LITTLE BEAR CREEK CORRIDOR HABITAT ASSESSMENT

Woodinville, Washington

Prepared for:

THE CITY OF WOODINVILLE
17301 133rd Avenue NE
Woodinville, Washington 98072-8534

WOOD0000-0010

Prepared by:

DAVID EVANS AND ASSOCIATES, INC.
415 – 118th Avenue SE
Bellevue, Washington 98005-3518

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July 2002

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EXECUTIVE SUMMARY

The City of Woodinville is bisected by several creeks, the largest of which is Little Bear Creek. Little Bear Creek is recognized as an important salmon-bearing stream within the Lake Washington – Cedar – Sammamish Basin (Water Resource Inventory Area 8). With the listing of chinook salmon as a threatened species under the Endangered Species Act (ESA), numerous cities, including the City of Woodinville, have undergone stream inventories to document existing habitat conditions in streams within their jurisdiction. The City of Woodinville contracted with David Evans and Associates, Inc. (DEA) to prepare this Little Bear Creek Corridor Habitat Assessment. The project goals were to document existing fish and wildlife habitat conditions and utilization, and identify potential restoration opportunities along Little Bear Creek within the City of Woodinville. This assessment provides a detailed analysis of stream and riparian habitat conditions, fish and wildlife utilization, and includes data that assisted in the determination of limiting factors as they relate to ESA listed salmon.

Because of project specific goals, and a desire to have the results comparable to other on-going stream inventory efforts, DEA utilized the *Inventory Methods for Wadable Streams in King County* (King County, 2001a) as the primary methodology. Both the King County 1991 (Appendix B) and 2001a (Appendix C) protocols are based on the methods defined in the *USDA Forest Service Stream Habitat Classification and Inventory Procedures for Northern California* (McCain et al., 1990) as modified by King County staff. Additional data as outlined in the United States Forest Service (USFS) – *Stream Inventory Handbook for Region 6, Version 2.1* (USFS, 2001) was included.

Existing stream and watershed conditions were quantified by using watershed and habitat parameters as defined by the "Matrix of Pathways and Indicators" developed by the National Marine Fisheries Service (NMFS) (Table S-1). The "Matrix of Pathways and Indicators" summarizes important parameters for six major pathways that are vital for the continued survival of salmon including:

- Water Quality;
- Habitat Access;
- Habitat Elements;
- Channel Condition and Dynamics;
- Flow/Hydrology; and
- Watershed Conditions.

These six major pathways are further broken down into a total of 18 "indicators." As an example, the water quality pathway is composed of three indicators: temperature, sediment/turbidity, and chemical contamination/nutrients. Scientifically sound data was collected during this assessment to accurately assign the appropriate "condition" to each indicator as defined by the NMFS. The indicator conditions are classified as either: "properly functioning," "at risk," or "not properly functioning." Criteria for each condition is defined by a range or goal based on the best available scientific data available, but criteria are not absolute, and may be adjusted for unique watersheds (NMFS, 1996). Within this report, definitions and determinations of an indicators status are distinguishable by font. Definitions are italicized and determinations are in bold font. Existing conditions were documented to a level of detail that would allow for future trend analysis. Should

the criteria for the Matrix of Pathways and Indicators change, an appropriate condition for each indicator could be assigned based on the results presented in this report.

This report has also consolidated numerous supporting references such as salmon spawning survey data from the Washington Department of Fish and Wildlife (WDFW), and presents all the raw data for ease of record keeping and as an aid to future researchers. Furthermore, opportunities for restoration have been listed and prioritized based on the findings present within this report.

Little Bear Creek is currently utilized by at least nine species of fish including resident, adfluvial, and anadromous species. Resident fish spend their entire life in a specific stream. Adfluvial fish spawn and sometimes rear in a stream, but migrate to a lake to mature before returning to a stream to spawn. Anadromous fish spawn and rear in freshwater, but reach maturity at sea prior to returning to freshwater to start the process over again. Resident species documented in Little Bear Creek include coast range sculpins (*Cottus aleuticus*), western brook lampreys (*Lampretra richardsoni*), and cutthroat trout (*Oncorhynchus clarki*). Cutthroat trout are somewhat unique in that resident, adfluvial, and anadromous forms may utilize the same stream depending upon watershed conditions, life history type, and access to the ocean. Species that utilize the adfluvial life history include cutthroat trout and kokanee salmon (*O. nerka* [freshwater sockeye]). Anadromous species documented in Little Bear Creek include chinook salmon (*O. tshawytscha*), coho salmon (*O. kisutch*), and sockeye salmon (*O. nerka*). Some species such as pink (*O. gorbuscha*) and chum (*O. keta*) salmon have rarely been observed in Little Bear Creek. However, due to their scarcity, they are not part of an established population, rather, they are strays from another watershed. Undocumented species such as steelhead trout (*O. mykiss*) could potentially utilize Little Bear Creek.

The results of this assessment indicate that Little Bear Creek is very similar to most urbanized Puget Sound lowland streams in that it has been severely impacted by past and current land-use activities. The percentage of total impervious surface has increased to about 37 percent and road density to 5.9 kilometers per square kilometer (km/km^2) (2.28 mi/mi^2) in the past 12 years (Purser and Simmonds, Snohomish County Surface Water Management, unpublished data as reported by Kerwin, 2001). Out of the 18 indicators examined, one was found to be partially **properly functioning** (temperature). Three were found to range from **not properly functioning** to **at risk** (varied by reach), three were **at risk**, while the remaining 11 were **not properly functioning**. The results are summarized below.

Although the existing habitat conditions reflect those frequently associated with an urbanized basin, Little Bear Creek is still an important salmon-bearing stream. Little Bear Creek possess numerous opportunities for enhancement and restoration that could significantly improve conditions for salmonids. The City of Woodinville is currently undertaking several stream restoration projects along the Little Bear Creek Corridor. Appendix R outlines current habitat enhancement projects along the corridor.

Little Bear Creek was segmented into three reaches based on land use and permanent landmarks. Reach 1 is defined as extending from the mouth to the SR 202 culvert crossing. Reach 2 is defined as extending from the SR 202 culvert crossing to the SR 522 culvert crossing. Reach 3 is defined as extending from the SR 522 culvert crossing to the NE 205th Street culvert crossing.

The majority of Reach 1 is developed up to the banks. The banks are armored with riprap and there are signs of localized erosion. This riprap should be removed. It is recommended that the banks be restored and stabilized using bioengineering methods. Improvements to the mouth such as the installation of large woody debris and create scour pools would also improve existing habitat conditions.

The amount of bank armoring (riprap) in Reach 2 is significantly less than in Reach 1. However, there are opportunities for riprap removal, and bank restoration and stabilization using bioengineering methods. There are areas of riparian habitat between Little Bear Creek and SR 522 that are candidates for acquisition. Connectivity between these areas and Little Bear Creek could be improved. In this reach there are culverted outfalls from regional and private storm drainage systems, and tributaries that could be used to create off-channel habitat.

There are similar opportunities in Reach 3, especially in the lowermost section. Riprap removal, bank restoration and stabilization using bioengineering methods, installation of large woody debris, and improved connectivity between remaining riparian habitat would improve existing conditions in Reach 3.

The majority of the Little Bear Creek corridor is privately owned. The City has acquired four parcels along the corridor. The Washington State Department of Transportation owns one parcel, and the SR 522 right-of-way through which segments of Little Bear Creek flow. It is recommended that the City look for opportunities to partner with residents, property owners, business owners, and other agencies on habitat enhancement projects. As redevelopment occurs along this corridor, an evaluation of potential habitat improvement opportunities should be undertaken to determine what could be done to restore and enhance the habitat. Potential improvements are outlined later in this report.

The following properties are outside the Little Bear Creek corridor, but within the watershed, that the City should evaluate for possible acquisition to preserve undeveloped upland forest habitat:

- North of Woodinville High School and west of 136th Avenue NE
- Northeast of 144th Avenue NE and NE 195th Street
- Southwest of North Woodinville Way and NE Woodinville Duvall Road

Purchase of these properties would help to maintain the amount of impervious area within the watershed, provide areas for groundwater recharge, and provide water quality benefits.

Table S-1:
Matrix of Pathway and Indicators Summary

PATHWAY	INDICATORS	BASELINE CONDITIONS
Water Quality	Temperature	Juvenile Migration and Rearing = Not Properly Functioning to At Risk Adult Migration and Spawning = Properly Functioning
	Sediment	Not Properly Functioning
	Chemical Contamination & Nutrients	Not Properly Functioning
Habitat Access	Physical Barriers	At Risk
Habitat Elements	Substrate	At Risk
	Large Woody Debris	Not Properly Functioning
	Pool Frequency	Not Properly Functioning
	Pool Quality/Depth	At Risk (not properly functioning in Reach 1)
	Off-Channel Habitat	Not Properly Functioning
	Refugia	Not Properly Functioning
Channel Conditions and Dynamics	Width/Depth Ratio	Reach 1: Not Properly Functioning Reach 2 and 3: At Risk
	Streambank Condition	Not Properly Functioning
	Floodplain Connectivity	Not Properly Functioning
Flow/Hydrology	Change in Peak/Base Flows	At Risk
	Increase in Drainage Network	Not Properly Functioning
Watershed Conditions	Road Density and Location	Not Properly Functioning
	Disturbance History	Not Properly Functioning
	Riparian Reserve/Conservation Areas	Not Properly Functioning (at risk in Reach 3)

Based on the results of this assessment, several additional actions have been outlined that could potentially improve existing habitat conditions in Little Bear Creek. These recommended actions include:

1. Obtain, preserve, and enhance land along Little Bear Creek to minimize further habitat degradation from continued development along the Little Bear Creek corridor. Undeveloped properties along the corridor with quality riparian habitat should be high priority acquisitions, such as, the properties to the north of the City's "Lumpkin" property (east of 134th Avenue NE crossing). Another area to consider would be the properties to the west of 134th Avenue NE as described in item 7.
2. Immediately initiate a program to reestablish conifers within the riparian zone throughout the Little Bear Creek corridor.
3. Restore hardened rip/rap banks along Little Bear Creek. Include creation of pool, and addition of large woody debris as part of the restoration plan.
4. Retrofit potential pollution-generating sites such as large parking lots and roadways with pollution prevention and storm flow retention facilities where such facilities are presently absent.
5. Reforest upland areas dominated by introduced species such as reed canarygrass and Himalayan blackberry.

6. Create off-channel habitat at each culverted tributary confluence with Little Bear Creek. This can be accomplished by daylighting the maximum extent of culverted tributary possible at each confluence.
7. The City of Woodinville should investigate the feasibility of purchasing the wrecking yard on 134th Avenue NE along the west side of Little Bear Creek. If this lot could be purchased several stream enhancement opportunities could occur. The first goals would be to remove soil contaminants within the lot and remove all structures. The second goal would be to use this crossing for enhancement efforts between Little Bear Creek and Highway 522 within Reach 2. Once these actions were completed the 134th Avenue NE crossing could be permanently removed, or replaced with a bridge.
8. The newly purchased city property immediately upstream of NE 195th Street is an ideal site for intensive in-stream, riparian, and upland habitat restoration activities. Actions that would benefit Little Bear Creek at this site include removal of bank armoring, creation of pool habitat, removal of impervious surface (pavement) and non-native vegetation, and installation of large woody debris, and riparian and upland vegetation.
9. Maintain regular street sweeping, storm drainage system cleaning, and add sediment traps where feasible. This will reduce the amount of sediment entering Little Bear Creek.

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1.0 INTRODUCTION

At the request of the City of Woodinville, David Evans and Associates, Inc. (DEA) conducted a Corridor Habitat Assessment along Little Bear Creek in King County during 2001. This assessment was carried out by accomplishing several tasks including: existing data collection and review, habitat and presence surveys for fish and wildlife, and documentation of findings.

The project goals were to document existing fish and wildlife habitat conditions and utilization, and identify potential restoration opportunities along Little Bear Creek within the City of Woodinville (Figures 1 and 2). DEA initially focused on collecting existing data for review and determination of data gaps. Once all readily available information was obtained and reviewed, the specific parameters and methods to be documented by DEA biologists were finalized. Fieldwork began during the spring of 2001 and continued through October 2001.

DEA biologists surveyed the entire stretch of Little Bear Creek that occurs within the City of Woodinville from June 25, through August 1, 2001. A total of 3,484.1 meters (2.2 miles) of stream was surveyed from the mouth of Little Bear Creek at the Sammamish River to the crossing under NE 205th Street along the City of Woodinville and Snohomish County line. Little Bear Creek was segmented into three reaches based on current land use and location of permanent landmarks (Figures 2 and 3). Reach 1 began at the mouth of Little Bear Creek and extended to the downstream end of the culverts under State Route (SR) 202. Reach 1 is composed of primarily industrial and commercial development. Reach 2 began at the downstream side of the culverts under SR 202 and extended to the upstream side of the culverts under Highway 522. Reach 2 is composed of primarily commercial development and public park/open space. Reach 3 began at the upstream side of Highway 522 and ended at NE 205th Street, which follows the City of Woodinville and Snohomish County line. Reach 3 is composed primarily of residential development.

Because Endangered Species Act (ESA) considerations are an important facet of current stream-related surveys, DEA also focused on collecting data that would assist in the determination of limiting factors as they relate to ESA listed salmonids. This included data required to address the Matrix of Pathways and Indicators developed by the National Marine Fisheries Service (NMFS). DEA utilized two versions of the Matrix. The original version was developed by the NMFS in 1996 and encompasses the entire Pacific Northwest (Appendix L-1). The Mt. Baker – Snoqualmie National Forest modified several of the indicators as originally outlined by the NMFS (Appendix L-2). In each case where the modified NMFS version is used it is cited as "NMFS as modified by the Mt. Baker – Snoqualmie National Forest." If the original NMFS version is used it is cited as "NMFS, 1996." A definition of *properly functioning*, *at risk*, and *not properly functioning* is provided for each condition, and a copy of the modified version is provided as an appendix.

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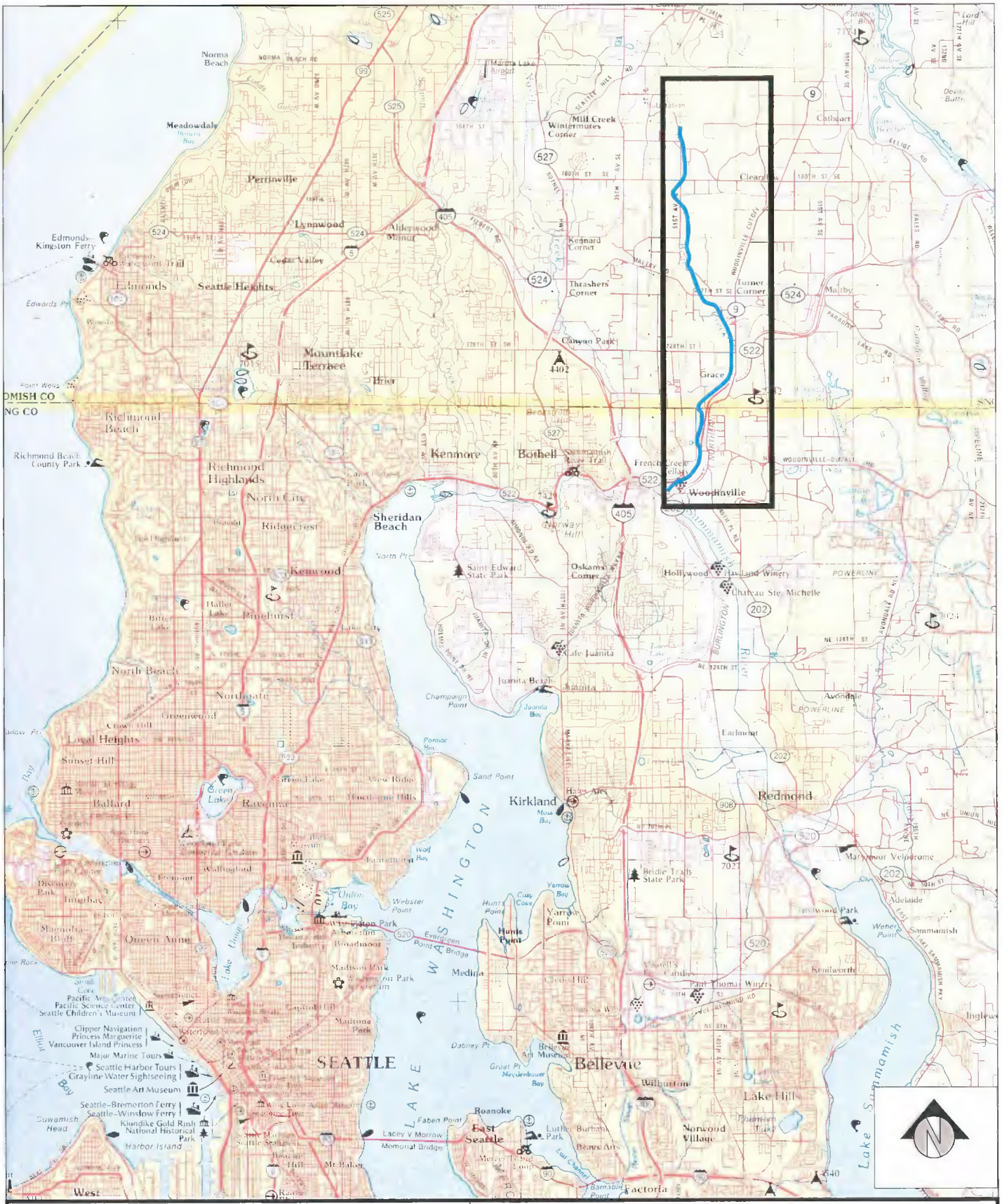

Vicinity Map

City of Woodinville - Little Bear Creek

WOOD0000-0010

September 2001

FIG. 1

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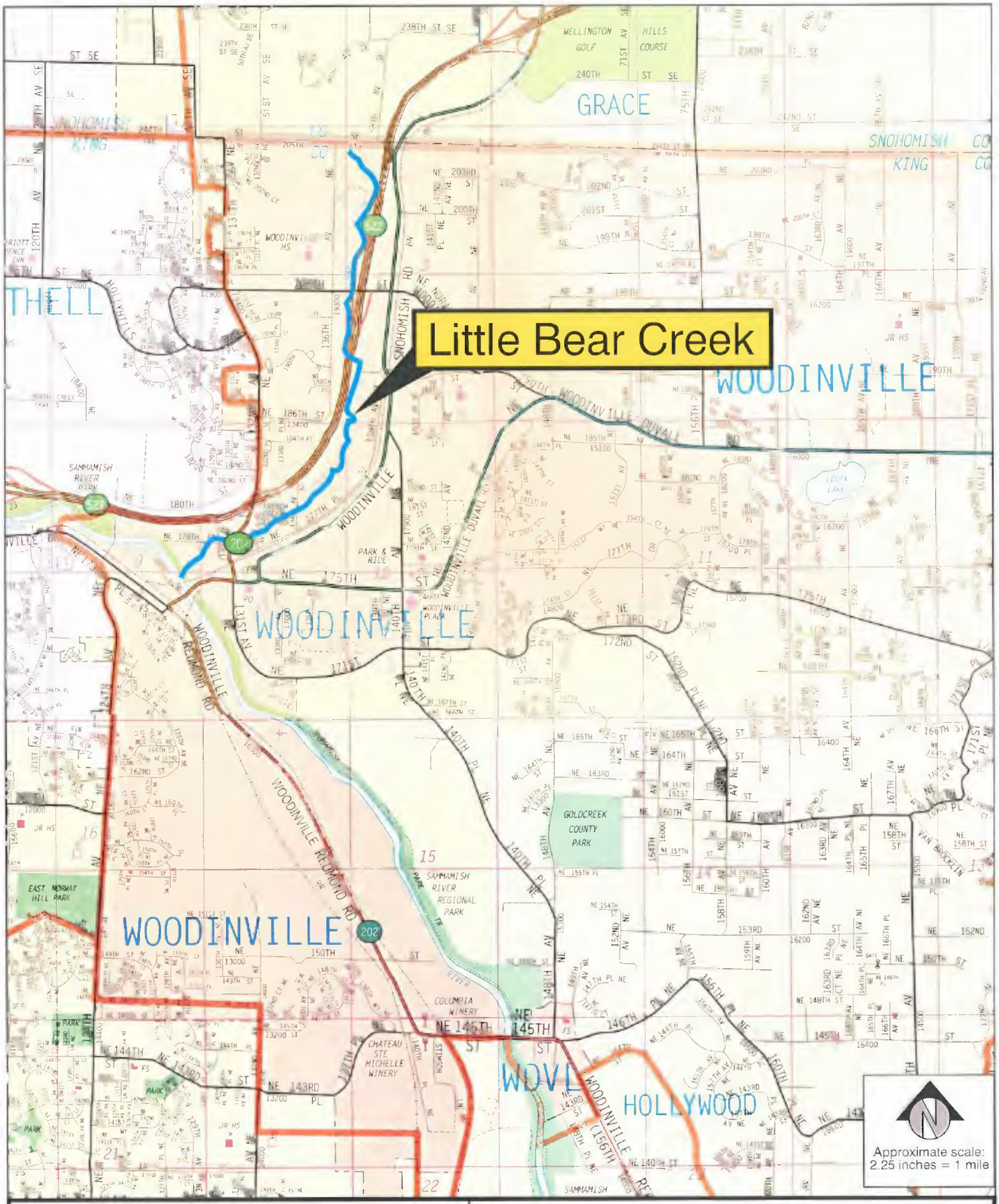
Gx0317



Site Map

City of Woodinville - Little Bear Creek

WOOD0000-0010

September 2001

FIG. 2

DAVID EVANS AND ASSOCIATES INC

Gx0317

SOURCE

Aerial photo provided by City of Woodinville, representing 1999 conditions.

