AQUATIC MACROINVERTEBRATE INVENTORY AND RTE ASSESSMENT

WELLS HYDROELECTRIC PROJECT

FERC NO. 2149

June, 2006

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ABSTRACT

This study was initiated to provide baseline information on the aquatic macroinvertebrate fauna and mollusks in the Wells Project. This aquatic macroinvertebrate inventory was conducted in order to characterize the aquatic macroinvertebrate and mollusk assemblage found within the Wells Project and in order to provide information on the possible occurrence of rare, threatened and endangered (RTE) macroinvertebrate species potentially occurring within the Wells Project. Additional objectives of the study include describing habitat associations and qualitative abundance for various species categories of macroinvertebrates.

In order to achieve these objectives, benthic macroinvertebrates were sampled within representative habitats throughout the Wells Project. The abundance and richness of the aquatic macroinvertebrate fauna varied according to habitat. There were eighty-eight different taxa observed in the study area with the most abundant and diverse taxa observed in littoral areas of fast and slow water habitats. Fast water areas were more abundant but generally had the same taxa richness as slow water habitat. Macroinvertebrate abundance in slow water littoral areas varied from 231 to 683 organisms per sample and fast water varied from 5,224 to 9,184 organisms per sample. Deepwater site abundance in the Columbia River ranged from 5 to 295 organisms per sample. In littoral areas, chironomids were consistently one of the most dominant taxa but other taxa were also important such as Gastropoda, Annelida, Crustacea, and Trichoptera. Similar taxa were important in the Methow and Okanogan rivers.

There were seventeen different mollusk species identified in the Wells Project. Of these seventeen species, nine were gastropods and eight were bivalves. The gastropods included eight native species and one non-native snail. The bivalves included seven native species and one non-native clam. There were two Washington State candidate species, the Columbia River spire snail and Columbia River limpet, found in the Methow River in relatively clean and complex substrate. The Columbia spire snail was also found in the Okanogan River in areas that once appeared to be riffle habitat. At these locations the water was approximately 2-meters deep and the substrate was mostly sand with fines, gravel, and cobble. These mollusks were not abundant at either site and in most instances were identified from shell fragments or dead organisms. No Federal ESA listed or Federal candidate macroinvertebrates or mollusks were found during the study.

1.0 INTRODUCTION

1.1 General Description of the Wells Hydroelectric Project

The Wells Hydroelectric Project is located at river mile (RM) 515.8 on the Columbia River in the State of Washington. Wells Dam is located approximately 30 river miles downstream from the Chief Joseph Project, owned and operated by the United States Army Corps of Engineers, and 42 miles upstream from the Rocky Reach Hydroelectric Project owned and operated by Chelan County PUD. The nearest town is Pateros, Washington, which is located approximately 8 miles upstream from the Wells Dam.

The Wells Project is the chief generating resource for Douglas PUD. It includes ten generating units with a nameplate rating of 774,300 kW and a peaking capacity of approximately 840,000 kW. The design of the Wells Project is unique in that the generating units, spillways, switchyard, and fish passage facilities were combined into a single structure referred to as the hydrocombine. Fish passage facilities reside on both sides the hydrocombine, which is 1,130 feet long, 168 feet wide, with a crest elevation of 795 feet in height.

The Wells Reservoir is approximately 30 miles long. The Methow and Okanogan rivers are tributaries of the Columbia River within the Wells Reservoir. The Wells Project boundary extends approximately 1.5 miles up the Methow River and approximately 15.5 miles up the Okanogan River. The normal maximum surface area of the reservoir is 9,740 acres with a gross storage capacity of 331,200 acre-feet and usable storage of 97,985 acre feet at elevation of 781. The normal maximum water surface elevation of the reservoir is 781 feet (Figure 1.1-1).

The purpose of this study is to provide biological information as a baseline inventory on aquatic macroinvertebrates in the Wells Project. This study is one of several studies that have been implemented in order to assess baseline environmental conditions prior to relicensing the Wells Project.

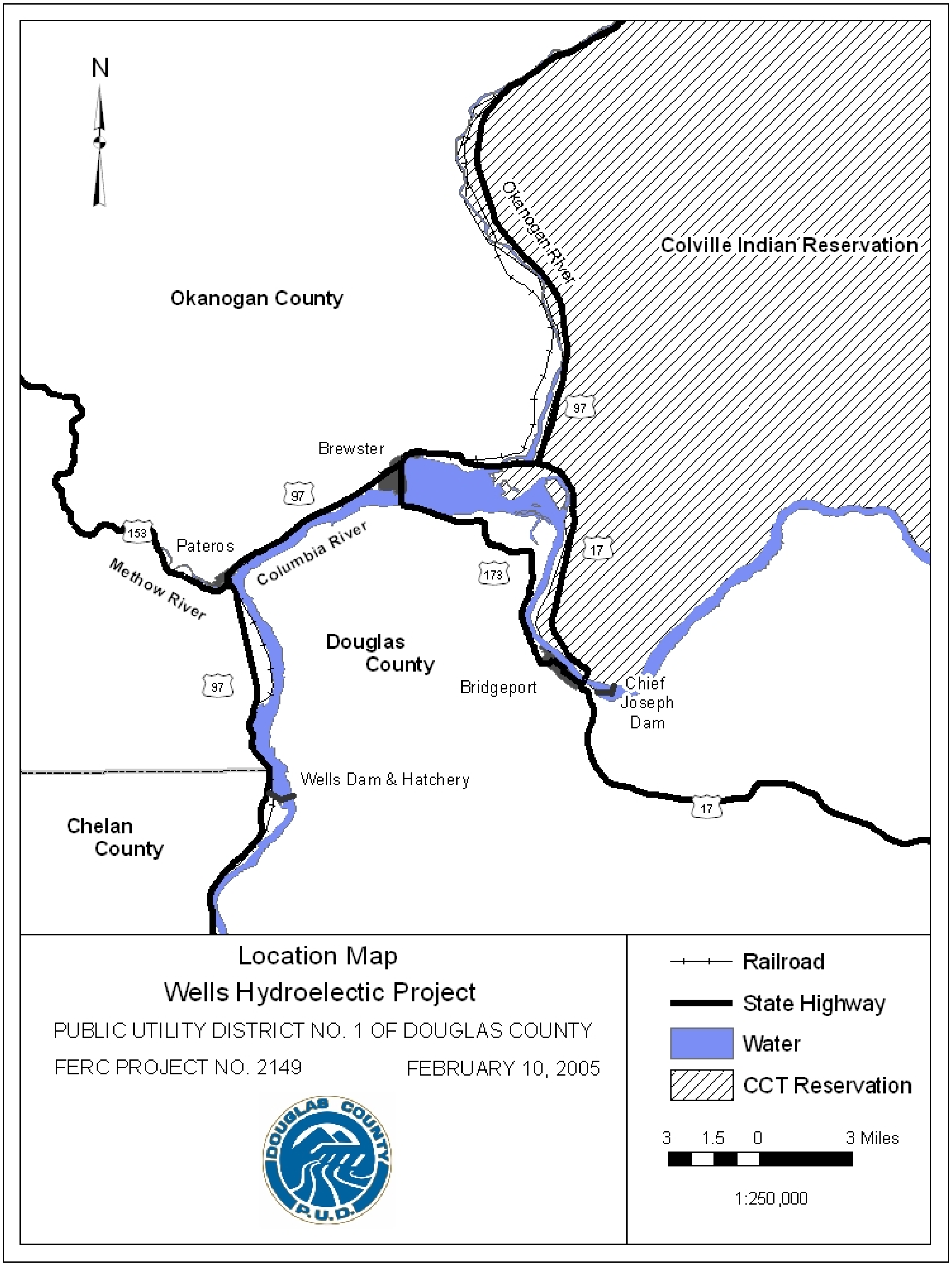

Figure 1.1-1 Location Map of the Wells Project

2.0 GOALS AND OBJECTIVES

The purpose of this study is to provide biological information as a baseline inventory on aquatic macroinvertebrates in the Wells Project. This study is one of several studies that have been implemented in order to assess baseline environmental conditions prior to relicensing the Wells Project. The goal of this study is to determine the current aquatic macroinvertebrate assemblage in the Wells Project. Specific objectives include:

1. Implement a rare, threatened, and endangered (RTE) species assessment in the Wells Project.
2. Collect aquatic macroinvertebrates from representative habitats within the Wells Project.
3. Identify aquatic macroinvertebrates (e.g. bivalves, gastropods, and insects) to the genus taxonomic level.
4. Provide habitat associations for aquatic macroinvertebrates by descriptive and quantitative measures of physical habitat characteristics (i.e., velocity, substrate, depth, etc).
5. Provide qualitative abundance (i.e., rare, common, abundant) for species categories within the Wells Project.

Based on literature review, there are three mollusks species that may occur in the Wells Project that have been listed as species of concern in Washington State. State and Federal status are provided in Table 2.0-1. An RTE assessment will provide a better understanding of the occurrence and habitat requirements of these species in the Wells Project.

Table 2.0-1 State and Federal status for mollusks that may occur in the Wells Project Area

		Status	
Common Name(s)[1]	**Scientific Name[2]**	**State**	**Federal**
Giant Columbia River Limpet Shortface Lanx	*Fisherola nutalli*	State Candidate	None
Giant Columbia Spire Snail Columbia Pebblesnail Ashy Pebblesnail	*Fluminicola columbiana =(fuscus)*	State Candidate	Species of Concern
California Floater	*Anodonta californiensis*	State Candidate	Species of Concern

[1] . Other common names for the Columbia River Limpet and Columbia Spire Snail are provided.

[2] . *Fluminicola columbiana* is now recognized as *F. fuscus* (Turgean et al. 1998).

3.0 STUDY AREA

The study area includes the Wells Reservoir from Wells Dam to the tailrace of Chief Joseph Dam. The Wells Reservoir is approximately 30 miles long extending from the forebay of Wells Dam to the tailrace of Chief Joseph Dam on the Columbia River and includes 1.5 miles of the lower Methow River and 15.5 miles of the lower Okanogan River. The tailrace waters just downstream from Wells Dam are included in the study area; however, the analysis of aquatic macroinvertebrates will primarily rely on data collected in the tailrace as part of a previous study (DE&S and RL&L, 2000).

