Freshwater Mussel Observations in Five Clark County, Washington Streams

WASHINGTON TROUT

Prepared for the USFWS Greenspaces Program
by Washington Trout

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Acknowledgements

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2004 Clark County Freshwater Mussel Survey Volunteers:
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Introduction

The United States has the greatest diversity of freshwater mussels in the world. Yet there has been a serious decline in diversity and abundance throughout much of the country that has led to the federal listing of many species as endangered or threatened (Williams & Neves 1995). Mussels are a valuable index of the overall health of a stream environment; their presence or absence in a watershed directly reflects habitat quality and water quality. As filter feeders, they play an important role in the aquatic food chain within streams, and are themselves a food source for wildlife including otters, muskrats, raccoons and birds.

Western Washington native freshwater mussels are represented by three genera with a total of six species. There is also one introduced species (see Appendix A). Of these species the most common and widespread is *Margaritifera falcata*. Also known as the Western Pearlshell, *M. falcata* is long-lived, with life spans that can exceed 100 years. Pearlshell mussels of the genus *Margaritifera* have a glochidial life stage that is an obligate fish parasite (Pers. comm. with Al Smith, 2004). Habitat destruction due to agriculture, urbanization, pollution and commercial exploitation has contributed to the decline and extinction in *Margaritifera* populations in many rivers of Europe, British Isles, and North America (Williams & Neves 1995). It is possible that reductions of host-fish abundances is also contributing to the decline of *Margaritifera*. In the Pacific Northwest the distribution and status of the region's native freshwater mussels is largely unknown.

Study Objectives

The objective of this study was to conduct a freshwater mussel population census on five southwestern Washington streams within the Columbia River Basin in Clark County (Figure 1). No study of mussel distribution, density, or species composition had previously been performed in these streams. The study watersheds are in a rapidly developing portion of Clark County, and are being transitioned from rural and agricultural lands into suburban and urban development. Even historically stable mussel populations are prone to mass die-offs in the face of water quality degradation stemming from poor land-use practices. Accordingly, this census was performed to collect baseline information about the health of Clark County mussels to allow measurement of changes in mussel diversity, location and abundance associated with future development.

During summer 2004 we surveyed portions of mainstem Gee Creek, Salmon Creek, Burnt Bridge Creek, Gibbons Creek, and Campen Creek (a tributary to Gibbons Creek) to determine freshwater mussel species composition, density, and distribution. Ancillary summer 2004 mussel observations from Schoolhouse Creek, a tributary of the Washougal River in Skamania County, are also included in this report. Each watershed surveyed had biological and physical characteristics suitable for supporting freshwater mussels, including the presence of salmonid populations, relatively low stream channel gradient and water velocity, and a substratum dominated by gravels and sands.

Because surveys could only be conducted where landowners had granted permission for field crews to access, the watershed censuses were not comprehensive. This study

reports observed mussel bed locations, species compositions, and densities against which future comparisons can be made to document population trends. We hope that this baseline study of mussel distribution, density, and species composition will enable resource agencies to better manage and protect our stream and river ecosystems.

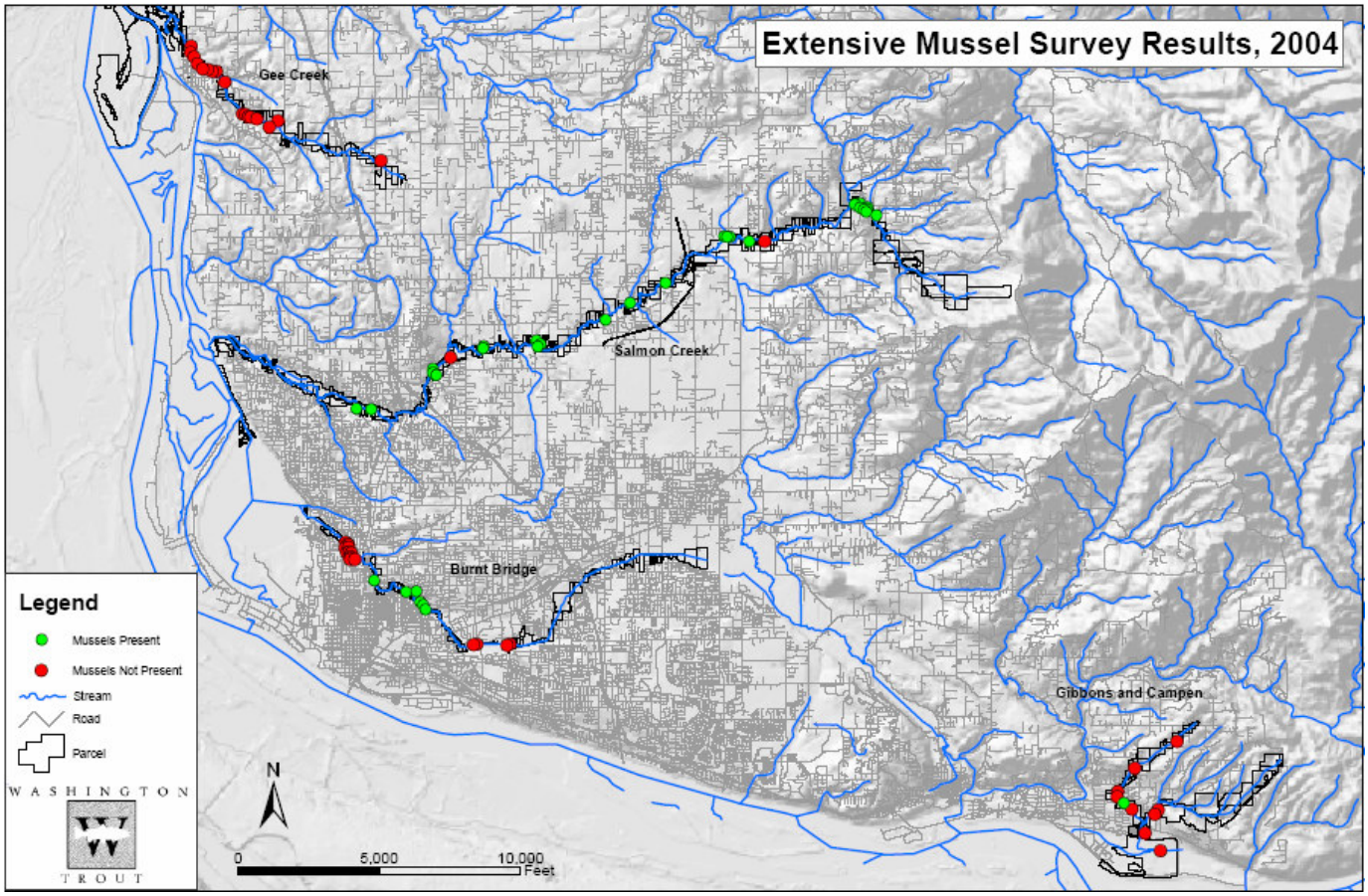

Figure 1. Extensive survey results near Vancouver in Clark County, WA showing the parcels where crews surveyed for mussel presence, where mussels were observed (green circles) and where mussels were not observed (red circles).

Methodology

Step One: Survey Effort Planning

Surveys were performed only on public lands and on those parcels where landowners had explicitly given permission for project surveyors to access. Washington Trout maintained a database tracking landowner requests and responses, and provided field maps to surveyors showing where access had been granted and denied.

In order to maximize survey efficiency, each stream was first coarsely surveyed to identify specific reach habitat types, to locate those reaches most likely to support mussels, and to prioritize the distribution of survey effort accordingly. Primary consideration was given to substrate type and stream flow. Reaches with gravel-

dominated substrates, moderate channel gradients (less than 7%), adequate flows, and heterogeneous pool–riffle complexes were considered most likely to support freshwater mussels (pers. comm. with mussel researcher Allan Smith on July 15th 2004). No survey effort was dedicated in areas where the channel gradient exceeded 7%. Reach identification and prioritization was performed using topographic data and visual inspections at various locations, primarily road crossings. Reach breaks were identified using standard Washington Dept. of Fish and Wildlife (WDFW) physical survey protocols. High priority reaches were marked on a field map, using Global Positioning System (GPS) points as needed. These priority reaches received the greatest survey effort.

Step Two: Presence–Absence; Extensive Survey Field Procedures

Within reaches identified as high priority in Step One and where permission to access had been granted, an extensive "shotgun" survey was conducted with field crews following the instructions below:

1) Begin at a parcel located approximately at the longitudinal midpoint within the high priority reach.

2) Inspect parcel number, match to the permission form, and verify that permission to access has been granted and that access terms described in the landowner comments have been met. Fill out the extensive survey field form for each parcel; adjoining tax parcels can be combined onto one form.

3) Starting at the downstream end of the parcel and wearing polarized sunglasses when appropriate, walk upstream looking for mussels. While the effort should be concentrated within the wetted areas, especially in pools with depths between 0.2 and 1.0 meters and riffles with depth greater than 0.2 meters and gradient not exceeding 5%, attention should also be paid to areas along the bank where foraging animal (raccoon or muskrat) presence is noted. Surveyors should document live mussels in beds as well as open (dead) mussel shells.

4) Characterize habitat for each parcel using WDFW parameters for estimated substrate composition (overall percentage of boulder, cobble, gravel, fines, bedrock), pool–riffle ratios, wetted width, ordinary high water level, mean gradient, percentage canopy cover, and land type (rural, urban, forest, agricultural). An estimate of the observed sample area should also be noted (was 100% of the entire area inspected or was a percentage unobservable for any reason?).

5) If mussels are found, identify and record all physical characteristics of the bed. Field data include a GPS point, a map sketch of bed locations, an estimate of the size of the bed and number of inhabitants, and photographs. Use surveying tape to flag the upstream and downstream extent of the mussel beds.

6) Attach this information to the parcel card for subsequent database entry (a field form can be stapled to the parcel permission card)

7) Move to the next parcel downstream where permission to access has been granted and repeat steps 2–6. Continue surveying downstream parcels until reaching the downstream end of the reach identified in Step One. Mark the reach break on a map and/or collect a GPS point.

8) Return to the mid-reach parcel and continue the survey upstream until the priority reach has been completely traversed.

9) Using one representative 60-meter stream segment in the mid section of each reach, characterize the habitat and pool riffle ratios within each reach.

(Appendix B: Extensive survey field forms)

Step Three: Intensive Survey Transects and Census Counts

After completing Step Two, the survey team selected mussel-bearing study reaches for intensive survey. At each twenty-meter study reach, the team conducted complete freshwater mussel census counts. Censuses were performed using an underwater viewing scope to enable the surveyors to accurately count mussels in deep or turbulent stream conditions (Figure 2). Ten study reaches were surveyed in Salmon Creek, three in Burnt Bridge Creek, and two in Campen Creek. At each of the sites field crews followed the instructions below. No intensive surveys were performed in Gee and Gibbons Creeks as no mussels were observed in those watersheds during the extensive surveys.

1) Collect a GPS point to document the location of each twenty-meter study reach, and make a written description of the location relative to a permanent reference point (bridge, tributary confluence, etc.) when possible.
2) Document the time, water temperature, pH, dissolved oxygen, and conductivity. Also measure stream gradient to the nearest percent surface slope. Characterize substrate types. Note water clarity and general weather conditions.
3) Run two tapes parallel to the stream channel along each bank for twenty meters. With two more tapes running from left bank to right bank, define 20 cross-sectional transects (upstream-downstream dimension: 1 m). Begin census (see Step 4) at the downstream-most transect and work upstream.
4) Within each transect, count all the mussels (dead and alive) within each square-meter division along the channel's wetted width. Identify mussel location on the stream transect to the nearest ¼ m. If mussel is not embedded, measure the length to the nearest millimeter, and then return animal to the same position in the stream from which it was taken. Care should be taken not to step on or disturb the mussels during censusing.
5) At each meter interval along each transect, measure water depth (substrate–water surface distance) to the nearest centimeter. If the stream is less than 2 m wide, measure depths at 0.5 m intervals.

6) Select an appropriate location in the study reach and take a discharge measurement. Reference the location to the subsample transects.
7) After each intensive study reach census is completed, enter all data into database.

Figure 2. Intensive survey sampling methodology, utilizing an underwater viewing scope.

Results

All five study creeks contained areas with habitat characteristics suitable for supporting freshwater mussel populations (Table 1). We focused our survey efforts in these areas. All of the streams also had backwater wetland pool/glide habitats at their mouths, and although we had access permission, we spent little or no time in these reaches due to poor visibility, silt substrates and low velocity. Similarly, parcels that contained wetland pools and beaver pond habitats were also given low priority for surveying.

During the extensive surveys, freshwater mussels were observed in Campen, Salmon, and Burnt Bridge Creeks (Figure 1; Table 2; Appendix B). The vast majority of mussels observed were Western Pearlshell mussels (*Margaritifera falcata)*. One Oregon floater shell (*Anadonta*), native fingernail clams (*Sphaeriidae*), and non-native Asian clams (*Corbicula*) were also observed. No mussels were observed in the Gee Creek and Gibbons Creek reaches where permission to access had been granted.

In addition to the data from the Clark County watersheds, we also report freshwater mussel data from Schoolhouse Creek in Skamania County. While implementing a fish habitat restoration project in this tributary to the Washougal River, Washington Trout staff documented an unexpectedly large population of *M. falcata* with many juvenile mussels, some under 14-mm in length.

Table 1. Intensive survey physical data summary, by study reach.