Site Map
Little Bear Creek Corridor Habitat Assessment

City of Woodinville - Little Bear Creek

WOOD0000-0010

May 2002

FIG. 3

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Gx0471

2.0 METHODOLOGY

A Little Bear Creek Corridor Habitat Assessment was conducted between June 25, 2001, and September 1, 2001, to evaluate existing habitat conditions of Little Bear Creek within the City of Woodinville, King County, Washington. The methodology utilized was an enhanced combination of several protocols that results in collecting data for 16 general tasks. DEA used aspects of two King County protocols (1991 and 2001a), and the U.S. Forest Service (USFS) protocol (USFS, 2001). The combining of aspects from all three methodologies results in a comprehensive habitat analysis that is compatible and comparable with other data collected using any of these methodologies. The stream survey included the following tasks:

1. Measure temperature, dissolved oxygen, conductivity, turbidity, and pH at the beginning and end of each project stream utilizing a Horiba U-10 water quality meter.
2. Measure stream flow with a Swoffer flow meter.
3. Measure stream gradient in each reach.
4. Document condition, type, and size of every culvert encountered within each stream to include sediment accumulation, fish passage, and photo documentation.
5. Categorize each habitat type into one of the 22 channel geomorphic types as outlined by McCain et al., 1990.
6. Measure the length, average depth, and average width of each habitat type.
7. Measure the length, tailout depth, maximum depth, average depth, and width of each pool encountered.
8. Measure bankfull width at several representative riffles within each reach.
9. Document the length, diameter, species, decay class, and zone of influence for each piece of woody debris longer than 2 meters (6.6 feet) and wider than 10 centimeters (3.9 inches) encountered within the stream channel.
10. Conduct a Wolman Pebble count in at least two representative riffles per reach. Increase the number of measures as reach length and complexity increase.
11. Document substrate composition visually throughout the stream.
12. Document riparian species composition and age.
13. Document the species and location of any fish or wildlife observed during the survey.
14. Document the location of all side channels or tributaries encountered.
15. Document the degree of bank armoring and severe erosion along each stream reach.
16. Photo document representative stream reaches and features of note encountered during the survey.

2.1 EXISTING DATA

A listing of initial existing data collected on fish and wildlife habitat, species presence and abundance, water quality and hydrology, and land use along Little Bear Creek was previously presented to the City of Woodinville (Appendix A). Additional literature collected after the initial review of existing data is cited within the text and reference section as appropriate.

2.2 FISHERIES RELATED DATA

2.2.1 In-stream Habitat

DEA utilized the *Inventory Methods for Wadable Streams in King County* (King County, 2001a) as the primary methodology. Both the King County 1991 (Appendix B) and 2001a (Appendix C) protocols are based on the methods defined in the *USDA Forest Service Stream Habitat Classification and Inventory Procedures for Northern California* (McCain et al., 1990) as modified by King County staff. Habitat units are defined as one of 22 habitat types listed in Table 1 below. Additional data as outlined in the USFS – *Stream Inventory Handbook for Region 6, Version 2.1* (USFS, 2001) was included.

Table 1:
Stream Habitat Types

1.	Low gradient riffle	12.	Lateral scour pool - bedrock formed
2.	High gradient riffle	13.	Dammed pool
3.	Cascade	14.	Glide
4.	Secondary channel pool	15.	Run
5.	Backwater pool - boulder formed	16.	Step run
6.	Backwater pool – rootwad formed	17.	Mid-channel pool
7.	Backwater pool – log formed	18.	Edgewater
8.	Trench/chute	19.	Channel confluence pool
9.	Plunge pool	20.	Lateral scour pool - boulder formed
10.	Lateral scour pool - log formed	21.	Pocket water
11.	Lateral scour pool - rootwad formed	22.	Corner pool

Source: McCain et al., 1990.

King County surveyed most of the entire length of Little Bear Creek in 1999 (King County, 2001b). Because of variations in project goals and methodologies only select results from their previous survey were incorporated into this report. Specifically, DEA used their bankfull width to depth ratio, scour, and bank stability data.

A hip-chain was used to measure habitat lengths and create station numbers. The hip-chain was zeroed at the lowermost starting point at each stream reach and utilized to document the location of each feature or action taken along the stream reach. Each habitat unit was defined as occupying only the area actually wetted at the time of the survey. Habitat width was measured with a 22.9-meter (75-foot) tape, habitat length with a hip chain, and habitat depth with a 1.2-meter (4-foot) stick graduated in centimeters. DEA biologists used the U.S. Geological Survey (USGS) standard of defining "left bank" (LB) and "right bank" (RB) as when facing downstream.

2.2.2 Fish Abundance and Distribution

Data collected by the Washington State Department of Fish and Wildlife (WDFW) and King County was used to document the presence, abundance, and distribution of salmonids in Little Bear Creek (WDFW, 2001a). Additional data was collected through field investigations.

DEA biologists electrofished four locations along the mainstem of Little Bear Creek on August 24 and 31, 2001, prior to the arrival of returning adult salmon. Sites electrofished included

immediately upstream of the mouth, upstream of SR 202, downstream and upstream of 134th Avenue NE, upstream of NE 195th Street, downstream of NE 205th Street (Figure 2), and several sites in one unnamed tributary (Figure 3 – Unnamed Tributary D). DEA utilized a Smith-Root Model 12 electrofisher with a frequency setting of 60 Hz and output voltage of 500 volts. All fish captured were first placed in a bucket of water containing a "pinch" of Tricaine Methanesulfonate prior to species identification and measurement of total length. Tricaine Methanesulfonate relaxes the fish for ease of handling, and reduces injuries and oxygen consumption. After handling, all fish were placed in a second bucket with fresh water to recuperate prior to release.

All fish observed during the habitat survey from June 25, 2001, to September 1, 2001, were identified to the species level when possible. Additional surveys directed at encountering returning/spawning adult salmonids were conducted between September 20, and October 18, 2001. The number and location of redds, and whether spawning behavior was occurring was also noted. Accessible points such as trail and road crossings were surveyed. DEA biologists also surveyed extended sections of various reaches to document the upper extent of spawning and potential presence of barriers.

2.2.3 Riparian Habitat

DEA biologists used aerial photo interpretation and ground truthing to document riparian scale and composition. The width of potential riparian habitat analyzed incorporated 61 meters (200 feet) from the stream edge along each side of the stream for a total corridor width of 122 meters (400 feet). The amount of riparian habitat and impervious surface within the 122-meter (400-foot) corridor was then calculated. DEA used aerial photographs from 1999 that were expanded to a scale of 2.54-centimeter (1-inch) equaling 31.40 meters (103 feet). The amount of forest, shrub/grass, gravel, and impervious area within 60.96 meters (200 feet) of each side of the stream was then calculated with a PLANIX 7 – Tamaya digital planimeter. The species composition, age, and structure were then listed and documented by ground truthing. The stream side vegetation was also classified as coniferous, deciduous, or mixed. Plant species were identified according to Cooke (1997), Pojar and MacKinnon (1994), and Hitchcock and Cronquist (1973).

2.2.4 Water Quality and Hydrology

2.2.4.1 Water Quality

Existing water quality data for Little Bear Creek was obtained from both King and Snohomish counties. Published water quality data for Little Bear Creek as it flows through the City of Woodinville is available in *Water Quality of Small Streams – Western King County 1990 – 1993* (King County, 1994).

Published water quality data for Little Bear Creek in Snohomish County is available in *The State of the Waters: Water Quality in Snohomish County's Rivers, Streams, and Lakes – 2000 Assessment* (Snohomish County, 2000). Additional water quality data for Little Bear Creek in Snohomish County was obtained by contacting the Snohomish County Public Works – Surface Water Management (Thornburgh, personal communication, 2001).

Additional water quality data was collected by DEA. A Horiba U-10 water quality meter was used on several occasions to document temperature, pH, conductivity, dissolved oxygen, and turbidity.

Furthermore, two temperature monitors were deployed in Little Bear Creek between June 15, and October 18, 2001, to document stream temperature on an hourly basis. DEA utilized two 32K waterproof Stowaway Tidbit monitors set to collect hourly readings. One was installed in Little Bear Creek near its confluence with the Sammamish River, and the other was installed near the King and Snohomish county line immediately downstream of NE 205th Street.

2.2.4.2 Hydrology

Hydrology data for Little Bear Creek was obtained from King County (2001c). Hydrology data is collected in King County at the SR 202 crossing of Little Bear Creek in the City of Woodinville (Station #30). DEA biologists also used a Swoffer Model 2100 flow meter on two occasions to document site specific conditions. The first measurement was made on June 25, 2001, at the beginning of the in-stream habitat survey near the confluence of Little Bear Creek and the Sammamish River. The second event occurred on August 29, 2001, to document variation of flow at Little Bear Creek as it enters Woodinville at NE 205th Street, and near its confluence with the Sammamish River.

2.3 WILDLIFE RELATED DATA

2.3.1 Habitat Availability

DEA biologists mapped plant communities by interpreting aerial photographs and ground-truthing. DEA translated plant communities into habitat types. Biologists established 17 circular plots with a 10-meter (32.8-foot) radius in representative locations between the creek and the nearest development in all habitat types. DEA identified dominant, common, and infrequent plant species; estimated tree diameter at breast height (DBH); counted snags, stumps, and logs; observed trees for raptor nests; and assessed overall condition of each habitat area.

2.3.2 Wildlife Presence

2.3.2.1 Birds

DEA biologists surveyed birds on May 18, May 31, and June 18, 2001, using the variable circular-plot method (Reynolds et al., 1980). Surveys began at sunrise and ended by 9:15 AM (Robbins, 1981). DEA established 20-meter (65.6-foot) radius plots in all habitat types and surveyed for 10 minutes in each plot, recording species observed visually and aurally both in and outside of the plots. Biologists surveyed 16 plots on May 18, and 13 plots on subsequent survey days.

2.3.2.2 Bats and Owls

DEA biologists surveyed for owls at seven stations on June 19, and July 7, 2001, by soliciting birds with amplified taped recordings and listening for a response with the unaided ear. At each of 7 stations, located in each habitat type in the study area, biologists broadcast calls for approximately 1 minute and listened for a period of approximately 3 minutes. DEA repeated this procedure 3 times at each station. Although there was no standard distance between stations, we chose stations that were far enough apart to avoid double counting while still covering the entire study area. Biologists scanned each station and the surrounding areas with a 20 to 160 kHz bat detector at 1- to 2-minute intervals for approximately 10 minutes and recorded all frequencies of all detections.

2.3.2.3 Mammals

DEA biologists recorded all mammal species observed during all visits to the study area. Biologists searched for, examined, and recorded all mammal sign, including tracks, scats (wildlife excrement), and runways (animal trails). In addition to the site visits conducted for the wildlife and habitat analyses, DEA biologists also documented mammal observations while conducting the stream survey.

2.3.2.4 Reptiles and Amphibians

DEA biologists conducted reptile and amphibian surveys on May 31, and conducted searches during stream surveys. Biologists overturned logs and debris and searched at the bases of plants and along Little Bear Creek. DEA biologists identified and recorded all individuals observed. All captured specimens were returned to the point of capture unharmed and all overturned logs and debris were placed back in their original location.

3.0 HISTORIC CONDITIONS

To better understand existing conditions and possible future trends, historic conditions must be considered. The focus of this report is on fish, wildlife, habitat, and restoration potential along the Little Bear Creek corridor through the City of Woodinville. Although very little site-specific information on the historic conditions of Little Bear Creek as they relate to fish and wildlife is known, some data is available. The "historic conditions" defined as that time from the retreat of the Vashon Glacier approximately 14,000 years ago to the present can be segmented into pre European settlement and post European settlement time periods. The transition between pre and post European settlement time period near Woodinville occurred during the early 1870s. A brief overview is provided below.

3.1 PRE EUROPEAN SETTLEMENT

For the purposes of this report the pre European time period began approximately 14,000 years ago with the retreat of the glaciers and lasted until the arrival of the European settlers in 1870. The Sammamish River Valley was historically dominated primarily by giant western red cedar trees (*Thuja plicata*). Other conifers such as Douglas fir (*Pseudotsuga menziesii*) and Sitka spruce (*Picea sitchensis*) were also present. Several stumps of these remnant trees were observed along the banks of Little Bear Creek during the 2001 survey conducted by DEA. They often had burn marks and "spring board" notches where planks were used by loggers to reach the desired cut location above the tree buttress. Furthermore, old cedar tree stump fragments were also encountered during the in-stream habitat survey and classified as woody debris when they met or exceeded the length and width parameters.

Lake Washington was larger and deeper than at present, and the Sammamish River was longer, and contained numerous meanders and oxbows. The Sammamish River was about 30 miles long, heavily forested to its banks, and very difficult to navigate due to the abundance of fallen trees (King County, 2001d). Besides being lined with large trees, "swamp land" abutted both banks especially near its mouth. The Sammamish River was previously known as Squak Slough, and while the local Indians

were also known as the Squaks, they were really part of the Simump tribe (Stickney and McDonald, 1977). The native Americans lived primarily near Lake Sammamish, but traveled and camped along the Sammamish River. The Sammamish River corridor was also likely utilized by several other tribes as an east-west route.

3.2 ARRIVAL OF EUROPEAN SETTLERS

One of the first Europeans known to have traveled up the Sammamish River was Sam Hancock, who in 1850 explored for coal in the region (Stickney and McDonald, 1977). The earliest land claims in the Woodinville area were by George Wilson and Columbus Greenleaf in 1870 (King County, 2001d). In 1871 the Woodins became the first settlers after rowing across Lake Washington with all their goods and building a log cabin along the bank of the Sammamish River. They passed a couple other homesteads on their journey up the Sammamish River. Other families slowly moved into the area to log the local forests and establish homesteads. By 1897 four families owned most of the land along Little Bear Creek in Township 26 North, Range 5 East (Appendix E). Each of these landholders owned approximately one-quarter section along Little Bear Creek in what today is known as the City of Woodinville. The City of Woodinville was given its name in honor of the first pioneers, Ira and Susan Woodin sometime around 1887. The railway network grew rapidly in the area from 1877 through 1888 and was used extensively for both timber and coal transport. The railroad reached Woodinville in 1877 and Issaquah in 1888. By the 1890s several stores, hotels, saw mills, meat markets, and other enterprises became established.

Logging the old-growth forest was the primary occupation during this period. The local rivers played an important role in the transport of timber prior to the arrival of railroad. However, as the land was cleared and large first-growth trees became more distant, farming became more prevalent. The Sammamish River valley had been mostly cleared of giant western red cedar trees by the early 1920s. What was referred to as "stump farms" dotted the landscape during this time, but were gradually being cleared. Because heavy equipment was scarce and consisted primarily of horse drawn devices, the most common method of stump removal was by dynamiting and then burning the stump. As the stumps were removed, farming the rich river valley became the primary occupation in the area and the local population grew.

Other events related to logging and navigation that would result in changes to Little Bear Creek were occurring closer to Seattle during this same time period. In the 1880s a small channel and lock was built at Montlake to carry logs to mills. Lake Washington originally drained into the Black River that flowed into the Duwamish River prior to reaching Elliott Bay. In 1912 the Cedar River was diverted from the Black River into Lake Washington. This resulted in the replacement of the Black River as Lake Washington's outlet with the Cedar River as a new inlet. The Hiram M. Chittenden Locks and a fish ladder were completed by 1916 resulting in Lake Washington being lowered 2.7 meters (9 feet). In the early 1920's the historically slow and meandering Sammamish River was straightened, narrowed, and later dredged. By the 1930s stocks of chum and pink salmon had been extirpated, but three new stocks including Baker River sockeye, Green River coho and chinook salmon had been introduced (Goetz, proceedings from Conference, 2000).

Little is known about the composition and distribution of fish and wildlife during the early days of Little Bear Creek. Early accounts say the land was occupied by deer, cougar, bear, and migratory

waterfowl (Stickney and McDonald, 1977). Additional stories mention settlers being confined to their cabins during bad weather and hearing the howling of wolves, and others mention trapping bear, otter, raccoon, muskrat, and mink. Waterfowl were apparently abundant in the adjacent marshes since hunters would travel from Seattle to hunt the area, and Indians used the area extensively to hunt ducks. Duck clubs were present along the river that catered to wealthy Seattle residents. They hunted mallards, teal, and widgeon using decoys and feed to attract them within the marshy areas. Many of the adjacent marshes were drained as a result of the lowering of Lake Washington.

Settlers make no mention of salmon in the early accounts. Although it was noted that the local Indians hunted ducks along the marshy land adjacent to the Sammamish River, no reference to salmon is made. According to one resident, fishing in the Sammamish River during the early 1920s was not very good (Repman, personal communication, 2001). Mr. Repman recalled catching bullheads, chub, and an occasional chum salmon as a youth. It is likely that native populations of anadromous salmonids had drastically declined by this time. However, populations of resident kokanee (land-locked sockeye) were very abundant in the Lake Washington System during this time period (King County, 2000a). Mr. Repman was also an avid hunter who targeted grouse, quail, and pheasant (introduced). Between 1925 and 1970 he did not see any bear, cougar, or deer. According to Mr. Repman, deer showed-up later, after the surrounding uplands had been logged, and were more prevalent after the 1970s.

Based on a review of the first aerial photographs of Little Bear Creek during 1936 (Appendix F), riparian vegetation had been cleared from much of the stream by this time. The lower most reach downstream of what would become SR 202 was totally devoid of riparian vegetation by this time. Further upstream, thin segments of riparian vegetation lined some sections of the stream. The stream banks became more forested upstream of what would become NE 195th Street during 1936.

The local population around Woodinville began to expand rapidly after World War II. The City of Woodinville had been agricultural and very rural until a large influx of people began arriving from the 1950s through the 1970s. The creation of Interstate 405 in the 1960s and Highway 522 allowed for the exponential expansion of the area as developers began building and selling entire neighborhoods. By the 1980s, rural Woodinville had completely changed into its current suburban landscape. Woodinville was part of unincorporated King County until 1993.

4.0 EXISTING CONDITIONS

4.1 LITTLE BEAR CREEK WATERSHED

Little Bear Creek is a 12.4-kilometer (7.7-mile) long second order stream that drains a 3,885-hectare (9,600-acre) watershed in both Snohomish and King counties, Washington. Approximately 3,108 hectares (7,680 acres) (80 percent) of the upper watershed are located in Snohomish County while 777 hectares (1,920 acres) (20 percent) are in King County. While in King County, Little Bear Creek flows through the City of Woodinville for approximately 3.5 kilometers (2.2 miles) from NE 205th Street to its mouth on the Sammamish River at River Mile (RM) 5.4 (Figure 4). The headwaters of Little Bear

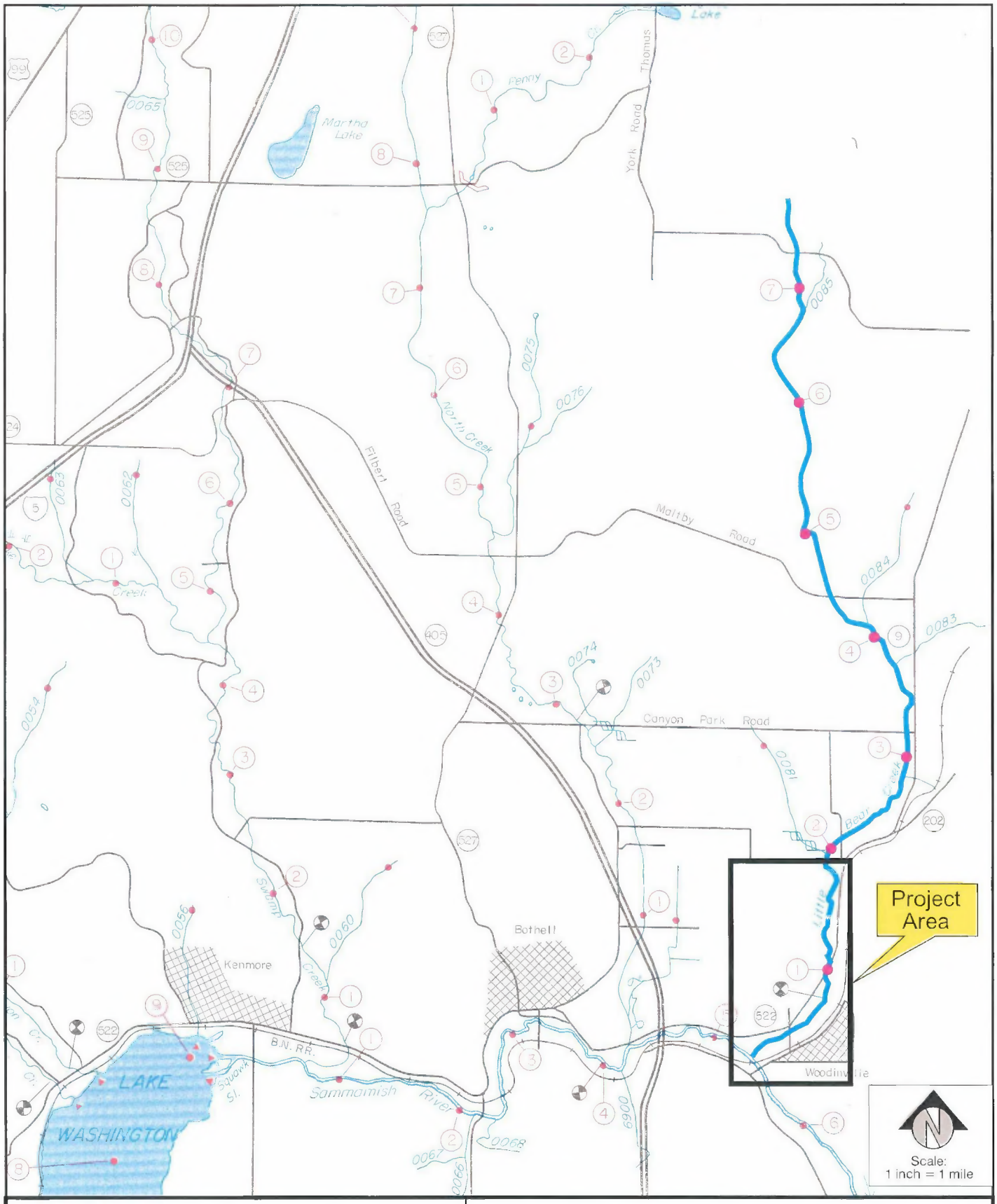
Creek are located in a peat bog 2.4 kilometers (1.5 miles) west of Clearview in Snohomish County. The elevation along Little Bear Creek varies from 76 meters (250 feet) near its headwaters to 6 meters (20 feet) at its confluence with the Sammamish River. Based on these elevations, the overall gradient of Little Bear Creek is about 0.6 percent. Other reports state the overall gradient is about 0.8 percent based on an elevation of 94.50 meters (310 feet) near Clearview (Kerwin, 2001).