4.0 BACKGROUND AND EXISTING INFORMATION

Aquatic macroinvertebrates are organisms like aquatic insects, worms, clams, snails, and other animals without backbones that can be seen without the aid of a microscope. Aquatic macroinvertebrates can inhabit a diverse array of habitats including streams, wetlands, springs, lakes, and reservoirs. The abundance and diversity of aquatic macroinvertebrates has been used as an indicator of ecosystem health and of local biodiversity (Plotnikoff and Ehinger 1997).

There is limited information on the RTE species that may occur in the Wells Project. There has been some baseline inventory information collected on aquatic macroinvertebrates in the upper Columbia River in the Rocky Reach reservoir (DE&S and RL&L 2000). There were no RTE species found in Rocky Reach reservoir. However, recent surveys in the Methow and Okanogan rivers, upstream from the Wells Project, have confirmed the presence of the Columbia pebblesnail and the shortface lanx (Neitzel and Frest 1990). Most collections of these mollusks have occurred in only a few sites: the Hanford Reach of the Columbia River, Washington; Black Canyon of the Payette River, Idaho; and the Deschutes River, Oregon. The Columbia pebblesnail is mostly found living in oligotrophic, hard-substrate, swift-flowing habitats, mostly in larger streams. Similarly, the shortface lanx is found mostly on boulders and cobbles in clear, cold, swift, and large streams.

The California Floater is declining throughout much of its former range and the species current distribution is not well known (Larsen et al. 1995). There have been only a few sites from which there are recent records of live California floaters and they include: portions of the Columbia and Okanogan rivers, Curlew Lake (Frest and Johannes 1993), and several ponds adjacent to the Columbia River downstream from the Hanford reactor sites (Pauley and Nakatani 1968). None of these locations include the Wells Project. The California Floater is mostly reported in rivers or river lakes in relatively stable, oxygenated mud, sand, or fine gravel beds, often located in pools just downstream from rapids. Larsen et al. (1995) suggest that the California Floater requires a relatively stable substrate so it is not buried and/or suffocated by shifting sediments.

5.0 METHODOLOGY

In autumn 2005, aquatic macroinvertebrate fauna were sampled throughout the Wells Project. Sample sites were selected to represent a variety of habitats and physical attributes. These habitats and physical attributes were selected within three major geographic areas of the Wells Project. These three areas were all within the Wells Reservoir and consisted of the Columbia

River portion of the Wells Reservoir and the inundated portions of the Methow and Okanogan rivers.

5.1 Site Description

Onsite field reconnaissance and bathymetric maps were used to select sampling stations among the diverse habitats of the Wells Project. Sampling areas were selected in the field to describe potential communities based on physical attributes (i.e., depth, substrate, and velocity) that might dictate the diversity and abundance of benthic macroinvertebrates and mollusks. The major geographic areas of the Wells Project were further stratified into zones such as littoral, pelagic/profundal, and riverine. The littoral zone was characterized as areas that extended from the shore just above the influence of waves and spray to a depth where light was insufficient for rooted aquatic vegetation (Goldman and Horne 1983). The pelagic or profundal zone was characteristic of deep water areas that extend beyond the littoral zone. The section of the Methow and Okanogan rivers within the Wells Project boundary was described as riverine because there was less variation in depth.

Another major difference in habitat is often associated with water velocity that can be described as fast water and slow water habitat types. To describe the immediate sampling area, Hawkins et al. (1993) level I classification was used to characterize stream habitat as either fast water or slow water areas. In general, fast-water areas tend to have larger substrate, more turbulence, a narrower stream channel, and higher stream gradient. Conversely, slow-water areas tend to be less turbulent, have smaller substrate, and a wider stream channel. Substrate composition was visually estimated based on the percentage of different size categories (Peck et al. 2001). The size categories used to describe the diameter of the substrate were: fines (<0.06mm), sand (0.06-2.0mm), gravel (2-64mm), cobble (64-250mm), and boulder (250-4000mm). In addition, at each sampling station water column depth, water temperature (°C), and the presence of aquatic macrophytes was noted.

A Hydrolab minisonde multimeter was used to collect basic water quality information during the study. This on-site information was augmented with more detailed information from the implementation of the Wells Project Comprehensive Limnological Investigation (EES Consulting, 2006) which was conducted during the same time period. In the following sections, the sampling areas and techniques used to assess aquatic macroinvertebrate assemblages in the Wells Project are described.

5.2 Benthic Macroinvertebrates

Benthic macroinvertebrate fauna were sampled in the Wells Project with colonization baskets, petite ponar grabs, and a suction device. Colonization baskets were placed at five locations throughout the Columbia River in late September to sample littoral areas of the Wells Project (Table 5.1-1). The colonization baskets were constructed similar to other baskets used in a previous study to sample macroinvertebrate fauna in the Rocky Reach Reservoir (DE&S and RL&L 2000). Each square basket was made of semi-rigid plastic mesh netting that measured 15x15x15 cm. The baskets were filled with gravel and cobble substrate. At each sample location, five substrate filled baskets were placed in a straight line extending out from the shoreline perpendicular to stream flow. The baskets were placed in good contact with the local substrate and evenly spaced to allow water flow around each basket. Placement of the colonization baskets on the river bottom allowed bottom-dwelling invertebrates as well as drifting animals to colonize the substrates. Flagging was attached to at least one basket to help SCUBA divers retrieve the baskets at a later date. Colonization baskets were retrieved in late October approximately 35 days after they were deployed. All five baskets were retrieved and placed in a large bucket where the substrate and baskets were scrubbed to remove aquatic macroinvertebrate fauna. The sample material was then sieved (500 μm) and preserved with 70% ethyl alcohol.

Petite ponar samples were taken from six stations throughout the Wells Project (Table 6.1-1). Petite ponar samples were taken at either deep or slow water habitats where silt and sand were the dominant substrate types. At each location, five petite ponar grabs were combined as one sample for each station. The petite ponar sampler used in this study had a maximum sample volume of 2.4 liters so the maximum volume of substrate sampled at each station was approximately 12 liters. Each petite ponar grab was placed into a bucket and sieved through a 500 µm mesh. After all five petite ponar grabs were sieved; benthic macroinvertebrates were combined into one sample and placed into a labeled sample bottle prepared with 70% ethyl alcohol. Substrate composition was qualitatively estimated from the material retrieved from all ponar grabs collected at each station. Depth (meters) was reported from a depth sounder when the boat was positioned at the sampling station.

A suction device was used to sample benthic macroinvertebrates within a one square meter area quadrat to a depth of approximately 15 cm below the sediment-water interface. Aluminum conduit about 2 cm in diameter was cut and bent to form a single square meter sampling quadrat. This active sampling technique was used at three of the five stations where colonization baskets were deployed to provide complimentary information on mollusks and other benthic macroinvertebrates. The suction device consisted of an aluminum pipe 3.8 cm in diameter and 68.5 cm long. One end (the extraction end) of the aluminum pipe was cut at a 45º angle and the other end was fitted with a cam-lock to extend the tube if needed. A handle was attached to the body of the device to help control the movement and a valve was used to regulate the amount of air infused into the pipe. A portable air compressor supplied air through a hose that was coupled to the suction device. At the distal end of the pipe a fine-mesh collection bag held the sample. Small substrates (fines and sand) were suctioned from the quadrat and screened through the sample bag while larger substrate was held up to the nozzle of the suction device and scrubbed with a hand brush. The total volume of substrate sampled equaled approximately 0.15 cubic meters. All benthic macroinvertebrate samples were internally-tagged and shipped to the processing laboratory (EcoAnalysts, Moscow, ID). Analytical results are presented in Appendix A and B for benthic macroinvertebrate sampling locations.

5.3 Mollusks

To accomplish the RTE assessment portion of the study, mollusks were sampled in the Columbia, Okanogan and Methow rivers with an airlift suction device. The same suction device that was used to provide complimentary information at colonization basket sites was used to sample mollusks. However, the suction device was used more intensively to search for RTE species. Instead of a single 1 square meter sample quadrat there were seven randomly selected quadrats used for collecting mollusks along a 40-meter transect. These seven randomly selected quadrats were intensively sampled by removing the top 15 cm of substrate with the suction device. In addition, SCUBA divers collected other visible mollusks as they inspected areas adjacent to each transect.

Sample locations for mollusks were based on general habitat preferences noted in the literature for Washington state candidate species and Federal species of concern (pebblesnail, California floater, and shortface lanx). The information suggested that stable environments with clean, flowing, well-oxygenated water were important (Neitzel and Frest 1990; Larsen et al. 1995; Clarke 1981). Preferences for substrate appeared to vary depending on the organism or life stage but typically gravels, boulders, and sand/mud were noted depending on how the organism was attached or secured to the bottom and the method of feeding (filtering or scraping). Snorkeling and SCUBA observations provided useful information on different habitat attributes within the Wells Project. Final selection of all areas was based on habitat and some evidence of mollusks (live specimens or shells).

Mollusk samples were collected at two sites each in the Columbia, Methow and Okanogan rivers within the Wells Project. Samples from each transect were sieved (500 micron screen), combined, preserved in 70% ethyl alcohol, and sent to the processing laboratory (Deixis Consulting, Seattle, WA). Analytical results are presented in Appendix C.

5.4 Field and Laboratory Techniques

Field collection methods followed procedures outlined in Plotnikoff and White (1996) to ensure that all samples were collected with the greatest quality assurance (QA). Because the purpose of this study was to provide a qualitative assessment of aquatic macroinvertebrates in the Wells Project, artificial substrate sampling procedures also included collections by SCUBA divers. These collections were used to enhance taxa representativeness by sampling within the substrate, which could reveal distinct or less abundant organisms in the substrate. QA/QC procedure was also important for sample processing, handling, sorting, preserving, identifying, and storing samples to meet or exceed guidelines established by federal and state agencies (Plotnikoff and White 1996; Plotnikoff and Ehinger 1997).

Aquatic macroinvertebrate samples were sent to different analytical laboratories. Benthic macroinvertebrate samples were sent to EcoAnalysts, Inc. in Moscow, ID. Mollusk samples were sent to Dr. Terrence Frest at Deixis Consulting in Seattle, WA. In both laboratories, all samples were inspected to make sure the containers were intact and properly preserved. The samples were inventoried and checked against the sample collection list.