Site Name	Date of Survey	Water Temp. (deg. C)	Dissolved Oxygen (%)	Dissolved Oxygen (mg/l)	Specific Conductivity (µS)	Relative Conductivity (µS)	pH (pH units)	Visibility (m)	Wetted Width (m)	Discharge (cfs)	Substrate
Salmon 1	8/11/2004	21.3	91.5	8.06	140.4	150.9	7.93	0.5–1.0	8	12.2	30% cobble, 50% gravel, 20% fines
Salmon 2	8/11/2004	18.5	80.9	7.53	53.3	60.9	7.33	0.3–0.6	7–9	3.1	20% boulder, 40% cobble, 20% gravel, 20% fines
Salmon 3	8/12/2004	18.5	80.9	7.53	53.3	60.9	7.53	0.5–1.0	7–11	3.1	50% Cobble, 50% gravel
Salmon 4	8/24/2004	15.9	80.3	7.93	44.0	53.3	7.06	0.4	7–8	17.0	Mostly bedrock with pockets of gravel
Salmon 5	8/30/2004	18.2	85.7	8.16	56.2	64.8	7.25	0.5	8–11	15.1	cobble, gravel
Salmon 6	8/30/2004	17.1	89.1	8.59	56.4	66.5	7.12	0.3–0.6	10–12	14.5	40% cobble, 45% gravel, 15% fines
Salmon 7	9/1/2004	18.5	84.5	7.87	76.0	86.7	7.41	0.3–0.5	10–13	15.6	20% bedrock, 10% boulder, 40% cobble, 15% gravel, 15% fines
Salmon 8	9/1/2004	18.7	80.0	7.41	85.6	97.5	7.22	0.3–0.4	11–14	17.4	40% cobble, 20% gravel, 40% fines
Salmon 9	9/8/2004	16.9	92.4	8.96	105.3	124.7	7.77	0.3–0.4	10–14	18.8	40% cobble, 40% gravel, 20% fines
Salmon 10	9/9/2004	17.5	89.8	8.58	130.0	151.9	7.55	0.3–0.4	7–12	25.6	15% boulder, 30% cobble, 10% gravel, 45% fines
Gee Creek	No mussels observed										
Burnt Bridge 1	8/10/2004	19.1	76.7	7.11	191.1	215.2	7.71	0.3–0.4	3–5	2.3	20% gravel, 80% fines
Burnt Bridge 2	9/10/2004	20.8	75.5	6.73	195.8	212.9	7.68	0.3–0.4	6–7	1.8	10% gravel, 90% fines
Burnt Bridge 3	9/13/2004	16.3	78.0	7.60	186.9	157.0	7.46	0.3–0.4	5–8	4.1	10% boulder, 10% cobble, 40% gravel, 40% fines
Gibbons Cr.	No mussels observed										
Campen Cr. 1	8/23/2004	17.2	80.0	7.73	27.2	32.2	7.19	0.2–0.3	1–2	n/a	45% gravel, 55% fines
Campen Cr. 2	8/23/2004	17.5	84.5	8.00	71.3	83.5	7.36	0.2–0.3	1	n/a	20% gravel, 80%fines
Schoolhouse Cr.	8/12/2004	12	n/a	n/a	n/a	n/a	n/a	de-watered	1	n/a	pea-gravel and glacial till

Table 2. Intensive survey mussel data summary, by transect.

Site Name	Date of Survey	Area Sampled (sq. meter)	Mussel Size Range (mm)	Total Mussel Count	Proportion Dead (%)	Live Density (#/sq. meter)
Salmon 1	8/11/2004	160	38–63	5	60.0	0.01
Salmon 2	8/11/2004	159	35–80	411	3.9	2.48
Salmon 3	8/12/2004	186	31–76	293	3.8	1.52
Salmon 4	8/24/2004	147	41–64	285	1.1	1.92
Salmon 5	8/30/2004	195	31–87	564	7.3	2.68
Salmon 6	8/30/2004	218	41–82	2158	3.8	9.52
Salmon 7	9/1/2004	224	19–85	1020	7.0	4.23
Salmon 8	9/1/2004	245	13–82	141	14.2	0.49
Salmon 9	9/8/2004	252	35–72	150	4.7	0.57
Salmon 10	9/9/2004	191	24–76	152	7.2	0.74
Gee Creek	No mussels observed					
Burnt Bridge 1	8/10/2004	83	36–75	32	0	0.39
Burnt Bridge 2	9/10/2004	134	57–75	16	6.3	0.11
Burnt Bridge 3	9/13/2004	127	63–83	17	0	0.13
Gibbons Cr.	No mussels observed					
Campen Cr. 1	8/23/2004	21	50–62	11	9.1	0.48
Campen Cr. 2	8/23/2004	20	31–65	120	5.0	5.70
Schoolhouse Cr.	8/12/2004	274	13-56	1490	0	5.45

GEE CREEK

Gee Creek enters Ridgefield National Wildlife refuge where it joins with Ledgerwood Creek and becomes a wetland complex of ponds and oxbow channels called Sherman Creek (Figure 3). Survey crews were told that salmon cannot access Gee Creek through the wetland complex due to a pond control structure located there. Habitat downstream of the Main Street Bridge in the City of Ridgefield is entirely pool and beaver pond. Although it was poor habitat for *M. falcata* we looked for signs of mussel presence. Substrates were dominated by silt and mud, and no mussels were observed. Upstream the habitat improves with low-gradient stable substrates with medium gravels and good riparian cover. Crews were also informed that an agricultural spill killed most of the resident fish in the past and a mudslide in Abrams Park silted-in the channel. Survey crews observed few cutthroat trout in this stream and no salmon or mussels were noted.

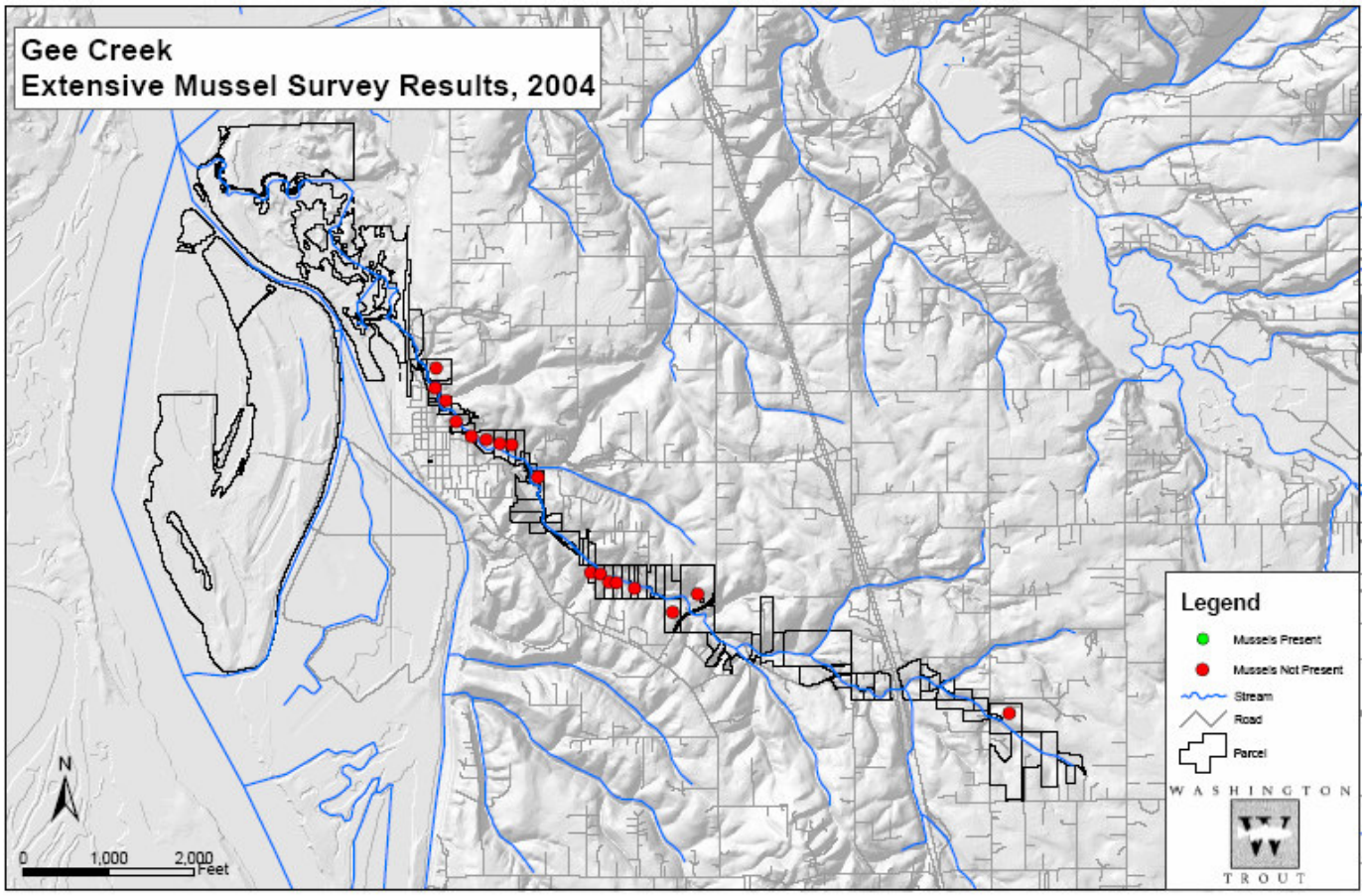

Figure 3. Gee Creek extensive survey results showing the parcels where crews surveyed for mussel presence/absence, where mussels were observed (green circles) and where mussels were not observed (red circles).

SALMON CREEK

Salmon Creek is the largest stream of the five surveyed in Clark County. It is a tributary of Lake Cr, which is the outlet stream of Lake Vancouver (Figure 4). The downstream end runs through County parkland, where substrates become silt-dominated with large backwater wetlands along the channel margins. We did not survey downstream of the Seward Avenue Bridge due to poor visibility.

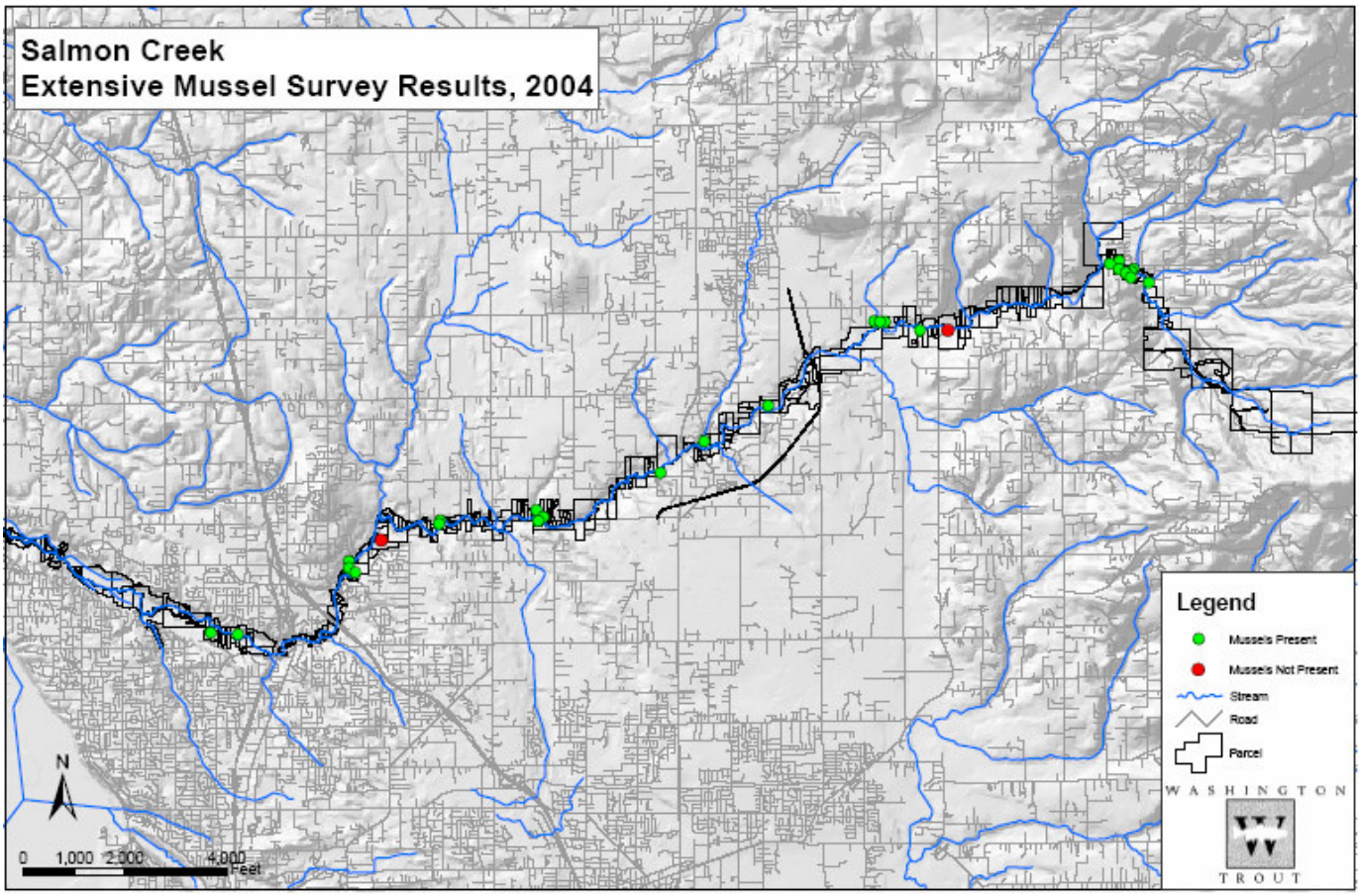

Figure 4. Salmon Creek extensive survey results showing the parcels where crews surveyed for mussel presence, where mussels were observed (green circles) and where mussels were not observed (red circles).

Mussels were found in the lower end of Salmon Creek but populations were intermittent and low density. We did find non-native *Corbicula* shells and live specimens in some of the sandy and silty areas. We also found an *Anodonta oregonensis* shell, the only one observed during this study, downstream of Interstate 5. We did not find a live specimen of this species. We also found native fingernail clams throughout the study reaches. Urban and suburban development dominates the landscape outside of the greenway park in the lower reaches of Salmon Creek. We identified *M. falcata* populations all the way up Salmon Creek to the upper parcels downstream of the barrier falls at the Westerholm community. The greatest densities of *M. falcata* were found in the upper third of the watershed, where the stream is less urbanized. We did not survey upstream of the falls. Salmon Creek supports chum and coho salmon, and also steelhead trout. Northern Pike Minnows and resident trout were also observed during the survey. The majority of live mussels in the Salmon Creek study reaches were observed between the depths of 0.08meters and 0.4 meters (Figure 5). Salmon Creek had by far the largest number and widest distribution of *M. falcata* of the five streams surveyed. We surveyed ten study reaches in the watershed.

