian Vegetation

The riparian areas along this section consist primarily of deciduous forest, fairly mature in the lower end and less mature in the upper end due to natural river function disturbances. Scattered young cedar trees are present in the lower section. As for Segment B, above, mature conifers would improve prospects for large woody debris recruitment, but more than half of the riparian vegetation is similar to the potential natural community. See detailed discussion under *Priority Habitat* below.

Width/Depth Ratio

See discussion under Segment A.

Streambank Condition

See discussion under Segment A.

Floodplain Connectivity

The channel through this segment is generally wide with gravel bars and riparian areas. However, some constriction in the floodplain occurs at each of the railroad and SR 203 bridges.

Peak/Base Flows

See discussion under Segment A.

Increase in Drainage Network

This segment includes park trails, roads and parking areas, a railroad bridge, and a railway line along the upstream end of the segment. A portion of SR 2 is also within the shoreline zone at the upper end.

Priority Habitat

Most of Segment C, more than two-thirds of Al Borlin Park, is mapped by WDFW as a priority riparian habitat because of its “excellent habitat for a broad array of wildlife species, and a major migration corridor” (WDFW 2001a). The portion of the park that is not specifically mapped as a priority riparian habitat actually has equal habitat value. The park is managed as a natural area, and is rather sparsely covered by formal and informal pedestrian trails. Except for a small grassy picnic area at the southwest tip of the park, the entire park is vegetated by a deciduous-dominant, mature forest. Snags and downed wood are abundant, and non-native species are limited except along trail margins and other edges. Much of the western half of the park is forested wetland, and the eastern half of the park likely contains pockets of forested wetland. The forest contains predominately bigleaf maple, red alder, and black cottonwood in the overstory. Conifers of varying ages, such as western hemlock, Douglas-fir and western red cedar, are present, but not in sufficient quantity to consider the area a mixed forest. The understory shrub layer is dense to sparse, and is dominated by salmonberry, willow, red-osier dogwood, and Japanese knotweed in wetland areas, and vine maple, red elderberry, osoberry, red huckleberry, salal, snowberry, rose, and thimbleberry in upland areas. Groundcovers include sword fern, lady fern, large-leaved avens, piggy-back plant, and stinging nettle.

Priority Species

See discussion under Segment A.

Recommendations

1. Bank erosion is occurring at a minimum of two locations in Al Borlin Park where trails meet the river and at a separate riverbank parking area. The trails and parking area should be moved back from the riverbank, and the banks and buffer area should be restored by planting native trees and shrubs.

2. Large woody debris could be anchored along the river channel extending from the mouth of Woods Creek to the railroad bridge. The portions of the segment upstream of the railroad bridge appear to have sufficient woody debris, though somewhat smaller in size than would be ideal.

3. Assuming it is no longer being used, remove the railroad bridge which crosses the river near the middle of this segment, including its approaches. The northern abutment of this bridge cuts across an area of historic channel, and the piers of the bridge rest in the present-day channel, possibly constricting the river at high flows. While this bridge undoubtedly has cultural and historic significance, it is potentially adversely affecting the Skykomish River. The City should consider plans to reduce or eliminate the impact the bridge may have on the Skykomish.

4. A railroad embankment lining the uppermost end of this segment is heavily armored with rip-rap. Investigate alternative bank stabilizing methods such as woody structure placement and bank barbs for this segment. Supplement the banks with soil and native vegetation.

4.2 WOODS CREEK

Shoreline areas along Woods Creek within the City of Monroe have been defined as those areas along the creek within the City limits (downstream of Old Owen Road to the Skykomish River) and within 200 feet of the floodway <u>or</u> within the 100-year floodplain, whichever is greater. The length of this shoreline is approximately 1.2 miles. Much of the section downstream of SR 2 flows through or borders on the City's Al Borlin Park.