For benthic macroinvertebrates, all materials from a sample were combined in a Caton tray and floated in water. A Caton tray is a large sampling tray with grids and a sieve bottom. Large debris was rinsed, inspected for macroinvertebrates, and discarded after being inspected by another technician. The remainder of the sample was repeatedly rinsed and sifted to remove macroinvertebrates and organic matter from inorganic sediments. The material was then sifted through a 500 micron sieve and any remaining inorganic sediments were inspected for macroinvertebrates too heavy to float off (e.g. mollusks, snails, stone-cased Trichoptera). Sample material was then evenly distributed throughout a sampling tray and inspected to determine the relative organism abundance. Samples with relatively few individuals were completely sorted. Samples with abundant organisms were subsampled by randomly selected squares. In subsampling, the fraction of squares sorted was recorded. The samples were sorted using a dissecting microscope (10X minimum magnification). Extracted macroinvertebrates were placed in labeled vials containing 70% ethanol and stored pending identification. Macroinvertebrates were identified to the lowest possible taxonomic level and counted (see Appendix A). Biological metrics (richness, community composition, taxa dominance, and biotic indices) were also calculated (see Appendix B).

At the laboratory, mollusk samples were sifted through a series of Taylor standard brass sieves to 40 mesh (<0.5mm). Mollusks were removed under a Leica Mz 7.5 binocular dissecting scope and retained in 95% ethanol. Picking was done at low power and the residues, insects, etc. retained under alcohol. Mollusks were segregated by species, identified, and stored in labeled bottles. After identification and enumeration, all material, including substrate, insects, mollusks, etc. were returned to the original sample bottles and stored in the original preserving fluid.

5.5 Data Analysis

For benthic macroinvertebrates, samples were analyzed to determine their abundance, taxa richness, community composition, and biotic indices (see Appendix B). For mollusks, species richness and qualitative abundance was provided for each sample site from both live and dead intact organisms as well as partial shell fragments (see Appendix C).

6.0 RESULTS

6.1 Benthic Macroinvertebrates

6.1.1 Site Descriptions

Habitat varied by depth, velocity, substrate, and presence of aquatic macrophytes in sampling sites of the Columbia River. Table 6.1-1 presents habitat features noted at each sampling site. Five sites were located in the Columbia River in the shallow littoral zone of the reservoir. Essentially, these sites were located in the zone that extends from the shore just above the influence of waves and spray to a depth where light is insufficient for rooted aquatic vegetation (Goldman and Horne 1983). Three sites were located in slow water depositional areas dominated by small substrates and extensive aquatic macrophyte beds. These three sites were indicative of most of the reservoir downstream from the confluence of the Okanogan River. The two remaining sites were located in fast water areas dominated by larger substrate with little or no aquatic macrophytes. These sites typify the area downstream from Chief Joseph Dam to the confluence of the Okanogan River. Two additional sites in the Columbia River were located in the deep water areas of the reservoir. These sites were characteristic of the pelagic/profundal zone or deep-water areas that extend beyond the littoral zone. Four sites were sampled in the riverine habitat of the Methow and Okanogan rivers. At these sites, major differences in habitat were associated with substrate composition and the presence of aquatic macrophytes.

Information collected from the 2005 comprehensive limnological study was used to describe water quality at the time benthic surveys were conducted (EES Consulting, 2006). During the study, mean September water temperature in the Wells Project was 18.9°C in the Columbia River and 18.8°C in the Okanogan River. Water temperature data was unavailable in the Methow River for September. Stream temperature in the Columbia River was fairly uniform and did not stratify with depth (EES Consulting, 2006). Likewise, dissolved oxygen (DO) did not appear to vary much with depth. Mean dissolved oxygen remained above 8.0 mg/l for September in littoral (8.7-10.1 mg/l) and pelagic (9.0-9.1 mg/l) areas (EES Consulting, 2006). Mean DO measurements in September for the Okanogan and Methow rivers were 9.0 mg/l and 9.7 mg/l, respectively (EES Consulting, 2006). In the Wells Project, mean pH readings for September were fairly uniform at 7.5 to 8.3.

Table 6.1-1 Information on benthic macroinvertebrate sample sites in the Columbia, Methow, and Okanogan river sections of the Wells Project

			Physical Attributes										
								Substrate (%)[3]					
Station	Location	Method[1]	Depth (m)	Aquatic Macrophytes	Stream Habitat[2]	Hydrology	Zone	W	F	S	G	C	B
1	Columbia R.	CB, SD	2.4	Present	Slow	Depositional	Littoral	0	10	20	40	30	0
2	Columbia R.	CB	1.8	Present	Slow	Depositional	Littoral	0	10	40	30	20	0
3	Columbia R.	CB, SD	1.8	Present	Slow	Depositional	Littoral	0	15	50	25	10	0
4	Columbia R.	CB	2.4	Absent	Fast	Erosional	Littoral	0	10	10	10	70	0
5	Columbia R.	CB, SD	3.0	Absent	Fast	Erosional	Littoral	0	0	10	10	80	0
6	Methow R.	PG	2.1	Absent	Slow	Depositional	Riverine	0	10	75	15	0	0
7	Methow R.	PG	3.0	Present	Slow	Depositional	Riverine	5	75	15	5	0	0
8	Columbia R.	PG	21.3	Absent	Slow	Depositional	Pelagic	0	0	100	0	0	0
9	Columbia R.	PG	18.3	Absent	Slow	Depositional	Pelagic	5	75	20	0	0	0
10	Okanogan R.	PG	2.4	Present	Slow	Depositional	Riverine	0	40	60	0	0	0
11	Okanogan R.	PG	4.0	Absent	Slow	Depositional	Riverine	5	55	40	0	0	0

1. Method used at sampling station: CB=Colonization Baskets: SD=Suction Device; PG=Petite Ponar Grab.

2. Stream habitat characterized as either fast or slow water areas (Hawkins et al. 1993).

3. Substrate Categories: W= Wood and organic debris; F=Fines (<0.06mm); S= Sand (0.06-2.0mm); G=Gravel (2-64 mm); C= Cobble (64- 250mm); B= Boulder (250-4000mm) (From Peck et al. 2001).

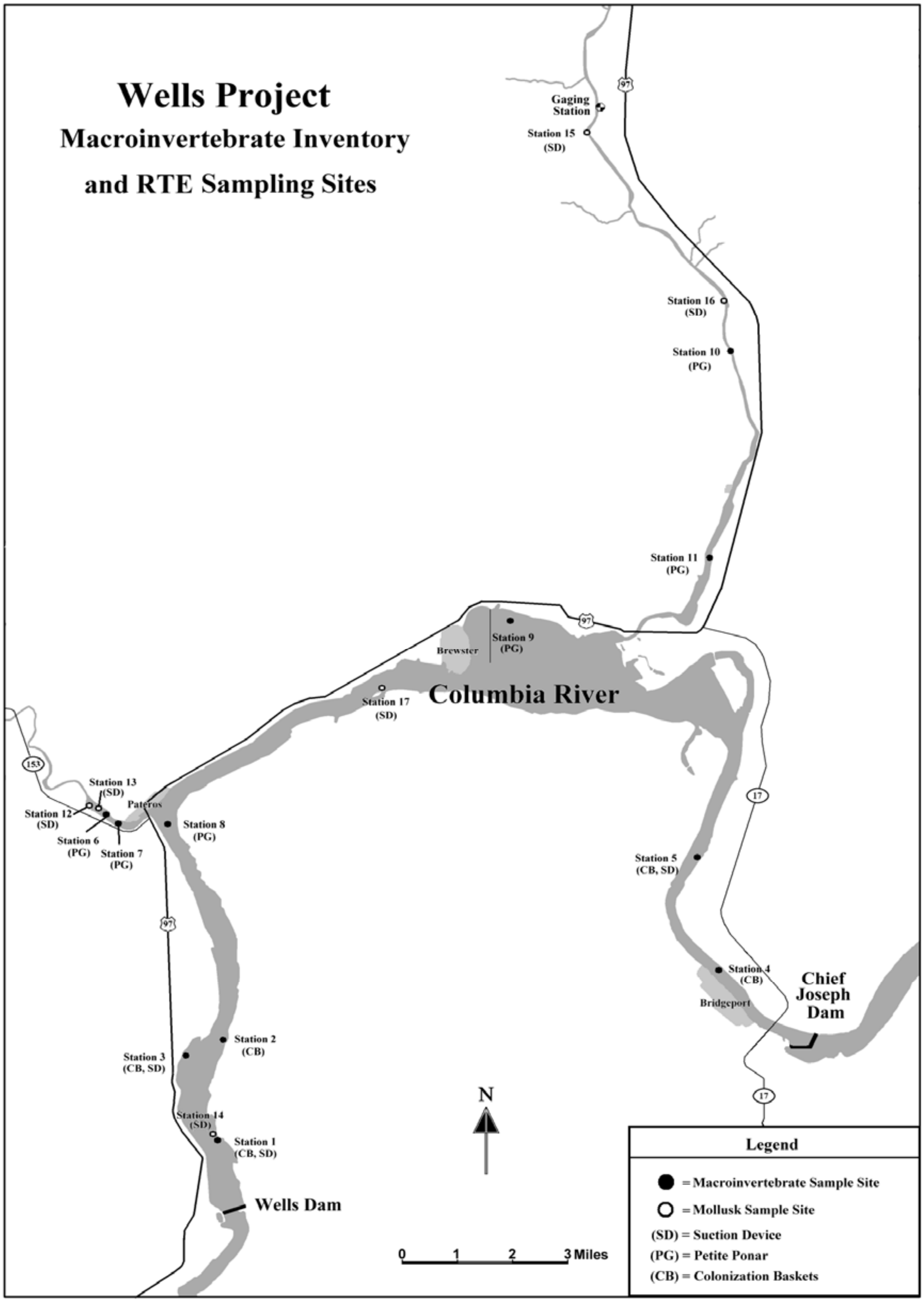

Figure 6.1-1 Wells Project macroinvertebrate inventory and mollusk RTE sampling sites

6.1.2 Abundance and Taxa Richness

Eighty-eight different taxonomic groups were identified in the Wells Project. Seventy-two taxa were identified downstream in the Rocky Reach Project (DE&S and RL&L 2000). Appendix A provides a complete taxa list and count for benthic fauna collected at each station. In general, higher abundance and taxa richness appeared to be associated with littoral areas of the reservoir (stations 1-5) (Table 6.1-1; Table 6.1-2). When comparing riverine locations, sample taxa richness was slightly higher in the Okanogan River (21 and 23 taxa) compared to the Methow River (19 and 21 taxa) (Table 6.1-2). Total taxa richness was 33 in the Okanogan River and 29 in the Methow River and both rivers had four distinct taxa. Distinct taxa at a station are organisms that were not observed at any other sampling station in the Wells Project. In the deep water, fine sediment habitat stations of the Columbia River (8 and 9), taxa richness varied from 5 to 17. The low taxa richness observed at station eight in the Columbia River might be explained by the unstable shifting sands associated with the alluvial fan located near the confluence of the Methow River. In comparison, taxa richness was much higher at station nine in deep water where the substrate was more diverse. Sampling in deep water did not reveal any distinct taxa that were not observed at other stations in the littoral areas. Mean taxa richness downstream in the Rocky Reach project varied from 9 to 24 per sample location (DE&S 2000).