4.2 CITY OF WOODINVILLE

The City of Woodinville currently covers 1,461 hectares (3,610 acres) and has a population of 9,294 people. The population is expected to reach 13,400 people by the year 2010 based on 1990 census data. Land use within the city is composed of residential (59.0 percent), commercial (9.2 percent), industrial (13.4 percent), park/open space (1.2 percent), public right-of-way (11.8 percent) and other (5.4 percent) designations.

4.3 FISHERIES

Little Bear Creek has been utilized by at least nine resident and anadromous species of fish. This includes anadromous, adfluvial, and resident salmonids, and sculpins and lampreys. Table 2 below lists the common name, scientific name, and documentation source for each species known to have utilized Little Bear Creek. Some species such as chum and pink salmon have been documented only once. Chinook salmon occur seasonally in low numbers, while other species such as sockeye and coho salmon, and cutthroat trout can be very abundant. Undocumented species could also occasionally utilize Little Bear Creek as well. An example of undocumented species that could be present includes steelhead trout (*Oncorhynchus mykiss*) and other species of sculpin (*Cottus* spp.). Native char (bull trout/Dolly varden) were not considered in this report due to a lack of documentation and absence of suitable habitat. Native char have never been documented in Little Bear Creek, and although it is theoretically possible that if they were to enter the Sammamish River they could investigate Little Bear Creek, the downstream limit of successful char spawning is always upstream of the winter snow line (WDFW, 1999). Because the headwaters of Little Bear Creek originate at an elevation of about 94.50 meters (310 feet), suitable char spawning habitat is not present in Little Bear Creek due to elevated stream temperatures throughout the basin. If bull trout were to ever be present in Little Bear Creek, it would likely be foraging adults or sub-adults, or possibly wayward adults searching for suitable spawning habitat.



SOURCE

Williams et al. 1975

WDFW - Lower Sammamish River Drainage

City of Woodinville - Little Bear Creek

WOOD0000-0010

November 2001

FIG. 4

DAVID EVANS AND ASSOCIATES INC.

Gx0317

Table 2:
Fish Species Documented in Little Bear Creek

#	Common Name	Scientific Name	Source
1.	Coast Range Sculpin	*Cottus aleuticus*	DEA
2.	Western Brook Lamprey	*Lampretra richardsoni*	DEA
3.	Cutthroat Trout	*Oncorhynchus clarki*	DEA
4.	Pink Salmon	*Oncorhynchus gorbuscha*	WDFW
5.	Chum Salmon	*Oncorhynchus keta*	WDFW
6.	Coho Salmon	*Oncorhynchus kisutch*	WDFW, King County, & DEA.
7.	Sockeye Salmon	*Oncorhynchus nerka*	WDFW & King County, & DEA
8.	Kokanee	*Oncorhynchus nerka*	WDFW & King County, & DEA
9.	Chinook Salmon	*Oncorhynchus tshawytscha*	WDFW, NMFS, & King County.

At least 40 different non-native species of fish have been introduced into the Lake Washington watershed since the arrival of the first European settlers. However, many of these introduced species did not survive and today approximately 24 species remain (Kerwin, 2001). A listing of 21 species of native and non-native fish that have been documented within the greater Lake Washington watershed are included in Table 3 below. Introduced species have become prevalent in both Lake Washington and Lake Sammamish, and continue to adversely impact native salmonids. Although the list presented in Table 3 below is not all-inclusive, it provides evidence of the shear abundance of non-native species of fish that still inhabit the Lake Washington watershed. Some of these species listed in Table 3 likely utilize the Sammamish River and therefore potentially the lowermost reach of Little Bear Creek. The likelihood of any of these additional undocumented species being present in Little Bear Creek varies by species.

Table 3:
Additional Fish Species Documented in the Greater Lake Washington Watershed

#	Common Name	Scientific Name	Native or Introduced	Resident or Anadromous	Status
1.	White sturgeon	*Acipenser transmontanus*	Locks created access	Anadromous	Rare visitor
2.	Largescale sucker	*Catostomus macrocheilus*	Native	Resident	Unknown
3.	Lake whitefish	*Coregonus clupeaformis*	Introduced in 1899	Resident	No longer present
4.	Prickly sculpin	*Cottus asper*	Native	Resident	Abundant
5.	Shorthead sculpin	*Cottus confusus*	Native	Resident	Abundant
6.	Carp	*Cyprinus carpio*	Introduced	Resident	Locally abundant
7.	Three-spine stickleback	*Gasterosteus aculeatus*	Native	Both	Unknown
8.	Brown bullhead	*Ictalurus nebulosus*	Introduced	Resident	Unknown
9.	Pumpkinseed	*Lepomis gibbosus*	Introduced	Resident	Sparse
10.	Pacific staghorn sculpin	*Leptocottus armatus*	Native	Both	Sparse
11.	Smallmouth bass	*Micropterus dolomieui*	Introduced	Resident	Abundant
12.	Largemouth bass	*Micropterus salmoides*	Introduced	Resident	Abundant
13.	Peamouth	*Mylocheilus caurinus*	Native	Resident	Unknown
14.	Olympic mudminnow	*Novumbra hubbsi*	Unknown	Resident	Rare: one siting
15.	Steelhead trout	*Oncorhynchus mykiss*	Native	Both	Stock depressed
16.	Yellow perch	*Perca flavescens*	Introduced	Resident	Abundant
17.	Black crappie	*Pomoxis nigromaculatus*	Introduced	Resident	Sparse
18.	Northern Squawfish	*Ptychocheilus oregonensis*	Native	Resident	Unknown
19.	Bull trout	*Salvelinus confluentus*	Native	Both	Rare
20.	Longfin smelt	*Spirinchus thaleichthys*	Native	Resident	Unknown
21.	Tench	*Tinca tinca*	Introduced	Resident	Unknown

4.3.1 Chinook Salmon

The Puget Sound chinook salmon evolutionarily significant unit (ESU) was designated as threatened on March 24, 1999 (64 FR 14308). This ESU includes all naturally spawned spring, summer, and fall runs of chinook salmon in the Puget Sound region. Puget Sound chinook salmon critical habitat was designated on February 16, 2000 (65 FR 7777). Critical habitat is designated to include all marine, estuarine and river reaches that could be utilized by chinook salmon in the Puget Sound region. This incorporates the riverbed, bank, and riparian zone in all rivers currently or historically utilized by Puget Sound chinook salmon. Based on the fact that fall run chinook salmon utilize Little Bear Creek, the stream and shoreline are designated critical habitat.

Salmon spawning ground survey data from the WDFW from 1952 through 2000 indicates that chinook salmon utilization of Little Bear Creek is typically limited to less than 8 individuals (Table 4). The maximum daily count was 28 chinook salmon on October 21, 1981, but was typically between 1 and 5 (Appendix J). The highest yearly count occurred in 1981 when a total of 62 chinook salmon were counted (Table 4). The majority of higher counts occurred between RM 4.4 and 5.5. Sightings were made as early as September 29, and live fish were observed as late as November 3. Although the WDFW has surveyed Little Bear Creek since 1952, the first documented adult chinook salmon did not occur in Little Bear Creek until 1971 when one carcass was found on November 11 between RM 4.4 and 5.4.

Table 4:
Chinook Salmon Summary for Little Bear Creek based on WDFW Salmon Spawning Ground Survey Data

Year	Live Count	Dead Count	Total Count
1971	0	1	1
1972	0	1	1
1973	0	1	1
1974	3	3	6
1975	4	1	5
1976	13	12	25
1977	2	16	18
1978	11	40	51
1979	0	1	1
1980	0	2	2
1981	20	42	62
1982	0	3	3
1983	0	3	3
1984	0	4	4
1985	11	4	15
1986	0	5	5
1987	7	3	10
1988	0	6	6
1989	1	3	4
1990	0	0	0
1991	0	0	0
1992	0	0	0

Table 4 continued

Year	Live Count	Dead Count	Total Count
1993	0	0	0
1994	0	7	7
1995	0	0	0
1996	1	4	5
1997	0	0	0
1998	0	0	0
1999	0	0	0
2000	0	0	0
Total	73	162	235
Average	2.4	5.4	7.8

During the King County surveys from 1996 to 1999, year to year sightings have varied from zero to 12 observations. These numbers represent the minimum number of fish present since the entire stream was not surveyed. However, it does further indicate that Little Bear Creek is not heavily utilized by chinook salmon.

The origin of chinook salmon in Little Bear Creek is uncertain. Straying from either Bear Creek and/or the Issaquah Creek Hatchery is highly probable. Plants of fry and fingerling chinook salmon directly into Little Bear Creek totaled 1,083,300 from 1983 through 1992 (Appendix H). These were all fall chinook from the Issaquah Hatchery. No more plants by the WDFW are currently planned for Little Bear Creek (Foley, personal communication, 2001). In May of 2001, the Issaquah Creek Hatchery released 2,194,773 juvenile chinook salmon into Issaquah Creek. Some of the juveniles from the Issaquah Creek Hatchery and from naturally produced spawners in Bear Creek may utilize the lower segment of Reach 1 during their outmigration through the Sammamish River.

Juvenile chinook salmon typically exhibit either ocean-type or stream-type life history strategies. The primary difference between these strategies is residence time and growth rates. For the purposes of this report, residence time is important. Juvenile chinook salmon within the Lake Washington watershed exhibit the ocean-type strategy which means they rapidly exit their natal stream after emergence from the gravel (Fresh, personal communication, 2000). Data collected and analyzed by the WDFW indicate that the majority of the total juvenile out-migration in Bear Creek (immediately east of Little Bear Creek) occurred after mid-April, but varied between years (Seiler, 2001). The overall out-migration period ranges from mid-January through late June, but spikes between March and June. These trends can be expected to be "similar" to what occurs in Little Bear Creek.

4.3.2 Coho Salmon

Puget Sound/Strait of Georgia coho salmon was designated as a candidate for listing under the ESA on July 25, 1995 (60 FR 38011). If its status is changed to either threatened or endangered in the future, critical habitat may be designated at that time.

Salmon spawning ground survey data from the WDFW from 1952 through 2000 indicates "fair" numbers of coho salmon consistently spawn in Little Bear Creek, but during some years they are very abundant. The average total number of coho salmon observed each year in Little Bear Creek is

approximately 380 (1952 through 2000 excluding 1962 and 1969 [no data]). However, from 1976 to 1978 when the WDFW conducted intensive salmon spawning surveys at Little Bear Creek an average of approximately 2,700 coho were observed per year (range = 1,448 to 4,852). The abundance of coho salmon in Little Bear Creek appears to have dropped in the late 1980s to early 1990s. Prior to 1991 the yearly average total number of observations was approximately 460, after 1991 the yearly average was 68 with a high of 168 in 1995.

The two highest single day counts included 197 on December 14, 1979, and 191 on December 11, 1987 (Appendix J). Both of these daily counts only represent the adults observed between RM 4.4 and 5.5 on a specific day, and therefore, do not represent the total number of spawning adults in Little Bear Creek. From 1988 through 2000, the highest daily counts have been 40, 45, 46, 36, 9, 26, 4, 48, 38, 68, 25, 12, and 36, respectively. As previously stated, these numbers are not absolute in that they can only be used as an indicator of abundance. Numerous factors such as time of year, observer bias, survey effort, survey timing, flow, water clarity, and weather can all play a role in the total number of observations.

Unlike chinook salmon, coho juveniles spend from 1 to 2 years in freshwater before heading to sea. Their extended period of rearing in freshwater makes them especially vulnerable to changes in habitat, water quality, and hydrology. Following this period of freshwater residence, the juveniles migrate downstream to Lake Washington and then the ocean. They then spend about 18 months at sea before returning to their stream of origin for spawning (Wydoski and Whitney, 1979). Returning adult coho salmon stray within a watershed, and between watersheds.

Low numbers of juvenile coho salmon were captured in Reach 1, 2, and 3 during our electrofishing survey on August 24, and 31, 2001 (Appendix K). The total coho catch in Reach 1 was three juveniles during 110 seconds of effort, or one per 36.7 seconds. Juvenile coho represented 8.3 percent of the catch in Reach 1. One of the three coho had a clipped adipose fin and was therefore likely from the Issaquah Hatchery. The hatchery coho was much larger than the others with a total length of 10.7 centimeters (4.2 inches) versus an average length of 8.6 centimeters (3.4 inches) for the naturally produced coho (range: 8.4 to 8.9 centimeters [3.3 to 3.5 inches]). Two coho were captured in Reach 2 during 320 seconds of effort.

Electrofishing in Reach 3 produced the most coho, except that all the captures occurred in the upper-most section downstream of NE 205th Street. A total of nine juvenile coho were captured in the upper section of Reach 3 during 141 seconds of effort. This equates to one coho per 15.7 seconds of effort. Juvenile coho represented 20.4 percent of the salmonid catch in the upper section of Reach 3. Juvenile coho in the upper section of Reach 3 were smaller than those captured in Reach 1 with an average length of 7.8 centimeters (3.08 inches) ranging from 7.6 to 8.3 centimeters (3 to 3.25 inches). Overall, juvenile coho represented 7.7 percent of the total catch in Little Bear Creek. No coho were captured immediately upstream of NE 195th Street although 29 cutthroat trout and six sculpins were caught. No hatchery coho were captured in any section of Reach 2 or Reach 3.

The WDFW has planted 2,927,707 emergent, fingerling, fry, pre-smolt, and smolt coho salmon into Little Bear Creek between 1952 and 1978, and 1,161,763 between 1984 and 1997 (Appendix H). This does not include additional plants by the tribes, schools, or other organizations. During March of 2001, the Issaquah Creek Hatchery released two different size classes into Issaquah Creek totaling

2,250,549 (Appendix I). One of these juvenile coho was captured in Reach 1 of Little Bear Creek on August 24, 2001.

4.3.3 Sockeye Salmon

Sockeye salmon differ from other species of salmon in that juveniles require a lake environment to exist, where they spend 12 to 15 months maturing prior to going to sea (Wydoski and Whitney, 1979). Returning adult sockeye enter Lake Washington in late June and July, reside in Lake Washington until late August, and then spawn in numerous tributaries between September through early December (peaking in mid-October). An average female will produce approximately 4,000 eggs that hatch in 6 to 9 weeks, and then reside within the substrate for another 2 to 3 weeks. The newly hatched juveniles migrate from the tributaries into Lake Washington between January and April, but typically peak during March. These fish are the progeny of transplants from Baker River around the 1930s.

Kokanee are sockeye salmon that spend their entire life in freshwater. They are segmented into early-run and late-run races. Early-run kokanee spawn from August through September while the late-run spawns from October through December (King County, 2000a). The early-run variance is native to the Lake Washington system and has received much notice lately due to a decline in abundance. The late-run are the progeny of hatchery fish from Lake Whatcom planted in Big Bear Creek in the 1930s and 3.5 million planted in Lake Sammamish between 1976 and 1979 (King County, 2000a). However, the total number of kokanee planted in the Lake Washington system was approximately 35 million fry and fingerlings.

Several organizations have petitioned the United States Fish and Wildlife Service (USFWS) to list the early-run kokanee as an endangered species. To date, the USFWS has not responded to these petitions despite the population crash that occurred in the 1980s. During 2000, efforts were initiated to capture, rear, and then release early-run kokanee in order to increase the egg-to-fry survival rate. As of yet, these efforts have failed due to a lack of captured adult spawners.

Kokanee have been documented in Little Bear Creek (King County, 2000a). According to King County, up to 221 kokanee spawned in the lower most section of Reach 1 between September 27, through November 8, 1999. Kokanee were observed spawning in Little Bear Creek by DEA biologists during a water quality-monitoring event on September 20, 2001. Between 6 and 10 kokanee ranging from 17.8 to 35.6 centimeters (7 to 14 inches) long were observed immediately below the NE 178th Street culvert. The exact number is uncertain due to a lack of visibility under the overhanging cluster of Japanese knotweed where several more were hiding. One female between 17.8 to 20.3 centimeters (7 and 8 inches) long was observed digging a redd immediately under the downstream culvert edge in the center of a low-gradient riffle. Several others, suspected to be males, would occasionally be by her side, but dart between the redd and the cluster of Japanese knotweed along the left-bank. A minimum of four were observed, and several others were under the overhanging cluster of Japanese knotweed, and "thrashing/splashing noises" were emanating from under the cluster of knotweed. One additional redd was identified immediately downstream of the railroad crossing near the mouth (upstream of the Sammamish River trail crossing). The timing of these observations does not conclusively categorize them as either early or late-run kokanee, but leads to the possibility that they could be either. Some researchers have stated that during 1996, the timing of the early-run in Issaquah Creek extended from August 14, through September 16 (Ostergaard 1988 as reported by King County, 2000). Due to yearly

variations in water temperature and run timing, these dates are not absolute. However, due to the closeness between the observed spawning of kokanee in Little Bear Creek on September 20th, it is possible that these fish were a component of the early-run race.

Sockeye salmon are occasionally the most abundant spawning anadromous salmonid in Little Bear Creek. Based on salmon spawning ground data from the WDFW, adult sockeye salmon were first observed in Little Bear Creek in 1970 (WDFW, 2001). Low numbers (n) were observed in 1970 (n = 14), 1975 (n = 1), 1976 (n = 8), 1977 (n = 2), 1978 (n = 34), 1979 (n = 91), but began to increase substantially during 1987 when over 2,000 spawning adults were observed (Appendix J). Exceptionally large numbers of sockeye salmon spawned in Little Bear Creek in 1996 when 4,716 were recorded. Based on observations during field visits this year, 2001 will be another productive year for sockeye in Little Bear Creek.

4.3.4 Chum Salmon

Chum salmon often spawn near tidewater and begin to migrate back to the ocean soon after emergence. Spawning primarily occurs between October through December, and outmigration between March and June (Wydoski and Whitney, 1979). Chum salmon were considered extirpated from Lake Washington by the early 1930s (Goetz, proceedings from Conference, 2000). However, they are occasionally observed in tributaries to both Lake Washington and Lake Sammamish. Only two chum salmon have been observed in Little Bear Creek during the WDFW annual salmon spawning ground surveys from 1952 through 2000. These two adults were observed between RM 4.4 and 5.5 on November 6, 1976 (Appendix J). Based on the low number of observations of chum salmon in Little Bear Creek, these adults likely strayed from either the Cedar River or other Puget Sound watersheds.

4.3.5 Pink Salmon

Pink and chum salmon are similar in that they have a short residence time in freshwater as both adults and juveniles. Spawning occurs primarily between August and September (Wydoski and Whitney, 1979). Pink salmon were also considered extirpated from Lake Washington by the early 1930s (Goetz, proceedings from Conference, 2000). Only one adult pink salmon has been observed in Little Bear Creek (WDFW, 2001). The single adult was observed dead between RM 0.0 and 1.1 on November 1, 1977 (Appendix J). Based on the single observation of a pink salmon in Little Bear Creek, this adult was likely a strayed from a different Puget Sound watershed.

4.3.6 Cutthroat Trout

The life history of cutthroat trout is very diverse. Sea-run, adfluvial, and resident forms utilize the Lake Washington system. The resident form is likely the most abundant trout and the only resident salmonid in Little Bear Creek. During our electrofishing survey on August 24 and 31, 2001, cutthroat trout increased in abundance as we progressed upstream. They represented 8.6 percent of the catch in Reach 1 (n = 3), 50.8 percent in Reach 2 (n = 32), and 76.2 percent in Reach 3 (n = 64). Overall, cutthroat trout represented 54.4 percent of the total catch in Little Bear Creek. The largest specimen captured was in Reach 3 and was 21.6 centimeters (8.5 inches) long (Appendix K).

4.3.7 Western Brook Lamprey

Three species of lamprey have been documented in the State of Washington including the western brook lamprey (*Lampetra richardsoni*), Pacific lamprey (*Entosphenus tridentatus*), and river lamprey (*Lampetra ayresi*). Of these, only the western brook lamprey was documented in Little Bear Creek by DEA.

Adult western brook lampreys are the smallest of the lamprey family by being usually less than 17.8 centimeters (7 inches) in length (Wydoski and Whitney, 1979). They are slender, have dull/ nonfunctional teeth, may live for up to 6 years, and spend their entire life in freshwater. Unlike other species of lampreys, the brook lamprey does not attach themselves to other fish. Spawning occurs in small-excavated "nests" from April to July. Up to 12 adults may use a single nest and die soon after spawning. Juveniles are called ammocoetes and are non-parasitic filter feeders that consume primarily microscopic plant and animal matter such as diatoms, algae, and detritus.

Western brook lampreys were observed in Reaches 2 and 3, and in Tributary D as depicted on Figure 3 immediately downstream of 140th Place NE. Spawning behavior in the form of nest building and quivering was noted in the large pool immediately downstream of NE 205th Street and in a low-gradient riffle in Reach 2. In Reach 3 approximately 12 spawning lampreys were observed on June 15, 2001, at the NE 205th Street site. It is interesting to note that the same site along the edge (RB) of the pool near the tailout was later used by sockeye salmon for spawning. Numerous other sightings of lampreys occurred throughout Reaches 2 and 3 during the survey.

4.3.8 Coastrange Sculpin

The coastrange sculpin inhabits medium to large streams along the West Coast from California to Alaska. They grow to 7.6 to 10.2 centimeters (3 to 4 inches) long depending on geographic location, and spawn from mid-February to June (Wydoski and Whitney, 1979). They feed primarily on aquatic insects but will eat stray salmonid eggs when available. Large adult sculpins may feed on salmonid fry but are in-turn eaten by larger salmon and trout.

Sculpins are the most difficult fish in Washington to identify to species because of their morphological variations and small size (Wydoski and Whitney, 1979). At least 11 species occur in Washington State, some of which may hybridize and result in similar characteristics that further complicates species identification. Some of the characteristics that distinguish the coastrange sculpin from other species include its non-contiguous dorsal fin (separated to base), distinct tubular nostril, lack of palatine teeth, and absence of prickles and dark vertical bars (Wydoski and Whitney, 1979).

DEA documented coastrange sculpins throughout Little Bear Creek (Appendix K). Sculpins represented 82.9 percent of the catch in Reach 1 (n = 29), 46 percent in Reach 2 (n = 29), and 13.1 percent in Reach 3 (n = 23). The overall catch in Little Bear Creek was 37.9 percent. Although the majority of specimens captured were coastrange sculpins, some differed and may have been reticulated sculpins. The variation included the presence of a slightly contiguous dorsal fin on larger specimens.

