Pool and Habitat Studies on Rush and Lee Vining Creeks

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INTRODUCTION

In nearly every stream system that supports brown trout, high quality pools - the largest and deepest pools with the highest amount of hiding cover - tend to be the domain of the biggest trout (Canjuk and Power 1986; Heggenes et al. 1993; Heggenes 2002; Meyers et al. 1992). To determine if the distribution and abundance of high quality pool habitats were changing within Rush Creek, pool surveys were conducted between the Mono Gate One Return Ditch (MGORD) and Mono Lake during June 2002 and September 2003 and again in July and September 2008. During the 2008 survey lengths of all habitat-types were measured, including high and low gradient riffles, run/glides and all pools – not just the high quality pools as was done in 2002. The purpose for conducting a full habitat survey along Rush Creek in 2008 was to compare these results to habitat typing that was conducted in 1991 (Trihey and Associates 1994). A similar pool plus habitat-typing survey was conducted on 1.9 miles of lower Lee Vining Creek from the Town of Lee Vining to Mono Lake during September 2008 and April 2009.

The exact dates of these surveys and the stream discharge rates that were present during the evaluation of various stream sections on Rush and Lee Vining creeks are shown on Table 1. The stream flows for the MGORD to the Narrows section were taken from the LADWP gauge at the MGORD. The flows for the sections downstream of the Narrows were the total of the MGORD plus the Parker and Walker LADWP gauging station flows. The stream flows for Lee Vining Creek were taken from the LADWP gauge at the diversion.

Table 1. Stream Flows and dates of the Pool/Habitat Surveys on Rush and Lee Vining Creeks.

Rush Creek Section	**Initial Survey Date**	**Initial Survey Flow (cfs)**	**Follow-up Survey Date**	**Follow-up Survey Flow (cfs)**	**Difference in Flow**
MGORD to Narrows	June 25, 2002	50	July 18, 2008	42	+8 cfs
Narrows to 10-Ch Exit	June 26, 2002	92	July 19-20, 2008	70	+22 cfs
10-Ch to Co. Rd. Ford	September 13, 2002	54	July 20-21, 2008	73	-19 cfs
Co. Rd Ford to Mono Lk.	September 6, 2003	59	September 12-13, 2008	43	+16 cfs
Lee Vining Creek Section	**Initial Survey Date**	**Initial Survey Flow (cfs)**			
Glide #4 to Glide #11	Sept. 9th and 13th 2008	21			
Rest of Lee Vining Ck.	April 26-27, 2009	45			

The initial Rush Creek survey was started in June 2002 and finished in September 2003. During that time period it is unlikely that there were any major changes in either sizes or depths of pools in Rush Creek because the 2003 runoff was below average. Maximum stream discharge rates in

the MGORD during Runoff Year 2003 were low, ranging from 193 to 203 cfs from June 3rd to June 8th. Given the low discharge rate and brief duration of this peak runoff flow, it is unlikely that any noticeable bedload or channel movement occurred on Rush Creek between June 2002 and September 2003. However, the above average runoff flows of 2005, and especially 2006, caused noticeable channel scouring and bedload movement, which appeared to increase the amount of high quality or "big pool" habitat on Rush Creek, particularly in the bottomlands (downstream of the Narrows).

It was the advent of these channel-changing flows, which peaked at nearly 600 cfs for close to a month in the bottomlands during 2006 that spurred the follow-up pool survey on Rush Creek in 2008. Quantification of the length and periodicity of all habitat units during the 2008 and 2009 surveys on Rush and Lee Vining creeks also aided in the selection of the stream study reaches that were ultimately used during the Instream Flow Studies (IFS) on these streams.

The habitat of the MGORD, which is a 1.4 mile canal that transports water from Grant Reservoir to the historic Rush Creek channel, was not surveyed during 2002 or 2008. Generally speaking, the MGORD is comprised primarily of low-gradient glide/run or pool habitat. Most overhead cover is provided by submerged vegetation (elodea), which varies in density during different seasons; and, to a lesser extent, by large in-stream boulders and some mature willow clusters. LADWP's current practice of not cutting back the riparian vegetation along the inside (left) bank of the canal should lead to increased densities of mature willows in the future. The lower 1200 ft of the MGORD contains a series of grade-control weirs that step the canal down to its confluence with Rush Creek's natural channel. This somewhat higher - gradient portion of the MGORD contains ample amounts of suitable sized spawning substrate.