For survey purposes, the length of Woods Creek within the Monroe City limits was broken down into two segments, which are shown on all figures. Segment A extends from the mouth of the creek at the Skykomish River, in Al Borlin Park just east of the SR 203 Skykomish River bridge, to the SR 2 bridge over the creek. Segment B extends from the SR 2 bridge to the City limits at the Old Owen Road bridge. On February 13, 2002, Greg Johnston, fisheries biologist with The Watershed Company, made a qualitative habitat survey of the shoreline areas in the City of Monroe along Woods Creek. The general purpose of the survey was to assess, where applicable, the level of functioning of the various indicators as listed on NMFS' Matrix of Pathways and Indicators, as described previously in Section 3.3.1 *Basin-Wide Ecological Functions/Ecosystem-Wide Processes*.

4.2.1 Segment A

Land Use

The right bank of Woods Creek is primarily park and residential, with smaller areas of industrial and commercial. Much of the shoreline area in these zones is sloped, vegetated creek buffer unsuitable for additional development, although there are some fairly substantial intrusions by existing residential development. Planned growth in the City of Monroe is not expected to increase the amount of impervious surface in the shoreline zone, unless the industrial area is redeveloped more intensively. Currently, much of the industrial zone in the shoreline is bare dirt or gravel storage area. The left bank of Segment A consists entirely of Al Borlin Park, which has already been discussed several times in the preceding sections.

Aquatic Habitat

The following discussion of aquatic habitat conditions is summarized in Table 13.

Table 13. Environmental Baseline – completed at segment scale for Segment A, Woods Creek.

PATHWAYS INDICATORS	**ENVIRONMENTAL BASELINE**
Water Quality	
Temperature	Moderately elevated summer temperatures
Sediment/Turbidity	Sediment load and turbidity are moderately elevated
Chem. Contam./Nut.	303(d) listed for fecal coliform; nitrogen, phosphorus, and DO also a concern
Habitat Access	
Physical Barriers	no barriers present
Habitat Elements	
Substrate	Medium sandy gravel with moderate embeddedness
Large Woody Debris	LWD limited w/ limited recruitment potential
Pool Frequency/Quality	Adequate frequency with quality diminished by low LWD supply
Off-Channel Habitat	A few small and one large high-quality side channel present
Refugia	NA
Riparian Vegetation	Variable-width deciduous forest – large patches of non-native shrubs, few conifers
Channel Cond. & Dyn.	
Width/Depth Ratio	ratio low, stream downcut but probably naturally healing
Streambank Cond.	Banks stable – few armored areas around bridge abutments
Floodplain Connectivity	slight reduction from railroad grade
Flow/Hydrology	
Peak/ Base Flows	high peak and low base flows
Drainage Network	compromised by roads, driveways and trails

Temperature

The upper watershed generally meets state standards for temperature (Thornburgh and Williams 2000), but the *1992 Watershed Analysis* for the basin stated that high water temperatures could be acting as an upstream migration barrier in the basin (Thorn et al. 1992). DOE collected stream data for Woods Creek in 1996 and 1992. Based on those two years, temperature was of low and moderate concern (http://www.ecy.wa.gov/apps/watersheds/riv/station.asp?sta =07F055). Temperatures in lower Woods Creek are likely moderately elevated due to land use changes in the basin. Though these increased temperatures do not preclude fish use, lowering of temperatures would be of benefit.

Sediment/Turbidity

The substrate appeared to be primarily medium-sized gravel with sand. The sediment regime for lower Woods Creek is listed as "not properly functioning" in the *Snohomish River Basin Chinook Salmon Habitat Evaluation Matrix* (SBSRTC 2000), citing a number of references including a finding of 25 percent total impervious surface as determined by Snohomish County (2000). A more recent study by Snohomish County (Purser and Simmonds 2001) reports total impervious surface area in the lower Woods Creek subbasin is at 12.5 percent. Because the performance standard given in the *Snohomish River Basin Chinook Salmon Habitat Evaluation Matrix* indicates that the sediment regime is "not properly functioning" if total impervious surface is greater than 12 percent, the updated 12.5 percent total impervious surface value still justifies the "not properly functioning" classification.

