RECOMMENDATIONS

To properly manage *P. bruneauensis* populations in the Bruneau River drainage, the biology of these Springsnails must be well understood. Mladenka (1992), Taylor (1982), and Fritchman (1985) made significant contributions to knowledge of the biology of *P. bruneauensis*. Additionally, recent population and habitat monitoring done by Idaho State University (Varricchione and Minshall 1997, 1996, 1995a, 1995b; Royer and Minshall 1993; Robinson et al. 1992) have made contributions. Still, many questions remain unanswered. The most pressing question regards the uniqueness of the Springsnail populations at the different thermal streams and springflows along the Bruneau River. Because of the different temperature regimes and the spatial separation of the populations, there is a good chance for the existence of unique gene pools and, thus, different species or subspecies of the Bruneau Hot-spring Springsnail at the various locations within the drainage. Experiments such as controlled growth-rate studies and population genetics studies may provide additional insight into the biology of the Springsnails. This insight might improve habitat management strategies for *P. bruneauensis*.

Hot Creek conditions are very poor and appear to be the result of poor land management practices on the watershed upstream of Site 1. As recommended previously by Varricchione and Minshall (1995a, 1996, 1997), Springsnail population and habitat data collected to date indicate that immediate measures should be taken to rehabilitate the Indian Bathtub-Hot Creek area and restore the habitat conditions to at least those found prior to July 1992. This is the minimum effort required to restore the Bruneau Hot-spring Springsnail to Hot Creek. Habitat restoration would show whether the Springsnail will repopulate naturally or if transplantation is necessary. Extensive dredging in Hot Creek probably would be needed before any significant improvements would be seen. Other procedures that could lead to substrate improvement might be 1) the destruction of the small dams (believed to have been installed by local residents for fish habitat) both upstream and downstream of Site 1, and 2) the placement of cobble-sized substrate on top of the current

substrate to increase the surface area of hard substrate for Springsnails to place their eggs.

Long-term restoration is dependent on sound land management practices (e.g. continued prevention of grazing on high risk areas within the watershed) and increased thermal flows. Also, a recolonization experiment would be an important step in developing a recovery plan for *P. bruneauensis* in Hot Creek. A large-scale exclosure could be built in the creek to prevent fish predation. Springsnail-covered cobbles from a rockface site could be transplanted to within the exclosures. Emergent vegetation should be included within the exclosure so that Springsnails could crawl out of the water to cool themselves. However, efforts toward transplantation should proceed cautiously until it can be determined whether populations from potential sources, including the relict population adjacent to Hot Creek, are genetically similar. In addition to these experiments, Hot Creek, Indian Bathtub, and rockface seep discharge could potentially be increased with a reduction in the intensity of groundwater mining on the surrounding agricultural lands. This habitat improvement could result in the restoration of reliable flows in perpetuity and provide a greater chance for natural recolonization.