4.3.9 Mollusks and Crawfish

Other aquatic species observed in Little Bear Creek include mollusks, crawfish, and macroinvertebrates. The western pearlshell (*Margaritifera falcata*) has been documented within

upper Little Bear Creek within Snohomish County. Several shells were observed in Little Bear Creek within King County, but no live specimens were documented during the DEA stream survey. These shells likely floated downstream during flood events. Another mollusk referred to as the Asian clam (*Coricula fluminea*) was observed in the Sammamish River near the mouth of Little Bear Creek during the DEA stream survey. The Asian clam is an introduced species known to be present in the Colombia River, but never previously documented in the Sammamish River. Crawfish are also present in the Sammamish River and Little Bear Creek. However, their presence in Little Bear Creek appears to be limited to the lowermost section of Reach 1.

4.4 STREAM HABITAT

DEA biologists surveyed the entire section of Little Bear Creek within the City of Woodinville between its mouth to NE 205th Street from June 25, through August 1, 2001. A total of 3,484.1 meters (2.2 miles) of stream was surveyed from the mouth of Little Bear Creek at the Sammamish River to the crossing under NE 205th Street along the City of Woodinville and Snohomish County line (Table 5). Little Bear Creek was segmented into three reaches. Reach 1 began at the mouth of Little Bear Creek and extended to the downstream end of the culverts under SR 202. Reach 2 started at the downstream side of the culverts under SR 202 and extended to the upstream side of the culverts under Highway 522. Reach 3 began at the upstream side of Highway 522 and ended at NE 205th Street, which follows the City of Woodinville and Snohomish County line.

Table 5:
Survey Summary for Reach 1, 2, and 3 of Little Bear Creek in Woodinville, Washington (WDFW Stream Number 08-0080)

	Reach 1	Reach 2	Reach 3
Date Surveyed	6/25/01	6/26/01 – 7/6/01	7/19/01 – 8/1/01
Total Length Surveyed	388.2 meters (0.24 mile)	1,725.7 meters (1.07 miles)	1,370.2 meters (0.85 mile)
Bank Full Width	4.5 – 6.6, x[1] = 5.8 meters	3.1 – 8.8, x = 6.2 meters	5.6 – 8.2, x = 6.9 meters
Total # of Habitat Units (NSOs)	14	105	94
Total Habitat Area	1,773.58 m^2	9,267.05 m^2	7,379.52 m^2
Percent Pool by Area	13.74%	34.01%	36.57%
Percent Glide by Area	15.04%	20.48%	21.34%
Percent Riffle by Area	71.22%	47.67%	42.09%
# Hardened Crossings	3	4	3
Percent Armoring	98.3%	13.7%	15.5%
Placed Structures	6 log weirs	0	5 rip/rap weirs
Gradient	0.25 – 1.25%	0.56 – 1.2%	0.31 - 0.87%
Sinuosity	1.01	1.15	1.08
Number Wolman Measurements	2	5	4
% Fines < 6 mm	19 – 40%, x = 29.5%	15 – 41%, x = 27%	13 – 31%, x = 21.5%
Wolman Pebble Count D-50	x = 20.6 mm	x = 21.9 mm	x = 29.6 mm
Dominant Substrate Type	Coarse gravel	Coarse gravel	Coarse gravel
Flow Measurement (8/24/01)	15.02 cfs	Not measured	13.77 cfs

Note #1: X = mean measurement.

4.4.1 Pool/Riffle Habitat

Pools and riffles are the basic components of stream habitat. The percentage and quality of these basic components help define the overall health of a stream. They are also key parameters that help

support both resident and anadromous populations of salmonids as well as other aquatic species that depend on a "healthy" stream.

Pool Habitat: Pools are used by adult salmonids for cover and resting, and pool tailouts are key spawning sites for many species. Juveniles depend on pools for cover, feeding, and refuge during extremes in stream flow. As the quantity and quality of pool habitat decreases, so does the abundance of aquatic life (salmonids, insects, mollusks, etc.). The importance of pool habitat and their associated tailouts can not be overstated. All spawning sockeye in Little Bear Creek observed during our studies were spawning in pool tailouts or the transition between the pool and their associated tailout. Although riffle habitat is also used in streams such as Little Bear Creek, riffles tend to be too shallow to be used consistently by most salmonids.

Pools are typically formed by stationary features such as large woody debris and boulders, abrupt changes in elevation, and changes in the direction of flow and substrate. The loss of large conifers within the riparian zone that contribute to in-stream woody debris and removal of in-stream wood has reduced the abundance and quality of pool habitat. Additional factors such as reduction in sinuosity, increased sedimentation, and changes in hydroperiod have further reduced habitat complexity.

In order to rate a stream within an urbanized environment, comparisons are made to more natural streams that have not been as heavily impacted by anthropogenic factors. Several researchers as well as state and federal agencies have suggested some basic standards upon which to rate a stream. Because of the wide variation in streams, bankfull width (BFW) and gradient are typically used as the parameters to which the standards are based. This is done so that comparisons are made to similar sized streams. Regardless of size, the overall area of pool habitat in a stream is typically expected to be about 40 percent to 60 percent to be considered optimum (Peterson et al., 1992).

Pool Frequency: The NMFS (1996) utilizes channel width (BFW) to develop a desired pool frequency (# pools/mile). Since the average BFW varied by reach, the desired pool frequency also varies. A stream is considered *properly functioning* if it meets the desired pool frequency and the large woody debris standards for properly functioning is also met (NMFS, 1996). A stream is considered *at risk* if it meets the desired pool frequency but large woody debris recruitment is inadequate to maintain pools overtime. A stream is considered to be *not properly functioning* if it does not meet the pool frequency standards. A comparison of the NMFS pool frequency standards and results of the DEA survey are presented below in Table 6.

Table 6:
Pool Frequency Data for Little Bear Creek, Woodinville

Reach	BFW	NMFS Match	NMFS Goal	Actual
Reach 1	19.0 ft.	20 ft.	56 pools/mile	21 pools/mile
Reach 2	20.3 ft.	20 ft.	56 pools/mile	43 pools/mile
Reach 3	22.6 ft.	25 ft.	47 pools/mile	41 pools/mile
Average	20.7 ft.	20 ft.	56 pools/mile	40 pools/mile

Based on the results presented in Table 6, pool frequency in Little Bear Creek is **not properly functioning**. This conclusion is strengthened by the fact that large woody debris recruitment is not sufficient to maintain existing pools over time due to the absence of large mature conifers within most of the riparian zone. Furthermore, the overall number of pools per kilometer in Little Bear Creek as it

flows through the City of Woodinville is 24.7 (40/mile), and the overall percentage of pool habitat is 33.1 percent. This further indicates that the frequency of pool habitat is below optimum levels.

Pool Quality: Although the number of pools is very important, another important factor is the residual depth, which is defined as the maximum depth minus tailout depth. The premise of residual depth is that deeper pools provide more cover, are more stable, and can be utilized by larger salmonids such as chinook. Shallow pools provide less cover, can be rapidly filled by sediment, and do not provide good refugia for salmonids.

The NMFS (1996) considers that pool quality is *properly functioning* when they contain pools >1 meter (3.3 feet) deep with good cover and cool water, and minor reduction of pool volume by fine sediment. Pool quality is *at risk* when few pools >1 meter (3.3 feet) are present or have inadequate cover/temperature, and only a moderate reduction in pool volume by fine sediment. Pool quality is *not properly functioning* when no pools are >1 meter (3.3 feet) deep and have inadequate cover/temperature, and there is a major reduction of pool volume by fine sediment. The NMFS Matrix of Pathways and Indicators does not mention "residual depth," therefore maximum depth will be used.

Within Reach 1, none of the five pools had a maximum depth >0.90 meter (2.9 feet). The maximum pool depth was 0.90 meter (2.9 feet), average pool depth was 0.60 meter (2 feet), average maximum depth was 0.85 meter (2.8 feet), average residual depth was 0.55 meter (1.8 feet), and maximum residual depth was 0.70 meter (2.3 feet). These pools also lacked "good" cover and "cool" water. Therefore, pool quality in Reach 1 is **not properly functioning**.

Reach 2 contained 46 pools, but only eight (17.4 percent) had a maximum depth equal to or >1 meter (3.3 feet). The maximum pool depth was 1.1 meter (3.6 feet), average pool depth was 0.43 meter (1.4 feet), average maximum depth was 0.73 meter (2.4 feet), average residual depth was 0.55 meter (1.8 feet), and maximum residual depth was 0.90 meter (2.9 feet). Although some of the pools contained good cover, most did not. Therefore, pool quality in Reach 2 is considered **at risk**.

Pool quality increased in Reach 3 due to the presence of deeper pools. Reach 3 contained 35 pools, nine (25.7 percent) of which had a maximum depth equal to or greater than 1 meter (3.3 feet). The maximum pool depth was 1.71 meter (5.6 feet), average pool depth was 0.39 meter (1.3 feet), average maximum depth was 0.75 meter (2.5 feet), average residual depth was 0.54 meter (1.8 feet), and maximum residual depth was 1.51 meter (4.9 feet). Compared to Reaches 1 and 2, the percentage of deeper pools increased and overall water temperature decreased, but few pools were considered to provide adequate cover. A reduction in pool volume due to fines was observed. Although conditions improved in Reach 3, pool quality is considered **at risk**. The overall pool quality in Little Bear Creek as it flows through the City of Woodinville is considered also **at risk** because few pools are greater than 1 meter (3.3 feet) deep.

Riffle Habitat: Riffles are also important spawning areas in many streams, and support a myriad of macroinvertebrates that provide the primary food source for juvenile salmonids as well as other species of fish. Gradient and water depth dictates the suitability for salmonid spawning while embeddedness and overall abundance of fines influence productivity. The NMFS (1996) states that gravel or cobble should be the dominant substrate, with embeddedness being less than 20 percent to be *properly functioning*. In other words, the interstitial spaces between the gravel or cobble should not be filled with more than 20 percent fines, and the gravel should not be compacted. Although

salmonids can and do spawn in gravel containing excess fines, the egg-to-fry ratio may be low. This could result in few, if any eggs surviving to the fry stage due to suffocation and entrapment.

Table 7 below summarizes the pool, riffle, and glide habitat parameters quantified by this survey. The raw data are provided in Appendix M. Table 7 is segmented by reach in order to capture trends as Little Bear Creek flows through the City of Woodinville. Overall, Reach 1 near the mouth of Little Bear Creek has been severely degraded while Reach 2 and 3 still contain "fair" habitat. Although pool habitat is **not properly functioning** based on NMFS standards, Reaches 2 and 3 of Little Bear Creek do contain a fair amount of suitable habitat (although somewhat degraded). The primary factors that have degraded pool habitat in Little Bear Creek are the lack of in-stream large woody debris, and relatively heavy sediment load.

Table 7:
Pool, Riffle, and Glide Habitat Summary for Reach 1, 2, and 3 of Little Bear Creek

	Reach 1	Reach 2	Reach 3
Total Habitat Area	1,773.58 m^2	9,267.05 m^2	7,379.52 m^2
Total Pool Area	243.66 m^2	3,151.51 m^2	2,698.64 m^2
Total Glide Area	266.81 m^2	1,898.24 m^2	1,574.86 m^2
Total Riffle Area	1,263.11 m^2	4,417.305 m^2	3,106.02 m^2
Percent Pool by Area	13.74%	34.01%	36.57%
Percent Glide by Area	15.04%	20.48%	21.34%
Percent Riffle by Area	71.22%	47.67%	42.09%
Number of Pools	5 (4 of 5 man made)	46	35
Pools per Kilometer	12.88	26.66	25.54
Total Length of Pool Habitat	74.8 meters	548.2 meters	421.9 meters
Dominant Pool Type	Plunge	Scour	Scour
Average Length of Pools	14.96 meters	11.92 meters	12.05 meters
Average Residual Pool Depth	0.55 meter	0.55 meter	0.54 meter
Maximum Residual Depth	0.70 meter	0.90 meter	1.51 meter
Maximum Pool Depth	0.90 meter	1.1 meter	1.71 meter
Average Maximum Pool Depth	0.85 meter	0.73 meter	0.75 meter
Average Pool Depth	0.60 meter	0.43 meter	0.39 meter
Average Pool Width	4.02 meters	6.10 meters	6.19 meters
Number of Riffles	4	43	40
Total Length of Riffle Habitat	246.80 meters	841.4 meters	634.28 meters
Average Length of Riffles	61.70 meters	19.57 meters	15.86 meters
Average Width of Riffles	5.35 meters	4.80 meters	4.81 meters
Average Depth of Riffles	0.34 meter	0.20 meter	0.16 meter
Number of Glides	5	16	19
Total Length of Glides	66.60 meters	336.1 meters	313.98 meters
Average Length of Glide Habitat	13.32 meters	19.57 meters	16.53 meters
Average Width of Glides	4.1 meters	4.75 meters	5.09 meters
Average Depth of Glides	0.43 meter	0.34 meter	0.25 meter

4.4.2 Large Woody Debris

Large woody debris (LWD) is a critical component of stream habitat because it creates pools, structure, and habitat diversity. Large pieces of coniferous trees provide the best habitat since they

are long-lived and will not decay as rapidly as deciduous trees. Large pieces will also stay stationary during high flows and scour out pool habitat as water velocity is redirected around them.

The USFS protocol for LWD west of the Cascades segments wood into three size categories based on length and diameter (USFS, 2001). Small LWD must have a diameter >30.5 centimeters (12 inches) at a length of 7.62 meter (25 feet) from the large end. Medium LWD must have a diameter >61 centimeters (24 inches) at a length of 15.24 meter (50 feet) from the large end. Large LWD must have a diameter >0.91 meter (36 inches) at a length of 15.24 meter (50 feet) from the large end. The NMFS recommends that streams should have a minimum of 80 pieces of LWD per 1.61 km (1 mile) that are at least 15.24 meter (50 feet) long with a diameter of at least 61 centimeters (24 inches) to be *properly functioning*.

Both the USFS and NMFS standards are larger than what is now typically found in Puget Sound lowland streams. Although present in some streams in low numbers, LWD of this size are more appropriately categorized as remnant key pieces. Because of their scarcity, the new standard of measuring and categorizing pieces >2 meters (6.6 feet) long and wider than 10 centimeters (3.9 inches) has been adopted by several jurisdictions. Although these smaller pieces are not as influential as the key pieces, they do provide some function. By measuring and categorizing their size, abundance, and species, a more accurate account of existing habitat conditions can be obtained. Appendix N contains all the specific details of each piece of wood >2 meters (6.6 feet) long and 10 centimeters (4 inches) wide encountered in Little Bear Creek as it flows through the City of Woodinville.

Only 5 pieces large enough to meet the NMFS standard were recorded throughout the 3.48 kilometers (2.2 miles) of stream surveyed within the City of Woodinville. Researchers have documented that the occurrence of smaller pieces of wood such as those inventoried during this survey in natural streams occur at a rate of 150 to 460 pieces per kilometer (0.62 mile) (Peterson et al., 1992). The total number of pieces of LWD greater than 2 meters (6.6 feet) long per kilometer (0.62 mile) in Little Bear Creek is 110.5. Based on the NMFS criteria, large woody debris is **not properly functioning** in Little Bear Creek. Table 8 below summarizes our findings by reach, and the raw data are presented in Appendix N.

Table 8:
Woody Debris Summary for Reach 1, 2, and 3 of Little Bear Creek

	Reach 1	Reach 2	Reach 3
Total Wood Inventoried	16 pieces	217 pieces	152 pieces
# NMFS Woody Debris	0	4	1
Pieces (> 2 m long) per Meter	0.04	0.13	0.11
Pieces (> 2 m long) per kilometer	47.31	125.75	110.93
Distance between Pieces	24.26 meters	7.95 meters	9.01 meters
% Coniferous Woody Debris	66.7% (weirs)	23.6%	34.5%
% Deciduous Woody Debris	33.3%	76.4%	65.5%
Dominant Conifer Species	Cedar	Cedar	Cedar
Dominant Deciduous Species	Alder	Alder	Alder
Average Length	3.66 meters	3.31 meters	3.74 meters
Average Diameter	32.5 cm	29.2 cm	27 cm
# Stumps	0	18	10
# Log Jams	0	4	3

Note: The results for Reach 1 were skewed due to the presence of log weirs.

4.4.3 Sediment and Substrate

Stream substrate varies significantly on all scales, and no survey method is perfect at documenting substrate composition on the reach scale. DEA utilized the Wolman (1954) pebble count due to its ease of use, comparability with existing data, and acceptance by both King County and the USFS. However, the Wolman pebble count method focuses on riffle habitat and hence does document substrate composition in pool tailouts. Pool tailouts are often extensively used for spawning.

Variation in substrate occurs by watershed, stream, reach, and habitat type. The substrate also varies on the site-specific scale when analyzing either lateral or longitudinal change. This variation in conjunction with the numerous methods of assessing substrate composition has created difficulties in adequately documenting and interpreting the results of sampling efforts. However, the variation in substrate composition on the watershed scale is one of the many factors that allows for a diverse benthic community to exist such as macroinvertebrates, mollusks, and numerous species of fish that reside within the substrate during their larval stage. A few of the factors that influence substrate composition include flow, gradient, sediment load, and location within the watershed.

Sediment: The focus of most stream substrate assessments is to determine the percentage of fines in potential salmonid spawning habitat. The percentage of fines is then used to infer the quality of spawning habitat because too many fines can degrade in-stream habitat and adversely impact salmonid spawning success. Streams in urbanized watersheds "tend" to have a larger percentage of smaller particles (May, 1996). The NMFS Matrix, as modified by the Mt. Baker/Snoqualmie National Forest, uses percent fines as an indicator of the quality of potential spawning and rearing habitat. Percent fines is used for assessing both spawning and incubation habitat. However, the size range depends on if the field data is collected from the stream surface (<6 millimeters [0.24 inch]) or from within the substrate (<0.85 millimeter [0.03 inch]). The Wolman pebble count collects stream substrate surface data. Therefore, based on NMFS Matrix values as modified by the Mt. Baker/Snoqualmie National Forest that includes surface fines: ≤20 percent fines (<6 millimeters [0.24 inch]) and low turbidity is considered *properly functioning* in most watersheds, 12 percent to 20 percent fines and moderate turbidity is considered *at risk*, and >20 percent fines and high turbidity is considered *not properly functioning* (Appendix L-2).

The results of the Wolman pebble count data collected in Little Bear Creek highlights the variability of fines (Table 9). Data was collected at 11 riffles, the percent fines <6 millimeter (0.24 inch) ranged from 13 percent to 41 percent, with an overall average of 25.45 percent. Based on these results, the sediment indicator at the local level ranges from **properly functioning** to **not properly functioning**, but averages in the **at risk** range. Assuming this data is representative and enough samples were collected to identify possible trends, an overall general trend of fewer fines per reach occurred as sampling progressed upstream. The average percent fines in Reach 1 was 29.5 percent, Reach 2 was 27 percent, and Reach 3 was 21.5 percent. These reach averages are all greater than 20 percent, and therefore indicates that the overall sediment indicator for Little Bear Creek is **not properly functioning**.

Table 9:
Substrate Composition Based on Wolman Pebble Counts in Little Bear Creek, Woodinville

#	Reach #	NSO	Location	Fines <6 mm	D35	D50	D84	D95
1.	1	1	R1: Station 18.4	40%	1.9 mm	16.0 mm	175.8 mm	299.3 mm
2.	1	14	R8: Imm. D. stream SR 202	19%	14.2 mm	25.1 mm	132.4 mm	203.4 mm
3.	2	2	Imm. U. stream SR 202	21%	19.2 mm	29.6 mm	64.9 mm	99.5 mm
4.	2	15	R9	41%	1.9 mm	10.1 mm	30.7 mm	44.0 mm
5.	2	27	Station 558.9, UW Bug site	26%	9.6 mm	16.5 mm	35.0 mm	50.7 mm
6.	2	56	R26: Station 1015	32%	8.0 mm	17.9 mm	30.9 mm	43.2 mm
7.	2	76	NSO 76	15%	27.0 mm	35.5 mm	67.5 mm	93.8 mm
8.	3	3	R2	13%	22.9 mm	30.6 mm	57.1 mm	78.1 mm
9.	3	38	R23	24%	20.1 mm	48.7 mm	48.7 mm	61.1 mm
10.	3	50	R30	18%	16.1 mm	22.7 mm	58.4 mm	87.5 mm
11.	3	81	R49	31%	7.4 mm	16.2 mm	41.9 mm	63.9 mm

Wolman pebble count data also documents larger particle size distribution (D35 – D95). The "D" represents distribution, while the adjoining number represents the percentile of interest. The D35 equates to the distribution of the 35 percentile of the particle size distribution. Whereas the D50 is the median particle size of a distribution that divides the distribution in two equal parts (mid-point/median). Another way of expressing this concept is that a percentile is a sediment size indicated by the cumulative distribution curve for a particle "percent finer" value. Therefore, D35 means 35 percent of the sample was smaller than the cumulative particle size (diameter in millimeters) documented at the riffle. In the case of the first sample site, 35 percent of the pebbles measured were smaller than 1.9 millimeter (0.075 inch) in diameter. The data in the form of a cumulative distribution curve from each of the sample sites is provided in Appendix O.

Substrate: The NMFS utilizes both embeddedness and substrate composition as the indicators for substrate quality. The percentage embeddedness is obtained visually and is extremely subjective. The NMFS criteria for *properly functioning* is a dominance of gravel or cobble (interstitial spaces clear) and embeddedness <20 percent, *at risk* is gravel and cobble subdominant or if dominant embeddedness is between 20 percent and 30 percent, and *not properly functioning* if bedrock, sand, silt or small gravel dominant or if gravel and cobble dominant embeddedness is >30 percent.

Based on the D50 results, the median gravel size in riffles throughout Little Bear Creek in the City of Woodinville ranged from medium to very coarse gravel. The D50 in Reach 1 ranged from 16 to 25.1 millimeters (0.63 to 0.99 inch) with the average being 20.55 millimeters (0.81 inch) (coarse gravel). The D50 in Reach 2 ranged from 10.1 to 35.5 millimeters (0.40 to 1.4 inches) with the average being 21.92 millimeters (0.86 inch) (coarse gravel). The D50 in Reach 3 ranged from 16.2 to 48.7 millimeters (0.64 to 1.92 inches) with the average being 29.55 millimeters (1.16 inches) (coarse gravel). Although more samples should be taken to increase confidence levels, there appears to be a trend of increasing D50 results as the upstream distance from Reach 1 increases. Although coarse gravel was dominant, interstitial spaces were not clear, and embeddedness averaged from 20 percent to 30 percent (sometimes >30 percent). Based on these results, the Habitat Element Pathway – Substrate Indicator is **at risk**.