DOE's WQI scores for suspended solids and turbidity, which are related, fluctuate between low and moderate concern over the two-year period of record (http://www.ecy.wa.gov/apps/watersheds/riv/station.asp?sta=07F055).

Chemical Contamination/Nutrients

Water quality for lower Woods Creek was found to be "at risk" in the *Snohomish River Basin Chinook Salmon Habitat Evaluation Matrix* (SBSRTC 2000). This determination is based in part on the 1998 303(d) listing of Woods Creek for fecal coliform (Thornburgh and Williams 2000). DOE's WQI scores for fecal coliform, phosphorus and dissolved oxygen indicate "moderate concern" (http://www.ecy.wa.gov/apps/watersheds/riv/station.asp?sta=07F055). In one year, nitrogen "did not meet expectations" and is "of highest concern." Richardson Creek and Lake Roesiger Creek, tributaries of Woods Creek, were also found to have possibly significant loadings of metals.

Physical Barriers

No fish migration barriers are present in Segment A.

Substrate

The substrate along the entire length of Woods Creek within the City of Monroe is dominated by medium-sized, sandy gravel including some cobbles and with a moderate level of embeddedness. As such, the substrate is considered to be less than ideal as spawning habitat due to sandy materials which tend to fill interstitial spaces.

Large Woody Debris

The *Snohomish River Basin Chinook Salmon Habitat Evaluation Matrix* (SBSRTC 2000) rates lower Woods Creek as "not properly functioning" for large woody debris, citing the *1992 Watershed Analysis* of the watershed (Thorn et al. 1992), which reported an almost complete loss of LWD and that most available wood was deciduous with few conifers available for the future. No large pieces and few small and medium pieces of wood were observed along the in-City portion of Woods Creek. The deciduous forests lining the banks do not yet provide adequate recruitment potential.

Pool Frequency and Quality

During a walk of the in-City segments of Woods Creek in October 2001, pool frequency was observed to be generally adequate. At the time of observation in February 2002, however, pool habitat was not readily discernible, due to moderately elevated flows, which tended to make the creek appear to be a more or less continuous run. For a stream the size of Woods Creek, pools should be greater than 1 meter deep with good cover, and the reach should provide adequate woody debris recruitment. Since large woody debris quantities and recruitment potential are low (see above), pool frequency and quality are likely to be adversely affected.

Off-Channel Habitat

Suitable off-channel habitat consists of backwaters with cover and low-energy, off-channel areas. A few, small, infrequently flooded overflow channels occur in the lower section, and one large side channel joins Woods Creek between the two railroad bridges just downstream of SR 2.

Refugia

Refugia are areas of important remnant habitat for sensitive aquatic species. The concept of refugia is more applicable on a larger sub-basin or basin-wide scale and is not particularly applicable to the localized segments contained within the City of Monroe. No such refugia areas are contained within the City.

Riparian Vegetation

The streambanks and riparian areas along this segment are vegetated with a maturing deciduous forest consisting primarily of cottonwood, bigleaf maple, and alder. Non-native Himalayan blackberry and Japanese knotweed are prevalent in some areas, interfering with the functioning of native vegetation. The width of this forest is narrow, and even non-existent in places, on the right bank bordering residential areas. It is almost entirely lacking in conifer trees and, as such, does not provide adequate large woody debris recruitment potential.

Width/Depth Ratio

No depth data was available for this study, and the actual width/depth ratio has not been determined. Woods Creek is largely entrenched between approximately SR 2 and the Skykomish River. Entrenchment is the result of downcutting, indicating that the stream has eroded its bed, making it deeper and therefore decreasing the W/D ratio. Over time, a stream that has downcut can achieve a new equilibrium at the lower level, developing a floodplain within the entrenched reach. This appears to be occurring in Woods Creek, especially in the lower sections. Therefore, while the W/D ratio may be smaller than expected, it is probably in the process of healing itself. Also, a smaller W/D ratio is less problematic than one that is too large.

Streambank Condition

Streambanks in this segment are generally stable. Rip-rap lines the bank and its toe around bridge abutments.