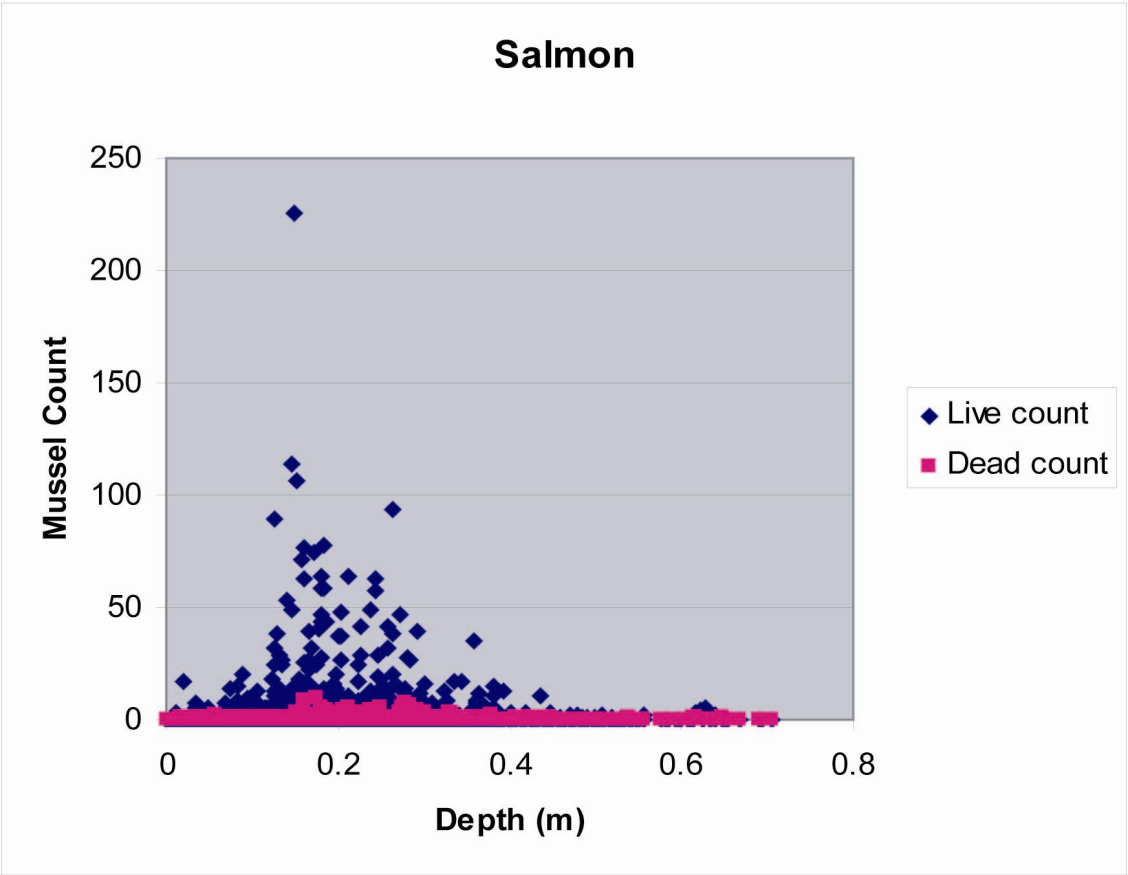

Figure 5. Abundance at depth of live and dead mussels observed in the ten Salmon Creek study reaches.

Individual Salmon Creek cross-section results at Study Reach #5 demonstrate the consistent observation of mussel preference for lateral (channel margin) habitats, as opposed to thalweg habitats (Figure 6, 7).

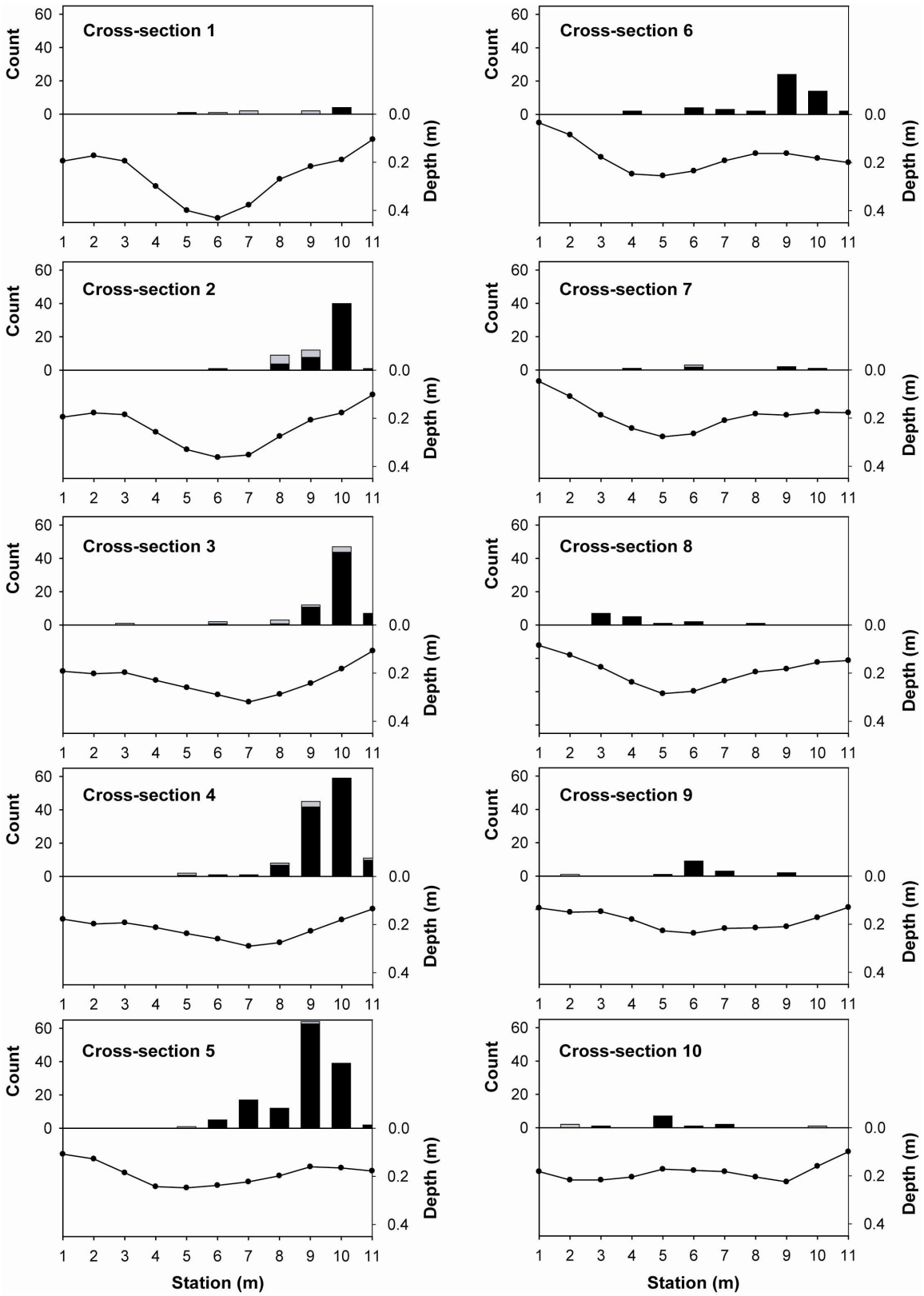

Figure 6. Mussel densities, water depth, and channel profiles along cross-sections 1-10 at Study Reach #5 on Salmon Creek. Black shading represents live-counts, grey shading represents dead-counts.

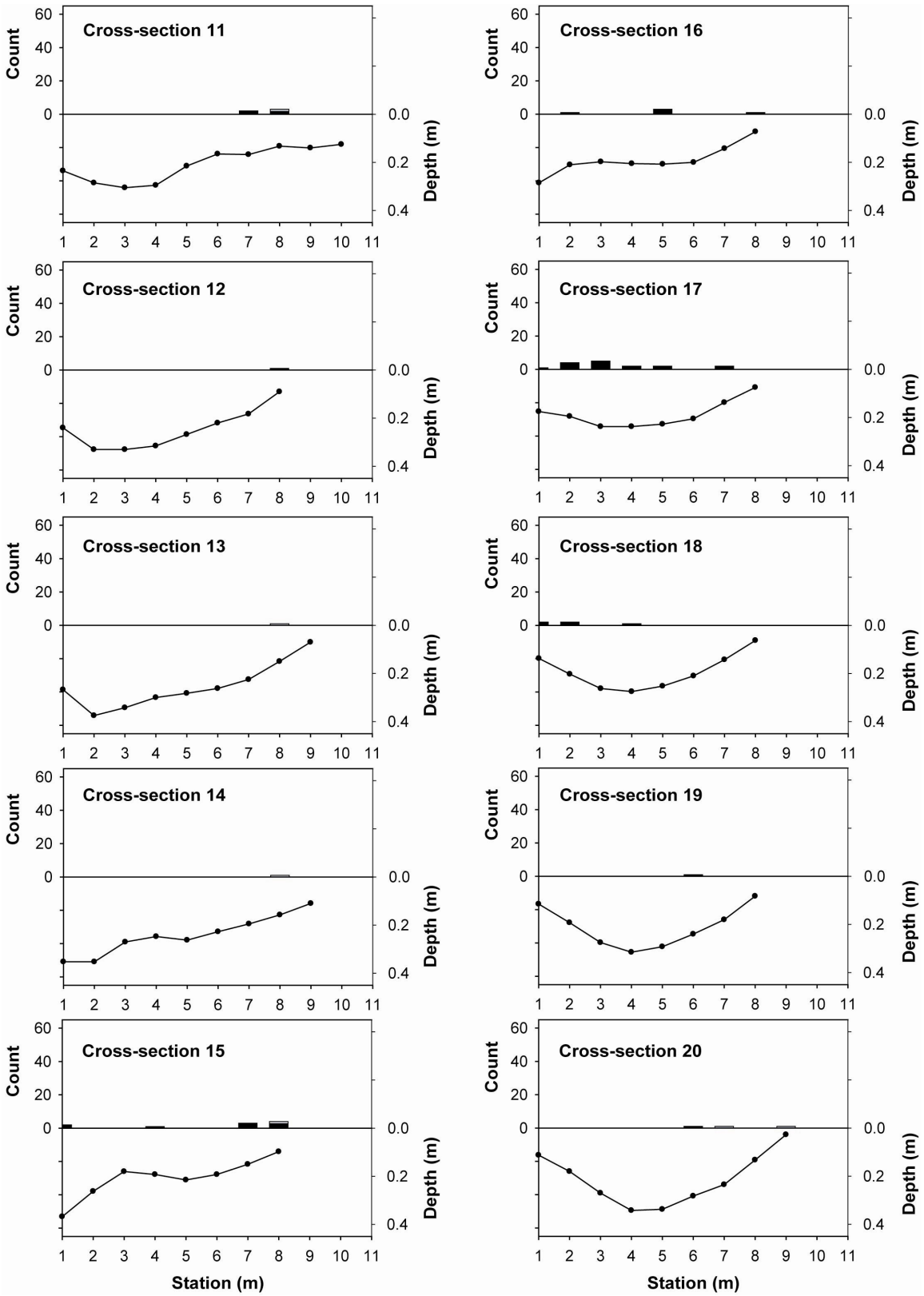

Figure 7. Mussel densities, water depth, and channel profiles along cross-sections 11-20 at Study Reach #5 on Salmon Creek. Black shading represents live-counts, grey shading represents dead-counts.

BURNT BRIDGE CREEK

Burnt Bridge Creek is a tributary of Vancouver Lake (Figure 8). Of the five streams included in this study, Burnt Bridge Creek has the highest density of urban development. Most of the downstream portion flows through urban development with greenbelt park land. This stream has a high risk of residential and light-industrial runoff affecting wildlife. Much of the stream is altered with bank armoring and landscaped riparian cover. In the upper reaches the stream is highly channelized. We concentrated most of our effort in the central part of the watershed along the adjacent city and county park lands. This stream has known salmonid use. We performed intensive surveys in three study reaches within Burnt Bridge Creek, and found populations of *M. falcata* as well as numerous non-native *Corbicula*. Live mussels were observed between the depths of 0.05 meters and 0.2 meters (Figure 9).