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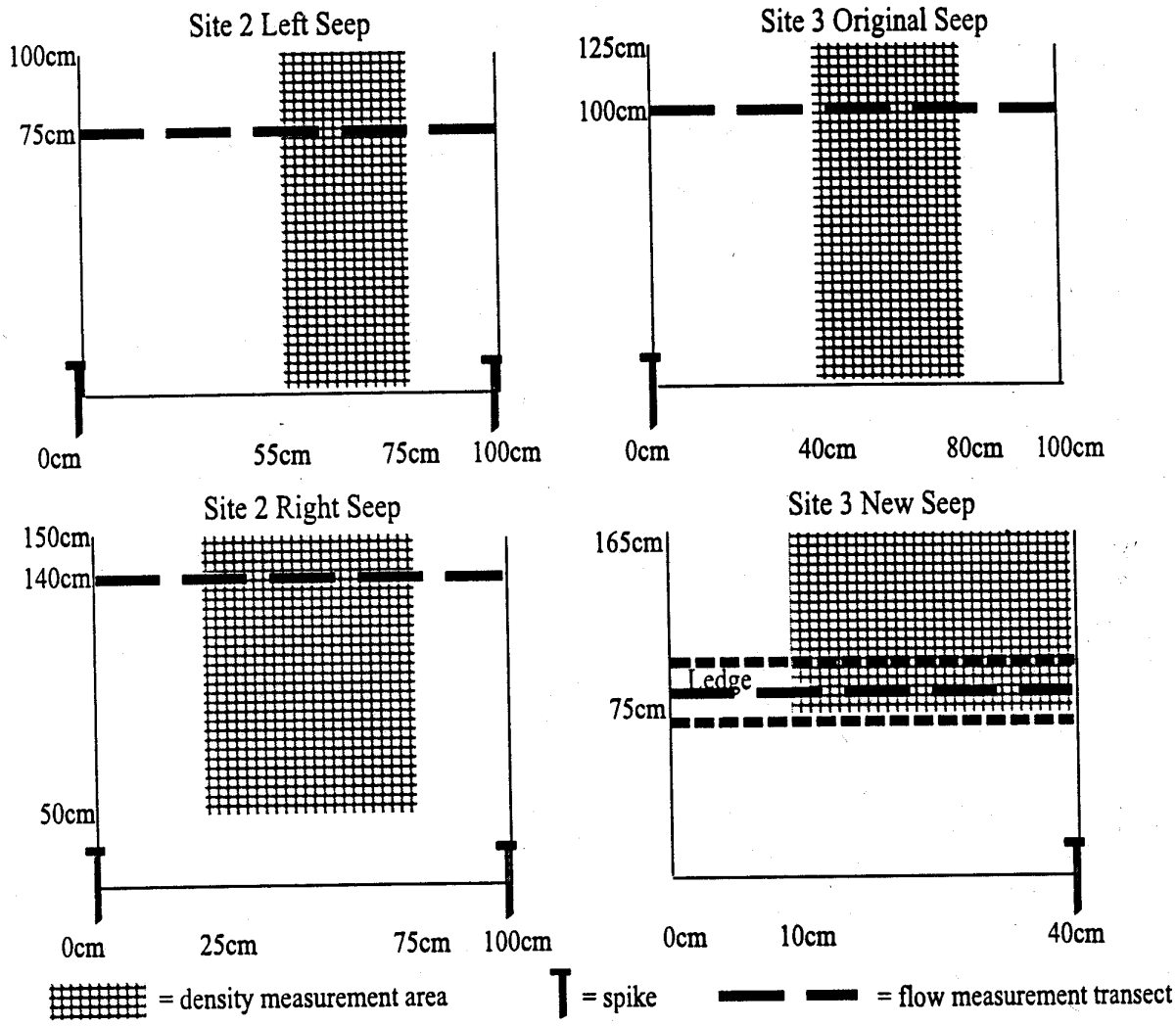

Appendix A. Springsnail density, wetted rockface, and springflow measurement locations at the rockface seeps. Maps are not drawn to scale.

Habitat Assessment, Glide/Pool Prevalence (modified after Platkin et al., 1989).

Stream Name: _____ Station: _____ Date: _____ Location Description: _____

Idaho Department of Health and Welfare - Division of Environmental Quality
HABITAT ASSESSMENT FIELD DATA SHEET
GLIDE/POOL PREVALENCE

HABITAT PARAMETER	CATEGORY: OPTIMAL	SUB-OPTIMAL	MARGINAL	POOR
1. Bottom substrate/ instream cover	Greater than 50% mix of rubble, gravel, submerged logs, undercut banks, or other stable habitat. 16-20 ___	30-50% mix of rubble, gravel, or other stable habitat. Adequate habitat. 11-15 ___	10-30% mix of rubble, gravel, or other stable habitat. Habitat availability less than desirable. 6-10 ___	Less than 10% rubble, gravel or other stable habitat. Lack of habitat is obvious. 0-5 ___
2. Pool substrate characterization	Mixture of substrate materials with gravel and firm sand prevalent, root mats and submerged vegetation common. 16-20 ___	Mixture of soft sand, mud, or clay; mud may be dominant; some root mats and submerged vegetation present. 11-15 ___	All mud or clay or channelized with sand bottom; little or no root mat; no submerged vegetation. 6-10 ___	Hard-pan clay or bedrock; no root mat or vegetation. 0-5 ___
3. Pool variability	Even mix of deep/shallow/ large/small pools present. 16-20 ___	Majority of pools large and deep; very few shallow. 11-15 ___	Shallow pools much more prevalent than deep pools. 6-10 ___	Majority of pools small and shallow or pools absent. 0-5 ___
4. Canopy cover (shading)	A mixture of conditions where some areas of water surface fully exposed to sunlight, and other receiving various degrees of filtered light. 16-20 ___	Covered by sparse canopy; entire water surface receiving filtered light. 11-15 ___	Completely covered by dense canopy; water surface completely shaded. OR nearly full sunlight reaching water surface. Shading limited to < 3 hours per day. 6-10 ___	Lack of canopy, full sunlight reaching water surface. 0-5 ___

Stream Name: _____ Station: _____ Date: _____ Location Description: _____

Idaho Department of Health and Welfare - Division of Environmental Quality
HABITAT ASSESSMENT FIELD DATA SHEET
GLIDE/POOL PREVALENCE