4.4.4 Off-Channel Habitat/Refugia

The availability of "adequate" off-channel habitat and refugia are indicators of a stream's ability to provide a safe haven for primarily juvenile fish during high flow events. These are generally areas of lower stream velocity that can be accessed during flood events, but also includes low energy areas during normal stream flows such as backwater areas with cover, ponds, and oxbows.

Few side-channels, oxbows, or other types of potential off-channel habitat/refugia exist along Little Bear Creek. Although a few potential off-channel habitat and refugia sites were noted, they were not adequately abundant or distributed in Little Bear Creek. It appears that hydromodifications in the form of rip/rap armoring throughout Reach 1, and sections of Reaches 2 and 3 in conjunction with the loss of adjacent wetlands and tributaries that are culverted into Little Bear Creek, the indicator for off-channel habitat and refugia are **not properly functioning**.

4.4.5 Channel Condition and Dynamics

The channel condition and dynamics pathway includes three primary indicators assessed by the NMFS. These include: (1) width/depth ratio, (2) streambank condition, and (3) floodplain connectivity. Additional parameters not included in the Matrix of Pathways and Indicators developed by the NMFS (1996) that also provide insight into channel conditions and dynamics of a stream include: channel sinuosity and percent armoring. Although no specific percentages have been defined by the federal agencies for these last two indicators, they provide insight into the degree of anthropogenic influences that have been placed upon a stream. Both channel sinuosity and percent armoring are often closely associated with each other in that as the percentage of armoring increases the overall sinuosity decreases.

Width/Depth Ratio: The width/depth ratio concept relies on the premise that a stream channel will incise when banks are armored. This channel down cutting is created as high-flows that would normally spill-out into and over the adjacent stream banks are forced to stay within the defined channel by the presence of armoring (typically large rip/rap). The hydrologic impacts of urbanization typically widen and/or deepen a stream channel when the banks are not armored, but streamside development will often have the opposite effect (May et al., 1997).

The NMFS (1996) states that a *properly functioning* stream has a width/depth ratio of <10, an *at risk* stream has a ratio between 10 to 12, and the ratio for a *not properly functioning* stream is >12 (Appendix L-1). Based on the results of King County (2001b), the width/depth ratio for Reaches 1 through 3 is 5.8, 5.3, and 8.0, respectively. Based on their data, this indicator is **properly functioning** throughout Reaches 1 through 3. Although this could possibly be true for Reaches 2 and 3, it does not seem possible that Reach 1 could be properly functioning given that 98.3 percent is armored close to the bankfull line. Based on this, and that May et al., (1997) found varying results, this indicator as currently defined does not appear to be suited for urbanized streams in Puget Sound. Considering these issues, the width/depth ratio in Reach 1 is considered by DEA to be **not properly functioning**, and **at risk** in Reaches 2 and 3.

Streambank Condition: Streambank condition refers to the percentage of the bank that is stable and the percentage that is actively eroding. The NMFS (1996) defines a *properly functioning* streambank as being >90 percent stable with <10 percent actively eroding, 80 percent to 90 percent stable when *at risk*, and <80 percent stable when *not properly functioning*. This indicator also appears at least

partially flawed since a streambank that is completely armored would be considered stable using this approach and would be categorized as properly functioning. If the banks contain a predominance of gravels and not fines, the addition of new gravels to a stream channel can be beneficial. King County (2001b) reported that Reach 1 was 32 percent armored, 32 percent full scour, 33 percent low scour, and zero percent stable. Reach 2 was 9 percent armored, 18 percent full scour, 46 percent low scour, and 27 percent stable (King County, 2001b). Reach 3 was 6 percent armored, 16 percent full scour, 26 percent low scour, and 52 percent stable (King County, 2001b).

DEA biologists documented 98.3 percent armoring in Reach 1 distributed equally between the left and right banks. The percent armoring in Reach 2 varied depending upon bank (Table 10). The right bank (RB) was armored for a distance of 185.6 meters (608.9 feet) or 10.7 percent, while the left bank (LB) was armored for 288.4 meters (946.2 feet) or 16.7 percent. This discrepancy is due to the abundance of businesses along the left bank, and the relatively long distance between the right bank and Highway 522. Several sites along the left bank were experiencing localized sloughing as a result of streambank encroachment and absence of riparian vegetation (Appendix D – Reach 2 Photo 7). The percent armoring in Reach 3 also varied depending upon bank. The right bank was armored for a distance of 225.6 meters (740.2 feet) or 16.5 percent, while the left bank was armored for a distance of 198.5 meters (651.2 feet) or 14.5 percent. Based on these results, the streambank condition indicator is **not properly functioning**.

Table 10:
Bank Armoring Along Little Bear Creek in Woodinville

#	Reach	Bank	Downstream Station (m)	Upstream Station (m)	Length	Comment
1.	1	RB	6.6	388.2	381.6 meters	Rip/rap +
2.	1	LB	6.6	388.2	381.6 meters	Rip/rap +
3.	2	RB	0.0	39.7	39.7 meters	SR 202 culvert
4.	2	LB	0.0	39.7	39.7 meters	SR 202 culvert
5.	2	LB	128.6	138.2	9.6 meters	Rip/rap
6.	2	RB	196.0	226.5	30.5 meters	132nd Ave culvert
7.	2	LB	196.0	226.5	30.5 meters	132nd Ave culvert
8.	2	LB	254.5	274	19.5 meters	Rip/rap
9.	2	LB	311.4	315.2	3.8 meters	Rip/rap
10.	2	RB	487.1	498.6	11.5 meters	134th Ave culvert
11.	2	LB	487.1	498.6	11.5 meters	134th Ave culvert
12.	2	LB	778.4	786.0	7.6 meters	Gabion weir
13.	2	LB	839	846.1	7.1 meters	Rip/rap
14.	2	LB	870.9	898.5	27.6 meters	Rip/rap
15.	2	LB	1262.7	1274.2	11.5 meters	Rip/rap
16.	2	LB	1281.2	1286.3	5.1 meters	Rip/rap
17.	2	LB	1380.7	1390.2	9.5 meters	CMP discharge
18.	2	RB	1595.7	1637.1	41.4 meters	Old crossing +
19.	2	LB	1595.7	1615.6	19.9 meters	Old crossing +
20.	2	LB	1651.7	1666.7	15.0 meters	Rip/rap
21.	2	RB	1666.7	1725.7	62.5 meters	Hwy 522 culvert
22.	2	LB	1666.7	1725.7	62.5 meters	Hwy 522 culvert
23.	3	RB	0.0	17.1	17.1 meters	Rip/rap deflector
24.	3	LB	135.3	155.4	20.1 meters	Rip/rap - On-ramp

Table 10 continued

#	Reach	Bank	Downstream Station (m)	Upstream Station (m)	Length	Comment
25.	3	LB	267.6	273.1	5.5 meters	Rip/rap - On-ramp
26.	3	RB	277.7	313.6	35.9 meters	Rip/rap - House
27.	3	LB	271.3	313.6	42.3 meters	Rip/Rap - On-ramp
28.	3	RB	313.6	350.2	36.6 meters	NE 195th Street culvert
29.	3	LB	313.6	350.2	36.6 meters	NE 195th Street culvert
30.	3	RB	350.2	396.0	45.8 meters	Old business
31.	3	LB	350.2	396.0	45.8 meters	Old business
32.	3	LB	616.9	634.9	18.0 meters	Hwy 522 edge
33.	3	RB	915.3	1005.5	90.2 meters	Old Bridge + yards
34.	3	LB	915.3	934.5	19.2 meters	Old Bridge
35.	3	LB	1297.5	1308.5	11.0 meters	House

Floodplain Connectivity: The floodplain indicator as defined by the NMFS (1996) includes hydrologic linkage between adjacent off-channel areas, wetlands, and riparian vegetation and succession. This indicator does not specify quantifiable measurements, but relies on subjective inferences of frequently linked, reduced linkage, and severe reduction in linkage. Based on the lack of off-channel habitat, adjacent wetlands, and greater than 10 percent armoring along all three reaches, this indicator is **not properly functioning**.

4.4.6 Riparian Habitat

Riparian habitat is defined as the land adjoining the stream that influences stream habitat and its processes. The composition and quantity of riparian habitat directly influences temperature, sedimentation, productivity, habitat complexity, and the streams disturbance regime. An "intact" riparian zone buffers the stream from outside elements. One issue today is how large does a buffer have to be to protect a stream from anthropogenic influences. A buffer of 30.5 meters (100 feet) is often used for salmonid-bearing streams. However, many researchers have documented that a 30.5-meter (100-foot) buffer is not sufficient in protecting a stream and its processes from all anthropogenic influences, especially when the quality of the existing buffer is low. Some researchers have suggested that if the goal is to truly protect a valuable resource, than buffer width should be at least 100 meters (328 feet). However, this width can be adjusted downward depending on the maturity and overall percentage of the existing riparian habitat. Furthermore, it is also recognized that the composition of the entire watershed plays a vital role in a stream's overall health. On the watershed scale, the percent or fraction of total impervious area has been found to have a direct correlation with a stream's productivity (May et al., 1997).

This report will focus on a linear corridor adjacent to the stream, 61 meters (200 feet) from each bank or 122 meters (400 feet) total width. Site specific conditions within the City of Woodinville based on aerial photographs from 1999 indicate the width of the Little Bear Creek vegetated riparian buffer varies considerably by reach (Appendix G).

The width of the vegetated riparian buffer in Reach 1 averages about 7.6 meters (25 feet) wide and is abutted by development along both banks. The overall 121.9-meter (400-foot) wide corridor

within Reach 1 was composed of 64.36 percent impervious surface, 27.97 percent shrub/grass habitat, 5.11 percent forest habitat, and 2.59 percent gravel area.

The width of the vegetated buffer in Reach 2 varied between the left and right banks. The left bank ranges from 7.6 to 22.9 meters (25 to 75 feet) wide (average width about 7.6 meters [25 feet]) and is abutted by businesses. The right bank ranges from 15.2 to >61 meters (50 to >200 feet) wide (average width about 45.7 meters [150 feet]) and is abutted by Highway 522. The overall 122-meter (400-foot) wide corridor within Reach 2 was composed of 19.38 percent impervious surface, 46.46 percent shrub/grass habitat, 21.63 percent forest habitat, and 12.52 percent gravel area.

The width of the vegetated riparian buffer along both banks of Reach 3 varies from 15.2 to >61 meters (50 to >200 feet). The right bank is relatively unconstrained while the left bank is defined by Highway 522. The overall 122-meter (400-foot) corridor in Reach 3 was composed of 17.12 percent impervious surface, 1.55 percent gravel area, 45.76 percent forested habitat, and 35.56 percent shrub/grass habitat (Table 11).

Table 11:
Land Use Based on 1999 Aerial Photograph
Along Little Bear Creek, Woodinville

Land Use	Reach 1	Reach 2	Reach 3	Total
Developed Impervious	64.36%	19.38%	17.12%	24.05%
Gravel - cleared impervious	2.59%	12.52%	1.55%	6.56%
Forested Habitat	5.11%	21.63%	45.76%	29.94%
Shrub/Grass Habitat	27.97%	46.46%	35.56%	39.45%

Based on the photo interpretation of the 1999 aerial photographs (Appendix G), two trends are apparent. The percentage of developed impervious (developed and gravel [cleared impervious]) surface is significantly higher along the lower reaches while the percentage of forested habitat significantly decreases. The high percentage (12.52 percent) of cleared gravel area along Reach 2 may be an indicator that more development is planned and that the percentage of developed impervious surface will continue to increase within potential buffer habitat.

The remaining riparian buffer and upland forest habitat is of vital importance to the continued functionality of Little Bear Creek. However, the composition of the buffer along Little Bear Creek is varied, and typically dominated by deciduous trees and non-native species of grasses and shrubs. Red alder (*Alnus rubra*), Himalayan blackberry (*Rubus procerus*), bittersweet nightshade (*Solanum dulcamara*), and reed canarygrass (*Phalaris arundinacea*) are abundant throughout Reaches 1 and 2, and the lowermost section of Reach 3. Japanese knotweed (*Polyonum cuspidatum*), another introduced species is also present and locally abundant, but not as widespread as the other aforementioned invasive species.

A continuous 61-meter (200-foot) riparian buffer along each bank composed of mature coniferous forest with numerous adjoining wetlands should be the goal along the Little Bear Creek corridor. Based on our survey results, these target conditions are absent, but scattered sections along the left bank of Reach 3 do possess some of the desired traits.

The remaining buffer is composed of primarily deciduous trees, shrubs, and grasses. A detailed list of the species observed along Little Bear Creek is contained in Tables 12, 13, 14, and 15 below. As mentioned previously, red alder is the most abundant tree species along Little Bear Creek, followed by black cottonwood (*Populus balsamifera*), big-leaf maple (*Acer macrophyllum*), and willow (*Salix* spp). Other species such as Douglas fir and western red-cedar become more prevalent in Reach 3. Two Pacific yew (*Taxus brevifolia*) trees were observed along Reach 2. These are long-lived small conifer trees that were used extensively by native Americans and are a source of the cancer fighting drug taxol. The two observed along Little Bear Creek are remnants from pre-settlement. Once gone, Pacific yews will likely not become reestablished because of the absence of mature coniferous forest.

Table 12:
Tree Composition Along Little Bear Creek, Woodinville

#	Reach #	Common Name	Scientific Name	Comment
1.	2, 3.	Vine maple	*Acer circinatum*	Native.
2.	1, 2, 3.	Big-leaf maple	*Acer macrophyllum*	Native.
3.	1, 2, 3.	Red alder	*Alnus rubra*	Native.
4.	2, 3.	Black hawthorne	*Crataegus douglasii*	Native.
5.	1, 3.	Oregon ash	*Fraxinus latifolia*	Native.
6.	1, 2, 3.	Sitka spruce	*Picea sitchensis*	Native.
7.	1	Shore pine	*Pinus contorta*	Native.
8.	1, 2, 3.	Black cottonwood	*Populas balsamifera*	Native.
9.	1, 2, 3.	Bitter cherry	*Prunus emarginata*	Native.
10.	1, 2, 3.	Douglas fir	*Pseudotsuga menziesii*	Native.
11.	2, 3.	Cascara buckthorn	*Rhamnus purshiana*	Native.
12.	1, 2, 3.	Pacific willow	*Salix lasiandra*	Native.
13.	2, 3.	Scouler willow	*Salix scouleriana*	Native.
14.	1, 2, 3.	Sitka willow	*Salix sitchensis*	Native.
15.	2.	Pacific yew	*Taxus brevifolia*	Native.
16.	2, 3.	Western red cedar	*Thuja plicata*	Native.
17.	2, 3.	Western hemlock	*Tsuga heterophylla*	Native.

Shrubs and vines are abundant along Little Bear Creek. The most common along the stream bank include Himalayan blackberry, bittersweet nightshade, and Pacific ninebark (*Physocarpus capitatus*). Others such as Scotch broom (*Cytisus scoparius*) are also abundant, but typically occur beyond the riparian zone, especially within the disturbed areas between Little Bear Creek and Highway 522 along Reaches 2 and 3.

Table 13:
Shrub and Vine Composition Along Little Bear Creek, Woodinville

#	Reach #	Common Name	Scientific Name	Comment
1.	1, 2, 3.	Red-twig dogwood	*Cornus sericea*	Native.
2.	2	Beaked hazelnut	*Corylus cornuta*	Native.
3.	1, 2, 3.	Scotch broom	*Cytisus scoparius*	Introduced, invasive.
4.	2	Salal	*Gaultheria shallon*	Native.
5.	3.	Black twinberry	*Lonicera involucrata*	Native.
6.	2, 3.	Indian plum	*Oemieria cerasiformis*	Native.
7.	3.	Devil's club	*Oplopanax horridus*	Native.
8.	1, 2, 3.	Pacific ninebark	*Physocarpus capitatus*	Native.
9.	2, 3.	Sword fern	*Polysticum munitum*	Native.
10.	3.	Stink currant	*Ribes bracteosum*	Native.
11.	2	Wild rose	*Rosa* spp.	Native.
12.	1, 2, 3.	Evergreen blackberry	*Rubus laciniatus*	Introduced, invasive.
13.	2, 3.	Thimble berry	*Rubus parviflorus*	Native.
14.	1, 2, 3.	Himalayan blackberry	*Rubus procera*	Introduced, invasive.
15.	1, 2	Salmonberry	*Rubus spectabilis*	Native.
16.	2, 3.	Trailing blackberry	*Rubus ursinus*	Native.
17.	2	Red elderberry	*Sambucus racemosa*	Native.
18.	2, 3.	Douglas spirea	*Spiraea douglasii*	Native.
19.	3.	Highbush-cranberry	*Viburnum edule*	Native.

Herbs represent the most diverse subset of plants encountered along Little Bear Creek. The most common groups include the grasses and weeds. The herb category also contains the largest percentage of introduced species, many of which are invasive. They typically are the first group of species to colonize disturbed areas and once present are difficult to remove. Some of these species such as reed canarygrass and bittersweet nightshade can be extremely abundant, and have established extensive monocultures within the riparian zone. Others such as purple loosestrife and yellow flag iris are present but sparse.

Table 14:
Herb Composition Along Little Bear Creek, Woodinville

#	Reach #	Common Name	Scientific Name	Comment
1.	2	Creeping bentgrass	*Agrostis stolonifera*	Introduced.
2.	3.	Pearly everlasting	*Anaphalis margaritacea*	Native.
3.	1, 2, 3.	Lady fern	*Athyrium felix-femina*	Native.
4.	2, 3.	Canada thistle	*Cirsium arvense*	Introduced, invasive.
5.	3	Poison hemlock	*Conium maculatum*	Introduced.
6.	1, 2, 3.	Morning glory	*Convolvulus arvensis*	Introduced, invasive.
7.	2	Bristly hawksbeard	*Crepis setosa 'Haller'*	Introduced.
8.	2	Orchard grass	*Dactylis glomerata*	Introduced.
9.	2	Bleeding heart	*Dicentra formosa*	Native.
10.	1, 2	Fireweed	*Epilobium* sp.	Introduced.
11.	2	Field horsetail	*Equisetum arvense*	Native.
12.	1, 2	Giant horsetail	*Equisetum telmateia*	Native.

Table 14 continued

#	Reach #	Common Name	Scientific Name	Comment
13.	2	Tall fescue	*Festuca arundinacea*	Introduced.
14.	2, 3.	Bedstraw	*Galium aparine*	Native.
15.	2, 3.	Robert geranium	*Geranium robertianum*	Introduced, invasive.
16.	3.	Big-leaf avens	*Geum macrophyllum*	Native.
17.	1	St. John's-wort	*Hypericum perforatum*	Introduced, invasive, noxious.
18.	1, 2	Yellow touch-me-not	*Impatiens noli-tangere*	Introduced.
19.	1, 2	Yellow-flag iris	*Iris pseudacorus*	Introduced, invasive.
20.	1, 2,	Soft rush	*Juncus effusus*	Native.
21.	2	Daggerleaf rush	*Juncus ensifolius*	Native.
22.	3	Duck weed	*Lemna minor*	Native.
23.	2, 3.	Birdsfoot trefoil	*Lotus corniculatus*	Introduced, invasive.
24.	3	Skunk cabbage	*Lysichitum americanum*	Native.
25.	2, 3.	Purple loosestrife	*Lythrum salicaria*	Introduced, invasive.
26.	2	False lily-of-the-valley	*Maianthemum dilatatum*	Native.
27.	2, 3.	Small water forget-me-not	*Myosotis laxa*	Native.
28.	2	Common evening primrose	*Oenothera biennis*	Introduced – N.E. USA.
29.	1, 2, 3.	Reed canarygrass	*Phalaris arundinacea*	Introduced, invasive.
30.	1	English plantain	*Plantago major*	Introduced.
31.	1, 2, 3.	Japanese knotweed	*Polygonum cuspidatum*	Introduced, invasive.
32.	2, 3.	Bracken fern	*Pteridium aquilinum*	Native.
33.	2, 3.	Creeping buttercup	*Ranunculus repens*	Introduced, invasive.
34.	2	Water cress	*Rorippa nasturtium-aquaticum*	Introduced.
35.	2	Red sorrel	*Rumex acetosella*	Introduced.
36.	2, 3.	Curly dock	*Rumex crispus*	Introduced.
37.	2, 3.	Bitter dock	*Rumex obtusifolius*	Introduced.
38.	1, 2, 3.	Small-fruited bulrush	*Scirpus microcarpus*	Native.
39.	1, 2, 3.	Bittersweet nightshade	*Solanum dulcamara*	Introduced, invasive.
40.	2, 3.	Hedge nettle	*Stachys cooleyae*	Native.
41.	1	Tansy	*Tanacetum vulgare*	Introduced, invasive.
42.	1	Dandelion	*Taraxacum officinale*	Introduced, invasive.
43.	2, 3.	Piggy-back plant	*Tolmeia menziesii*	Native.
44.	2	White clover	*Trifolium repens*	Introduced.
45.	2, 3.	Stinging nettle	*Urtica dioica*	Introduced.

Ornamentals represent introduced species that were typically planted in private yards or businesses. They are usually not invasive, except for English ivy (*Hedera helix*), which can choke trees. Most do not represent a threat and are unable to naturally propagate. Others such as English holly (*Liex aquifolium*) are distributed by bird droppings, but are not problematic.