Floodplain Connectivity

Floodplain connectivity has not been reduced by artificial diking along this section. Some banks are high enough that overbank flows may be infrequent in those areas. A railroad grade at the extreme uppermost end of this segment reduces floodplain connectivity slightly.

Peak/Base Flows

Flows were not measured as a part of this survey, but their functioning along the City of Monroe would be the same as for lower Woods Creek as a whole. The *Snohomish River Basin Chinook Salmon Habitat Evaluation Matrix* (SBSRTC 2000) lists lower Woods Creek as “not properly functioning” for both peak and base flows due to a high impervious surface percentage.

Increase in Drainage Network (due to roads)

Residential areas including roads and driveways exist along the right (west) bank of the creek. Park roads and trails are present in Al Borlin Park.

Priority Habitat

The left bank of Segment A is Al Borlin Park, which has already been described above under Segment C of the Skykomish River (Section 4.1.3). In general, a vegetated area between 100 and 150 feet wide is present along the right bank. The vegetation composition of this band is quite variable. At the extreme south end is a narrow upland forest which includes bigleaf maple, western red cedar, red alder, hazelnut, snowberry, red elderberry, salmonberry, sword fern, and some Himalayan blackberry and Japanese knotweed. Wildlife habitat value is limited given the steepness of the slope and narrowness of the vegetated area adjacent to the Lewis Street Park lawn. However, substantial overhanging vegetation is provided benefiting aquatic habitat. North of this area is a band of deciduous-dominant forest with an average tree size between 12 and 20 inches in diameter at breast height (dbh). The overstory consisted of black cottonwood and Pacific and other willows, with red-osier dogwood, Himalayan blackberry, Japanese knotweed, and reed canarygrass in the understory. Except for reed canarygrass, the invasive non-natives were present in monotypic patches. Generally speaking, this area provides moderate wildlife habitat, limited by the absence of conifers and species diversity in general, the presence of non-natives, and the proximity of residential development. The outer shoreline area was primarily residential lawns and landscaping. A residential area cleared of the vegetation between the houses and the creek, leaving only grass, English ivy, and Himalayan blackberry, interrupted this deciduous forest habitat. This area had little to no habitat value and should be restored by planting species typical of a mixed forest, upland or wetland as conditions dictate.

The band of vegetation adjacent to the industrial area is similar to the other deciduous forested areas, but the tree density is much lower and the presence of invasive non-native species is much higher. A 150-foot-wide section of the right bank between the BNSF railroad and SR 2 is a conifer-dominant forest with western red cedar, Douglas-fir, willows, and abundant Himalayan blackberry. Although the understory is non-native and the area is adjacent to SR 2, this section provides some forage diversity to birds and other wildlife that utilize conifers.

Priority Species

Bald eagles could be found during the breeding and winter foraging seasons feeding on salmon and/or waterfowl in Woods Creek. Salmon can be found spawning the entire length of the in-City portions of Woods Creek, providing an excellent source of bald eagle prey. In addition, salmon carcasses from farther upstream collect on the banks when deposited by high flows, are grounded on gravel bars, or are trapped in vegetation or pockets of the bank. Carcasses also provide an excellent source of forage for bald eagles, as well as a variety of other non-priority species such as gulls and raccoons. Perch trees, primarily cottonwoods, are abundant along the Woods Creek shoreline.

Recommendations

1. Planting, encouraging, and preserving streambank vegetation which shades or would shade the creek sections within the City during the summer months is the primary method by which the City could ensure that any elevated stream temperatures were not being exacerbated by conditions within the City and under its control or influence.

2. The City should work to prevent or reduce erosion along the banks of Woods Creek within its jurisdiction, as well as to control the sediment loading of storm runoff water.

3. Secure large woody debris along the channel banks.

4. Plant conifer trees to in-fill the riparian/floodplain area, now dominated by deciduous trees, to enhance shade, woody recruitment, biofiltration, erosion protection, and other habitat functions. (This has already been done to some extent in some areas.)

5. Selectively remove non-native vegetation including Himalayan blackberry and Japanese knotweed from the floodplain and shoreline zone and plant native trees and shrubs in their place, also to enhance habitat functions.