In the littoral areas of the Columbia River, sample taxa richness observed from the colonization baskets varied from 19 to 25 taxa (Table 6.1-2). Complimentary samples obtained at stations 1, 3, and 5 with the suction device had a taxa richness that ranged from 17 to 28 taxa. When the sampling techniques were combined at these stations, the range in taxa richness increased (28-35 taxa) (Table 6.1-2). Complimentary sampling with the suction device enhanced taxa richness and distinct taxa observations at stations 1, 3, and 5. That is, the suction device sampled several organisms within the substrate that were not represented in the colonization baskets. The increase in taxa richness generally was observed from organisms (mollusks, annelids, and crustacean) living deeper in the substrate.

Benthic fauna abundance within the Wells Project varied from 5 to 9,184 organisms per sample and was generally the most abundant at fast water stations (4 and 5). Similar to taxa richness, macroinvertebrate fauna were the least abundant at station eight. Macroinvertebrates were the most abundant at station five. The relatively low abundance and taxa richness observed with the suction device at station 5 may, in part, be due to difficulties associated with collecting samples in very fast waters.

Table 6.1-2 Taxa richness and abundance for benthic fauna samples collected in the Wells Project

Sampling Location	Columbia								Methow		Columbia		Okanogan	
Collection Method[1]	CB	SD	CB	CB	SD	CB	CB	SD	PG	PG	PG	PG	PG	PG
Station	1	1	2	3	3	4	5	5	6	7	8	9	10	11
Abundance	683	1,092	339	231	697	5,224	9,184	79	801	1,788	5	295	152	334
Distinct Taxa	2	2	0	1	5	3	2	2	2	2	0	0	1	3
Sample Taxa Richness	25	23	23	19	28	25	22	17	21	19	2	16	21	23
Total Taxa Richness	35		23	35		25	28		29		17		33	

[1.] Method used at sampling station: CB=Colonization Baskets: SD=Suction Device; PG=Petite Ponar Grab.

6.1.3 Community Composition and Taxa Dominance

Benthic fauna in littoral areas was diverse with apparent differences in community composition observed between fast and slow water areas. Community composition observed from sample stations in the Wells Project are presented in Table 5.1-3 and Table 5.1-4. At stations four and five, which were in the narrower, swifter currents of the Wells Reservoir, chironomids and trichopterans were the most abundant taxa and made up 65 to 71 percent of the sample, respectively (Table 5.1-3; Appendix B). At these stations, there were larger substrate (gravels and cobbles) mixed with sand and aquatic macrophyte beds were absent. In the slow water littoral areas (stations 1-3), chironomids and trichopterans were also abundant but gastropods made up the largest percentage of the organisms identified (Table 5.1-3: Appendix B). Flatworms and isopods were also a large percentage of the taxa identified at stations one and two, respectively. These stations were in close proximity to aquatic macrophyte beds where the majority of the substrate was sand and silt with less large substrate such as cobbles and gravels. Comparative sampling conducted with the suction device showed a community composition of benthic organisms dominated by Acari (water mites) and Odonata (damselflies and dragonflies), which are typically found down within the sediments.

The benthic macroinvertebrate community downstream in the Rocky Reach Project was dominated by chironomids, trichopteran, crustacea, bivalvia, gastropoda, acari, and segmented worms. Combined, these taxa contributed 95% to the total number of animals in the samples collected. Chironomid larvae were the most prevalent of taxa, accounting for between 21% and 92% of the animals at a given site.

Table 6.1-3 Community composition in percent for dominant taxa collected in the Columbia River of the Wells Project with colonization baskets and a suction device

	Colonization Baskets (%)					Suction Device (%)		
Taxanomic Group	**1**	**2**	**3**	**4**	**5**	**1**	**3**	**5**
Ephemeroptera (Mayflies)	0.0	0.0	0.9	0.0	0.0	0.0	4.3	0.0
Trichoptera (Caddisflies)	1.2	24.8	9.9	6.0	9.1	8.2	10.8	43.0
Lepidoptera (Butterflies and Moths)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.3
Coleoptera (Beetles)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Diptera-Chironomidae (Chironomid Flies)	29.6	2.9	32.9	88.2	85.2	2.6	2.6	32.9
Diptera (Flies)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Odonata (Damselflies and Dragonflies)	0.0	0.3	0.9	0.0	0.0	0.0	0.2	0.0
Gastropoda (Snails and Limpets)	8.4	46.6	47.2	0.5	0.0	5.0	29.9	10.1
Bivalvia (Clams and Mussels)	0.5	5.9	0.0	0.0	0.0	12.8	1.5	1.3
Acari (Mites)	1.3	0.9	0.9	2.4	3.1	1.1	8.9	3.8
Crustacea (Crayfish, isopods)	7.0	17.4	6.9	0.3	0.3	69.4	39.0	6.3
Annelida (Segmented Worms)	4.8	1.2	0.4	2.1	1.9	0.4	2.8	0.0
Nematoda (Roundworms)	0.0	0.0	0.0	0.5	0.4	0.5	0.0	1.3
Tubellaria (Flatworms)	47.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0

In the deep water or fine bottom substrate habitats segmented worms, clams, and chironomids were the most dominant taxa (Table 6.1-3; Appendix B). In the deep water habitat of the Columbia River (stations 8 and 9), benthic fauna consisted mostly of clams and roundworms. At these stations, the sediment was mostly sand and silt with some organic debris found at station nine. In the Methow River samples, segmented worms, chironomids, and clams were the most dominant taxa. Habitat in the Methow River differed in the amount of sand and silt contained in the substrate and the presence of aquatic macrophytes at station seven (Table 6.1-1). Clams and segmented worms were more dominant in the silt substrate with the aquatic macrophytes along the channel margins at station seven, while chironomids were more dominant in the sandy substrate near the main channel. In the Okanogan River, coleopterans, trichopterans, and chironomids were abundant at station ten, which was located along the channel margin among aquatic macrophytes and sand dominated substrate. At station eleven, located near the main channel, clams, segmented worms, and chironomids were the most dominant taxa. At this station, the substrate was mostly silt with sand and some organic material. The introduced Asian clam (*Corbicula fluminea)* was the dominant bivalve noted at most of the stations.

6.2 Mollusks

6.2.1 Site Descriptions

Sites selected for mollusk sampling were based on literature review and conversations with Dr. Terrence Frest, a regional expert on mollusks. The areas finally selected for intensive sampling were based predominantly on the presence of diverse habitat (substrate and velocity) to enhance the possibility of collecting rare, threatened or endangered (RTE) mollusks in the Wells Project. Snorkel surveys helped refine sampling areas by exploring different habitats and finding areas where at least shell fragments or live specimens of mollusks were present.

Sampling sites for mollusk surveys were in slow water depositional areas with fairly diverse substrate in the Columbia, Methow and Okanogan rivers. Table 6.2-1 presents habitat features noted at each sampling site. In the Columbia River, the sites were located in the shallow littoral zone. Station 17 was located just downstream from the town of Brewster near a series of three small islands (RM 528.5). Station 14 was located further downstream near Bonita Flats (RM 517.0). Both sites were depositional areas dominated by sand and gravel substrates that were close to aquatic macrophyte beds.

Sites selected in the Methow and Okanogan rivers were also in slow water depositional areas dominated by small substrates (Table 6.2-1). In the Methow River, stations 12 and 13 were located in the North and South channels of the river in depths less than 2 meters as it transitions from the free flowing river into the reservoir. In the Okanogan River, station 15 and 16 were located in areas that appeared to be old riffle habitat on the bend of the river at depths less than 2.5 meters. At these stations there were some large cobbles and boulders partially exposed from the bottom sediments but the dominant substrate was sand with fines and gravel as subdominant.

Table 6.2-1 Habitat information on mollusk sample sites in the Columbia, Methow, and Okanogan rivers

			Physical Attributes										
								Substrate (%)[3]					
Station	Location	Method[1]	Depth (m)	Aquatic Macrophytes	Stream Habitat[2]	Hydrology	Zone	W	F	S	G	C	B
12	Methow R.	SD	1.7	Absent	Slow	Depositional	Riverine	0	10	40	40	10	0
13	Methow R.	SD	1.5	Absent	Slow	Depositional	Riverine	0	20	50	20	10	0
14	Columbia R.	SD	1.8	Present	Slow	Depositional	Littoral	0	10	40	20	10	0
15	Okanogan R.	SD	2.2	Absent	Slow	Depositional	Riverine	0	20	50	20	10	0
16	Okanogan R.	SD	2.4	Absent	Slow	Depositional	Riverine	0	30	50	10	10	0
17	Columbia R.	SD	2.1	Present	Slow	Depositional	Littoral	0	10	60	20	10	0

1. Method used at sampling station: CB=Colonization Baskets: SD=Suction Device; PG=Petite Ponar Grab.

2. Stream habitat characterized as either fast or slow water areas (Hawkins et al. 1993).

3. Substrate Categories: W= Wood and organic debris; F=Fines (<0.06mm); S= Sand (0.06-2.0mm); G=Gravel (2-64 mm); C= Cobble (64- 250mm); B= Boulder (250-4000mm) (From Peck et al. 2001).

6.2.2 Abundance, Taxa Richness, and RTE Assessment

There were 17 mollusk taxa identified from sample stations in the Wells Project. The number of mollusks identified at each station is presented in Appendix C. In summary, there were nine gastropod taxa and eight bivalve taxa identified in the Wells Project. The gastropods included eight native species and one introduced (*Radix auricularia*). The bivalves included seven native species and one non-native corbiculid (*Corbicula fluminea*). The number of mollusks found in the Wells Project is more than twice that observed within the Rocky Reach Reservoir with only eight mollusks (3 bivalves and 5 gastropods) found within the Rocky Reach Project (DE&S and RL&L 2000). The level of diversity (mean=9 taxa) also is similar with freshwater mollusk faunas previously reported from the Methow, Okanogan, and Columbia rivers by Taylor (1993), Neitzel & Frest (1993) and generally from the Columbia system by Neitzel & Frest (1993), and Frest & Johannes (1995, 2003, 2005).