Table 15:
Ornamental Composition Along Little Bear Creek, Woodinville

#	Reach #	Common Name	Scientific Name	Comment
1.	3	Norway maple	*Acer platanoides*	Introduced.
2.	3	Red maple	*Acer rubrum*	Introduced.
3.	1	Butterfly bush	*Buddleia davidii*	Introduced.
4.	3	Parneyi cotoneaster	*Cotoneaster lacteus*	Introduced.
5.	3	Crocosmia	*Crocosmia* sp.	Introduced.
6.	1	Buning bush	*Euonymus alaalatus*	Introduced.
7.	1, 2	English ivy	*Hedera helix*	Introduced, invasive.
8.	3	Blue star juniper	*Juniperus squamata*	Introduced.
9.	2	English holly	*Liex aquifolium*	Introduced.
10.	1	Apple fruit tree	*Malus* sp.	Introduced.
11.	1	Scotch pine	*Pinus sylvestris*	Introduced.
12.	3	Thundercloud plum tree	*Prunus cerasifera*	Introduced.
13.	1	Otto-luyken laurel	*Prunus laurocerasus*	Introduced.
14.	1	Plum fruit tree	*Prunus* sp.	Introduced.
15.	3	Flowering cherry tree	*Prunus* sp.	Introduced.
16.	1	Rhododendron species	*Rhododendron* sp.	Introduced.
17.	1, 2, 3.	Locust tree	*Robinia* sp.	Introduced.
18.	1	Weeping willow	*Salix babylonica*	Introduced.
19.	2	European mountain ash	*Sorbus acuparia*	Introduced.

The NMFS (1996) indicator for riparian reserves includes several factors that must be assessed in order to determine its existing state. These factors include: adequate shade, large woody debris recruitment, habitat protection, connectivity, and percent similarity of riparian vegetation to the potential natural community/composition. The functionality of the riparian reserve decreases as loss and fragmentation increase, and as the percent similarity of the existing riparian vegetation to the potential natural community/composition drops from >50 percent (*properly functioning*), to 25 percent to 50 percent (*at risk*), and finally <25 percent (*not properly functioning*). The percent "intact" can also be quantified in that >80 percent is considered *properly functioning*, 70 percent to 80 percent is considered *at risk*, and <70 percent is considered *not properly functioning*. Based on the analysis of aerial photographs, ground truthing, and detailed stream survey, the results indicate the riparian reserves vary by reach.

The riparian reserve in Reach 1 is **not properly functioning** due to only 5.11 percent being forested habitat within the 122-meter (400-foot) wide corridor. Furthermore, the limited amount of riparian reserves along Reach 1 are dominated by deciduous trees and introduced invasive species.

The functionality of the riparian reserve in Reach 2 is not as clear as Reach 1. Although the percent forested increased to 21.63 percent, it is also composed of primarily deciduous trees, introduced invasive species are abundant, and shrubs and grasses (46.46 percent) dominate large tracts. The riparian reserve in this reach is also confined between Highway 522 to the west and commercial businesses to the east. Furthermore, the ability of the reserve to provide large woody debris and

adequate shading has been extremely compromised. Therefore, based on these facts, the riparian reserve in Reach 2 is also **not properly functioning**.

The functionality of the riparian reserve in Reach 3 increases as the percent forested habitat increased to 45.76 percent, and overall shading increased (except immediately upstream of NE 195th Street). Although the potential for future large woody debris recruitment is still unacceptably low, and much of the forest has a high deciduous component, conifers become much more prevalent. Because of these factors, the riparian reserve is considered **at risk** in Reach 3.

The overall rating for the riparian reserve in Little Bear Creek as it flows through the City of Woodinville is considered **not properly functioning**. Although conditions improve in the upper reaches, the overall dominance of deciduous trees, poor potential for future large woody debris recruitment and lack of shade in Reaches 1 and 2 indicate that overall the riparian reserve is **not properly functioning**.

4.4.7 Water Quality

The NMFS (1996) considers temperature, sediment, and chemical contamination/nutrients in their Matrix of Diagnostics/Pathways and Indicators criteria. Of these, sediment was previously discussed in Section 4.4.3, Substrate.

Temperature: Water temperature is a key factor controlling the ability of salmonids to survive in a stream. It will also influence species composition in that some species such as bull trout require exceptionally colder water to successfully reproduce. Water temperatures rising above a 7-day average maximum of 7.8°C (46°F) is reported to limit spawning and rearing success of bull trout.

The following temperatures are average 7-day maximums. The NMFS (1996) considers 10 to 13.9°C (50 to 57°F) or less to be *properly functioning*. At risk temperatures depend on time of year or life cycle (spawning or migration and rearing). Water temperature is considered *at risk* for spawning adults when between 13.9 to 15.6°C (57 to 60°F), and for migration and rearing when 13.9 to 17.8°C (57 to 64°F). Stream temperatures above 15.6°C (>60°F) for spawning and above 17.8°C (>64°F) for migration and rearing are considered *not properly functioning*. The Washington State Department of Ecology reported that temperatures from 21 to 22°C (69.8 to 71.6°F) are lethal to chinook salmon while temperatures from 20 to 21°C (68 to 69.8°F) create thermal barriers (Hicks, 2000 as reported by Kerwin, 2001).

DEA biologists monitored two Hobo temperature data loggers in Little Bear Creek between June 16 and October 17, 2001 (4 months). The lowermost data logger was installed near the mouth of Little Bear Creek while the uppermost was installed downstream of NE 205th Street crossing near the King/Snohomish County line. Each data logger was set to collect hourly readings. The City of Woodinville is continuing the monitoring effort beyond the period of analysis documented in this report (Monzaki, personal communication, 2001).

Table 16 below presents the consolidated stream temperature data in the NMFS 7-day average maximum temperature format for Little Bear Creek from June 16 through October 17, 2001. Juvenile

life cycle data is for chinook salmon as defined by Kerwin (2001) as adapted by Myers et al., 1998. The outmigration period lasts from early March through late July, peaking in June. Adult migration and spawning life cycle data was determined by reviewing the WDFW salmon spawning ground survey data from 1952 through 2000. The earliest observation of an adult chinook in Little Bear Creek occurred on September 29 while the latest live sighting occurred on November 5th, peaking in October. Although this analysis is focused on chinook salmon it is important to note that some species such as juvenile coho salmon, resident cutthroat trout, coastrange sculpins, and western brook lampreys are present in Little Bear Creek throughout the year.

Table 16:
7-day Average Maximum Stream Temperatures for Little Bear Creek, Woodinville

Week	Reach 1 Mouth	Reach 3 205th	Chinook Salmon Life Cycle	NMFS Indicator Status
6/16 – 6/22	15.3°C	14.9°C	Peak Juvenile Migration and Rearing	At Risk
6/23 – 6/29	14.8°C	14.5°C	Peak Juvenile Migration and Rearing	At Risk
6/30 – 7/6	16.4°C	16.1°C	Peak Juvenile Migration and Rearing	Not Properly Functioning
7/7 – 7/13	17.0°C	16.6°C	Juvenile Migration and Rearing	Not Properly Functioning
7/14 – 7/20	15.1°C	14.7°C	Juvenile Migration and Rearing – Adults in Lake Wa.	At Risk
7/21 – 7/27	16.1°C	15.6°C	Juvenile Migration and Rearing – Adults in Lake Wa.	Not Properly Functioning
7/28 – 8/3	15.0°C	14.7°C	Juvenile Migration and Rearing – Adults in Lake Wa.	At Risk
8/4 – 8/10	16.8°C	16.3°C	Juvenile Chinook now absent – Adults in Lake Wa.	Not Properly Functioning
8/11 – 8/17	17.2°C	16.5°C	Adults in Lake Washington	Not Properly Functioning
8/18 – 8/24	15.6°C	15.0°C	Adults in Lake Washington	Not Properly Functioning/At Risk
8/25 – 8/31	16.3°C	15.8°C	Adults in Lake Washington	Not Properly Functioning
9/1 – 9/7	14.8°C	14.4°C	Adults in Lake Washington	At Risk
9/8 – 9/14	14.7°C	14.2°C	Adults in Lake Washington	At Risk
9/15 – 9/21	13.7°C	13.3°C	Adults possibly present in Little Bear Creek	High-end of Properly Functioning
9/22 – 9/28	13.7°C	13.1°C	Adult Chinook likely present Little Bear Creek	High-end of Properly Functioning
9/29 – 10/5	12.0°C	11.6°C	Adult Chinook present – spawning in Little Bear Creek	Properly Functioning
10/6 – 10/12	11.1°C	10.6°C	Adult Chinook present – spawning in Little Bear Creek	Properly Functioning
10/13 – 10/17	11.0°C	10.6°C	Adult Chinook present – spawning in Little Bear Creek	Properly Functioning

Notes: *Properly Functioning* = 10 to 13.9° C.
At Risk = 13.9 to 15.6° C for migrating adults, and 13.9 to 17.8° C for migration and rearing.
Not Properly Functioning = >15.6° C for spawning, and >17.8° C for migration and rearing.

Based on the stream temperature data collected by DEA between June 16, through October 17, 2001, this parameter ranges from **at risk** to **not properly functioning** during juvenile migration and rearing, and **properly functioning** during adult migration and spawning. However, between September 15, 2001, through September 28, 2001, temperatures were at the upper end of **properly functioning** and will likely shift to **at risk** during warmer years.

The stream temperature data collected during this study is presented in Appendix P (Reach 1) and Appendix Q (Reach 3). It is interesting to note that daily stream temperatures fluctuated from 0.46 to 4.68 degrees and that on average, Reach 1 was approximately 0.4 degree warmer than Reach 3. The greatest daily fluctuations "typically" occurred on days when the maximum hourly temperature

was higher than average, and as stream temperature decreased so did the degree of fluctuation. Stream temperature was typically the coolest from 0700 to 0900 hours, and warmest from 1600 to 1800 hours. However, these "typical" time periods would shift substantially during cooling events. The highest hourly stream temperature reading occurred in Reach 1 measuring 18.16°C (64.69°F) for a 1-hour period between 1700 and 1800 hours on August 12, 2001.

Stream temperature data collected by Snohomish County Public Works – Surface Water Management (SWM) in the upper reaches of Little Bear Creek reported only one monthly measurement above 16°C (60.8°F) (SWM, 2000). However, these were spot checks during water quality sampling events utilizing hand held thermometers, and likely occurred prior to the daily peak. Snohomish County also reported that mean fecal coliform levels have violated Class AA standards, nitrate levels are some of the highest in the county, and dissolved oxygen levels violated standards about 8 percent of the time (SWM, 2000). Furthermore, the SWM reported that sediment samples collected near the mouth contained chromium, copper, lead, nickel, and zinc, although exact levels were not reported (SWM, 2000). Some of the peak water quality measurements during the year 2000 include 8,600 colonies/100 mL for fecal coliform, 0.00812 mg/L for copper, 0.000624 mg/L for lead, and 0.00691 mg/L for zinc collected on July 12, 2000 near the headwaters of Little Bear Creek (Thornburgh, personal communication, 2001).

Water quality data is collected by King County in Little Bear Creek at Station No. 0478 located in Reach 1 near the mouth. Stream temperature data collected by King County from 1990 through 1993 ranged from a low of 1.0°C (33.8°F) on February 16, 1993, to a high of 16.2°C (61.2°F) on July 20, 1992 (King County, 1994). Dissolved oxygen levels were generally good, with a low of 9.2 mg/L on August 19, 1991, when the stream temperature was 16.0°C (60.8°F), and a high of 14 mg/L on a couple of dates during the winter when stream temperatures were extremely low at 1.0 to 1.5°C (33.8 to 34.7°F). There is an inverse relationship of stream temperature and dissolved oxygen in that as stream temperature increases dissolved oxygen decreases.

Additional parameters analyzed by King County indicate turbidity fluctuates widely from 0.3 to 42 nephelometric turbidity units (NTU). The highest measurements recorded for various parameters were pH = 8.30, turbidity = 42.0 NTUs, suspended solids = 87.00 mg/L, fecal coliform = 1,700 organisms/100mL, nitrate + nitrite = 1.600 mg/L, ortho-phosphorus = 0.190 mg/L, and total phosphorus = 0.570 mg/L. Stormwater metal levels were below detection levels for cadmium, lead, and nickel, but averaged 0.006 mg/L copper, and 0.023 mg/L zinc (King County, 1994). Levels of copper and zinc in Little Bear Creek were higher than in Swamp, North, Bear-Evans, Issaquah, and Tibbetts creeks.

Chemical Contamination/Nutrients: The NMFS (1996) reports that for the chemical contamination/nutrients indicator, a *properly functioning* stream has low levels of chemical contamination from agricultural, industrial, and other sources, no excess nutrients, and no Clean Water Act (CWA) 303d designated reaches. An *at risk* stream has moderate levels of chemical contamination from agricultural, industrial, and other sources, some excess nutrients, and one CWA 303d designated reach. A *not properly functioning* stream contains high levels of chemical contamination, high levels of excess nutrients, and more than one Clean Water Act 303d designated reach. The Washington Department of Ecology has reported that Little Bear Creek does not support designated uses, and contains three 303(d) listed stream reaches due to elevated fecal

coliform levels (Kerwin, 2001). Furthermore, a recent King County small streams toxicity/pesticide study indicates a variety of pesticides are present in Little Bear Creek at levels high enough to be "toxic" to test species (Kerwin, 2001). Based on the data presented by Kerwin (2001), and reports by SWM (2000) and King County (1994), the water quality pathway and associated chemical contamination/nutrients are **not properly functioning** in Little Bear Creek.

Additional Water Quality Data: Water quality data was collected in the field with a Horiba U-10 water quality meter during this survey. The goal was to document change by reach, and compare Little Bear Creek with the Sammamish River utilizing data collected on the same day. Based on this effort, the following data in Table 17 is presented. On September 25, 2001, pH, turbidity, and dissolved oxygen levels were noticeably lower in the Sammamish River, while temperature was elevated (Table 17). Based on the results, water quality is generally better in Little Bear Creek than in the Sammamish River due to lower water temperature and higher dissolved oxygen levels in Little Bear Creek. Within Little Bear Creek, conductivity and turbidity increased, and temperature decreased from Reach 1 to 3. Dissolved oxygen and pH fluctuated little between reaches.

Table 17:
Water Quality Data on 9/25/01 for Little Bear Creek, Woodinville

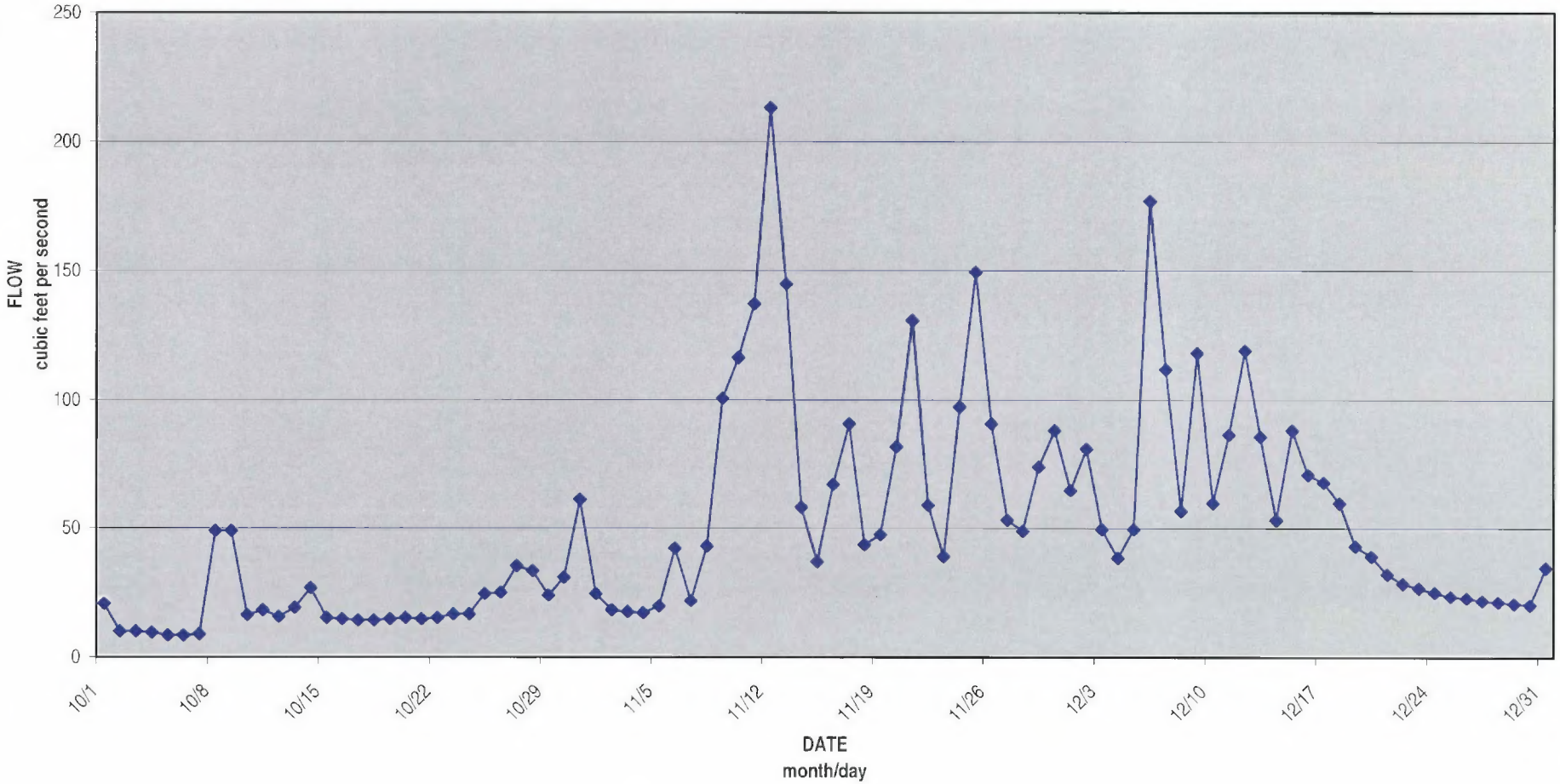
#	Parameter	Sammamish River	Reach 1 Mouth	Reach 2 134th	Reach 3 205th
1.	pH	6.85	7.70	7.89	7.72
2.	Conductivity (mS/cm)	0.145	0.144	0.147	0.148
3.	Temperature (C)	16.0	13.2	13.3	13.0
4.	Turbidity (NTU)	1	7	10	12
5.	Dissolved oxygen (mg/L)	6.90	9.40	8.65	8.95

4.4.8 Flow/Hydrology

The flow/hydrology pathway contains two indicators: change in peak/base flow and increase in drainage network. Increased urbanization results in increased flood frequency and streamflow variability (May et al., 1997). The result is that flow levels change frequently and extreme flow events occur more often. This condition is exasperated by an increase in the drainage network. Elements of the drainage network include ditches, road crossings, and stormwater outfalls. The overall result is that rainwater reaches the stream channel exponentially faster then what would occur naturally.

Peak/Base Flow: The NMFS (1996) Matrix of Diagnostics/Pathways and Indicators utilizes watershed hydrographs to document changes in peak/base flow. A *properly functioning* stream's hydrograph would indicate peak, base, and flow timing is comparable to a similar undisturbed watershed. An *at risk* stream shows some evidence of change. A *not properly functioning* stream's hydrograph indicates pronounced change in peak, base, and flow timing. Based on the following hydrographs (Figures 5a through 5c), the peak/base flow indicator is **at risk** due to evidence of change when compared with hydrographs from minimally disturbed watersheds.