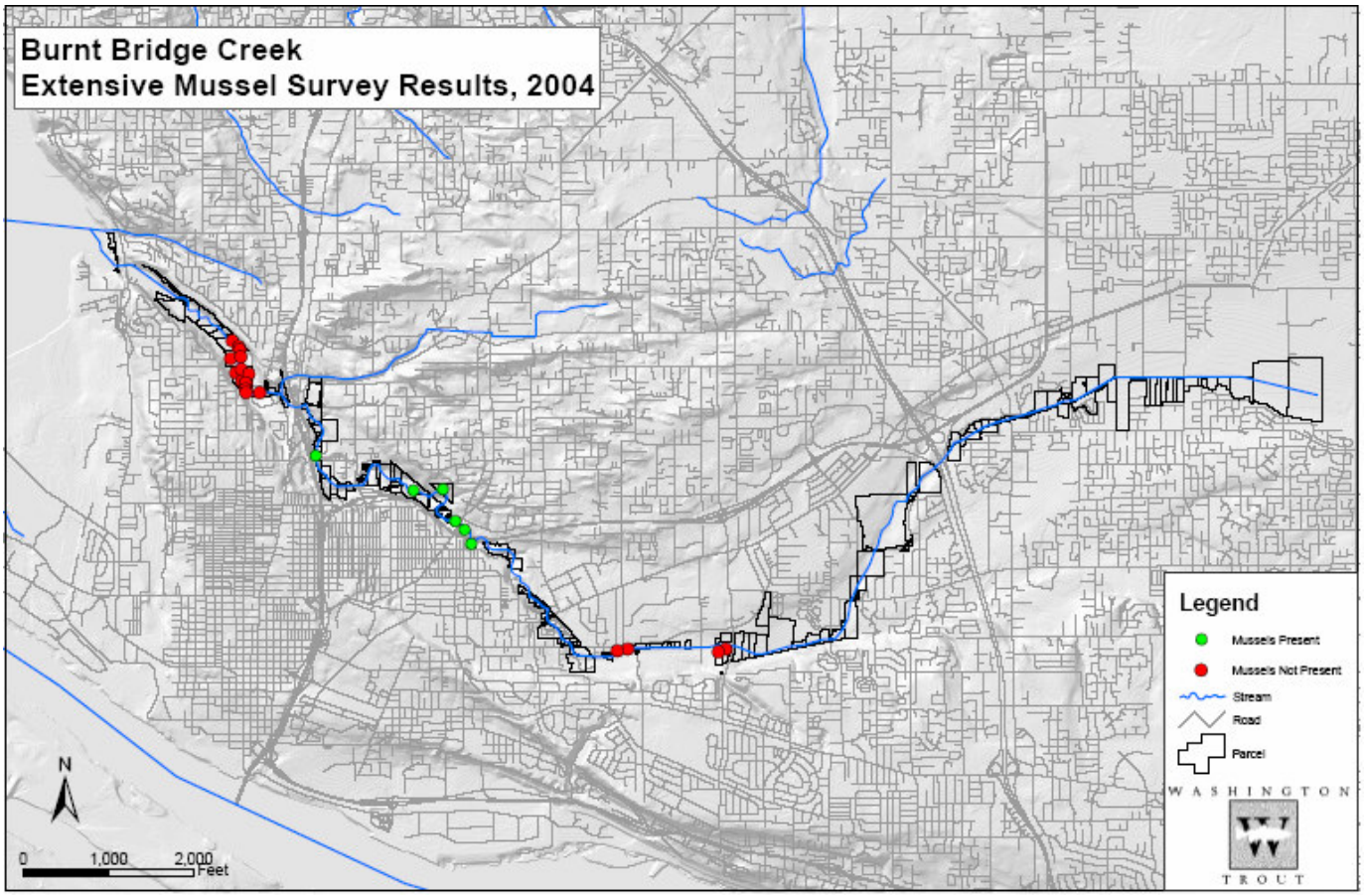

Figure 8. Burnt Bridge Creek extensive survey results showing the parcels where crews surveyed for mussel presence, where mussels were observed (green circles) and where mussels were not observed (red circles).

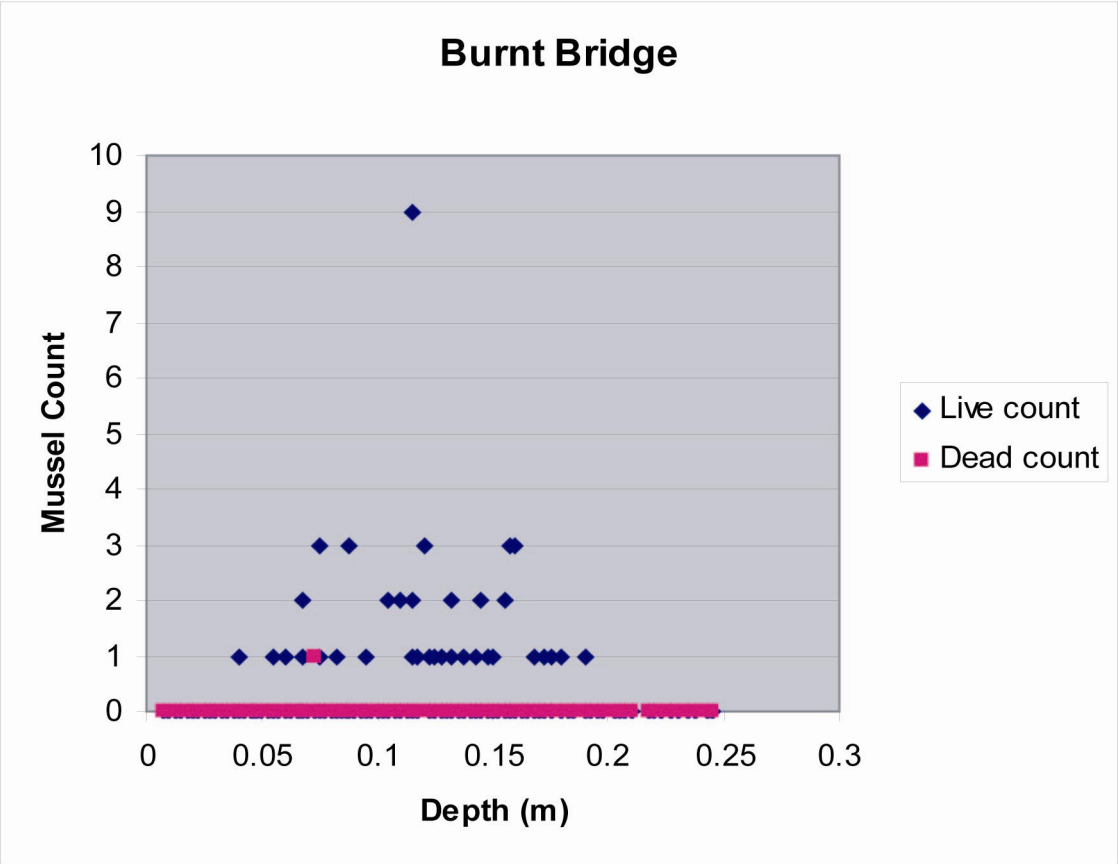

Figure 9. Abundance at depth of live and dead mussels observed in the three Bunt Bridge Creek study reaches.

GIBBONS / CAMPEN CREEK

The Gibbons Creek watershed is a small tributary of the Columbia River (Figure 10). No freshwater mussel presence was documented in those mainstem Gibbons Creek parcels where permission to access had been granted. The downstream portion of the mainstem flows though an extensive wetland complex in the Columbia River floodplain. Our survey did not extend into the lower wetland area. Upstream of the floodplain the stream gains gradient and flows through mostly rural suburban and agricultural land. Access was difficult in many places due to thick blackberries and brush. Gibbons/Campen Creek has known salmonid use and mussel survey crews saw coho salmon juveniles as well as resident trout.

Campen Creek is a small tributary of Gibbons Creek. Where permission was granted on Campen Creek, crews found mussel populations with some juvenile specimens as small as 15 mm. Campen Creek is a small stream with only 1.5 m width at ordinary high water, and mussels were observed in the stream where it was less than 1 meter wide. Crews

performed intensive surveys within two study reaches in Campen Creek. The majority of live mussels observed were documented between the depths of 0.05 meters and 0.1 meters (Figure 11).

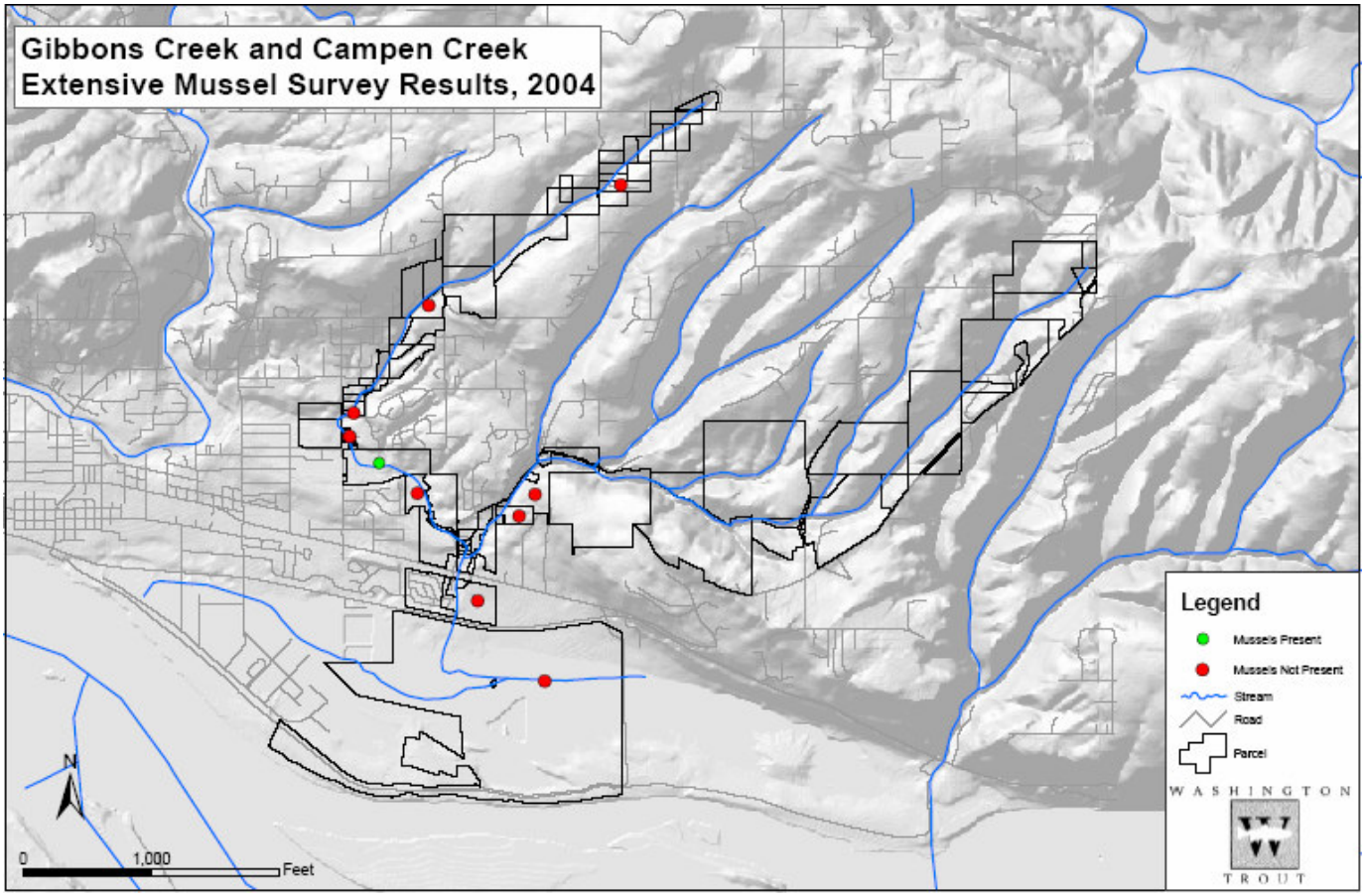

Figure 10. Burnt Bridge Creek extensive survey results showing the parcels where crews surveyed for mussel presence, where mussels were observed (green circles) and where mussels were not observed (red circles).

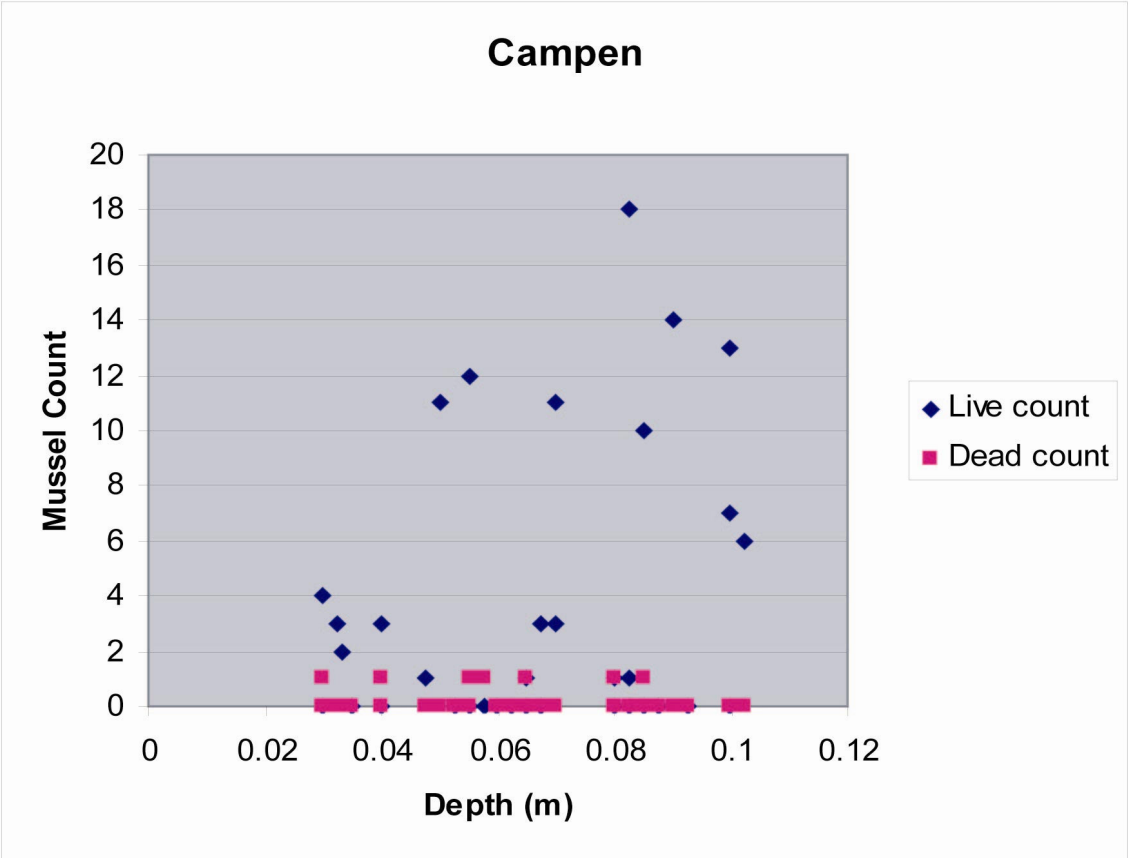

Figure 11. Abundance at depth of live and dead mussels observed in the two Campen Creek study reaches.