METHODS

Pools were rated in the field using criteria developed by Platts et al. (1983) for use on trout streams that range from 20 to 60 feet in width. To account for variations in pool depths that occur with changing stream discharge rates (and resulting stream stage heights), riffle crest depths were also measured at the tail-out of each pool (Lisle 1988). These measurements allowed us to calculate residual pool depths; where:

Maximum Pool Depth – Riffle Crest Depth = Residual Pool Depth

Using residual depths removes differences in maximum depths attributable to stage height differences. Residual depths also predict the maximum depths of pools that would be present during a worst-case (zero discharge) situation. We used the more stringent residual depth measurements (instead of maximum depth as suggested by Platts et al. 1983) when rating pools on Rush Creek. During the initial survey only the largest or highest quality pools (those rated Class-4 or Class-5) were recorded, using the following criteria:

The pool's maximum width had to be at least 90% of the mean channel width, and its residual depth had to be at least 2.0 feet; then –

(1) The pool was rated as Class-5 if (a) it had a residual depth >3.0 feet with some (>25%) hiding cover, or if (b) it had a residual depth of 2.0 to 2.9 feet with abundant (>75%) cover;
(2) The pool was rated as Class-4 if (a) it had a residual depth >3.0 feet with sparse (<25%) cover, or if (b) it had a residual depth of 2.0 to 2.9 feet with intermediate (50-74%) cover.

Within the Class-5 pools, the percent-relative abundance (PRA) of seven stream bottom substrate-types, ranging from silt to bedrock; and seven stream bank vegetation-types, ranging from none (or exposed) to moist-site shrubs (like willows or dogwood), were recorded. Also recorded was the percentage of a pool's surface area that was covered by eight habitat-types - overhanging vegetation, submerged vegetation, large woody accumulations, small woody accumulations, boulders, root wads, undercut banks and bubble curtains were estimated. The total of these percentages provided a Total Habitat PRA score for each Class-5 pool.

During the follow-up surveys in 2008 and 2009, the lengths and residual depths of Class-2 and Class-3 pools were also measured. The maximum widths of these pools were generally <50% of the stream's mean width. The residual depths of these smaller pools were also typically <2.0 feet, although some larger pools with residual depths of 2.0 to 2.9 feet – but with sparse (<25%) cover – were also rated as Class-2 or Class-3. The 2008/09 surveys also recorded the lengths of all high gradient riffles, low gradient riffles and glide/run habitat units:

High Gradient Riffle (HGR) units were typically found within moderate to high gradient stream sections, which resulted in most (>50%) of the unit's surface area being covered with surface agitation (or "bubble curtains").

Low Gradient Riffle (LGR) units were usually within low gradient stream sections, which resulted in only some (<25%) of the unit's surface area being covered by surface agitation.

Glide/Run habitat units were mostly within low to moderate gradient stream sections. These units were characterized by relatively uniform and/or "u-shaped" channel cross sections with no pronounced scour pockets or areas of surface agitation.

We did not break out, or measure, the lowest quality (Class-1) pools during the 2008 Rush Creek survey. These small, mostly "pocket pools" were primarily within riffles (either high- or low-gradient), and thus were measured as part of these riffle units. In Lee Vining Creek, the number of pocket pools within each riffle unit was enumerated because, collectively, these small units comprised the majority of pool habitat in this high-gradient stream. Changes in pocket pool areas within Lee Vining Creek were also evaluated during the IFS.

The lengths of all habitat units were measured to the nearest foot with a hip chain. Because of the ever-changing location of Mono Lake's shoreline, and thus the mouths of the streams, we started both surveys at the upper end of the study areas and proceed in a downstream direction. The latitude and longitude of each pool was also taken with a hand-held GPS unit. The accuracy of these measurements ranged from ±15 to 45 feet, depending upon the number of satellites that were present.

We compared the results of our 2008 Rush Creek survey to pool data collected during 1991 (Trihey and Associates 1994) using the locations, lengths and residual depths of all the pools they reported. This allowed us to compare, by stream reach, the number of pools that had residual depths ranging from 2.0 – 2.9 ft, and those with residual depths >3.0 ft (potential Class-5 pools) during 1991, 2002 and 2008.