In Washington, there are several mollusks that are state candidates and some that are Federal species of concern that may occur in the Wells Project. The ashy pebblesnail (*Fluminicola fuscus*) is a Washington State candidate species and was a former candidate species for Federal listing under the name Giant Columbia Spire Snail (*F. Columbiana*) in 1989. It is also commonly referred to as the Columbia pebblesnail (Frest and Johannes 1995). It was determined that the ashy pebblesnail did not require Federal protection and is no longer a Federal candidate species but is still a species of concern. The Giant Columbia Spire snail is mostly found living in oligotrophic, hard-substrate, swift-flow habitats, mostly in larger streams.

The Giant Columbia River Limpet (*Fisherola nuttalli*) is also known as the shortface lanx and is a Washington State candidate species. The limpet was under consideration as a Federal listing candidate in 1989 but was removed from the candidate list. This large limpet is found mostly on boulders and cobbles in clear, cold, swift, and large streams. It has been reported historically in the Methow, Okanogan, and Columbia rivers, and a few other Washington streams (Neitzel & Frest, 1993).

The California Floater (*Anodonta californiensis)* is a Washington State candidate species and is no longer a Federal candidate for listing but is still considered a Federal species of concern. The California Floater is most commonly reported from rivers or river lakes in relatively stable, oxygenated mud, sand, or fine gravel beds, often located in pools just downstream from rapids. Since it is unable to move rapidly across or through benthic materials, this clam requires a relatively stable substrate so it is not buried and/or suffocated by shifting sediments (Larsen et. al 1995).

Stations in the Methow River were located in the inundated portion of North and South channels where the substrate was fairly diverse and in close proximity to large cobbles and boulders located along the shoreline. There was noticeable current at both sites although the habitat was considered slow water habitat. Downstream from these sites the Methow River is dominated by silt and sand and snorkel surveys in this area revealed very little evidence of a diverse mollusk community. In the Methow River, there were 10 different mollusk species identified with the ridgebeak peaclam and remnants of the Columbia Spire Snail as the most abundant specimens found at the sampling sites (Table 6.2-2; Appendix C). Evidence of the Columbia Spire Snail and Columbia River Limpet were limited mostly to dead organisms and shell fragments. Only one live specimen of the Columbia Spire Snail was found.

Mollusks in the Methow River that were alive at time of collection were dominated by bivalves with few live gastropods. The patchy mollusk composition observed at the two Methow River sites is common to mollusk communities. The two sites (12 and 13) were very similar with little differences in habitat descriptors (Table 6.2-1) yet mollusk communities were very different. Site 12 was dominated by *Fluminicula fuscus* (84 individuals) with full ontogeny while Site 13 was dominated by *Pisidium compressum* (40 individuals), again with full ontogeny. No whole shells of *F. fuscus* were found at Site 13. It is likely that the apparent mollusk communities at these two Methow sites were shaped by both drift of dead shells from upstream areas and habitat conditions at the sites.

In the Okanogan River, most of the stream is dominated by sand and silt. Water velocity and depth appeared to be fairly uniform within the inundated portion of the Okanogan River. Thus, stations selected in the Okanogan River were much less based on substrate or velocity but more on direct observations from snorkelers who found live specimens. The sampling areas appeared to be old riffle habitat on the bend of the river because there were some large cobbles and boulders partially exposed from the bottom sediments. In the Okanogan River there were nine mollusks species identified (Table 6.3-1). Recently, dead and live specimens of the Columbia Spire Snail were found in the Okanogan River. No other Washington state candidate or Federal ESA listed species was observed.

In contrast to Methow sites, Okanogan mollusk sites were much further downstream from the free-flowing Okanogan River and more shaped by on-site habitat conditions rather than by drift from upstream areas. Dominant mollusks at these sites were mostly live bivalves with large numbers of the very large, *Gonidea angulata* and the small fingernail clam, *Sphaerium striatinum.* In the more lacustrine Okanogan sites, gastropods were in low numbers although diversity was high. It is noteworthy that the introduced clam, *Corbicula fluminea,* so dominant at Columbia River sites was nearly absent in the Okanogan sites with only one individual found.

Stations selected in the Columbia River were also based on prior snorkeling and SCUBA diving. Observations in littoral areas of slow water habitat with diverse substrate and some water current showed considerable evidence of mollusks. Fast water areas upstream and in close proximity to Chief Joseph Dam did not show as much evidence of a diverse mollusk community. This observation was confirmed when the suction device was used to collect benthic macroinvertebrates. In slow water habitat at stations 1 and 3 there were at least seven mollusks observed compared to the three mollusks observed in fast water in the Chief Joseph tailrace (see Appendix A). Investigators found no mollusks in the tailrace of Wells Dams during surveys of Rocky Reach reservoir (DE&S and RL&L 2000).

There was nine mollusk species identified in the Columbia River. At Columbia River sites the Western Floater, Ridgebeak Peaclam, and Asian Clam were well represented. Gastropods were also diverse with large numbers of individuals found. High diversity, high numbers of individuals and a tendency for complete ontogeny of both bivalves and gastropods all indicate more stable environments at the Columbia River sites. No state candidate or Federal ESA listed species were observed in the Columbia River (Table 6.2-2).

Table 6.2-2 Mollusks observed in the Methow, Okanogan, and Columbia rivers in the Wells Project

Mollusks	Methow	Okanogan	Columbia
Bivalves			
Western Pearlshell *Margaritinopsis falcata*	Present		
Asian Clam *Corbicula fluminea**		Present	Present
Western Floater *Anodonta kennerlyi*	Present		Present
Ridgebeak Peaclam *Pisidium compressum*	Present	Present	Present
Ubiquitous Peaclam *Pisidium casertanum*		Present	
Western Lake Fingernail Clam *Musculium raymondi*	Present	Present	
Western Ridge Mussel *Gonidea angulata*		Present	
Striate Fingernail Clam *Sphaerium striatinum*		Present	
Gastropods			
Three Ridge Valvata *Valvata tricarinata*			Present
Giant Columbia River Spire Snail *Fluminicola fuscus***	Present	Present	
Giant Columbia River Limpet *Fisherola nuttalli***	Present		
Big-ear Radix *Radix auricularia**	Present		Present
Golden Fossaria *Fossaria obrussa*	Present		Present
Prairie Fossaria *Fossaria (Bakerilymnaea) bulimoides*	Present		Present
Ash Gyro *Gyraulus parvus*	Present	Present	Present
Fragile Ancylid *Ferrissia californica*		Present	
Rocky Mountain Physa *Physella propinqua propinqua*			Present
*Introduced Species			
**State Candidate or Federal Species of Concern			

7.0 DISCUSSION

Macroinvertebrate communities varied in abundance and taxa richness based on differences in habitat and proximity to macrophyte beds. Macroinvertebrate communities in the Wells Project vary with substrate, depth, and velocity. Dominant taxa such as round worms (Nematoda) or segmented worms (Annelida) showed definite preferences for fine substrates while caddisflies (Trichoptera) were more abundant in more complex, coarser substrates. Still other taxonomic groups like chironomids (Diptera) appeared to have a wide distribution throughout the Wells Project. Observations suggested that taxa richness appeared to increase with habitat complexity. This was seen in the littoral areas of the reservoir where substrate and velocity varied but also when aquatic macrophytes were present. Mollusks appeared to need varied substrate to suit different modes of feeding (filtering and scraping), or the demands of different life stages.

Mollusks in the Wells Project were more diverse than areas noted downstream (DE&S and RL&L 2000). Samples collected in the Methow and Okanogan rivers showed that some State and Federal species of concern exist within the Wells Project. Areas where the Columbia River Spire Snail and Columbia River Limpet were found suggest that areas with complex habitat (more varied substrate, water velocity, and proximity to plant beds) provide more cover and feeding opportunities. Large expansive areas of sand and silt were not favorable habitat for mollusks. Perhaps areas with more complex substrate are more stable and mollusks in these areas are less likely to be buried or dislodged with variations in water velocity. Taxa present in the littoral areas of the Wells Project, which were formerly terrestrial habitat, suggests that numerous macroinvertebrates and several native mollusks have been able to exploit and disburse throughout these new submerged habitats.

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Appendix A

Benthic Macroinvertebrate Fauna Abundance and Diversity

Appendix A1. Abundance of different taxa counted from colonization baskets deployed in the Columbia River. Numbers in parenthesis represent percent subsampled.

		Station				
Taxonomic Groups	**Taxa**	**1 (88%)**	**2 (100%)**	**3 (100%)**	**4 (12.5%)**	**5 (6.3%)**
Ephemeroptera	*Caenis sp.*	0	0	2	0	0
Odonata	*Aeshna sp.*	0	1	2	0	0
Diptera-Chironomidae	*Cricotopus bicinctus gr.*	0	0	0	75	16
	Cricotopus sp.	0	0	0	21	9
	Dicrotendipes sp.	40	2	20	143	117
	Nilothauma sp.	1	0	0	0	0
	Orthocladius Complex	45	1	0	190	155
	Orthocladius annectens	0	0	0	1	0
	Orthocladius sp.	0	0	0	15	6
	Parakiefferiella sp.	1	0	0	2	0
	Paratanytarsus sp.	84	5	56	95	140
	Polypedilum sp.	1	1	0	0	0
	Potthastia longimana gr.	3	0	0	0	0
	Psectrocladius sp.	0	0	0	0	1
	Pseudochironomus sp.	1	0	0	0	0
	Rheotanytarsus sp.	0	0	0	0	1
	Synorthocladius sp.	1	0	0	28	16
	Tanytarsus sp.	0	1	0	6	28
Trichoptera	*Cheumatopsyche sp.*	0	0	0	0	4
	Hydroptila sp.	1	4	0	12	24
	Leptoceridae	0	0	1	0	0
	Mystacides sp.	3	0	0	0	0
	Nectopsyche sp.	0	0	2	0	0
	Ochrotrichia sp.	2	80	20	0	0
	Oecetis sp.	1	0	0	0	0
	Polycentropus sp.	0	0	0	27	18
	Psychomyia sp.	0	0	0	0	6
Gastropoda	*Fossaria sp.*	43	107	70	0	0
	Gyraulus sp.	2	21	15	3	0
	Lymnaeidae	0	1	1	0	0
	Physa (Physella) sp.	5	9	10	0	0
	Promenetus umbilicatellus	0	6	1	0	0
	Radix auricularia	0	0	4	0	0
	Valvata tricarinata	0	14	8	0	0
Bivalvia	*Corbicula sp.*	3	17	0	0	0
	Pisidium sp.	0	3	0	0	0
Annelida	*Alboglossiphonia heteroclita*	1	1	0	0	0
	Enchytraeidae	0	0	0	1	0
	Helobdella sp.	0	3	1	0	0
	Nais barbata	0	0	0	1	0
	Nais bretscheri	0	0	0	4	6
	Nais communis	0	0	0	1	0
	Nais pardalis	0	0	0	1	0
	Nais variabilis	28	0	0	4	4
	Pristina sp.	0	0	0	2	1
Acari	*Acari*	0	0	1	0	0
	Hygrobates sp.	0	2	0	0	0
	Lebertia sp.	8	1	1	3	3
	Limnesia sp.	0	0	0	11	11
	Oribatei	0	0	0	2	4
Crustacea	*Caecidotea sp.*	16	53	15	0	0
	Crangonyx sp.	20	0	0	0	0
	Hyalella sp.	1	3	0	2	2
	Ostracoda	0	3	0	0	0
	Pacifastacus leniusculus	5	0	1	0	0
Other Organisms	*Nematoda*	0	0	0	3	2
	Turbellaria	283	0	0	0	0
Total Organisms	**Subsample Abundance**	**599**	**339**	**231**	**653**	**574**
	Corrected Abundance	**683**	**339**	**231**	**5224**	**9184**

Appendix A2. Abundance of different taxa counted from petite ponar grabs at stations in the Wells Project. Numbers in parenthesis represent percent subsampled.