Figure 5a: 1999 Hydrograph, October through December
Little Bear Creek



o:/project/w/wood0000-0010/0500 deliverables/Figure 5a 5b 5c.xls/5a, 1999

Figure 5b: 2000 Hydrograph, January through December
Little Bear Creek

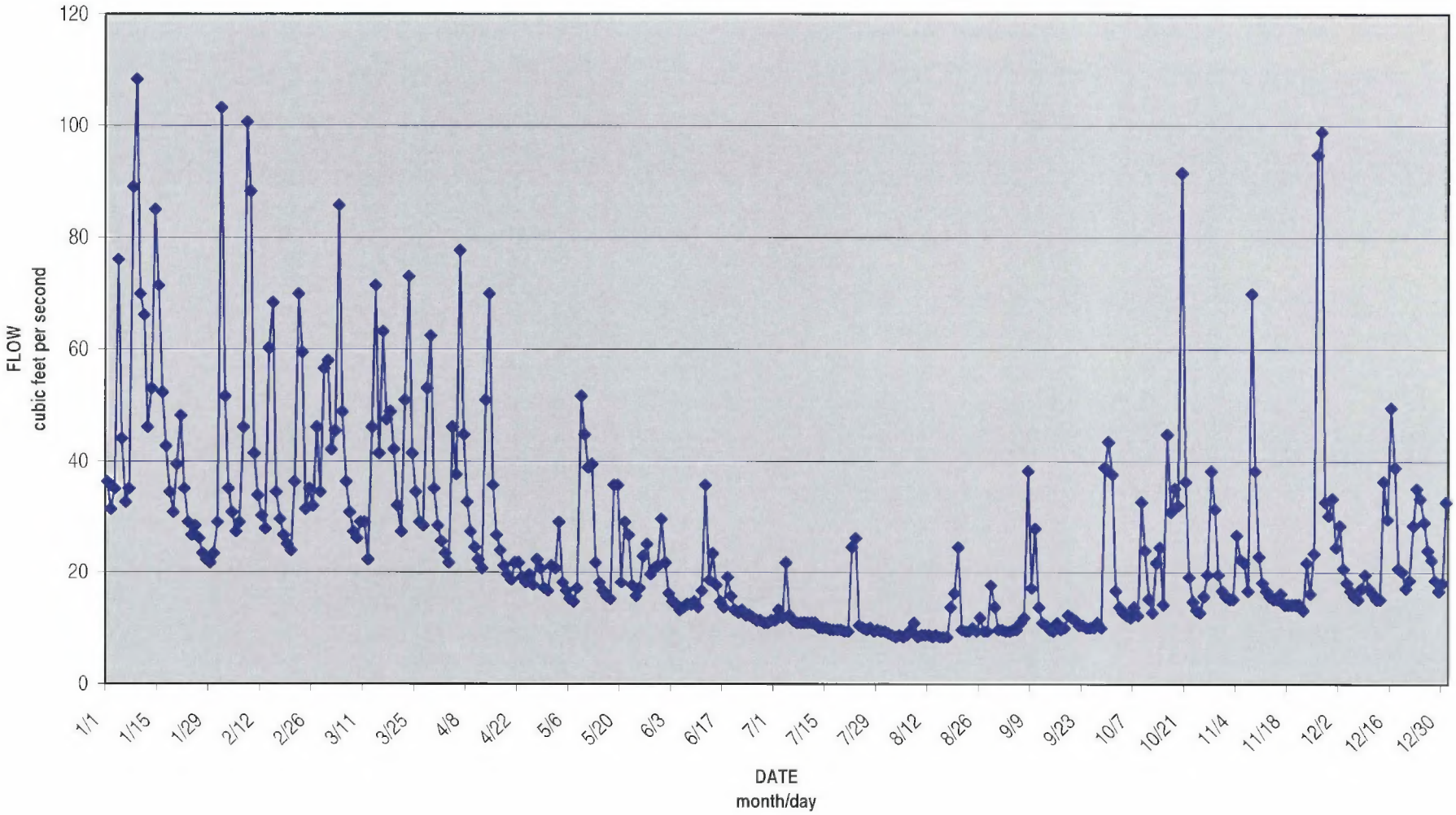
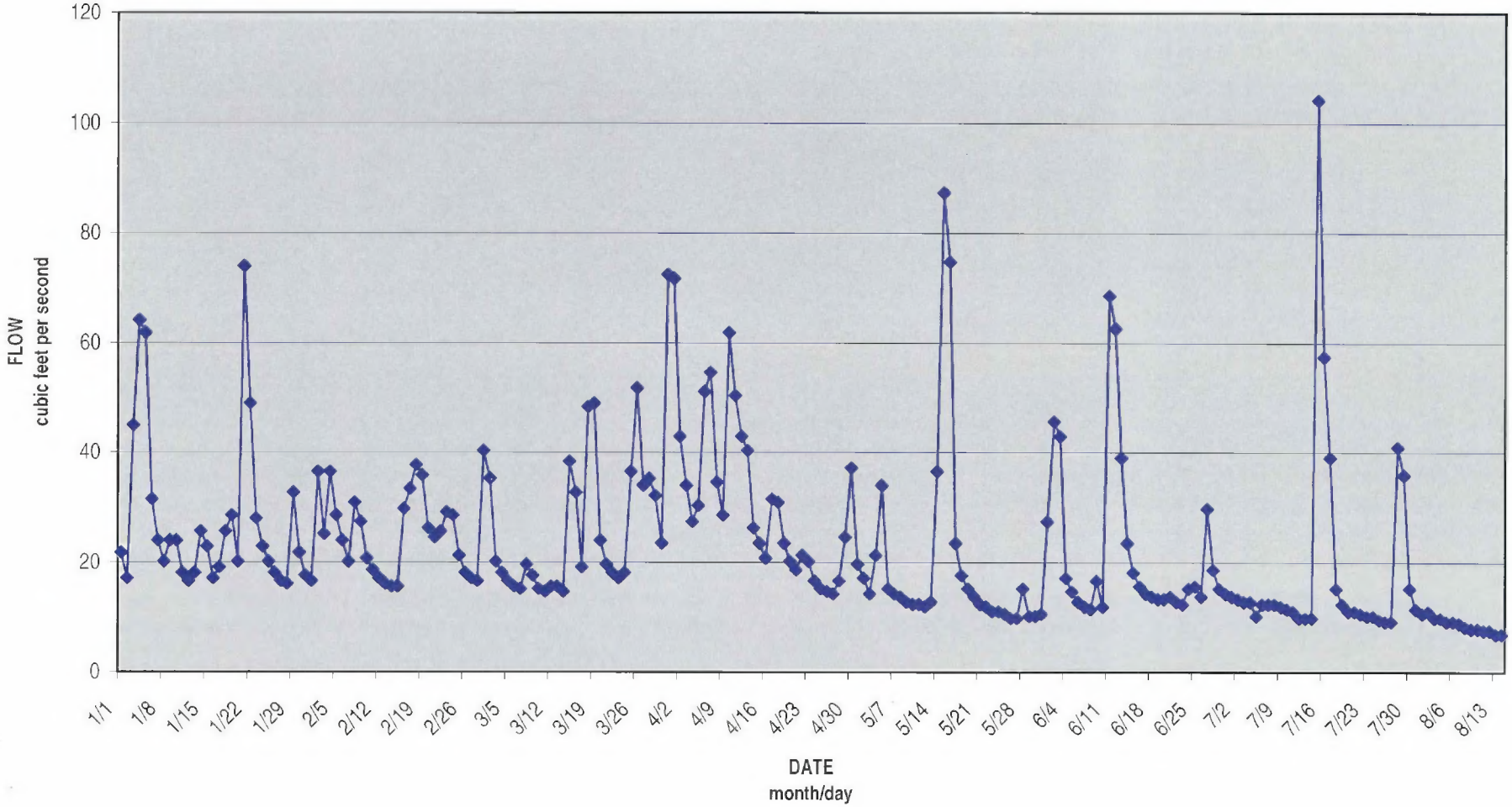


Figure 5c: 2001 Hydrograph, January through August
Little Bear Creek



Increase in Drainage Network: The NMFS (1996) Matrix of Diagnostics/Pathways and Indicators utilizes an increase in drainage network to document change. A *properly functioning* stream will have zero or minimum increases in drainage network due to roads. An *at risk* stream will have a moderate increase in drainage density due to roads (e.g., 5 percent). A *not properly functioning* stream will have a significant increase in the drainage network due to roads (e.g., 20 to 25 percent).

The percentage of total impervious surface has increased to about 37 percent and road density to 5.9 kilometers per square kilometer (km/km^2) (2.28 mi/mi^2) in the past 12 years (Purser and Simmonds, Snohomish County Surface Water Management, unpublished data as reported by Kerwin, 2001). Based on these changes, the increase in drainage network indicator is **not properly functioning**.

4.4.9 Watershed Conditions

The watershed conditions pathway is gauged by three indicators: road density and location, disturbance history, and riparian reserves. Riparian habitat was documented above in Section 4.4.6 – Riparian Habitat.

Road Density and Location: The NMFS (as modified by the Mt. Baker Snoqualmie National Forest) has quantified parameters to rank the degree of road density and location within their Matrix of Diagnostics/Pathways and Indicators (Appendix L-2). Based on their criteria, a *properly functioning* watershed contains less than 1.61 km/km^2 (<1 mi/mi^2) of roads and no valley bottom roads. An *at risk* watershed contains 1.61 to 3.86 km/km^2 (1 to 2.4 mi/mi^2) of roads with some valley bottom roads. A *not properly functioning* watershed contains >3.86 km/km^2 of roads (>2.4 mi/mi^2), and many valley bottom roads.

May et al. (1997) documented numerous watershed characteristics based on aerial photographs from 1989. At that time, the percent total impervious surface in the Little Bear Creek Basin was 13.8 percent and the road density was 4.9 km/km^2 (1.90 mi/mi^2). They reported that the basin was composed of 43 percent undeveloped forest, 12 percent undeveloped open land, 32 percent rural residential land, 6 percent suburban residential land, 2 percent urban residential land, and 7 percent commercial industrial land. This equates to a total of 57 percent of the land being developed to some degree at that time.

During the past 12 years, the percentage of total impervious surface has increased to about 37 percent and road density to 5.9 km/km^2 (2.28 mi/mi^2) (Purser and Simmonds, Snohomish County Surface Water Management, unpublished data – as reported by Kerwin, 2001). Based on these changes, the NMFS watershed condition indicators for road density is **not properly functioning**. During this period, the amount of undeveloped forest has only dropped to 40 percent. This indicates that the majority of new impervious surface since 1989 has been established in the previously undeveloped open land and rural residential land.

Disturbance History: The NMFS (1996) defines a *properly functioning* watershed as containing <15 percent equivalent clear-cut acres (ECA) within the entire watershed with no concentration of disturbance in unstable or potentially unstable areas, and/or refugia, and/or riparian areas. Additional parameters specific for the Northwest Forest Plan do not apply. An *at risk* watershed

also contains <15 percent ECA within the watershed, but disturbance is concentrated in unstable or potentially unstable areas, and/or refugia, and/or riparian areas. A *not properly functioning* watershed contains >15 percent ECA and disturbance is concentrated in unstable or potentially unstable areas, and/or refugia, and/or riparian areas.

This indicator is difficult to judge based on the NMFS (1996) criteria and may be more applicable to watersheds outside the Puget Sound lowlands due to the extensive amount of development within this region. The ECA concept appears to be applicable in watersheds where logging is the dominant land use. Instead, DEA proposes to utilize the Urban Stream Rehabilitation guideline presented by May (1996) that ranks a stream based on percent total impervious area (percent TIA). This system results in a ranking of natural (percent TIA < 5 percent), impacted (percent TIA 10 to 30 percent), degraded (percent TIA 30 percent to 40 percent), and non-supporting (percent TIA >45 percent). Therefore, DEA equated natural to *properly functioning*, impacted to *at risk*, and degraded and non-supporting to *not properly functioning*. The location of the disturbance can also be factored into the formula.

Since about 37 percent of the watershed is impervious, and much of the riparian zone in the lower reaches has been developed, this watershed appears to be degraded. Therefore, the disturbance history indicator is **not properly functioning**. This is especially apparent when reviewing the rate of increase in new impervious area from 1989 to present.

4.4.10 Habitat Access

The Habitat Access Pathway includes the Physical Barriers Indicator. The NMFS (1996) states that a *properly functioning* stream with man-made barriers allows upstream and downstream fish passage during all flows. An *at risk* stream with man-made barriers does not allow upstream and/or downstream passage at base/low flow. A *not properly functioning* stream with man-made barriers does not allow upstream and/or downstream fish passage during a wide range of flows.

The Adopt-A-Stream Foundation conducted a Washington State Department of Transportation (WSDOT) Level A assessment of 88 culverts that posed potential fish passage barriers throughout the Little Bear Creek watershed (Adopt-A-Stream, unpublished data as reported by Kerwin, 2001). They concluded that only 8 of these culverts were fully passable during winter and spring flow conditions. The remaining 80 culverts posed at least partial barriers during this high flow period. The 8 culverts that were fully passable during high flows could also pose fish passage barriers during lower flows. Although this may seem dire, adult salmon are not usually present during peak flow periods in the early winter and spring time period, and "most" juvenile salmonids are migrating downstream during the spring. Therefore, this condition may primarily impact resident trout and juvenile coho salmon. This conclusion does not negate the need to continue basin wide removal of restrictive culverts, or the conversion of round culverts to larger bottomless culverts and bridges.

Habitat Access is not a major limiting factor along the mainstem of Little Bear Creek as it flows through the City of Woodinville. Potentially restrictive road crossings containing culverts within the City of Woodinville include SR 202, 132nd Avenue NE, 134th Avenue NE, Highway 522, NE 195th Street, and NE 205th Street. The crossing at NE 178th Street is considered passable to all life stages regardless of flow. All crossings within the City of Woodinville are passable to adult salmonids during the late summer and early fall. All of these crossings are also passable to juveniles with the possible exception of NE 205th Street which likely restricts upstream movement

by juveniles. It is likely that during peak flows that occur during the winter and spring, juvenile upstream passage is further restricted by all the aforementioned culverts. The primary issue is shear velocity due to the funneling effect of the culverts along the mainstem, and loss of three tributaries as the result of extensive culverting at their interface with Little Bear Creek in Reach 2 (Figure 3). Based on these conclusions, the physical barrier indicator within the City of Woodinville is **at risk**, but could become **properly functioning** as existing culverts are replaced with bridges, removed, or retrofitted to improve upstream passage for juvenile salmonids.

4.5 WILDLIFE

Biologists recorded bird, mammal, reptile, and amphibian species along Little Bear Creek both during surveys and incidentally during other site visits. Additional species to those observed likely use the area but remain undocumented by this study, as field visits were limited to spring and summer of a single year. A list of additional wildlife species that could potentially be present along the Little Bear Creek corridor but were not documented during these surveys is included in Appendix S.

4.5.1 Bird Observations

Thirty-nine bird species were observed along Little Bear Creek during site visits and surveys (Table 18). The majority of these species likely breed in the area, as most males were observed singing during the breeding season. One species, willow flycatcher (*Empidonax traillii*), is a federally designated species-of-concern. Five singing males were identified on three survey plots. The WDFW Priority Habitat and Species (PHS) program classifies great blue heron rookeries as vulnerable aggregations (Criterion 2) and are protected. Although no rookeries are documented within 2 miles of the corridor (WDFW, 2001b), suitable foraging habitat exists within the creek and adjacent wetlands, and biologists observed one individual during stream surveys.

Table 18:
Bird Observations Along Little Bear Creek, Woodinville

#	Reach #	Common Name	Scientific Name	S Rank	Comment
1.	2, 3	Mallard	*Anas platyrhynchos*	S5B	
2.	2, 3	Great blue heron	*Ardea herodias*	S4S5	
3.	1, 2, 3	Cedar waxwing	*Bombycilla cedrorum*	S4N	NMBS*
4.	1, 2	Canada goose	*Branta canadensis*	S5B	
5.	2, 3	Red-tailed hawk	*Buteo jamaicensis*	S5B	
6.	3	Pine siskin	*Carduelis pinus*	S5B	
7.	1, 2, 3	American goldfinch	*Carduelis tristis*	S5B	
8.	1, 2, 3	House finch	*Carpodacus mexicanus*	S5	
9.	3	Swainson's thrush	*Catharus ustulatus*	S5B	NMBS
10.	1, 2, 3	Belted kingfisher	*Ceryle alcyon*	S5	NMBS
11.	1, 2	Killdeer	*Charadrius vociferus*	S5B	
12.	2, 3	Northern flicker	*Colaptes auratus*	S5	
13.	1, 2, 3	American crow	*Corvus brachyrhynchos*	S5	
14.	2, 3	Steller's jay	*Cyanocitta stelleri*	S5	
15.	2, 3	Willow flycatcher	*Empidonax traillii*	S5B	NMBS; Federal Species of Concern.
16.	3	Brewer's blackbird	*Euphagus cyanocephalus*	S5	
17.	3	Dark-eyed junco	*Junco hyemalis oreganus*	S5B	
18.	1	California gull	*Larus californicus*	S4B	Flying over creek.
19.	1, 2, 3	Song sparrow	*Melospiza melodia*	S5B	

Table 18 continued

#	Reach #	Common Name	Scientific Name	S Rank	Comment
20.	1, 2, 3	Brown-headed cowbird	*Molothrus ater*	S4N	
21.	1	House sparrow	*Passer domesticus*	SE	
22.	2, 3	Black-headed grosbeak	*Pheucticus melanocephalus*	S5B	NMBS
23.	1, 3	Downy woodpecker	*Picoides pubescens*	S5	
24.	3	Hairy woodpecker	*Picoides villosus*	S4S5	
25.	2, 3	Spotted towhee	*Pipilo erythrophthalmus*	S5B	Nest observed in Reach 3.
26.	1, 2, 3	Black-capped chickadee	*Poecile atricapilla*	S5	Nest observed in Reach 2.
27.	2, 3	Chestnut-backed chickadee	*Poecile rufescens*	S5	
28.	1, 2, 3	Bushtit	*Psaltriparus minimus*	S5	Nest observed in Reach 3.
29.	3	Golden-crowned kinglet	*Regulus satrapa*	S5B	NMBS
30.	3	Red-breasted sapsucker	*Sphyrapicus ruber*	S4S5	
31.	1, 2, 3	European starling	*Sturnus vulgaris*	SE	Nest observed in Reach 2.
32.	1, 2, 3	Violet-green swallow	*Tachycineta thalassina*	S5B	NMBS
33.	1, 2, 3	Bewick's wren	*Thryomanes bewickii*	S5	
34.	1, 2, 3	American robin	*Turdus migratorius*	S5B	
35.	3	Warbling vireo	*Vireo gilvus*	S5B	NMBS
36.	3	Hutton's vireo	*Vireo huttoni*	S5	
37.	2, 3	Wilson's warbler	*Wilsonia pusilla*	S5B	NMBS
38.	1	Mourning dove	*Zenaidura macroura*	S5B	NMBS
39.	1, 2, 3	White-crowned sparrow	*Zonotrichia leucophrys*	S5B	NMBS

*NMBS = neotropical migrant bird species

The WDFW PHS program maintains a list of species for which it has occurrence and status information. A global rank (GRank) describes the species' relative rarity or endangerment worldwide, and a state rank (SRank) describes the status within Washington State. Most bird species observed in the study area have a GRank of G5, which signifies that they are demonstrably secure globally. Most species have an SRank of S5 or S4 (Table 18), defining them as "demonstrably secure in state" or "apparently secure, with many occurrences", respectively. SRanks may include the qualifiers "B" and "N", which indicate breeding and nonbreeding status, respectively, of migrant species. The breeding status of these species may differ greatly from their nonbreeding status in the state. SE indicates an established exotic species. Two codes for any one species indicates an intermediate rank.

Eleven of the species recorded along Little Bear Creek are neotropical migrant bird species. Neotropical migrants breed in North America and winter in Mexico, Central America, the Caribbean, and South America. The publication of results from long-term survey programs confirms that populations of many neotropical migrants are declining, in some cases precipitously. Habitat loss and related problems are key issues in the causes of the declines. Therefore, these species may be of interest, particularly if they are breeding in the area. The area could potentially provide breeding habitat for several of these species, including Swainson's thrush, black-headed grosbeak, willow flycatcher, warbling vireo, Wilson's warbler, mourning dove, and white-crowned sparrow (Table 18). In addition, neotropical migrant species not detected during surveys and field visits may use the corridor (Appendix S).

4.5.2 Mammal Observations

Biologists documented ten mammal species in the Little Bear Creek corridor (Table 19). None of the species observed have federal or state special status. Other mammal species that may utilize the corridor include mink (*Mustela vison*), striped skunk (*Mephitis mephitis*), and coyote (*Canis latrans*). Appendix S contains a complete list of mammals that could potentially be present based on habitat types and historic range.

Table 19:
Mammal Observations Along Little Bear Creek, Woodinville

#	Reach #	Common Name	Scientific Name	Comment
1.	2	Beaver	*Castor canadensis*	Chewed shrubs and trails.
2.	3	Opossum	*Didelphis marsupialis*	Introduced, dead in stream.
3.	3	River otter	*Lutra canadensis*	Tracks, scat, and eaten salmon.
4.	2	Longtail weasel	*Mustela frenata*	Crossing stream on log.
5.	1, 2, 3	Myotis bat	*Myotis* spp.	
6.	2, 3	Black-tailed deer	*Odocoileus heminonus columbianus*	Tracks along stream bank; pellets.
7.	2, 3	Raccoon	*Procyon lotor*	Tracks along stream bank.
8.	2	Norway rat	*Rattus norvegicus*	Introduced.
9.	2, 3	Eastern gray squirrel	*Sciurus carolinensis*	Introduced.
10.	1, 2	Eastern cottontail	*Sylvilagus floridanus*	Introduced, dead young in nest (Reach 2).

4.5.3 Reptile and Amphibian Observations

Four reptile and amphibian species were observed in and along Little Bear Creek during field visits and surveys (Table 20). None of the species have state or federal special status. Other reptiles and amphibians not documented during this survey that could potentially be present along the Little Bear Creek corridor include: northern alligator lizard (*Elgaria coerulea*), painted turtle (*Chrysemys picta*), red eared slider (*Trachemys scripta*), common garter snake (*Thamnophis sirtalis*), western terrestrial garter snake (*Thamnophis elegans*), long-toed salamander (*Ambystoma macrodactylum*), rough-skinned newt (*Taricha granulosa*), western red-backed salamander (*Plethodon vehiculum*), ensatina (*Ensatina eschscholtzii*), western toad (*Bufo boreas*), and red-legged frog (*Rana aurora*). Both species of turtles were included due to the close proximity of several lakes to the study area.

Table 20:
Amphibian and Reptile Observations Along Little Bear Creek, Woodinville

#	Reach #	Common Name	Scientific Name	Comment
1.	3	Pacific Tree frog	*Hyla regilla*	3 in wetland near reach end.
2.	2	Bull frog	*Rana catesbeiana*	Introduced species captured next to stream.
3.	Tributary D	Northwestern salamander	*Ambystoma gracile*	Larva in small tributary.
4.	3	Northwestern garter snake	*Thamnophis ordinoides*	Near barricades at NE 195th.

4.5.4 Wildlife Habitat

Habitat in the Little Bear Creek corridor consists of wetlands, uplands, and a riparian zone. Vegetative composition in the riparian zone is discussed in detail in Section 4.4.6, Riparian Habitat. Wetland habitats include mixed forest, young deciduous, and scrub/shrub wetlands. Upland

habitats include second- and third-growth mixed forest, young alder, shrub, and open grassy areas. Exotic and invasive plant species occur both as infestations and in small, scattered clusters.

Most of the corridor in Reach 1 is disturbed shrub, dominated by Himalayan blackberry, red alder saplings, and Scotch broom. Approximately 5.1 percent of the corridor along Reach 1 consists of forested riparian habitat. An area of non-native planted species occurs in the developed area between 130th Avenue NE and NE 178th Street. The corridor is relatively narrow along this reach and provides limited wildlife habitat, although the mouth of the creek adjoins more heavily vegetated habitat along the Sammamish River and may be utilized by birds and other wildlife using the Sammamish River corridor. Red alder saplings, red-osier dogwood, and Himalayan blackberry were dominant in Reach 1 sampling plots. No snags, logs, or suitable raptor nesting or perching trees fell within sampling plots. Invasive species are common in all habitat types in the reach. The wildlife community in this reach is most likely made up of species habituated to human disturbance and able to utilize highly fragmented habitat (see Tables 18, 19, and 20 for wildlife species occurrence by reach).

Approximately 22 percent of Reach 2 is composed of young and mature deciduous forest. The remaining area is largely scrub/shrub, much of it disturbed and dominated by invasive weeds. One small area at the southeast junction of Highway 522 and SR 202 that fell within a sampling plot consisted of mature riparian vegetation, including red cedar of 61 to 76 centimeters (24 to 30 inches) DBH and several black cottonwoods and Douglas firs each approximately 61 centimeters (24 inches) DBH. Dominant species in this plot were hazelnut, big leaf maple, and Indian plum. Red alder, black cottonwood, and big-leaf maple dominate the deciduous forest in Reach 2. Common species include Himalayan blackberry, salmonberry, willow, Douglas fir, and giant horsetail. Few mature trees occurred outside of the mature forested sampling plot, although 2 snags were present on another plot. Sampling plots in disturbed riparian habitat, including young forest and scrub/shrub, were dominated by red alder, with infestations of Himalayan blackberry, Scotch broom, reed canarygrass, and other invasive species. Common native species included salmonberry, willow, and bitter cherry. The most extensive tracts of undeveloped land in Reach 2 are highly disturbed, while less disturbed areas tend to be small and highly fragmented. These areas support scattered mature trees, some red cedar along the creek, that may provide limited perching/nesting opportunities for raptors. The reach contains little breeding habitat for neotropical migrant bird species, which generally breed in forest interiors.