	CATEGORY			
HABITAT PARAMETER	OPTIMAL.	SUB-OPTIMAL.	MARGINAL.	POOR
5. Channel alteration	Little or no enlargement of islands or point pars, and/or no channelization. 12-15 ___	Some new increase in bar formation, mostly from coarse gravel; and/or some channelization present. 8-11 ___	Moderate deposition of new gravel, coarse sand on old and new bars; and/or embankments on both banks. 6-10 ___	Heavy deposits of fine material, increased bar development; and/or extensive channelization 0-3 ___
6. Deposition	Less than 5 % of bottom affected; minor accumulation of coarse sand and pebbles as snags and submerged vegetation. 12-15 ___	5-30% affected; moderate accumulation of sand at snags and submerged vegetation. 8-11 ___	30-50% affected; major deposition of sand at snags and submerged vegetation; pools shallow, heavily silted. 4-7 ___	Channelized; mud, silt and/or sand in braided or nonbraided channels; pools almost absent due to deposition. 0-3 ___
7. Channel sinuosity	Instream channel length 3 to 4 times straight line distance. 12-15 ___	Instream channel length 2 to 3 times straight line distance. 8-11 ___	Instream channel length 1 to 2 times straight line distance. 4-7 ___	Channel straight; channelized waterway. 0-3 ___
8. Lower bank channel capacity	Overbank (lower) flows rare. Lower bank W/D ratio < 7. (Channel width divided by depth or height of lower bank.) 12-15 ___	Overbank (lower) flows occasional. W/D ratio: 8-15 8-11 ___	Overbank (lower) flows occasional. W/D ratio: 15-25 4-7 ___	Peak flows not contained or contained through channelization. W/D ratio > 25 0-3 ___

Stream Name: _____ Station: _____ Date: _____ Location Description: _____

Idaho Department of Health and Welfare - Division of Environmental Quality
HABITAT ASSESSMENT FIELD DATA SHEET
GLIDE/POOL PREVALENCE

HABITAT PARAMETER	CATEGORY: OPTIMAL	SUB-OPTIMAL	MARGINAL	POOR
9. Upper bank stability	Upper bank stable. No evidence of erosion or bank failures. Side slopes generally < 30°. Little potential for future problems. 9-10 ___	Moderately stable. Infrequent, small areas of erosion mostly healed over. Side slopes up to 40° on one bank. Slight potential in extreme floods. 6-8 ___	Moderately stable. Moderate frequency and size of erosional areas. Side slopes up to 60° on some banks. High erosion potential during extreme high flow. 3-5 ___	Unstable. Many eroded areas. "Raw" areas frequent along straight sections and bends. Side slopes 60° common. 0-2 ___
10. Bank vegetation protection OR Grazing or other disruptive pressure	Over 90% of the streambank surfaces covered by vegetation. 9 10 ___ Vegetative disruption minimal or not efficient. Almost all potential plant biomass at present stage of development remains. 9 10 ___	70-89% of the streambank surfaces covered by vegetation. 6-8 ___ Disruption evident but not affecting community vigor. Vegetative use is moderate, and at least one-half of the potential plant biomass remains. 6-8 ___	50-79% of the streambank surfaces covered by vegetation. 3-5 ___ Disruption obvious; some patches of bare soil or closely cropped vegetation present. Less than one half of the potential plant biomass remains. 3-5 ___	Less than 50% of the streambank surfaces covered by vegetation. 0-2 ___ Disruption of streambank vegetation is very high. Vegetation has been removed to 2 inches or less in average stubble height. 0-2 ___

Stream Name: _____ Station: _____ Date: _____ Location Description: _____

Idaho Department of Health and Welfare - Division of Environmental Quality
HABITAT ASSESSMENT FIELD DATA SHEET
GLIDE/POOL PREVALENCE

	CATEGORY			
HABITAT PARAMETER	OPTIMAL	SUB-OPTIMAL	MARGINAL	POOR
11. Streamside cover	Dominant vegetation is shrub. 9-10 ___	Dominant vegetation is of tree form. 6-8 ___	Dominant vegetation is grass or forbes. 3-5 ___	Over 50% of the stream bank has no vegetation and dominant material is soil, rock, bridge materials, culverts, or mine tailings. 0-2 ___
12. Riparian vegetative zone width (least buffered side)	> 18 meters 9-10 ___	Between 12 and 18 meters. 6-8 ___	Between 6 and 12 meters. 3-5 ___	< 6 meters. 0-2 ___
Column Totals	___	___	___	___
Score				

Appendix C. Stage height and discharge at the rockface seep discharge weirs.

Date	Site 2 Right Seep Stage Height (cm)	Site 2 Right Seep Discharge (L/min)	Site 3 New Seep Stage Height (cm)	Site 3 New Seep Discharge (L/min)	Site 3 Original Seep Stage Height (cm)	Site 3 Original Seep Discharge (L/min)
17 Oct 97	9.8	5.28	7.3	0.34	9.7	2.17
14 Nov 97	10.1	6.1	7.5	0.39	10.5	5.3