		Stations					
Taxanomic Groups	**Taxa**	**6 (66%)**	**7 (33%)**	**8 (100%)**	**9 (100%)**	**10 (100%)**	**11 (100%)**
Diptera-Chironomidae	*Apedilum sp.*	2	0	0	0	0	0
	Chironomini	0	0	0	0	1	0
	Chironomus sp.	112	72	0	3	0	9
	Cladopelma sp.	0	1	0	2	0	1
	Cladotanytarsus sp.	3	2	0	0	0	0
	Cricotopus bicinctus gr.	0	3	0	0	0	0
	Cricotopus sp.	0	0	0	0	3	0
	Cryptochironomus sp.	8	3	0	2	0	3
	Harnischia sp.	0	0	0	1	0	10
	Microtendipes pedellus gr.	1	0	0	0	2	0
	Monodiamesa sp.	0	1	0	0	0	0
	Orthocladius annectens	0	22	0	0	5	0
	Paracladopelma sp.	0	1	0	0	0	0
	Paratanytarsus sp.	0	0	0	0	1	0
	Phaenopsectra sp.	5	6	0	1	0	0
	Polypedilum sp.	0	0	0	0	1	3
	Procladius sp.	2	0	0	1	0	2
	Psectrocladius sp.	0	0	0	0	3	0
	Stempellinella sp.	0	0	0	0	0	2
	Stictochironomus sp.	0	6	0	0	0	3
	Tanytarsini	1	0	0	0	0	0
	Tanytarsus sp.	75	48	0	4	0	45
Trichoptera	*Hydroptila sp.*	1	0	0	0	2	0
	Nectopsyche sp.	0	0	0	1	27	2
	Ochrotrichia sp.	0	0	1	0	5	0
	Oecetis sp.	0	0	0	14	1	10
Coleoptera	*Dubiraphia sp.*	0	0	0	0	72	24
Diptera	*Ceratopogoninae*	0	0	0	0	0	2
Lepidoptera	*Petrophila sp.*	0	0	0	0	0	0
Gastropoda	*Gyraulus sp.*	0	1	0	0	0	0
	Physa (Physella) sp.	0	0	0	0	1	1
Bivalvia	*Anodonta sp.*	0	0	0	1	0	0
	Corbicula sp.	33	86	4	131	0	97
	Sphaeriidae	0	0	0	0	1	0
Annelida	*Enchytraeidae*	0	0	0	2	0	0
	Limnodrilus hoffmeisteri	264	316	0	0	13	54
	Nais variabilis	1	0	0	0	0	0
	Tubificidae w/ cap setae	11	18	0	0	1	29
Acari	*Acari*	1	1	0	0	5	4
	Hygrobates sp.	0	4	0	2	0	1
	Lebertia sp.	0	0	0	1	1	0
	Limnesia sp.	1	4	0	0	1	1
	Neumania sp.	0	0	0	0	0	18
Crustacea	*Caecidotea sp.*	2	1	0	0	0	0
	Hyalella sp.	1	0	0	1	0	0
	Ostracoda	1	0	0	0	3	8
Other Organisms	*Nematoda*	1	0	0	128	3	5
	Turbellaria	1	0	0	0	0	0
Total Organisms	**Subsample Abundance**	**527**	**596**	**5**	**295**	**152**	**334**
	Corrected Abundance	**801**	**1788**	**5**	**295**	**152**	**334**

Appendix A3. Abundance of different taxa counted from suction dredge samples collected in the Columbia River. Numbers in parenthesis represent percent subsampled.

		Station		
		1	3	5
Taxonomic Group	**Taxa**	**(50%)**	**(77%)**	**(100%)**
Ephemeroptera	*Caenis sp.*	0	23	0
Odonata	*Coenagrion/Enallagma sp.*	0	1	0
Diptera-Chironomidae	*Cricotopus sp.*	0	0	2
	Dicrotendipes sp.	12	6	14
	Orthocladius Complex	0	0	3
	Paratanytarsus sp.	0	2	7
	Psectrocladius sp.	1	0	0
	Pseudochironomus sp.	1	4	0
Trichoptera	*Hydroptila sp.*	1	0	18
	Mystacides sp.	35	7	0
	Nectopsyche sp.	1	0	0
	Ochrotrichia sp.	6	43	0
	Oecetis sp.	0	3	0
	Oxyethira sp.	0	5	0
	Polycentropus sp.	1	0	13
	Psychomyia sp.	1	0	3
Lepidoptera	*Petrophila sp.*	0	0	1
Gastropoda	*Fossaria sp.*	10	1	0
	Gyraulus sp.	12	66	1
	Lymnaeidae	0	3	0
	Physa (Physella) sp.	3	18	0
	Radix auricularia	1	0	0
	Stagnicola sp.	0	0	7
	Valvata tricarinata	1	72	0
Bivalvia	*Anodonta sp.*	0	2	0
	Corbicula sp.	39	0	0
	Pisidium sp.	31	6	0
	Sphaeriidae	0	0	1
Annelida	*Alboglossiphonia heteroclita*	0	1	0
	Eclipidrilus sp.	1	0	0
	Enchytraeidae	0	2	0
	Helobdella sp.	0	12	0
	Helobdella stagnalis	1	0	0
Acari	*Arrenurus sp.*	0	1	0
	Hygrobates sp.	0	3	0
	Lebertia sp.	6	32	2
	Limnesia sp.	0	12	1
Crustacea	*Amphipoda*	0	3	0
	Caecidotea sp.	371	204	2
	Crangonyx sp.	6	0	2
	Hyalella sp.	2	1	1
	Ostracoda	0	1	0
Other Organisms	*Nematoda*	3	0	1
Total Organisms	**Subsample Abundance**	**546**	**536**	**79**
	Corrected Abundance	**1092**	**697**	**79**

Appendix B

Benthic Macroinvertebrate Fauna Biological Metrics

Appendix B1. Biological metrics for macroinvertebrate fauna collected from colonization baskets at five locations in the Wells Project

	Station				
	1	2	3	4	5
Abundance Measures					
Corrected Abundance	682.86	339.00	231.00	5224.00	9184.00
EPT Abundance	7.98	84.00	25.00	312.00	832.00
Dominance Measures					
1st Dominant Taxon	*Turbellaria*	*Fossaria sp.*	*Fossaria sp.*	*Orthocladius Complex*	*Orthocladius Complex*
2nd Dominant Taxon	*Paratanytarsus sp.*	*Ochrotrichia sp.*	*Paratanytarsus sp.*	*Dicrotendipes sp.*	*Paratanytarsus sp.*
3rd Dominant Taxon	*Orthocladius Complex*	*Caecidotea sp.*	*Ochrotrichia sp.*	*Paratanytarsus sp.*	*Dicrotendipes sp.*
1st Dominant Abundance	322.62	107.00	70.00	1520.00	2480.00
2nd Dominant Abundance	95.76	80.00	56.00	1144.00	2240.00
3rd Dominant Abundance	51.30	53.00	20.00	760.00	1872.00
Percent 1st Dominant Taxon	47.25	31.56	30.30	29.10	27.00
Percent 2nd Dominant Taxon (cumulative)	61.27	55.16	54.55	51.00	51.39
Percent 3rd Dominant Taxon (cumulative)	68.78	70.80	63.20	65.54	71.78
Richness Measures					
Species Richness	25.00	23.00	19.00	25.00	22.00
EPT Richness	4.00	2.00	4.00	2.00	4.00
Ephemeroptera Richness	0.00	0.00	1.00	0.00	0.00
Plecoptera Richness	0.00	0.00	0.00	0.00	0.00
Trichoptera Richness	4.00	2.00	3.00	2.00	4.00
Chironomidae Richness	9.00	5.00	2.00	10.00	10.00
Oligochaeta Richness	1.00	0.00	0.00	7.00	3.00
Non-Chiro. Non-Olig. Richness	15.00	18.00	17.00	8.00	9.00
Rhyacophila Richness	0.00	0.00	0.00	0.00	0.00
Community Composition (%)					
Ephemeroptera	0.00	0.00	0.87	0.00	0.00
Plecoptera	0.00	0.00	0.00	0.00	0.00
Trichoptera	1.17	24.78	9.96	5.97	9.06
EPT	1.17	24.78	10.82	5.97	9.06
Coleoptera	0.00	0.00	0.00	0.00	0.00
Diptera	29.55	2.95	32.90	88.21	85.19
Oligochaeta	4.67	0.00	0.00	2.14	1.92
Baetidae	0.00	0.00	0.00	0.00	0.00
Brachycentridae	0.00	0.00	0.00	0.00	0.00
Chironomidae	29.55	2.95	32.90	88.21	85.19
Ephemerellidae	0.00	0.00	0.00	0.00	0.00
Hydropsychidae	0.00	0.00	0.00	0.00	0.70
Odonata	0.00	0.29	0.87	0.00	0.00
Perlidae	0.00	0.00	0.00	0.00	0.00
Pteronarcyidae	0.00	0.00	0.00	0.00	0.00
Simuliidae	0.00	0.00	0.00	0.00	0.00

Appendix B1. Concluded.