6. An unused railroad crossing and associated elevated railroad grade occurs in the floodplain just downstream of SR 2. The current plan is to incorporate the old rail line into a multi-purpose trail as part of the King County Rails to Trails program that would connect Monroe to Duvall. If this railroad is not converted to a trail, the bridge and elevated grade should be removed in order to improve floodplain connectivity for both Woods Creek and the Skykomish River.

7. Encourage residential property owners along the right bank to increase the effective buffer widths along their properties by landscaping with native vegetation and increasing the density and diversity of such vegetation. This revegetation could be accomplished without sacrificing views given the high, steep slope between the residences and the creek.

4.2.2 Segment B

Land Use

The right bank of Segment B, from SR 2 north to Old Owen Road, is zoned commercial and planned for commercial land use. Currently, much of the shoreline in the commercial zone is undeveloped land (forest and shrubs, pasture) with a few residences. Because this area is floodplain with some significant wetland areas, additional commercial development is unlikely without incurring substantial impacts to the natural environment. A better use of this area would be to enhance the existing wetland and surrounding upland buffers for fish and wildlife, and create off-channel fish habitat.

The south half of the left bank is currently zoned public open space and general commercial, but is planned for commercial development. The entire shoreline area in this section is forested, with no developments observed in aerial photographs or in the field. Given its current natural state and the presence of steep slopes (see Figure 9), commercial development without substantial impacts to the natural environment is unlikely. The north half of the segment is zoned (UR 9600) and planned (R3-5) for residential use. The current use is for a motel complex with some trailers and other structures.

Aquatic Habitat

The following discussion of aquatic habitat conditions is summarized in Table 14.

Table 14. Environmental Baseline – completed at segment scale for Segment B, Woods Creek.

PATHWAYS INDICATORS	**ENVIRONMENTAL BASELINE**
Water Quality	
Temperature	Moderately elevated summer temperatures
Sediment/Turbidity	Sediment load and turbidity are moderately elevated
Chem. Contam./Nut.	303(d) listed for fecal coliform; nitrogen, phosphorus, and DO also a concern
Habitat Access	
Physical Barriers	None in Woods Creek – access through piped tributary may be an issue
Habitat Elements	
Substrate	Medium sandy gravel with moderate embeddedness
Large Woody Debris	LWD limited w/ limited recruitment potential
Pool Frequency/Quality	Adequate frequency with quality diminished by low LWD supply
Off-Channel Habitat	little to no habitat present
Refugia	NA
Riparian Vegetation	Mix of deciduous forest, non-native shrubs, mowed areas, paved areas and buildings
Channel Cond. & Dyn.	
Width/Depth Ratio	Appropriate
Streambank Cond.	failing and armored banks present on east side
Floodplain Connectivity	reduced on east side by raised/armored bank
Flow/Hydrology	
Peak/ Base Flows	high peak and low base flows
Drainage Network	compromised by Old Owen Road, SR 2, driveways, & other paved areas

Temperature

See discussion under Segment A.

Sediment/Turbidity

See discussion under Segment A.

Chemical Contamination/Nutrients

See discussion under Segment A.

Physical Barriers

No fish migration barriers are present in Woods Creek in this segment. However, a small unnamed tributary, number 07-0827, enters Woods Creek through a piped section on the right bank immediately upstream of SR 2. The piped section is likely a hindrance or barrier to any fish trying to enter this small creek.

Substrate

See discussion under Segment A.

Large Woody Debris

See discussion under Segment A.

Pool Frequency and Quality

See discussion under Segment A.

Off-Channel Habitat

This segment includes little or no off-channel habitat.

Refugia

See discussion under Segment A.

Riparian Vegetation

Riparian and shoreline areas along this segment include some young alders, salmonberry, and a few conifers, but consist largely of Himalayan blackberry, Japanese knotweed, mowed areas, paved areas, and buildings. Mobile homes and buildings along the left bank are close to the stream above armored, vertical banks with no vegetated buffers.