SCHOOLHOUSE CREEK (Skamania County)

Schoolhouse Creek is a small first-order tributary to the Washougal River located in Skamania County (N 45deg 36.646min, W 122deg 14.324 min, Figure 12). In September 2004, during the course of an ongoing restoration project, Washington Trout crews temporarily de-watered a 600 ft. reach of the 1.5 m. wide channel. Because twenty live mussels (*M. falcata*) had been observed during the planning of the restoration project, mussels were salvaged from the affected channel at the time of the de-watering. In the days subsequent to the de-watering, a total of 1,492 live *M. falcata* were transported out of the drying channel into the wetted reach upstream. Four native fingernail clams were also documented. This small watershed has supported a resident cutthroat trout population for the past several decades, and only through recent (2002) fish passage restoration efforts have coho salmon regained access to the watershed.

Presented with the opportunity to closely inspect a small, nearly dry channel, and to sift through the substrates with bare hands, we documented 74 times as many mussels as we had originally observed while looking through flowing water. This experience suggests that mussel bed censuses performed in running water (a constraint common to most surveys) may significantly underestimate the actual number of individuals present.

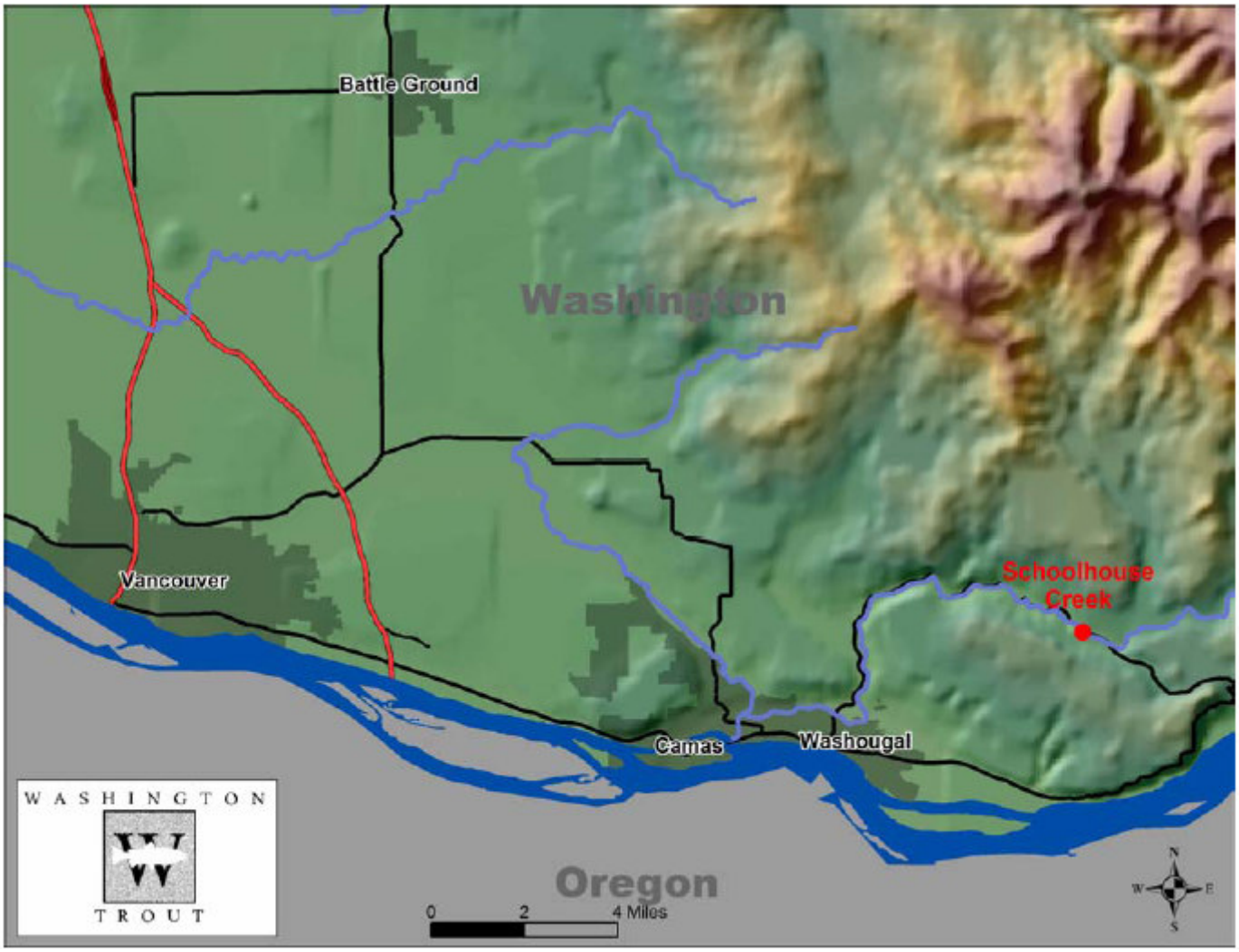

Figure 12. Location of Schoolhouse Creek freshwater mussel observations.

Discussion

This report provides a baseline characterization of the freshwater mussels in five Clark County watersheds against which future surveys of bed location, species composition, density, and population age structure can be compared to document changes in the health of the mussel populations and commensurate changes in the biological integrity of these watersheds.

No mussels were observed on Gee and Gibbons Creeks where permission to survey was granted. *M. falcata* accounted for the majority of mussel observations. Mussel beds were observed on Campen Creek, Salmon Creek, and Burnt Bridge Creek. Live mussel bed densities ranged from zero to 9.52 mussels per square meter; densities were greatest on Salmon Creek. The observation of dead mussels was greatest on Salmon Creek, where approximately 11% of the observed mussels were dead.

Project Design Standards

1. Knowledgeable and trained personnel were involved in the design and implementation of survey activities.

2. Project personnel stayed out of the stream channel as much as possible and avoid disturbing aquatic fauna when entering the stream.

3. Project personnel working in a stream did not cause a significant increase in the turbidity from the suspension of fine sediments.

4. Project personnel did not conduct activities within a stream channel when federally listed fish or other aquatic species were actively spawning.

5. Equipment and materials use during surveys activities were not toxic to terrestrial or aquatic species.

6. Project personnel coordinated with Federal, State, and local agencies and organizations to avoid the duplication of survey, assessment, and monitoring activities. All required permits were obtained from appropriate agencies before performing the surveys.

7. This report will be made available to other interested parities, to the extent possible, by publishing and disturbing reports or providing the information on an Internet web site.

Appendix A
Key to Freshwater mussels of the Pacific Drainages
Al Smith, July 2004

This key was developed by Smith (2004) to enable the user to identify mussels under three circumstances: a shell in hand, a live mussel in hand and a live mussel *in situ* underwater. As a result, there are a number of key characteristics for most species. Also included is a glossary for terms used in the key and a list of common names. John Fleckenstein generously contributed some cautions on using the key.

Species in the genus *Anodonta* are difficult to separate. Shell characteristics are extremely plastic, depending on area found and on conditions such as water velocity and substrate. Some individuals cannot be identified by shell characteristics, even by an expert. In addition, taxonomy and ranges are not entirely settled. The characteristics listed below can be used to make a guess about individuals, but an expert should confirm identification. This requires collection of shells. The *Anodonta* species are not common in many areas of the Northwest. Taking live mussels is discouraged.

Genera Key

2 Outline of shell triangular or round. Well-developed concentric sculpture lines, absent on other genera. (Introduced)…….**Corbicula**

3… Well-developed pseudocardinal teeth. Ventral outline slightly concave. Nacre purple on fresh specimens. Arborescent incurrent opening papillae……**Margaritifera**

4 Distinct, heavy ridge running at an angle from umbo to posterior vental surface. Shell thick, heavy, and sturdy. Divided, purplish incurrent opening papillae. ……..….**Gonidea**

5 Pseudocardinal teeth and heavy ridge absent. Shell thin, light, and fragile. Single, whitish incurrent opening papillae. ……**Anodonta**

Species Key

1 Outline of shell triangular or round. Well-developed concentric sculpture lines. Adults small in size up to about 60mm. Widespread in streams, rivers, some standing water. (Introduced) …….**Corbicula fluminea**

2 Hinge with well developed pseudocardinal teeth. Shell with even surface; no distinct ridge. Ventral outline of shell slightly concave. Nacre purple on fresh specimens. Shell is thick heavy and sturdy ……**Margaritifera falcata**
AK, BC, WA, OR, CA, MT, ID, NV, UT, WY, prefers gravelly bottom

3 Hinge lacking pseudocardinal teeth. Distinct, heavy ridge running at an angle from umbo to posterior vental surface. Ventral outline of shell straight or broadly curved. Shell is thick heavy and sturdy..……**Gonidea angulata**
Pacific drainages from BC to CA, prefers gravelly bottoms

4 Shell height: length ratio usually 1.5 or less. Height of posterior half of shell is greater than height of anterior half. Shell broadly ovate in outline. …….5

Shell height: length ratio close to or exceeding 2. Height of posterior half of shell is nearly equal to height of anterior half. ……...6

5 Shell with high, conspicuous wing. Shell outline compressed. Shell thinner than other Anodonta species……..**Anodonta nuttalliana**
WA, OR, CA

Shell with a wing of moderate height. Shell outline less compressed, especially in standing water. Shell comparable in thickness to other Anodonta species……**Anodonta californiensis**
BC, WA, OR, CA, ID, NV, UT, WY, AZ, Baja, Chihuahua

6 Shell inflated only over anterior half of shell. Umbo clearly projects above hinge line. ……**Anodonta beringiana**
AK, YT, BC

Shell inflated primarily along posterior ridge of the shell. Umbo does not or barely projects above the hinge line. ……..**Anodonta kennerlyi**
BC, Alberta, WA, OR

Shell primarily inflated over median portion of shell. Umbo does not project above hinge line…… .**Anodonta Oregonensis**
AK, BC, WA, OR, CA, NV, UT

GLOSSARY

Anterior – the shorter end of the shell from the umbo where the foot emerges
Arborescent – tree like, feathery
Compressed - shells flattened together laterally
Dorsal – the top of the mussel where the hinge and umbo occur
Height – distance from the umbo to the ventral surface
Hinge – the flexible attachment of the two shells on the dorsal side
Incurrent opening – the ventral posterior where water flows in
Inflated – swollen, expanded
In situ – situated in a natural place or habitat
Length – distance between both ends of the mussel shell
Median – the line that divides an animal in half, in the middle
Nacre – the inner layer of the shell
Ovate – oval shaped
Papillae – small projections or protuberances
Posterior – the longer end of shell from the umbo where the siphons emerge
Pseudocardinal teeth – teeth inside the anterior part of the shell along the hinge
Sculpture lines – raised narrow concentric ridges on the outside of the shell
Umbo – raised part of the dorsal edge of each shell
Ventral – the bottom of the shell that can be opened
Wing – the thin, flat extension of the top of the shell on some mussels

COMMON NAMES (italicize all scientific names)

Gonidea angulata – Western Ridged mussel
Margaritifera falcata Western Pearlshell
Anodonta nuttalliana – Winged floater
Anadonta californiesis – California floater

Anadonta beringiana – Yukon floater
Anadonta kennerlyi – Western floater
Anadonta oregonensis – Oregon floater

Appendix B

Extensive Survey Field Data, Summer 2004

Extensive Mussel Survey Data, 2004

Parcel #	Stream	Crew	Date	%Pool/Riffle Ratio	Average Stream Length
012511	Gee	FS / SM	7/19/2004	80/20	0.00

Average Max Depth Pool	Riffle	Average Wetted Width	Ordinary High Water (m)	Gradient %
0.60	0.10	6.00	7.50	2.00%

Boulder	Cobble	Gravel	Fines	Rural	Urban	Forest
0.00%	20.00%	40.00%	40.00%	✔	✔	☐

Agriculture	Percentage Observed Coverage	Reason	Mussel Presence	Species	Shells	Live Mussels
☐	70.00%	turbid	☐		☐	☐

Beds	Size	Estimated Popluation<200	Estimated Population >200	Picture#	Description	GPS#
☐	0.00	☐	☐			0

N	W	Sketch of Beds Taken
		☐

Notes

In Abrams Park in city of Ridgefield. US end of Abrams Park creek banks are armored with rip-rap.

Parcel #	Stream	Crew	Date	%Pool/Riffle Ratio	Average Stream Length
011525	Gee	FS / SM	7/19/2004	99/01	0.00

Average Max Depth Pool	Riffle	Average Wetted Width	Ordinary High Water (m)	Gradient %
0.90	0.00	7.00	7.00	0.00%

Boulder	Cobble	Gravel	Fines	Rural	Urban	Forest
0.00%	5.00%	5.00%	90.00%	✔	✔	☐

Agriculture	Percentage Observed Coverage	Reason	Mussel Presence	Species	Shells	Live Mussels
☐	5.00%	poor visibility	☐		☐	☐

Beds	Size	Estimated Popluation<200	Estimated Population >200	Picture#	Description	GPS#
☐	0.00	☐	☐	235	DS at Main St. x-in	0

N	W	Sketch of Beds Taken
		☐

Notes

At Main St crossing in city of Ridgefield. Entire reach is low velosity pool habitat with poor visibility.

Parcel #	Stream	Crew	Date	%Pool/Riffle Ratio	Average Stream Length
011526	Gee	FS / SM	7/19/2004	80/20	0.00

Average Max Depth Pool	Riffle	Average Wetted Width	Ordinary High Water (m)	Gradient %
0.90	0.20	5.00	5.50	1.00%

Boulder	Cobble	Gravel	Fines	Rural	Urban	Forest
0.00%	15.00%	45.00%	40.00%	✔	✔	☐

Agriculture	Percentage Observed Coverage	Reason	Mussel Presence	Species	Shells	Live Mussels
☐	60.00%	silt, turbid	☐		☐	☐

Beds	Size	Estimated Popluation<200	Estimated Population >200	Picture#	Description	GPS#
☐	0.00	☐	☐			10

N	W	Sketch of Beds Taken
4549.463	12244.689	☐

Notes

Is still parcel #11525. DS end of the parcel is more debris and beaver jams with not much resent activity. Bridge at private drive at 932 Main S in Ridgefield is US end of R-1 all pool habitat DS of this point.