	Station				
	1	**2**	**3**	**4**	**5**
Functional Group Composition					
Filterer Richness	1.00	3.00	0.00	1.00	3.00
Gatherer Richness	14.00	7.00	6.00	15.00	10.00
Predator Richness	3.00	3.00	3.00	5.00	5.00
Scraper Richness	3.00	4.00	4.00	1.00	1.00
Shredder Richness	1.00	1.00	1.00	2.00	2.00
Piercer-Herbivore Richness	1.00	1.00	0.00	1.00	1.00
Unclassified	1.00	4.00	3.00	0.00	0.00
Percent Filterers	0.5	6.19	0.00	0.92	5.75
Percent Gatherers	41.07	43.36	49.35	75.04	78.05
Percent Predators	48.75	1.18	1.73	7.04	6.62
Percent Scrapers	8.35	40.71	41.56	0.46	1.05
Percent Shredders	0.17	0.29	0.87	14.70	4.36
Percent Piercer-Herbivores	0.17	1.18	0.00	1.84	4.18
Percent Unclassified	0.17	7.08	4.33	0.00	0.00
Diversity/Evenness Measures					
Shannon-Weaver H' (log 10)	0.82	0.90	0.91	0.92	0.91
Shannon-Weaver H' (log 2)	2.74	3.00	3.02	3.07	3.03
Shannon-Weaver H' (log e)	1.90	2.08	2.10	2.13	2.10
Margalef's Richness	3.68	3.78	3.31	2.80	2.30
Pielou's J'	0.59	0.66	0.71	0.66	0.68
Simpson's Heterogeneity	0.74	0.81	0.83	0.83	0.82
Biotic Indices					
Percent Individuals with HBI Value	98.00	87.02	93.51	97.55	96.86
Hilsenhoff Biotic Index (HBI)	5.40	6.06	6.31	6.48	6.34
Percent Individuals with MTI Value	81.14	83.78	91.77	54.21	64.63
Metals Tolerance Index (MTI)	3.66	3.42	3.12	3.71	3.31
Percent Individuals with FSBI Value	0.17	1.18	0.00	1.84	4.88
Fine Sediment Biotic Index (FSBI)	5.00	5.00	-99.00	5.00	7.00
FSBI – average	0.20	0.22	-99.00	0.20	0.32
FSBI - weighted average	5.00	5.00	-99.00	5.00	4.57
Percent Individuals with TPM Value	8.01	2.95	0.00	46.86	41.64
Temperature Preference Metric (TPM) - average	0.48	0.61	-99.00	0.72	1.00
TPM - weighted average	5.75	2.40	-99.00	4.44	4.63
Karr BIBI Metrics					
Long-Lived Taxa Richness	2.00	3.00	2.00	0.00	0.00
Clinger Richness	6.00	7.00	7.00	6.00	7.00
Percent Clingers	8.35	63.42	48.92	22.05	17.42
Intolerant Taxa Richness	0.00	0.00	0.00	0.00	1.00
Percent Tolerant Individuals	7.92	30.17	18.52	0.29	0.08
Percent Tolerant Taxa	28.00	26.09	21.05	36.00	22.73
Coleoptera Richness	0.00	0.00	0.00	0.00	0.00

Appendix B2. Biological metrics for macroinvertebrate fauna collected from petite ponar grabs at six locations in the Wells Project.

	Stations					
	6	**7**	**8**	**9**	**10**	**11**
Abundance Measures						
Corrected Abundance	801.04	1788.00	5.00	295.00	152.00	334.00
EPT Abundance	1.52	0.00	1.00	15.00	35.00	12.00
Dominance Measures						
1st Dominant Taxon	*Limnodrilus hoffmeisteri*	*Limnodrilus hoffmeisteri*	*Corbicula sp.*	*Corbicula sp.*	*Dubiraphia sp.*	*Corbicula sp.*
2nd Dominant Taxon	*Chironomus sp.*	*Corbicula sp.*	*Ochrotrichia sp.*	*Nematoda*	*Nectopsyche sp.*	*Limnodrilus hoffmeisteri*
3rd Dominant Taxon	*Tanytarsus sp.*	*Chironomus sp.*		*Oecetis sp.*	*Limnodrilus hoffmeisteri*	*Tanytarsus sp.*
1st Dominant Abundance	401.28	948.00	4.00	131.00	72.00	97.00
2nd Dominant Abundance	170.24	258.00	1.00	128.00	27.00	54.00
3rd Dominant Abundance	114.00	216.00	0.00	14.00	13.00	45.00
Percent 1st Dominant Taxon	50.09	53.02	80.00	44.41	47.37	29.04
Percent 2nd Dominant Taxon (cumulative)	71.35	67.45	100.00	87.80	65.13	45.21
Percent 3rd Dominant Taxon (cumulative)	85.58	79.53	100.00	92.54	73.68	58.68
Richness Measures						
Species Richness	21.00	19.00	2.00	16.00	21.00	23.00
EPT Richness	1.00	0.00	1.00	2.00	4.00	2.00
Ephemeroptera Richness	0.00	0.00	0.00	0.00	0.00	0.00
Plecoptera Richness	0.00	0.00	0.00	0.00	0.00	0.00
Trichoptera Richness	1.00	0.00	1.00	2.00	4.00	2.00
Chironomidae Richness	9.00	11.00	0.00	7.00	7.00	9.00
Oligochaeta Richness	3.00	2.00	0.00	1.00	2.00	2.00
Non-Chiro. Non-Olig. Richness	9.00	6.00	2.00	8.00	12.00	12.00
Rhyacophila Richness	0.00	0.00	0.00	0.00	0.00	0.00
Community Composition (%)						
Ephemeroptera	0.00	0.00	0.00	0.00	0.00	0.00
Plecoptera	0.00	0.00	0.00	0.00	0.00	0.00
Trichoptera	0.19	0.00	20.00	5.08	23.03	3.59
EPT	0.19	0.00	20.00	5.08	23.03	3.59
Coleoptera	0.00	0.00	0.00	0.00	47.37	7.19
Diptera	39.66	27.68	0.00	4.75	10.53	23.95
Oligochaeta	52.37	56.04	0.00	0.68	9.21	24.85
Baetidae	0.00	0.00	0.00	0.00	0.00	0.00
Brachycentridae	0.00	0.00	0.00	0.00	0.00	0.00
Chironomidae	39.66	27.68	0.00	4.75	10.53	23.35
Ephemerellidae	0.00	0.00	0.00	0.00	0.00	0.00
Hydropsychidae	0.00	0.00	0.00	0.00	0.00	0.00
Odonata	0.00	0.00	0.00	0.00	0.00	0.00
Perlidae	0.00	0.00	0.00	0.00	0.00	0.00
Pteronarcyidae	0.00	0.00	0.00	0.00	0.00	0.00
Simuliidae	0.00	0.00	0.00	0.00	0.00	0.00

Appendix B2. Concluded.

	Stations					
	6	7	8	9	10	11
Functional Group Composition						
Filterer Richness	20.87	22.48	80.00	46.10	1.97	42.51
Gatherer Richness	74.95	73.83	20.00	3.05	68.42	41.92
Predator Richness	2.66	2.01	0.00	50.17	7.24	13.77
Scraper Richness	0.95	1.17	0.00	0.34	0.66	0.30
Shredder Richness	0.00	0.50	0.00	0.34	20.39	1.50
Piercer-Herbivore Richness	0.19	0.00	0.00	0.00	1.32	0.00
Unclassified	0.38	0.00	0.00	0.00	0.00	0.00
Percent Filterers	4.00	2.00	1.00	3.00	2.00	2.00
Percent Gatherers	8.00	10.00	1.00	5.00	9.00	9.00
Percent Predators	6.00	4.00	0.00	6.00	5.00	9.00
Percent Scrapers	1.00	2.00	0.00	1.00	1.00	1.00
Percent Shredders	0.00	1.00	0.00	1.00	3.00	2.00
Percent Piercer-Herbivores	1.00	0.00	0.00	0.00	1.00	0.00
Percent Unclassified	1.00	0.00	0.00	0.00	0.00	0.00
Diversity/Evenness Measures						
Shannon-Weaver H' (log 10)	0.66	0.69	0.22	0.54	0.84	1.01
Shannon-Weaver H' (log 2)	2.20	2.31	0.72	1.79	2.78	3.34
Shannon-Weaver H' (log e)	1.53	1.60	0.50	1.24	1.93	2.31
Margalef's Richness	2.99	2.40	0.62	2.64	3.98	3.79
Pielou's J'	0.50	0.54	0.72	0.45	0.63	0.74
Simpson's Heterogeneity	0.68	0.67	0.40	0.61	0.74	0.85
Biotic Indices						
Percent Individuals with HBI Value	93.17	84.23	20.00	54.58	98.68	64.97
Hilsenhoff Biotic Index (HBI)	9.23	9.32	4.00	5.60	5.89	8.00
Percent Individuals with MTI Value	40.04	22.65	20.00	52.88	80.26	32.93
Metals Tolerance Index (MTI)	3.66	3.64	3.00	4.67	3.89	3.58
Percent Individuals with FSBI Value	0.19	0.00	0.00	0.00	1.32	0.00
Fine Sediment Biotic Index (FSBI)	5.00	-99.00	-99.00	-99.00	5.00	-99.00
FSBI – average	0.24	-99.00	-99.00	-99.00	0.24	-99.00
FSBI - weighted average	5.00	-99.00	-99.00	-99.00	5.00	-99.00
Percent Individuals with TPM Value	14.61	8.56	0.00	1.69	51.32	22.16
Temperature Preference Metric (TPM) -	0.29	0.16	-99.00	0.25	0.48	0.48
TPM - weighted average	2.00	1.94	-99.00	2.00	1.19	1.78
Karr BIBI Metrics						
Long-Lived Taxa Richness	1.00	1.00	1.00	2.00	1.00	1.00
Clinger Richness	6.00	5.00	1.00	4.00	9.00	7.00
Percent Clingers	15.56	9.23	20.00	6.78	77.63	29.34
Intolerant Taxa Richness	0.00	0.00	0.00	0.00	0.00	0.00
Percent Tolerant Individuals	37.52	22.31	0.00	10.56	12.67	47.00
Percent Tolerant Taxa	42.86	42.11	0.00	50.00	28.57	47.83
Coleoptera Richness	0.00	0.00	0.00	0.00	1.00	1.00

Appendix B3. Biological metrics for macroinvertebrate fauna collected by suction dredge at three locations in the Wells Project.