Width/Depth Ratio

No depth data was available for this study, and the actual width/depth ratio has not been determined. Visual estimates indicate that this segment is likely appropriate for a stream of this size.

Streambank Condition

A section of high, failing bank is located along the left bank (east) at the outside of a wide bend. Additional banks bordering a mobile home park would likely be failing if not heavily armored.

Floodplain Connectivity

Raised, armored banks along the left bank of the stream protect buildings and a mobile home park from flooding, but reduce floodplain connectivity.

Peak/Base Flows

See discussion under Segment A.

Increase in Drainage Network

This segment includes Old Owen Road, SR 2, driveways and paved areas, and stormwater outfalls.

Priority Habitat

The shoreline along the right bank of Segment B is generally undeveloped (few structures), likely due to its status as floodplain; however, habitat alteration has occurred in the past through vegetation clearing to provide pasture/lawn areas associated with a private park and a few residences. Significant habitat remains as young deciduous forest and scrub-shrub wetland and uplands with black cottonwood, bigleaf maple, willows, red alder, salmonberry, and red-osier dogwood. Japanese knotweed and Himalayan blackberry are dominant as patches in the understory. As previously mentioned, much of this segment is worth preserving and enhancing for both terrestrial and aquatic habitat.

The shoreline along the south half of the left bank is also worth preserving as it is entirely forested and is part of a larger corridor of forested vegetation which extends northeast and east. Steep slopes likely preclude development. Unlike many of the shoreline areas in the City, this section appears to have very few non-natives. Red alder and bigleaf maple are the dominant trees, with willow, red-osier dogwood, and salmonberry along the bank. Red elderberry, hazelnut, and maidenhair fern were also observed.

The shoreline along the north half of the left bank has almost no habitat value. Vegetation is very limited except for the occasional large maple or fir on the bank. Otherwise, ivy, Himalayan blackberry, and lawn grasses are the only vegetation. Residences and the hotel occupy the entire shoreline area in this section.

Priority Species

See discussion under Segment A.

Recommendations

1. Selectively remove non-native vegetation including Himalayan blackberry and Japanese knotweed from the floodplain and shoreline zone and plant native trees and shrubs in their place to enhance shade, woody recruitment, biofiltration, erosion protection, and other habitat functions. Conifer trees are especially needed to provide a long-term source of persistent woody debris. Some existing mowed grassy areas could also be restored to native vegetation to increase effective buffer widths.

2. Encourage residential property owners along this segment to 1) substitute bank stabilization methods which are more compatible with habitat functions for the existing rip-rap and concrete, and 2) increase the effective buffer widths along their properties by landscaping with native vegetation and increasing the density and diversity of such vegetation. Existing rip-rap should be reduced and/or supplemented with soil and woody debris. If needed, alternative bank protection measures such as

bank barbs or woody structures should be considered. A wider buffer of native vegetation should be provided between the existing buildings and the creek.

3. Secure large woody debris along the channel banks.

4. As mentioned previously, a small unnamed tributary, number 07-0827, enters Woods Creek through a piped section on the right bank immediately upstream of SR 2. The feasibility of restoring the lower sections of this creek to an open, fish-passable channel should be investigated.

5. The Old Owen Road bridge has piers that rest in the channel bottom. Snohomish County Public Works is currently planning to replace the bridge. The City should work with the County to ensure that the piers are removed.

6. Consider retaining some of the land currently zoned "public open space," but designated as "general commercial" on the comprehensive plan future land use map, as the "parks/open space" designation. In particular, forested, sloped areas on the left bank of Woods Creek, just north of SR 203 that are not already developed should be re-classified.

5. GAP ANALYSIS

This report was prepared using the best information available. However, we were unable to fully address certain issues due to a lack of pre-existing data. We recommend that the following studies be undertaken in order to supplement the information contained in this report.

<u>Impervious Surface</u>: This report estimated impervious surfaces within the shoreline area from measurements of aerial photographs that had not been ortho-rectified. We recommend that a comprehensive study of impervious surfaces within the City limits, including subtotals for all critical areas, be undertaken using GIS when available.