Parcel #	Stream	Crew	Date	%Pool/Riffle Ratio	Average Stream Length
011836	Gee	FS / SM	7/19/2004	80/20	0.00

Average Max Depth Pool	Riffle	Average Wetted Width	Ordinary High Water (m)	Gradient %
0.70	0.10	3.70	5.00	1.00%

Boulder	Cobble	Gravel	Fines	Rural	Urban	Forest
0.00%	10.00%	70.00%	20.00%	✔	✔	☐

Agriculture	Percentage Observed Coverage	Reason	Mussel Presence	Species	Shells	Live Mussels
☐	60.00%	silt, turbid	☐		☐	☐

Beds	Size	Estimated Popluation<200	Estimated Population >200	Picture#	Description	GPS#
☐	0.00	☐	☐			0

N	W	Sketch of Beds Taken
		☐

Notes

Flows appears to be less than in Abrams Park up stream of this parcel.

Parcel #	Stream	Crew	Date	%Pool/Riffle Ratio	Average Stream Length
011834	Gee	FS / SM	7/19/2004	80/20	0.00

Average Max Depth Pool	Riffle	Average Wetted Width	Ordinary High Water (m)	Gradient %
0.70	0.10	4.00	5.50	1.00%

Boulder	Cobble	Gravel	Fines	Rural	Urban	Forest
0.00%	0.00%	30.00%	70.00%	✔	✔	☐

Agriculture	Percentage Observed Coverage	Reason	Mussel Presence	Species	Shells	Live Mussels
☐	60.00%	silt, turbid	☐		☐	☐

Beds	Size	Estimated Popluation<200	Estimated Population >200	Picture#	Description	GPS#
☐	0.00	☐	☐			0

N	W	Sketch of Beds Taken
		☐

Notes

More fines and low velosity pools with short riffles.

Parcel #	Stream	Crew	Date	%Pool/Riffle Ratio	Average Stream Length
012512	Gee	FS / SM	7/19/2004	80/20	0.00

Average Max Depth Pool	Riffle	Average Wetted Width	Ordinary High Water (m)	Gradient %
0.60	0.10	6.00	7.50	2.00%

Boulder	Cobble	Gravel	Fines	Rural	Urban	Forest
15.00%	20.00%	20.00%	45.00%	✔	✔	☐

Agriculture	Percentage Observed Coverage	Reason	Mussel Presence	Species	Shells	Live Mussels
☐	70.00%	turbid	☐		☐	☐

Beds	Size	Estimated Popluation<200	Estimated Population >200	Picture#	Description	GPS#
☐	0.00	☐	☐			0

N	W	Sketch of Beds Taken
		☐

Notes

In Abrams Park in city of Ridgefield. Canopy becomes more sparse heading up stream ~50% shaded. Open field on LB and forest up slope on RB. Some beaver activity noted but no dams on this reach.

Parcel #	Stream	Crew	Date	%Pool/Riffle Ratio	Average Stream Length
012515	Gee	FS / SM	7/19/2004	80/20	0.00

Average Max Depth Pool	Riffle	Average Wetted Width	Ordinary High Water (m)	Gradient %
0.60	0.10	6.00	7.50	2.00%

Boulder	Cobble	Gravel	Fines	Rural	Urban	Forest
0.00%	30.00%	50.00%	20.00%	✔	✔	☐

Agriculture	Percentage Observed Coverage	Reason	Mussel Presence	Species	Shells	Live Mussels
☐	80.00%	turbid	☐		☐	☐

Beds	Size	Estimated Popluation<200	Estimated Population >200	Picture#	Description	GPS#
☐	0.00	☐	☐			0

N	W	Sketch of Beds Taken
		☐

Notes

In Abrams Park in city of Ridgefield. Sculpin and frogs noted but few salmonids. One ~7in trout noted in Abrams Park reach. Mud slide from flood on left bank.

Parcel #	Stream	Crew	Date	%Pool/Riffle Ratio	Average Stream Length
012983	Gee	FS / SM	7/19/2004	80/20	0.00

Average Max Depth Pool	Riffle	Average Wetted Width	Ordinary High Water (m)	Gradient %
0.60	0.10	6.00	7.50	2.00%

Boulder	Cobble	Gravel	Fines	Rural	Urban	Forest
0.00%	30.00%	50.00%	20.00%	✔	✔	☐

Agriculture	Percentage Observed Coverage	Reason	Mussel Presence	Species	Shells	Live Mussels
☐	80.00%	turbid	☐		☐	☐

Beds	Size	Estimated Popluation<200	Estimated Population >200	Picture#	Description	GPS#
☐	0.00	☐	☐			0

N	W	Sketch of Beds Taken
		☐

Notes

Parcel is in Abrams Park in city of Ridgefield. Canopy is sparse conifer and brush along stream banks. Foot path along the stream edge. 60 to 70% shade cover.

Parcel #	Stream	Crew	Date	%Pool/Riffle Ratio	Average Stream Length
014834	Gee	FS / SM	7/21/2004	60/40	0.00

Average Max Depth Pool	Riffle	Average Wetted Width	Ordinary High Water (m)	Gradient %
0.80	0.10	2.00	3.50	2.00%

Boulder	Cobble	Gravel	Fines	Rural	Urban	Forest
0.00%	30.00%	30.00%	40.00%	✔	☐	☐

Agriculture	Percentage Observed Coverage	Reason	Mussel Presence	Species	Shells	Live Mussels
☐	70.00%	deep pools	☐		☐	☐

Beds	Size	Estimated Popluation<200	Estimated Population >200	Picture#	Description	GPS#
☐	0.00	☐	☐			0

N	W	Sketch of Beds Taken
		☐

Notes

These are 15th ave rural residential lots this includes parcel #'s 14838,14841,14843,14849. Ripaian area is large alder and conifer through backyards. Large backwater pools are mostly silt and sand substrates.

Parcel #	Stream	Crew	Date	%Pool/Riffle Ratio	Average Stream Length
015360	Gee	FS / SM	7/21/2004	70/30	0.00

Average Max Depth Pool	Riffle	Average Wetted Width	Ordinary High Water (m)	Gradient %
0.90	0.10	3.00	4.00	2.00%

Boulder	Cobble	Gravel	Fines	Rural	Urban	Forest
0.00%	10.00%	10.00%	80.00%	☐	☐	☐

Agriculture	Percentage Observed Coverage	Reason	Mussel Presence	Species	Shells	Live Mussels
✔	25.00%	deep pools, turbid	☐		☐	☐

Beds	Size	Estimated Popluation<200	Estimated Population >200	Picture#	Description	GPS#
☐	0.00	☐	☐			0

N	W	Sketch of Beds Taken
		☐

Notes

DS of 45th ave crossing stream runs through agriculture fields with thin riparian corridor and cannelized low velosity pool habitat.

Parcel #	Stream	Crew	Date	%Pool/Riffle Ratio	Average Stream Length
017180	Gee	FS / SM	7/21/2004	50/50	0.00

Average Max Depth Pool	Riffle	Average Wetted Width	Ordinary High Water (m)	Gradient %
0.30	0.05	0.90	1.20	2.00%

Boulder	Cobble	Gravel	Fines	Rural	Urban	Forest
0.00%	0.00%	30.00%	70.00%	✔	☐	☐

Agriculture	Percentage Observed Coverage	Reason	Mussel Presence	Species	Shells	Live Mussels
☐	0.00%	low flow	☐		☐	☐

Beds	Size	Estimated Popluation<200	Estimated Population >200	Picture#	Description	GPS#
☐	0.00	☐	☐	232	headwater habitat	0

N	W	Sketch of Beds Taken
		☐

Notes

Took photo US of 10th st crossing small trickle flow of headwater Gee Cr.did not survey US of this crossing.

Parcel #	Stream	Crew	Date	%Pool/Riffle Ratio	Average Stream Length
013321	Gee	FS / SM	7/21/2004	70/30	0.00

Average Max Depth Pool	Riffle	Average Wetted Width	Ordinary High Water (m)	Gradient %
0.90	0.10	2.00	3.50	1.00%

Boulder	Cobble	Gravel	Fines	Rural	Urban	Forest
0.00%	20.00%	30.00%	50.00%	✔	☐	☐

Agriculture	Percentage Observed Coverage	Reason	Mussel Presence	Species	Shells	Live Mussels
☐	60.00%	deep pools	☐		☐	☐

Beds	Size	Estimated Popluation<200	Estimated Population >200	Picture#	Description	GPS#
☐	0.00	☐	☐			0

N	W	Sketch of Beds Taken
		☐

Notes

US of Pioneer Ave. crossing is the parcel. Confluence with Tee Cr is ~150m upstream of the road crossing. Tee Cr is only ~10% of the flow, upstream there is mudstone embedded with gravel that create pool controls. Low velosity flow with long pools.

Parcel #	Stream	Crew	Date	%Pool/Riffle Ratio	Average Stream Length
012197	Gee	FS / SM	7/21/2004	80/20	0.00

Average Max Depth Pool	Riffle	Average Wetted Width	Ordinary High Water (m)	Gradient %
0.90	0.20	5.00	5.50	1.00%

Boulder	Cobble	Gravel	Fines	Rural	Urban	Forest
0.00%	10.00%	40.00%	50.00%	✔	✔	☐

Agriculture	Percentage Observed Coverage	Reason	Mussel Presence	Species	Shells	Live Mussels
☐	50.00%	silt, turbid	☐		☐	☐

Beds	Size	Estimated Popluation<200	Estimated Population >200	Picture#	Description	GPS#
☐	0.00	☐	☐			0

N	W	Sketch of Beds Taken
		☐

Notes

US of Heron Dr. in Ridgefield. Stream had < .3m depth visibility, beaver ponds connected by short riffles.

Parcel #	Stream	Crew	Date	%Pool/Riffle Ratio	Average Stream Length
015541	Gee	FS / SM	7/21/2004	80/20	0.00

Average Max Depth Pool	Riffle	Average Wetted Width	Ordinary High Water (m)	Gradient %
0.90	0.10	3.00	4.00	3.00%

Boulder	Cobble	Gravel	Fines	Rural	Urban	Forest
0.00%	15.00%	25.00%	60.00%	☐	☐	☐

Agriculture	Percentage Observed Coverage	Reason	Mussel Presence	Species	Shells	Live Mussels
✔	50.00%	deep pools, turbid	☐		☐	☐

Beds	Size	Estimated Popluation<200	Estimated Population >200	Picture#	Description	GPS#
☐	0.00	☐	☐			0

N	W	Sketch of Beds Taken
		☐

Notes

US of 45th ave crossing stream runs through pasture the riparian corridor improves US with nice gravels and habitat.

Parcel #	Stream	Crew	Date	%Pool/Riffle Ratio	Average Stream Length
035983	Salmon	FS/SM	7/22/2004	60/40	0.00

Average Max Depth Pool	Riffle	Average Wetted Width	Ordinary High Water (m)	Gradient %
1.00	0.20	11.00	12.00	3.00%

Boulder	Cobble	Gravel	Fines	Rural	Urban	Forest
10.00%	20.00%	40.00%	30.00%	✔	☐	☐

Agriculture	Percentage Observed Coverage	Reason	Mussel Presence	Species	Shells	Live Mussels
☐	60.00%	deep pools	✔	falcata	✔	✔

Beds	Size	Estimated Popluation<200	Estimated Population >200	Picture#	Description	GPS#
☐	0.00	✔	☐	230,231	shells	11

N	W	Sketch of Beds Taken
N4543.211	W12238.069	☐

Notes

Also includes parcel #'s 34944,34442,34195.Rural residential area some of the stream banks have boulder armourment. Lots of juv. Coho note in the pools. Although we saw mussels populations were low in these segments of the stream.

Parcel #	Stream	Crew	Date	%Pool/Riffle Ratio	Average Stream Length
032722	Salmon	FS/SM/JP/JH	7/27/2004	60/40	0.00

Average Max Depth Pool	Riffle	Average Wetted Width	Ordinary High Water (m)	Gradient %
0.90	0.20	10.00	12.00	1.00%

Boulder	Cobble	Gravel	Fines	Rural	Urban	Forest
0.00%	20.00%	40.00%	40.00%	✔	☐	✔

Agriculture	Percentage Observed Coverage	Reason	Mussel Presence	Species	Shells	Live Mussels
☐	60.00%	deep pools	☐		☐	☐

Beds	Size	Estimated Popluation<200	Estimated Population >200	Picture#	Description	GPS#
☐	0.00	☐	☐			0

N	W	Sketch of Beds Taken
		☐

Notes

Parcel is Pleasant Valley County park stream goes though open pasture area that is landscaped parkland. No mussels were noted but area look like suitable habitat for mussels.

Parcel #	Stream	Crew	Date	%Pool/Riffle Ratio	Average Stream Length
032073	Salmon	FS/SM	7/27/2004	60/40	0.00

Average Max Depth Pool	Riffle	Average Wetted Width	Ordinary High Water (m)	Gradient %
0.90	0.20	12.00	12.50	2.00%

Boulder	Cobble	Gravel	Fines	Rural	Urban	Forest
0.00%	25.00%	50.00%	25.00%	✔	☐	☐

Agriculture	Percentage Observed Coverage	Reason	Mussel Presence	Species	Shells	Live Mussels
✔	75.00%	deep pools	✔	falcata	✔	✔

Beds	Size	Estimated Popluation<200	Estimated Population >200	Picture#	Description	GPS#
✔	2.00	☐	✔			0

N	W	Sketch of Beds Taken
		✔

Notes

Also incudes parcel #'s 31095,31781. Large debris jam at parcel 31781. Fresh water sponge noted in this area. Lots of shells noted and small clusters of mussels.