	Station		
	1	**3**	**5**
Abundance Measures			
Corrected Abundance	1092.00	696.80	79.00
EPT Abundance	90.00	105.30	34.00
Dominance Measures			
1st Dominant Taxon	*Caecidotea sp.*	*Caecidotea sp.*	*Hydroptila sp.*
2nd Dominant Taxon	*Corbicula sp.*	*Valvata tricarinata*	*Dicrotendipes sp.*
3rd Dominant Taxon	*Mystacides sp.*	*Gyraulus sp.*	*Polycentropus sp.*
1st Dominant Abundance	742.00	265.20	18.00
2nd Dominant Abundance	78.00	93.60	14.00
3rd Dominant Abundance	70.00	85.80	13.00
Percent 1st Dominant Taxon	67.95	38.06	22.78
Percent 2nd Dominant Taxon (cumulative)	75.09	51.49	40.51
Percent 3rd Dominant Taxon (cumulative)	81.50	63.81	56.96
Richness Measures			
Species Richness	23.00	28.00	17.00
EPT Richness	6.00	5.00	3.00
Ephemeroptera Richness	0.00	1.00	0.00
Plecoptera Richness	0.00	0.00	0.00
Trichoptera Richness	6.00	4.00	3.00
Chironomidae Richness	3.00	4.00	4.00
Oligochaeta Richness	1.00	1.00	0.00
Non-Chiro. Non-Olig. Richness	19.00	23.00	13.00
Rhyacophila Richness	0.00	0.00	0.00
Community Composition (%)			
Ephemeroptera	0.00	4.29	0.00
Plecoptera	0.00	0.00	0.00
Trichoptera	8.24	10.82	43.04
EPT	8.24	15.11	43.04
Coleoptera	0.00	0.00	0.00
Diptera	2.56	2.61	32.91
Oligochaeta	0.18	0.37	0.00
Baetidae	0.00	0.00	0.00
Brachycentridae	0.00	0.00	0.00
Chironomidae	2.56	2.61	32.91
Ephemerellidae	0.00	0.00	0.00
Hydropsychidae	0.00	0.00	0.00
Odonata	0.00	0.19	0.00
Perlidae	0.00	0.00	0.00
Pteronarcyidae	0.00	0.00	0.00
Simuliidae	0.00	0.00	0.00

Appendix B3. Concluded.

	Station		
	1	**3**	**5**
Functional Group Composition			
Filterer Richness	12.82	1.49	1.27
Gatherer Richness	79.67	55.60	45.57
Predator Richness	2.01	9.70	21.52
Scraper Richness	4.76	16.42	6.33
Shredder Richness	0.18	0.00	2.53
Piercer-Herbivore Richness	0.18	0.93	22.78
Unclassified	0.18	15.86	0.00
Percent Filterers	2.00	2.00	1.00
Percent Gatherers	9.00	12.00	7.00
Percent Predators	4.00	6.00	4.00
Percent Scrapers	4.00	4.00	3.00
Percent Shredders	1.00	0.00	1.00
Percent Piercer-Herbivores	1.00	1.00	1.00
Percent Unclassified	1.00	3.00	0.00
Diversity/Evenness Measures			
Shannon-Weaver H' (log 10)	0.60	0.95	1.01
Shannon-Weaver H' (log 2)	1.98	3.16	3.35
Shannon-Weaver H' (log e)	1.37	2.19	2.32
Margalef's Richness	3.14	4.12	3.66
Pielou's J'	0.44	0.66	0.82
Simpson's Heterogeneity	0.52	0.81	0.88
Biotic Indices			
Percent Individuals with HBI Value	91.39	75.19	96.20
Hilsenhoff Biotic Index (HBI)	7.43	7.28	6.32
Percent Individuals with MTI Value	83.88	72.57	88.61
Metals Tolerance Index (MTI)	4.69	4.11	3.36
Percent Individuals with FSBI Value	0.18	0.00	22.78
Fine Sediment Biotic Index (FSBI)	5.00	-99.00	5.00
FSBI – average	0.22	-99.00	0.29
FSBI - weighted average	5.00	-99.00	5.00
Percent Individuals with TPM Value	0.55	0.19	30.38
Temperature Preference Metric (TPM) –	0.17	0.07	0.88
TPM - weighted average	2.00	2.00	2.75
Karr BIBI Metrics			
Long-Lived Taxa Richness	2.00	2.00	1.00
Clinger Richness	7.00	5.00	5.00
Percent Clingers	5.86	21.64	44.30
Intolerant Taxa Richness	1.00	0.00	1.00
Percent Tolerant Individuals	38.98	56.50	5.26
Percent Tolerant Taxa	30.43	35.71	23.53
Coleoptera Richness	0.00	0.00	0.00

Appendix C

Mollusk Fauna Abundance and Diversity

Appendix C1. Mollusks identified from surveys in the Methow River.

Location	Taxon	Common Name(s)	Specimens	Comments
Station # 12 Methow River	*Margaritinopsis falcata*	Western Pearlshell	3	> 3 < 5 years old
	Corbicula sp.		Fragments only	Identified from fragments; rare
	Sphaerium striatinum	Striate Fingernail Clam	Fragments only	Identified from fragments; rare
	Pisidium compressum	Ridgebeak Peaclam	7	Most specimen were dead; rare
	Musculium raymondi	Western Lake Fingernail Clam	1	One live specimen
	Fisherola nuttalli	Giant Columbia River Limpet or Shortface Lanx	12	Most adults all dead
	Fluminicola fuscus	Giant Columbia River Spire Snail or Ashy Pebblesnail	84	Most found dead; 1 live specimen; size range from small to gerontic; several operculi also (from live specimens)
Station # 13 Methow River	*Margaritinopsis falcata*	Western Pearlshell	7	All <10 years old
	Anodonta kennerlyi	Western Floater	3	All <5 years old
	Pisidium compressum	Ridgebeak Peaclam	40	Full ontogeny, including dead
	Pisidium casertanum	Ubiquitous Peaclam	11	Range but not full ontogeny; all live
	Radix auricularia	Big-ear Radix	6	Immature
	Fossaria obrussa	Golden Fossaria	1	Immature
	Fossaria (Bakerilymnaea) bulimoides	Prairie Fossaria	1	Adult
	Gyraulus parvus	Ash Gyro	1	Adult
	Fluminicola fuscus	Giant Columbia River Spire Snail or Ashy Pebblesnail	Fragments only	Fragmentary only (dead); very rare

Appendix C2. Mollusks identified from two stations in the Okanogan River.

Location	Taxon	Common Name(s)	Specimens	Comments
Station # 15 Okanogan River	*Gonidea angulata*	Western Ridgemussel	36	Essentially complete ontogeny; all live
	Sphaerium striatinum	Striate Fingernail Clam	108	Complete ontogeny but most adult, live
	Pisidium compressum	Ridgebeak Peaclam	10mni[3]	Rare; most adult; ½ dead
	Pisidium casertanum	Ubiquitous Peaclam	4mni	Rare; live
	Corbicula fluminea	Asian Clam	1mni	Rare; live
	Fluminicola fuscus	Giant Columbia River Spire Snail or Ashy Pebblesnail	16	All live or recent dead; none more than ½ grown; may include 1 or 2 small Fluminicola n. sp.
	Ferrissia californica	Fragile Ancylid	2	Very rare; small
	Physella sp.		2	Very rare; juvenile
	Gyraulus parvus	Ash Gyro	1	Very rare; half grown
Station # 16 Okanogan River	*Gonidea angulata*	Western Ridgemussel	35	Common; Full ontogeny but most <5 years old; includes dead, but mostly as small fragments
	Anodonta sp.		1	Very young juvenile; likely kennerlyi, judging from beak sculpture
	Sphaerium striatinum	Striate Fingernail Clam	10	Rare; most adult
	Pisidium compressum	Ridgebeak Peaclam	66mni	Common; full ontogeny but many small; some recent and long-dead
	Musculium raymondi	Western Lake Fingernail Clam	1	One live
	Fluminicola fuscus	Giant Columbia River Spire Snail or Ashy Pebblesnail	1	One long dead, small
	Physella sp.	Rocky Mountain Physa	8	Several live; most very young; but likely *propinqua*
	Gyraulus parvus	Ash Gyro	1	Rare, live
	Ferrissia californica	Fragile Ancylid	1	Rare, recently dead

[1] mni= minimum number of individuals.

Appendix C3. Mollusks identified from two stations in the Columbia River.

Location	Taxon		Specimens	Comments
Station # 14 Columbia River	*Anodonta kennnerlyi*	Western Floater	7	Rare; all young (<5 years old)
	Corbicula fluminea	Asian Clam	703	Abundant; but small only (<15 mm) except for 1 or 2
	Pisidium compressum	Ridgebeak Peaclam	306	Abundant; full ontogeny, common dead also
	Valvata tricarinata	Three Ridge Valvata	45	Uncommon; first 2/3 ontogeny
	Physella propinqua propinqua	Rocky Mountain Physa	72	Common, but all small (<1/6 adult size), live
	Gyraulus parvus	Ash Gyro	157	Nearly complete ontogeny but lacking largest; some recently dead
	Fossaria (F.) obrussa	Golden Fossaria	6	Very rare; immature; 5 dead
	Fossaria (Bakerilymnaea) bulimoides	Prairie Fossaria	90	Common live, full ontogeny; also dead
	Radix auricularia	Big-ear Radix	27	Uncommon live & dead; full ontogeny to ½ adult size
Station # 17 Columbia River	*Anodonta kennerlyi*	Western Floater	24	Common; nearly complete ontogeny, except for very old
	Corbicula fluminea	Asian Clam	256	Abundant; but small only (<15 mm); w/only 1 > 15mm & 1< 4mm
	Pisidium compressum	Ridgebeak Peaclam	117	Abundant; full ontogeny
	Valvata tricarinata	Three Ridge Valvata	114	Common; first 2/3 ontogeny
	Physella propinqua propinqua	Rocky Mountain Physa	4	Very rare; <1/3 grown; but very likely this species
	Gyraulus parvus	Ash Gyro	41	Nearly complete ontogeny, including some dead
	Fossaria (F.) obrussa	Golden Fossaria	1	Very rare; immature
	Fossaria (Bakerilymnaea) bulimoides	Prairie Fossaria	67	Common live, full ontogeny; also dead
	Radix auricularia	Big-ear Radix	24	Common live & dead; mostly to ½ grown