<u>Aquifer Recharge</u>: General soil characteristics were used to estimate the aquifer recharge potential of the shoreline area, and it was assumed that shoreline areas were hydrologically connected to the streams that constitute the shoreline area. A comprehensive study of groundwater resources in the City should be undertaken to supplement and verify the generalizations given in this report.

<u>Geologic Hazards</u>: With the exception of steep slopes, which were mapped by the City, geologic hazard areas were estimated based on USGS topographic maps and USDA Soil Conservation Service Soil Survey maps. These maps are generally insufficient to detect small-scale variations in slope, soil, and hydrological characteristics that may be important for determining the hazard potential of a particular site. Similarly, the earthquake hazards listed are primarily determined from regional data and may not be

accurate for site-specific applications. The City should consider developing a comprehensive geologic hazard study which could be used to guide future land-use decisions.

Channel Migration Zone/Flood Hazard: The channel migration zone in Monroe is complex, given the abundance of side channels, bank protection, and infrastructure. Additionally, while flood hazard areas are fairly well defined by the FEMA 100-year floodplain, the floodway mapped by FEMA may have been interpolated in some areas and may not accurately reflect the actual floodway. We recommend that a comprehensive channel migration zone and flood hazard study be undertaken to more accurately assess the potential for erosion and flooding in and near the shoreline area.

Disturbance History: It would be nice to know, to the extent feasible, what the original forested conditions of the shoreline areas within the City were, and how they evolved into their present condition. For example, many areas are now occupied by cottonwood forests of varying maturity. We might surmise that these areas were once cedar forests or at least forests with more cedar in them and propose a management or “restoration” strategy aimed at establishing cedar forests there. But before we actually implemented such a “restoration” strategy, it would be wise to verify, if possible, that our goal actually resembles the original condition. There could be reasons, such as frequent disturbance, perhaps, why cedars and other conifers would be inappropriate in certain areas.

Along Woods Creek, we noticed a few, very short isolated sections of the creek which were inexplicably armored, and a few features which appeared to be the remnant foundations of structures that previously existed in the area. If possible, it would be helpful to establish a timeline of land use for shoreline areas within the City including original clearing, possible use as agricultural land, re-growth of deciduous forest, and/or any other intervening uses bringing us to the present.

Refugia: Specific references to refugia in the Skykomish basin could not be located. It would be helpful to know if such refugia exist, if the survival of any populations of fish depends primarily on those refugia and their continued existence and functioning, and whether any populations now confined to comparatively limited refugia areas could and would expand their ranges and population sizes if conditions elsewhere in the basin were to improve.

The *Initial Snohomish River Basin Chinook Salmon Conservation/Recovery Technical Work Plan* (SBSRTC 1999) also identifies the following data gaps for the mainstem Skykomish River.

- Determine how egg survival is affected by river channel bed scour.
- Identify, perhaps via snorkeling surveys, what habitat juveniles are using.
- Determine if there are spring chinook salmon in the basin and if so, where.

- Determine if the apparently high number of yearlings is due to the amount of available habitat or the unique characteristics of the stocks.
- “Evaluate whether geomorphological analysis can be conducted to help define ‘potential’ habitat that may not be currently used.
- Research the extent to which loss of LWD has reduced the potential habitat.
- Gather historical data and examine how the mainstem Skykomish River channel changed (in area, type, etc.) between the 1930s when the first diking occurred and today.
- Gather data on historical changes in the braided reach channel length and area.
- Study how groundwater recharge affects landslides on the terraces.
- In the Skykomish River system, increased peak-flow frequency and amplitude resulting from forestry and other land-use practices significantly impact fish production by increasing channel scour and instability, and reducing the recruitment and retention of pool-forming large wood. Quantitative studies and modeling are needed to address these impacts within the mainstem Skykomish River and each of its tributaries of historically high salmonid production.”

The City of Monroe can fund or partially fund studies with other jurisdictions and stakeholder groups to address one or more of the above-listed gaps.

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