Parcel #	Stream	Crew	Date	%Pool/Riffle Ratio	Average Stream Length
023138	Salmon	FS/SM/JP/JH	7/28/2004	60/40	0.00

Average Max Depth Pool	Riffle	Average Wetted Width	Ordinary High Water (m)	Gradient %
0.80	0.20	9.00	12.00	1.00%

Boulder	Cobble	Gravel	Fines	Rural	Urban	Forest
20.00%	20.00%	30.00%	30.00%	✔	☐	☐

Agriculture	Percentage Observed Coverage	Reason	Mussel Presence	Species	Shells	Live Mussels
☐	75.00%	thick brush	✔	falcata	✔	✔

Beds	Size	Estimated Popluation<200	Estimated Population >200	Picture#	Description	GPS#
✔	3.00	☐	✔			0

N	W	Sketch of Beds Taken
		✔

Notes

This also includes parcel #'s 23545,23550,23648,23929,23583.Cross section survey # 2 and 3 are in parcel #23545

Parcel #	Stream	Crew	Date	%Pool/Riffle Ratio	Average Stream Length
029715	Salmon	Poirier/Horel	7/29/2004	70/30	0.00

Average Max Depth Pool	Riffle	Average Wetted Width	Ordinary High Water (m)	Gradient %
0.45	0.12	10.60	13.70	1.00%

Boulder	Cobble	Gravel	Fines	Rural	Urban	Forest
0.00%	40.00%	10.00%	50.00%	✔	☐	☐

Agriculture	Percentage Observed Coverage	Reason	Mussel Presence	Species	Shells	Live Mussels
☐	40.00%	silt, turbidity	✔	falcata	✔	✔

Beds	Size	Estimated Popluation<200	Estimated Population >200	Picture#	Description	GPS#
✔	1.00	☐	✔			0

N	W	Sketch of Beds Taken
		☐

Notes

Most of the mussels were in a riffle at confluence with small RB tributary. Also includes parcel # 138600

Parcel #	Stream	Crew	Date	%Pool/Riffle Ratio	Average Stream Length
391307	Salmon	FS/SM	7/29/2004	80/20	0.00

Average Max Depth Pool	Riffle	Average Wetted Width	Ordinary High Water (m)	Gradient %
0.80	0.20	17.00	21.00	1.00%

Boulder	Cobble	Gravel	Fines	Rural	Urban	Forest
20.00%	30.00%	20.00%	30.00%	☐	✔	☐

Agriculture	Percentage Observed Coverage	Reason	Mussel Presence	Species	Shells	Live Mussels
☐	50.00%	deep wide, glides	✔	falcata	✔	☐

Beds	Size	Estimated Popluation<200	Estimated Population >200	Picture#	Description	GPS#
☐	0.00	✔	☐	.227.226	pike minnow,ospre	0

N	W	Sketch of Beds Taken
		☐

Notes

Parcel is within Salmom Cr Greenway Park begin survey ~300m DS of power line crossing up to I-5 bridge. Lots of milfoil, slack water with substrate hard to see. Few shells where noted but no live mussels found.Lots of pike minnows seen.

Parcel #	Stream	Crew	Date	%Pool/Riffle Ratio	Average Stream Length
025457	Salmon	FS/SM	7/29/2004	70/30	0.00

Average Max Depth Pool	Riffle	Average Wetted Width	Ordinary High Water (m)	Gradient %
0.80	0.15	6.70	7.50	1.00%

Boulder	Cobble	Gravel	Fines	Rural	Urban	Forest
0.00%	20.00%	60.00%	20.00%	✔	☐	☐

Agriculture	Percentage Observed Coverage	Reason	Mussel Presence	Species	Shells	Live Mussels
✔	80.00%	deep pools	☐		☐	☐

Beds	Size	Estimated Popluation<200	Estimated Population >200	Picture#	Description	GPS#
☐	0.00	☐	☐			0

N	W	Sketch of Beds Taken
		☐

Notes

Total absence of mussels and shells. Habitat looks great, indication of channel shift within last couple of years.

Parcel #	Stream	Crew	Date	%Pool/Riffle Ratio	Average Stream Length
024195	Salmon	Poirier/Horel	7/29/2004	60/40	0.00

Average Max Depth Pool	Riffle	Average Wetted Width	Ordinary High Water (m)	Gradient %
0.60	0.06	4.80	4.80	1.00%

Boulder	Cobble	Gravel	Fines	Rural	Urban	Forest
5.00%	15.00%	40.00%	40.00%	✔	☐	☐

Agriculture	Percentage Observed Coverage	Reason	Mussel Presence	Species	Shells	Live Mussels
☐	90.00%	tree	✔	falcata	☐	✔

Beds	Size	Estimated Popluation<200	Estimated Population >200	Picture#	Description	GPS#
☐	0.00	☐	✔	9 and 10	mussel cluster	2916

N	W	Sketch of Beds Taken
45 4614.80890N	122 2603.2492W	☐

Notes

Much of adjacent property is owned by landowners association they are OK with access now and in the future.Landowner has planted Coho in small RB tributary.

Parcel #	Stream	Crew	Date	%Pool/Riffle Ratio	Average Stream Length
023288	Salmon	Poirier/Horel	7/29/2004	40/60	0.00

Average Max Depth Pool	Riffle	Average Wetted Width	Ordinary High Water (m)	Gradient %
0.30	0.09	7.00	7.90	1.00%

Boulder	Cobble	Gravel	Fines	Rural	Urban	Forest
0.00%	20.00%	10.00%	70.00%	✔	☐	☐

Agriculture	Percentage Observed Coverage	Reason	Mussel Presence	Species	Shells	Live Mussels
☐	50.00%	thick brush	✔	falcata	✔	✔

Beds	Size	Estimated Popluation<200	Estimated Population >200	Picture#	Description	GPS#
✔	1.00	☐	✔	11,12,13	mussel cluster	0

N	W	Sketch of Beds Taken
		✔

Notes

Most of fines was bedrock. Nearly every pocket of gravel in bedrock has mussels.

Parcel #	Stream	Crew	Date	%Pool/Riffle Ratio	Average Stream Length
028381	Salmon	Poirier / Horel	7/29/2004	75/25	0.00

Average Max Depth Pool	Riffle	Average Wetted Width	Ordinary High Water (m)	Gradient %
0.91	0.15	7.30	9.80	1.00%

Boulder	Cobble	Gravel	Fines	Rural	Urban	Forest
0.00%	25.00%	5.00%	70.00%	✔	☐	☐

Agriculture	Percentage Observed Coverage	Reason	Mussel Presence	Species	Shells	Live Mussels
☐	30.00%	depth,turbid	✔	falcata	✔	✔

Beds	Size	Estimated Popluation<200	Estimated Population >200	Picture#	Description	GPS#
☐	0.00	✔	☐			0

N	W	Sketch of Beds Taken
		☐

Notes

Of 70% fines 40% is bedrock. Segment was about 20% shaded. Deep water made survey difficult.

Parcel #	Stream	Crew	Date	%Pool/Riffle Ratio	Average Stream Length
038439	Salmon	FS/SM	7/29/2004	70/30	0.00

Average Max Depth Pool	Riffle	Average Wetted Width	Ordinary High Water (m)	Gradient %
0.80	0.20	11.00	11.00	1.00%

Boulder	Cobble	Gravel	Fines	Rural	Urban	Forest
0.00%	30.00%	40.00%	30.00%	☐	✔	☐

Agriculture	Percentage Observed Coverage	Reason	Mussel Presence	Species	Shells	Live Mussels
☐	60.00%	debris,deep pools	✔	falcata,anadonta	✔	✔

Beds	Size	Estimated Popluation<200	Estimated Population >200	Picture#	Description	GPS#
✔	2.00	✔	☐			11

N	W	Sketch of Beds Taken
N45 42.630	W122 40.078	☐

Notes

Took GPS LMK 011,012,013 to mark mussels and and cobble and RB logjam with 013. Reach has large pools and lots of Pike Minnows note but no Salmonids seen. Also includes parcel # 39130

Parcel #	Stream	Crew	Date	%Pool/Riffle Ratio	Average Stream Length
025386	Salmon	FS/SM	7/30/2004	50/50	0.00

Average Max Depth Pool	Riffle	Average Wetted Width	Ordinary High Water (m)	Gradient %
0.80	0.15	4.00	6.00	2.00%

Boulder	Cobble	Gravel	Fines	Rural	Urban	Forest
0.00%	20.00%	60.00%	20.00%	✔	☐	☐

Agriculture	Percentage Observed Coverage	Reason	Mussel Presence	Species	Shells	Live Mussels
☐	80.00%	thick brush	✔	falcata	✔	☐

Beds	Size	Estimated Popluation<200	Estimated Population >200	Picture#	Description	GPS#
☐	0.00	✔	☐			0

N	W	Sketch of Beds Taken
		☐

Notes

Only 3 shells found. Area is in rural suburban housing with scattered trees and ~40% shade cover.

Parcel #	Stream	Crew	Date	%Pool/Riffle Ratio	Average Stream Length
031807	Salmon	FS/SM	7/30/2004	80/20	0.00

Average Max Depth Pool	Riffle	Average Wetted Width	Ordinary High Water (m)	Gradient %
1.20	0.20	14.00	14.50	2.00%

Boulder	Cobble	Gravel	Fines	Rural	Urban	Forest
0.00%	30.00%	30.00%	40.00%	✔	✔	☐

Agriculture	Percentage Observed Coverage	Reason	Mussel Presence	Species	Shells	Live Mussels
☐	60.00%	deep pools	✔	falcata	✔	☐

Beds	Size	Estimated Popluation<200	Estimated Population >200	Picture#	Description	GPS#
☐	0.00	✔	☐			0

N	W	Sketch of Beds Taken
		✔

Notes

Also includes parcel # 32179. Live mussels were likely present although none were noted dead count was fairly good over 40 found.

Parcel #	Stream	Crew	Date	%Pool/Riffle Ratio	Average Stream Length
134459	Gibbons	Poirier / Horel	7/30/2004	10/90	0.00

Average Max Depth Pool	Riffle	Average Wetted Width	Ordinary High Water (m)	Gradient %
0.31	0.15	2.74	6.09	4.00%

Boulder	Cobble	Gravel	Fines	Rural	Urban	Forest
10.00%	50.00%	15.00%	25.00%	✔	☐	☐

Agriculture	Percentage Observed Coverage	Reason	Mussel Presence	Species	Shells	Live Mussels
☐	40.00%	shallow riffles	☐		☐	☐

Beds	Size	Estimated Popluation<200	Estimated Population >200	Picture#	Description	GPS#
☐	0.00	☐	☐			0

N	W	Sketch of Beds Taken
		☐

Notes

Sparse tree cover with 20 to 30% shadecover and lots of blackberry in understory. Water temp was 16.6c.

Parcel #	Stream	Crew	Date	%Pool/Riffle Ratio	Average Stream Length
027553	Salmon	FS/SM	7/30/2004	50/50	0.00

Average Max Depth Pool	Riffle	Average Wetted Width	Ordinary High Water (m)	Gradient %
0.90	0.15	7.00	9.00	1.00%

Boulder	Cobble	Gravel	Fines	Rural	Urban	Forest
5.00%	20.00%	60.00%	15.00%	☐	☐	☐

Agriculture	Percentage Observed Coverage	Reason	Mussel Presence	Species	Shells	Live Mussels
✔	60.00%	extensive beds	✔	falcata	✔	✔

Beds	Size	Estimated Popluation<200	Estimated Population >200	Picture#	Description	GPS#
✔	10.00	☐	✔	225,26,23	mussel beds	0

N	W	Sketch of Beds Taken
		☐

Notes

Large population mostly in riffle section large long pool at US end of parcel had almost no mussels.

Parcel #	Stream	Crew	Date	%Pool/Riffle Ratio	Average Stream Length
135098	Gibbons	Poirier / Horel	7/30/2004	20/80	0.00

Average Max Depth Pool	Riffle	Average Wetted Width	Ordinary High Water (m)	Gradient %
0.30	0.06	4.87	4.87	2.00%

Boulder	Cobble	Gravel	Fines	Rural	Urban	Forest
0.00%	15.00%	40.00%	45.00%	✔	☐	☐

Agriculture	Percentage Observed Coverage	Reason	Mussel Presence	Species	Shells	Live Mussels
☐	70.00%		☐		☐	☐

Beds	Size	Estimated Popluation<200	Estimated Population >200	Picture#	Description	GPS#
☐	0.00	☐	☐			0

N	W	Sketch of Beds Taken
		☐

Notes

Heavy scour events due to USFWS digging out in front of fish diversion structure just DS of SR 14 bridge, may prevent colonization of musse

Parcel #	Stream	Crew	Date	%Pool/Riffle Ratio	Average Stream Length
135262	Gibbons	Poirier / Horel	7/30/2004	99/01	0.00

Average Max Depth Pool	Riffle	Average Wetted Width	Ordinary High Water (m)	Gradient %
0.76	0.00	2.00	2.00	1.00%

Boulder	Cobble	Gravel	Fines	Rural	Urban	Forest
0.00%	5.00%	10.00%	85.00%	✔	☐	☐

Agriculture	Percentage Observed Coverage	Reason	Mussel Presence	Species	Shells	Live Mussels
☐	40.00%	thick grass mat	☐		☐	☐

Beds	Size	Estimated Popluation<200	Estimated Population >200	Picture#	Description	GPS#
☐	0.00	☐	☐			0

N	W	Sketch of Beds Taken
		☐

Notes

Stream is a ~2m wide ditched channel with low velosity and beaver activeity. Channel covered with Reed Canary grass for most of reach.

Parcel #	Stream	Crew	Date	%Pool/Riffle Ratio	Average Stream Length
025207	Salmon	FS/SM	7/30/2004	80/20	0.00

Average Max Depth Pool	Riffle	Average Wetted Width	Ordinary High Water (m)	Gradient %
0.80	0.15	6.50	8.00	1.00%

Boulder	Cobble	Gravel	Fines	Rural	Urban	Forest
0.00%	15.00%	50.00%	35.00%	✔	☐	☐

Agriculture	Percentage Observed Coverage	Reason	Mussel Presence	Species	Shells	Live Mussels
☐	80.00%	deep pools	✔	falcata	✔	✔

Beds	Size	Estimated Popluation<200	Estimated Population >200	Picture#	Description	GPS#
☐	0.00	✔	☐			0

N	W	Sketch of Beds Taken
		☐

Notes

Also includes parcel #'s 25209,25197. Nice wide ripiarian area with an large field at DS end. 35% shaded with large slow moving glide pools US end.