Reach 3 contains the highest proportion of mature trees and native species-dominated areas, as well as the most extensive tract of habitat. Deciduous and mixed forest makes up approximately 46 percent of the habitat in this reach, with the remainder in shrub and grass habitats. The reach supports potential raptor and neotropical migrant bird habitat, particularly in the northern region, where habitat is most extensive and large conifers occur more frequently. Sampling plots in Reach 3 fell into three general vegetative communities translated here into habitat types. Douglas fir, western red-cedar, big-leaf maple, and red alder dominated forested sampling plots. Common species were western hemlock, red-osier dogwood, salmonberry, trailing blackberry, willow, vine maple, red elderberry, skunk cabbage, and lady fern. Less frequent species included red huckleberry, piggyback, and Indian plum. DBH averaged approximately 71 centimeters (28 inches) for Douglas fir and western red-cedar, 41 centimeters (16 inches) for big-leaf maple, and 23 centimeters (9 inches) for red alder. Snags, stumps, and logs were more common than in the other reaches, averaging one of each per sampling plot. Young deciduous forest in Reach 3 was dominated by red alder, and western red-cedar, black cottonwood, vine maple, and salmonberry

were common. Invasive species, mainly reed canarygrass and giant horsetail, were encroaching on one sampling plot. Red alders averaged 13 centimeters (5 inches) DBH, and a few larger cottonwoods ranging from 15 to 38 centimeters (6 to 15 inches) DBH were recorded. One stump and little downed wood occurred on two plots. Shrub wetland sampled in Reach 3 consisted of alder saplings, Himalayan blackberry, reed canarygrass, evergreen blackberry, and bracken fern.

5.0 RESTORATION POTENTIAL

The Little Bear Creek watershed has changed significantly since the arrival of European settlers in the late 1800s. Although the Little Bear Creek corridor is still utilized by numerous species of fish and wildlife the quality of instream and riparian habitat has been impacted by changes in land use. Throughout this report the existing status of numerous pathways and indicators as defined by the NMFS (1996) have been documented. The determination of *properly functioning*, *at risk*, and *not properly functioning* for each "indicator" was used as a basis for the prioritization of restoration efforts. Baseline conditions determined to be *not properly functioning* are likely the most limiting conditions for salmonids and are therefore considered the highest priority for restoration followed by the conditions determined to be *at risk*. Table 21 represents a summary of the baseline conditions in Little Bear Creek as they pertain to listed salmonids. Other important considerations in prioritizing possible restoration opportunities are cost, feasibility, and probability of success.

Table 21:
Little Bear Creek Environmental Baseline Condition Summary

PATHWAY	INDICATORS	BASELINE CONDITIONS
Water Quality	Temperature	Juvenile Migration and Rearing = Not Properly Functioning to At Risk Adult Migration and Spawning = Properly Functioning
	Sediment	Not Properly Functioning
	Chemical Contamination & Nutrients	Not Properly Functioning
Habitat Access	Physical Barriers	At Risk
Habitat Elements	Substrate	At Risk
	Large Woody Debris	Not Properly Functioning
	Pool Frequency	Not Properly Functioning
	Pool Quality/Depth	At Risk (not properly functioning in Reach 1)
	Off-Channel Habitat	Not Properly Functioning
	Refugia	Not Properly Functioning
Channel Conditions and Dynamics	Width/Depth Ratio	Reach 1: Not Properly Functioning Reach 2 and 3: At Risk
	Streambank Condition	Not Properly Functioning
	Floodplain Connectivity	Not Properly Functioning
Flow/Hydrology	Change in Peak/Base Flows	At Risk
	Increase in Drainage Network	Not Properly Functioning
Watershed Conditions	Road Density and Location	Not Properly Functioning
	Disturbance History	Not Properly Functioning
	Riparian Reserve/Conservation Areas	Not Properly Functioning (at risk in Reach 3)

The NMFS matrix of pathways and indicators is divided into six major pathways each having several indicators. The following discussion on stream and riparian habitat restoration possibilities and prioritization follows this habitat component approach. Many of these indicators are interwoven in that correcting one will also improve another. An example of this is that large woody debris, riparian reserve, refugia, pool frequency and quality, streambank conditions, and substrate are all related. Another important consideration is that no single action will fully restore Little Bear Creek, and that improving existing conditions will be the result of a multitude of efforts taken over an extended period of time.

The City of Woodinville has already begun undertaking numerous restoration measures along the Little Bear Creek corridor (Appendix R). This includes land acquisition, culvert removal, fish passage improvements, and non-native plant removal. These measures, in addition to those outlined below, will help improve fish and wildlife habitat along the Little Bear Creek corridor.

5.1 WATER QUALITY

Temperature: The temperature indicator ranges from **properly functioning** to **not properly functioning** depending on time of year and life cycle of the species under consideration (see Section 4.4.7 and Table 16). Stream temperature increases as Little Bear Creek flows towards the Sammamish River. Based on the results of data collected from two hobo temperature data loggers installed at the downstream and upstream extremes of Little Bear Creek within the City of Woodinville, stream temperature typically increases by 0.4 degree Celsius within the city.

Additional data documenting the contribution tributaries and ambient air temperature makes to the overall increase of stream temperature would be beneficial in analyzing potential mitigating measures. However, increasing shade by planting conifer trees along the mainstem and tributaries to Little Bear Creek is the primary action the City of Woodinville could undertake to address this issue. The simplistic step of drastically increasing the abundance of conifers along both banks of Little Bear Creek would help increase shade and thereby reduce the rate of increase in stream temperature. Furthermore, planting conifer trees along both banks would help increase bank stability, reduce the abundance of invasive species such as reed canarygrass, provide wildlife habitat, reduce sedimentation, and eventually provide LWD and habitat complexity.

Sediment: The sediment indicator is **not properly functioning** due to a high percentage of fines within the substrate. Primary sources of sediment include stormwater runoff from upland sources such as roads and disturbed areas that directly enter Little Bear Creek or its tributaries, eroding and sloughing banks, and upstream sources. Remedies to reduce the percent of fines within the substrate include best management practices (BMPs) associated with construction projects, bank stabilization efforts, stormwater impact reduction measures, and isolated sediment removal measures from potential spawning areas or introduction of quality spawning gravel (typically not practicable). The most practicable measures the City of Woodinville could undertake to address this issue include bank stabilization efforts utilizing native vegetation, increasing the enforcement and use of BMPs, and working with Snohomish County to address upstream sources.

Chemical Contamination and Nutrients: The chemical contamination and nutrients indicator is **not properly functioning** (Table 21). This determination was based primarily on high fecal

coliform levels (a 1998 303[d] listing), the presence of pesticides, and the presence of metals in sediment samples collected in Reach 1.

The presence of high fecal coliform levels in Little Bear Creek is likely the result of failing septic tanks and runoff from fields with livestock. Both of these potential sources appear to be restricted to the upper portions of Little Bear Creek in Snohomish County and therefore not within the jurisdiction of the City of Woodinville to correct. The source of pesticides in Little Bear Creek may also be the result of actions occurring in the upper watershed.

The presence of metals is likely the result of road runoff entering Little Bear Creek through stormwater runoff in tributaries and direct discharge of stormwater from retention/detention facilities throughout the watershed. However, no existing data on metal concentrations from various potential sources exists. Therefore, identification of priority sites that contribute the highest metal concentrations to Little Bear Creek would need to be initiated prior to the initiation of corrective actions. Junk and construction yards located in Reach 2 and 3, and immediately north of King County may also contribute to the high metal concentrations in Little Bear Creek. An alternative to investing money and time into additional data collection is to insert catch-basin filters in high capacity parking lots that have the highest probability of contributing pollutants. Existing stormwater catch basins can be fitted with filter systems designed to capture priority pollutants such as soluble metals. The overall cost of installing and maintaining catch basin filters depends on the quantity of systems installed. The installation of catch basins would not eliminate existing contamination, but would reduce the rate of future accumulation.

5.2 HABITAT ACCESS

Habitat Access is **at risk**, and therefore not an imminent concern (Table 21). Both the City of Woodinville and Snohomish County are currently addressing habitat access concerns at 132nd Avenue NE and NE 205th Street (Appendix R). The predominance of the culverts identified as potential barriers to fish passage by the Adopt-A-Stream foundation are in Snohomish County and therefore outside of the jurisdiction of the City of Woodinville to correct.

Although the 134th Avenue NE crossing is not currently a fish passage barrier to migrating adult salmonids, they do stack-up immediately downstream of the crossing. The City of Woodinville should investigate the feasibility of purchasing the wrecking yard on the west side of Little Bear Creek serviced by this crossing. If this lot could be purchased several stream enhancement opportunities could occur. The first goals would be to remove soil contaminants within the lot and remove all structures. The second goal would be to use this crossing for enhancement efforts between Little Bear Creek and Highway 522 within Reach 2. Once these actions were completed the crossing could be permanently removed.

5.3 HABITAT ELEMENTS

Four of six indicators of the Habitat Elements pathway are **not properly functioning** (Table 21). Indicators that are **not properly functioning** include LWD, pool frequency, off-channel habitat, and refugia. Although the substrate indicator is **at risk** versus **not properly functioning**, the status of this indicator is also a concern due to its impact on salmonid reproduction.

The lack of LWD plays a major role in decreasing pool frequency and the availability of refugia. The importance of LWD in creating and maintaining pool frequency and refugia is so vital that this may be the single most important habitat element requiring immediate attention in Little Bear Creek. Furthermore, because the riparian zone along Little Bear Creek does not contain adequate numbers of large conifers for LWD recruitment, this indicator will remain **not properly functioning**. The addition of LWD by mechanical means in itself is simplistic and only moderately expensive. However, streamside access and uncertainty in obtaining desired results can create problems. These facts limit the applicability of installing LWD or creating pool habitat. However, some areas with good access are present, and careful design and implementation can increase the probability of success. Sites where access is good include most of Reach 1, within Reach 2 near 132nd Avenue NE and 134th Avenue NE, and within Reach 3 immediately upstream of NE 195th Street. Additional sections of stream could be accessed along Highway 522.

Another important issue is the availability of future recruitment of LWD. Large conifer trees that could potentially add to the presence of instream LWD are lacking along the Little Bear Creek corridor. The only way to address this issue is to plant thousands of conifers along the riparian corridor. Although the time-delay between planting conifer saplings and achieving LWD recruitment would be many decades, this action is necessary for the long-term interest of Little Bear Creek. Because of this time-delay, the planting of conifers is of the highest priority. Additional actions associated with this effort include the removal of non-native and invasive species to facilitate conifer establishment, and long-term monitoring. Additional value is created by this action since planting conifers along the riparian zone will increase bank stability, shade, and wildlife habitat. The entire remaining vegetated corridor along Little Bear Creek is in need of immediate and intensive planting of conifer saplings.

Restoring or improving pool frequency above what would result from the placement of LWD in accessible locations is problematic and costly. Two sites where stream restoration efforts could be undertaken include the lowermost section of Reach 1 and within Reach 3 immediately upstream of NE 195th Street (Appendix G). Both of these sites are fully armored, linear, lack LWD, and consist of low-gradient riffle habitat. Because these sites are degraded, owned by the city, and accessible, they are deemed the best candidates for intensive site specific restoration efforts that could address a multitude of the indicators for the Habitat Elements pathway that are not properly functioning. Primary actions that could occur at these sites include removal of bank armoring, creation of refugia and off-channel habitat, creation of pool habitat, revegetation, and installation of LWD.

Off-channel habitat can also be used as refugia by juvenile salmonids. Off-channel habitat could be created as part of the site specific restoration plan that would be developed for the two stream restoration sites mentioned above. Another simplistic and relatively inexpensive measure that would create additional off-channel habitat and refugia would be to reduce the length of two or three culverts that currently extend into the active stream channel located in Reach 2 (Appendix D – Reach 2 Photos 10, 12, 17, 20, and 21). These culverts drain the unnamed tributaries within the City of Woodinville as shown on Figure 3. The idea here is to cut each culvert back as far as possible into the adjacent uplands for a distance of at least 6 meters (>20 feet) so that new off-channel habitat (and wetlands) is created where culverts and their associated fill material currently exists. The newly exposed area would need to be graded to the stream's

base-flow level and planted with native hydrophytic vegetation. LWD could also be installed at these sites to increase their overall functionality.

5.4 CHANNEL CONDITIONS AND DYNAMICS

Two indicators of the Channel Conditions and Dynamics pathway that are **not properly functioning** include streambank condition and floodplain connectivity. Streambank conditions can be improved by replacing non-native and invasive species with conifers as mentioned previously. Extensive sections of the streambank, especially between Little Bear Creek and Highway 522 could be greatly improved. The removal of armoring in conjunction with revegetation in the lower section of Reach 1 near the mouth and immediately upstream of NE 195th Street will also help to improve streambank conditions.

Floodplain connectivity relates to hydrologic linkage between Little Bear Creek and adjacent off-channel areas, wetlands, riparian vegetation, and succession. No connectivity occurs where stream armoring is present or the stream is abutted by development. No other areas were identified where floodplain connectivity could be increased except as where previously mentioned.

5.5 FLOW/HYDROLOGY

The Flow/Hydrology pathway includes two indicators that were identified as **not properly functioning**. The percent impervious surface within the watershed and abundance of man-made drainage networks are the primary factors influencing this pathway. The two actions that can improve this pathway include reducing the percent of impervious surface, and improving or creating retention/detention facilities within the watershed. The preservation and restoration of existing habitat are critical in protecting against the continued degradation of this pathway. These issues are watershed-wide problems that extend far beyond the Little Bear Creek corridor. Because of the scale of this issue, it is most appropriately dealt with through the implementation of the Growth Management Act (GMA), Shoreline regulations, and city and county codes throughout the Little Bear Creek watershed. However, retrofitting of stormwater retention/detention facilities and elimination of impervious surface should be undertaken whenever the opportunity arises. Actions that reduce the speed at which stormwater travels through existing ditch networks to Little Bear Creek will further reduce the flashy conditions of the existing hydrographs (Figures 5a through 5c).

5.6 WATERSHED CONDITIONS

All indicators for the Watershed Conditions pathway including road density and location, disturbance history, and riparian reserve/conservation areas are **not properly functioning**. With the exception of the riparian reserve/conservation areas indicator (previously addressed), the remaining indicators are influenced primarily by the total amount of impervious surface within the watershed. As was the case with the Flow/Hydrology pathway, this issue is most appropriately dealt with through the implementation of the GMA, Shoreline regulations, and city and county codes throughout the watershed.

Table 22 below summarizes the pathway, indicator, priority, and action for each baseline condition identified as *not properly functioning*. Included in Table 22 are indicators that may have been partially *properly functioning* or *at risk* in one reach or for a specific life history (adult

migration/spawning) but otherwise *not properly functioning*. The priority of each indicator was determined based on time required to achieve desired results, degree of additional benefit, potential for success, and feasibility. Several of the indicators will benefit from the same basic action (e.g. installation of LWD and planting conifers). Although prioritized, the actions required to address these conditions in Little Bear Creek should occur simultaneously.

Table 22:
Not Properly Functioning Baseline Conditions Summary

PATHWAY	INDICATORS	Priority	Basic Action
Water Quality	Temperature	Medium	Plant conifers in riparian zone to increase shading.
	Sediment	Medium	Stabilize problem areas (e.g. LB of Reach 2), stabilize banks, reduce/eliminate upland sources, clean substrate (not practicable).
	Chemical contamination and nutrients	Medium	Identify key sources and implement corrective actions at sources.
Habitat Elements	Large Woody Debris	High	Install LWD and plant conifers for future recruitment.
	Pool Frequency	Medium	Will increase through installation of LWD
	Off-Channel Habitat	High	Create through LWD and retracting culverts
	Refugia	High	Create through LWD and retracting culverts
Channel Conditions and Dynamics	Width/Depth Ratio	Low	Remove armoring and taper back, and address incision resulting from changes in hydrology.
	Streambank Condition	High	Remove non-natives & plant > 10,000 conifers
	Floodplain Connectivity	Medium	Protect and restore corridor
Flow/Hydrology	Increase in Drainage Network	Medium	Reduce ditching and impervious area.
Watershed Conditions	Road Density and Location	Medium	Limit new roads and remove unnecessary ones
	Disturbance History	Medium	Protect and restore corridor
	Riparian Reserve/Conservation Areas	High	Remove non-natives, plant > 10,000 conifers, preserve existing habitat, and acquire more.

In summary, several key actions could potentially improve existing habitat conditions in Little Bear Creek. These recommended actions include:

1. Obtain, preserve, and enhance land along Little Bear Creek to minimize further habitat degradation from continued development along the Little Bear Creek corridor. Undeveloped properties along the corridor with quality riparian habitat should be high priority acquisitions, such as, the properties to the north of the City's "Lumpkin" property (east of 134th Avenue NE crossing). Another area to consider would be the properties to the west of 134th Avenue NE as described in item 7.
2. Immediately initiate a program to reestablish conifers within the riparian zone throughout the Little Bear Creek corridor.
3. Restore hardened rip/rap banks along Little Bear Creek. Include creation of pool habitat, and addition of large woody debris as part of the restoration plan.
4. Retrofit potential pollution-generating sites such as large parking lots and roadways with pollution prevention and storm flow retention facilities where such facilities are presently absent.

5. Reforest upland areas dominated by introduced species such as reed canarygrass and Himalayan blackberry.
6. Create off-channel habitat at each culverted tributary confluence with Little Bear Creek. This can be accomplished by daylighting the maximum extent of culverted tributary possible at each confluence.
7. The City of Woodinville should investigate the feasibility of purchasing the wrecking yard on 134th Avenue NE along the west side of Little Bear Creek. If this lot could be purchased several stream enhancement opportunities could occur. The first goals would be to remove soil contaminants within the lot and remove all structures. The second goal would be to use this crossing for enhancement efforts between Little Bear Creek and Highway 522 within Reach 2. Once these actions were completed the 134th Avenue NE crossing could be permanently removed, or converted to a bridged crossing.
8. The newly purchased city property immediately upstream of NE 195th Street is an ideal site for intensive in-stream, riparian, and upland habitat restoration activities. Actions that would benefit Little Bear Creek at this site include removal of bank armoring, creation of pool habitat, removal of impervious surface (pavement) and non-native vegetation, and installation of large woody debris, riparian vegetation, and upland vegetation.
9. Maintain regular street sweeping, storm drainage system cleaning, and add sediment traps where feasible. This will reduce the amount of sediment entering Little Bear Creek.

5.7 WILDLIFE HABITAT

The Little Bear Creek corridor was originally dominated by large expanses of old-growth forest composed of primarily conifers. These forests were extensively logged throughout the late 1800s and early 1900s and subsequently converted to agricultural land. More recently, agricultural land has rapidly been replaced with an urban landscape. Wetlands adjacent to the Sammamish River were historically extensive but were later filled to reduce flooding and create more developable land. Habitat features such as snags, downed wood, large conifers with a multi-canopy understory, and large wetland complexes are now uncommon or absent along the Little Bear Creek corridor.

Because the existing landscape has been significantly degraded from native conditions, numerous wildlife habitat enhancement opportunities exist. Based on our survey results, five primary actions that would improve wildlife habitat have been identified including:

1. Replacement of existing reed canarygrass, Himalayan blackberry, and scotch broom expanses with native vegetation.
2. Addition of conifers and mast (food) producing shrubs within existing deciduous dominated forest habitat.
3. Addition of downed woody debris to the forest floor.
4. Wetland creation within the corridor.
5. Installation of bird boxes for cavity nesting species.

The first four actions would help create more natural conditions conducive to native wildlife species. These four actions would benefit wildlife by creating suitable habitat, and Little Bear Creek by improving buffer functions. The installation of bird boxes is presented as a temporary measure to provide habitat for cavity nesters until other restoration efforts are able to reestablish suitable cavity nesting sites.

Numerous opportunities for wildlife habitat enhancement exist along the Little Bear Creek corridor in the City of Woodinville. Non-native plant removal opportunities exist along all reaches of the creek. The south end of Reach 1 is highly disturbed and in need of restoration. Little cover exists and non-native plants, which generally provide poor wildlife habitat, are common. The creek in the remainder of Reach 1 is closely bordered by development and would also benefit from restoration, as the existing vegetation provides little cover for wildlife.

The south end of Reach 2 in the vicinity of 132nd Avenue NE also has habitat enhancement opportunities. Shrub habitat on the left bank between 132nd Avenue NE and 134th Avenue NE is heavily infested with Himalayan blackberry, reed canarygrass, and other invasive species and is in need of weed removal and enhancement. Large areas of Himalayan blackberry and Scotch broom exist on the right bank beyond the riparian strip. The area from 134th Avenue NE to the north end of Reach 2 would benefit from the removal of reed canarygrass and other exotics, followed by restoration and enhancement. Although it is highly disturbed, the corridor is relatively wide in the middle stretch of Reach 2 and could potentially provide habitat for birds and mammals. Access to the right bank is difficult because of thick blackberry. The riparian zone becomes very narrow and shade and cover decrease from south to north. The north end of Reach 2 in particular would benefit from habitat restoration, as there is currently only sparse tree cover.

The portion of Reach 3 below NE 195th Street is bordered by private property on the right bank and Highway 522 on the left bank, and accessibility is poor. The area along Highway 522 is densely vegetated with Himalayan blackberry, and intensive clearing would be necessary to access and enhance this area. Private ownership along the left bank (east side) could hinder restoration attempts along this segment.

A shrub area accessed by a gravel lot off of 136th Avenue NE immediately north of NE 195th Street has good access and potential to provide wildlife habitat. The area is adjacent to a stand of mixed forest, which supports scattered large conifers and could provide a corridor for wildlife using the shrub area. Restoration of the gravel lot and adjacent areas would likely provide additional habitat for wildlife using the corridor north of this point.

Wildlife habitat improves with the increase of forest in the northern portion of Reach 3. Abundance of potential nesting and perching trees increases northward, and the corridor increases in width. The middle of Reach 3 is accessible from 136th Avenue NE, and this area provides opportunities for habitat improvement. Weed removal and the addition of native trees and shrubs to upland clearings outside of the riparian zone would enhance habitat in this area. While much of the forested area is young deciduous trees, larger trees increase in number to the north. This area might benefit most from the preservation of large conifers and tracts of forest.

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APPENDICES