Parcel #	Stream	Crew	Date	%Pool/Riffle Ratio	Average Stream Length
133017	Gibbons	Poirier / Horel	7/30/2004	20/80	0.00

Average Max Depth Pool	Riffle	Average Wetted Width	Ordinary High Water (m)	Gradient %
0.31	0.09	3.04	3.65	4.00%

Boulder	Cobble	Gravel	Fines	Rural	Urban	Forest
20.00%	50.00%	10.00%	20.00%	✔	☐	☐

Agriculture	Percentage Observed Coverage	Reason	Mussel Presence	Species	Shells	Live Mussels
☐	40.00%	shallow riffles	☐		☐	☐

Beds	Size	Estimated Popluation<200	Estimated Population >200	Picture#	Description	GPS#
☐	0.00	☐	☐			0

N	W	Sketch of Beds Taken
		☐

Notes

Landowner Winters owned parcel 133017 and 134459 and both were done at same time.Due to lack of access survey conducted upstream to downstream.Lots of woody debris.

Parcel #	Stream	Crew	Date	%Pool/Riffle Ratio	Average Stream Length
134716	Campen	Poirier /	8/2/2004	40/60	0.00

Average Max Depth Pool	Riffle	Average Wetted Width	Ordinary High Water (m)	Gradient %
0.30	0.06	1.37	1.37	1.00%

Boulder	Cobble	Gravel	Fines	Rural	Urban	Forest
0.00%	10.00%	30.00%	60.00%	✔	☐	☐

Agriculture	Percentage Observed Coverage	Reason	Mussel Presence	Species	Shells	Live Mussels
☐	65.00%		✔	falcata	✔	✔

Beds	Size	Estimated Popluation<200	Estimated Population >200	Picture#	Description	GPS#
✔	0.00	✔	☐	11 and 12	mussel cluster	802171

N	W	Sketch of Beds Taken
		✔

Notes

Stream runs through golf course with nice wide riparian buffer along the banks.GPS and photos taken near center of parcelnear US end of mus area.

Parcel #	Stream	Crew	Date	%Pool/Riffle Ratio	Average Stream Length
134714	Campen	Poirier /	8/2/2004		0.00

Average Max Depth Pool	Riffle	Average Wetted Width	Ordinary High Water (m)	Gradient %
0.00	0.00	0.00	0.00	0.00%

Boulder	Cobble	Gravel	Fines	Rural	Urban	Forest
0.00%	0.00%	0.00%	0.00%	☐	☐	☐

Agriculture	Percentage Observed Coverage	Reason	Mussel Presence	Species	Shells	Live Mussels
☐	0.00%		☐		☐	☐

Beds	Size	Estimated Popluation<200	Estimated Population >200	Picture#	Description	GPS#
☐	0.00	☐	☐			0

N	W	Sketch of Beds Taken
		☐

Notes

Survey not completed due to thick brush and lack of access due to the brush.

Parcel #	Stream	Crew	Date	%Pool/Riffle Ratio	Average Stream Length
126644	Campen	Poirier /	8/2/2004	10/90	0.00

Average Max Depth Pool	Riffle	Average Wetted Width	Ordinary High Water (m)	Gradient %
0.27	0.09	3.00	3.60	4.00%

Boulder	Cobble	Gravel	Fines	Rural	Urban	Forest
20.00%	50.00%	20.00%	10.00%	✔	☐	☐

Agriculture	Percentage Observed Coverage	Reason	Mussel Presence	Species	Shells	Live Mussels
☐	40.00%	shaded, thick brush	☐		☐	☐

Beds	Size	Estimated Popluation<200	Estimated Population >200	Picture#	Description	GPS#
☐	0.00	☐	☐			0

N	W	Sketch of Beds Taken
		☐

Notes

Thick brush along the banks reduced visibility, most of parcel contained large substrate.

Parcel #	Stream	Crew	Date	%Pool/Riffle Ratio	Average Stream Length
132078	Campen	Poirier /	8/2/2004	10/90	0.00

Average Max Depth Pool	Riffle	Average Wetted Width	Ordinary High Water (m)	Gradient %
0.18	0.06	1.90	3.10	3.00%

Boulder	Cobble	Gravel	Fines	Rural	Urban	Forest
10.00%	30.00%	50.00%	10.00%	☐	✔	☐

Agriculture	Percentage Observed Coverage	Reason	Mussel Presence	Species	Shells	Live Mussels
☐	80.00%		☐		☐	☐

Beds	Size	Estimated Popluation<200	Estimated Population >200	Picture#	Description	GPS#
☐	0.00	☐	☐			0

N	W	Sketch of Beds Taken
		☐

Notes

Bank erosion entire parcel is in landscaped backyard with not much riparian cover.

Parcel #	Stream	Crew	Date	%Pool/Riffle Ratio	Average Stream Length
123185	Campen	Poirier /	8/2/2004		0.00

Average Max Depth Pool	Riffle	Average Wetted Width	Ordinary High Water (m)	Gradient %
0.00	0.00	0.00	0.00	0.00%

Boulder	Cobble	Gravel	Fines	Rural	Urban	Forest
0.00%	0.00%	0.00%	0.00%	☐	☐	☐

Agriculture	Percentage Observed Coverage	Reason	Mussel Presence	Species	Shells	Live Mussels
☐	0.00%		☐		☐	☐

Beds	Size	Estimated Popluation<200	Estimated Population >200	Picture#	Description	GPS#
☐	0.00	☐	☐			0

N	W	Sketch of Beds Taken
		☐

Notes

Stream was only ~.31m wetted with thick brush and grass, deminished habitat above this point.

Parcel #	Stream	Crew	Date	%Pool/Riffle Ratio	Average Stream Length
131231	Campen	Poirier /	8/2/2004	20/80	0.00

Average Max Depth Pool	Riffle	Average Wetted Width	Ordinary High Water (m)	Gradient %
0.18	0.06	1.95	2.74	2.00%

Boulder	Cobble	Gravel	Fines	Rural	Urban	Forest
5.00%	25.00%	60.00%	10.00%	☐	☑	☐

Agriculture	Percentage Observed Coverage	Reason	Mussel Presence	Species	Shells	Live Mussels
☐	60.00%		☐		☐	☐

Beds	Size	Estimated Popluation<200	Estimated Population >200	Picture#	Description	GPS#
☐	0.00	☐	☐			0

N	W	Sketch of Beds Taken
		☐

Notes

Parcel has easy access in landscaped backyard in residential area.

Parcel #	Stream	Crew	Date	%Pool/Riffle Ratio	Average Stream Length
076346	Burnt Bridge	Poirier / Horel	8/3/2004	70/30	0.00

Average Max Depth Pool	Riffle	Average Wetted Width	Ordinary High Water (m)	Gradient %
0.45	0.09	2.13	3.04	1.00%

Boulder	Cobble	Gravel	Fines	Rural	Urban	Forest
3.00%	7.00%	20.00%	70.00%	☑	☐	☐

Agriculture	Percentage Observed Coverage	Reason	Mussel Presence	Species	Shells	Live Mussels
☐	40.00%	shaded, thick brush	☑	falcata	☐	☑

Beds	Size	Estimated Popluation<200	Estimated Population >200	Picture#	Description	GPS#
☐	0.00	☑	☐			0

N	W	Sketch of Beds Taken
		☑

Notes

This parcel is Burnt Bridge Cr. Park the entire reach has thick brush with ~95% shade cover lots of fine sediment in the substrate.

Parcel #	Stream	Crew	Date	%Pool/Riffle Ratio	Average Stream Length
074497	Burnt Bridge	Poirier / Horel	8/3/2004	60/40	0.00

Average Max Depth Pool	Riffle	Average Wetted Width	Ordinary High Water (m)	Gradient %
0.18	0.06	3.87	4.26	2.00%

Boulder	Cobble	Gravel	Fines	Rural	Urban	Forest
3.00%	7.00%	10.00%	80.00%	☑	☐	☐

Agriculture	Percentage Observed Coverage	Reason	Mussel Presence	Species	Shells	Live Mussels
☐	50.00%	shaded	☑	falcata	☑	☑

Beds	Size	Estimated Popluation<200	Estimated Population >200	Picture#	Description	GPS#
☐	0.00	☑	☐	13 and 14	mussel in sand,han	0

N	W	Sketch of Beds Taken
		☑

Notes

Leverich park has less than 50 mussels noted in this reach, upper 1/2 had high sediment load, very few mussels observed. Lots of trash and lar qty. of dead crawfish fully intact noted. May be toxicity due to urban runoff exact cause is unknown.

Parcel #	Stream	Crew	Date	%Pool/Riffle Ratio	Average Stream Length
067056	Burnt Bridge	Poirier / Horel	8/3/2004	70/30	0.00

Average Max Depth Pool	Riffle	Average Wetted Width	Ordinary High Water (m)	Gradient %
0.45	0.12	3.65	4.87	1.00%

Boulder	Cobble	Gravel	Fines	Rural	Urban	Forest
5.00%	10.00%	5.00%	80.00%	✔	☐	☐

Agriculture	Percentage Observed Coverage	Reason	Mussel Presence	Species	Shells	Live Mussels
☐	40.00%	silt, turbidity	☐		☐	☐

Beds	Size	Estimated Popluation<200	Estimated Population >200	Picture#	Description	GPS#
☐	0.00	☐	☐			0

N	W	Sketch of Beds Taken
		☐

Notes

High abundance of (corbicula fluminea) asian clam with mostly dead shells on substrate. Parcels 67056 to 70269 is park land with free public access banks degraded with trash thoughout.

Parcel #	Stream	Crew	Date	%Pool/Riffle Ratio	Average Stream Length
098451	Burnt Bridge	Poirier / Horel	8/4/2004	99/01	0.00

Average Max Depth Pool	Riffle	Average Wetted Width	Ordinary High Water (m)	Gradient %
0.24	0.00	2.00	2.00	0.00%

Boulder	Cobble	Gravel	Fines	Rural	Urban	Forest
0.00%	0.00%	5.00%	95.00%	✔	☐	☐

Agriculture	Percentage Observed Coverage	Reason	Mussel Presence	Species	Shells	Live Mussels
☐	40.00%	thick grass, turbid	☐		☐	☐

Beds	Size	Estimated Popluation<200	Estimated Population >200	Picture#	Description	GPS#
☐	0.00	☐	☐			0

N	W	Sketch of Beds Taken
		☐

Notes

This is also parcel # 97217. Low velocity, grass covered banks. Abundance of (corbicula fluminea) substrates mostly fines and habitat is pond like.

Parcel #	Stream	Crew	Date	%Pool/Riffle Ratio	Average Stream Length
096419	Burnt Bridge	Poirier / Horel	8/4/2004	99/01	0.00

Average Max Depth Pool	Riffle	Average Wetted Width	Ordinary High Water (m)	Gradient %
0.60	0.00	1.82	1.82	0.00%

Boulder	Cobble	Gravel	Fines	Rural	Urban	Forest
0.00%	0.00%	1.00%	99.00%	☐	✔	☐

Agriculture	Percentage Observed Coverage	Reason	Mussel Presence	Species	Shells	Live Mussels
☐	60.00%	turbid	☐		☐	☐

Beds	Size	Estimated Popluation<200	Estimated Population >200	Picture#	Description	GPS#
☐	0.00	☐	☐			0

N	W	Sketch of Beds Taken
		☐

Notes

Also parcel # 96223. Mudd lined channelized ditch with uniform width and depth. Strong odor like sewage from walking through the stream v mudd .1m deep. Abundance of (corbicula fluminea) noted thoughout this reach.

Parcel #	Stream	Crew	Date	%Pool/Riffle Ratio	Average Stream Length
000000	Burnt Bridge	Poirier / Horel	8/4/2004	50/50	0.00

Average Max Depth Pool	Riffle	Average Wetted Width	Ordinary High Water (m)	Gradient %
0.18	0.06	2.89	3.96	2.00%

Boulder	Cobble	Gravel	Fines	Rural	Urban	Forest
5.00%	20.00%	25.00%	50.00%	☐	☑	☐

Agriculture	Percentage Observed Coverage	Reason	Mussel Presence	Species	Shells	Live Mussels
☐	50.00%	shaded, riffles	☑	falcata	☑	☐

Beds	Size	Estimated Popluation<200	Estimated Population >200	Picture#	Description	GPS#
☐	0.00	☑	☐			0

N	W	Sketch of Beds Taken
		☐

Notes

Parcel is city park land with adjacent mobile home park.Lots of duckweedand and algae 3/4 of reach has thick riparian corridor. No live muss where noted.Landowner said 4 tame racoons live in this area.

Parcel #	Stream	Crew	Date	%Pool/Riffle Ratio	Average Stream Length
081780	Burnt Bridge	Poirier / Horel	8/4/2004	70/30	0.00

Average Max Depth Pool	Riffle	Average Wetted Width	Ordinary High Water (m)	Gradient %
0.54	0.06	3.23	6.09	1.00%

Boulder	Cobble	Gravel	Fines	Rural	Urban	Forest
2.00%	3.00%	5.00%	90.00%	☑	☐	☐

Agriculture	Percentage Observed Coverage	Reason	Mussel Presence	Species	Shells	Live Mussels
☐	50.00%	thick brush	☑	falcata	☑	☑

Beds	Size	Estimated Popluation<200	Estimated Population >200	Picture#	Description	GPS#
☐	0.00	☑	☐			0

N	W	Sketch of Beds Taken
		☑

Notes

Most of the mussels observed were under HWY 500 bridge in silty substrates ended survey at parcel # 83865.

Parcel #	Stream	Crew	Date	%Pool/Riffle Ratio	Average Stream Length
080010	Burnt Bridge	Poirier / Horel	8/4/2004	85/15	0.00

Average Max Depth Pool	Riffle	Average Wetted Width	Ordinary High Water (m)	Gradient %
0.45	0.06	2.74	3.35	1.00%

Boulder	Cobble	Gravel	Fines	Rural	Urban	Forest
5.00%	0.00%	10.00%	85.00%	☑	☐	☐

Agriculture	Percentage Observed Coverage	Reason	Mussel Presence	Species	Shells	Live Mussels
☐	35.00%	silt, turbitity	☑	falcata	☑	☑

Beds	Size	Estimated Popluation<200	Estimated Population >200	Picture#	Description	GPS#
☐	0.00	☑	☐			0

N	W	Sketch of Beds Taken
		☑

Notes

Also parcel # 81086. Fish noted in culvert pool. Lots of fines with few shallow riffles.