RESULTS

Rush Creek

The survey reach on Rush Creek from the bottom end of the MGORD downstream to the Mono Lake Delta was divided into seven distinct reaches, with the 10-Channel split-out as an eighth reach (Table 2). Reaches #1-#3 were located upstream of the Narrows and Reaches #4-#7 were located downstream of the Narrows (Table 2). The upper end of the 10-Channel started at the top of Reach #5 and re-entered the main channel approximately 1/3 of the distance down Reach #5. Based on our hip chain measurements, the total length of the study area was relatively unchanged between the initial survey (45,950 ft) and the follow-up survey (45,868 ft). The lengths of the individual stream reaches were also fairly similar during the two surveys, except that Reach #3 (Highway 395 to the Narrows) appeared to decrease in length by 365 ft, or about 4%, between the surveys; whereas Reaches #6 and #7 (County Road Ford to Mono Lake) appeared to increase in length by a total of 648 ft, or about 7%. These changes in the total channel lengths are probably close to real. However, given the wavering accuracy of hip chain measurements when attempting to follow the thalweg down a slippery channel, the exact amounts of changes in channel lengths between the years may be slightly more or less (Table 2). Furthermore, our hip chain measurements may or may not coincide with the channel length measurements as reported for Termination Criteria, since the latter – and presumably more accurate - lengths are periodically recomputed from the most recent aerial photographs.

The percent relative abundance (PRA; total length of pools divided by total length of channel) and raw numbers of pools declined slightly from 2002/3 to 2008 in Rush Creek from the MGORD to the Narrows, but increased noticeably from the Narrows to Mono Lake (Table 2 and Figures 1 and 2). For example, between the County Road Ford and Mono Lake (Reaches #6 and #7) and in the 10-Channel (Reach #8) total high quality pool numbers and PRAs were two to five times higher in 2008 versus 2002/03. The most dramatic increase between the years was at Reach #7, from the County Road Culvert to Mono Lake. Here, the PRA of high quality pools increased from being only 3.4% of the total reach length in 2003, to 16.8% in 2008 (Figure 1); while the number of these pools increased from three to 10 (Figure 2).

The PRA and total numbers of high quality pools didn't increase as dramatically between the surveys at Reaches #4 and #5. However, these reaches already had fairly high numbers of high quality pools in 2002 (Figure 2). During 2002, Reach #5 – from the exit of the 10-Channel to the County Road Ford – had the highest PRA of high quality pools in the study area (15.3%). During 2008, Reach #5 still had the highest PRA of big pools among the Rush Creek main channel sections (21.4%). Only the 10-Channel had a higher PRA of high quality pools (34.1%) in 2008 (Figure 1).

Table 2. Length, percent relative abundance (PRA) and numbers of Class 4, Class 5 and total number of high-quality pools at eight stream reaches on Rush Creek during 2002-03 versus 2008.

Reach Information			Total Reach Length (ft)		Number of Class 4 Pools		Number of Class 5 Pools		Total Number of High Quality Pools	
#	Name		2002	2008	2002	2008	2002	2008	2002	2008
1	Gorge	Length (ft)	4,628	4,628	184	36	185	183	369	219
		PRA			4.0%	0.80%	4.0%	4.0%	7.9%	4.7%
		# of Units			5	1	4	4	9	5
2	Gorge to Hwy 395	Length (ft)	6,682	6,729	72	157	163	0	235	157
		PRA			1.1%	2.3%		0.0%	3.5%	2.4%
		# of Units			1	3		0	3	3
3	Hwy 395 to Narrows	Length (ft)	9,540	9,175	148	77	0	0	148	77
		PRA			1.6%	0.8%	0.0%	0.0%	1.6%	0.8%
		# of Units			3	1	0	0	3	1
4	Narrows to 10-Ch Exit	Length (ft)	8,010	8,050	228	505	401	700	629	1,205
		PRA			2.8%	6.3%	5.0%	8.7%	7.9%	15.0%
		# of Units			6	9	7	9	13	18
5	10-Ch Exit to Co. Rd. Ford	Length (ft)	6,345	6,362	493	482	477	882	970	1,364
		PRA			7.8%	7.6%	7.5%	13.9%	15.3%	21.4%
		# of Units			10	6	6	12	16	18
6	Co. Rd. Ford to Culvert	Length (ft)	4,122	4,430	51	115	62	208	113	323
		PRA			1.2%	2.6%	1.5%	4.7%	2.7%	7.3%
		# of Units			1	2	1	4	2	6
7	Culvert to Mono Lake	Length (ft)	4,629	4,969	58	0	96	833	154	883
		PRA			1.3%	0.0%	2.1%	16.8%	3.4%	16.8%
		# of Units			1	0	2	10	3	10
8	10-Channel Split	Length (ft)	1,994	1,525	184	256	45	262	229	518
		PRA			9.2%	16.8%	2.3%	17.2%	11.5%	34.0%
		# of Units			2	3	1	3	3	3
	TOTAL RUSH CK SURVEY	Length (ft)	45,950	45,868	1,418	1,628	1,429	3,068	2,847	4,696
		PRA			3.1%	3.5%	3.1%	6.7%	6.2%	10.2%
		# of Units			28	25	22	42	52	67

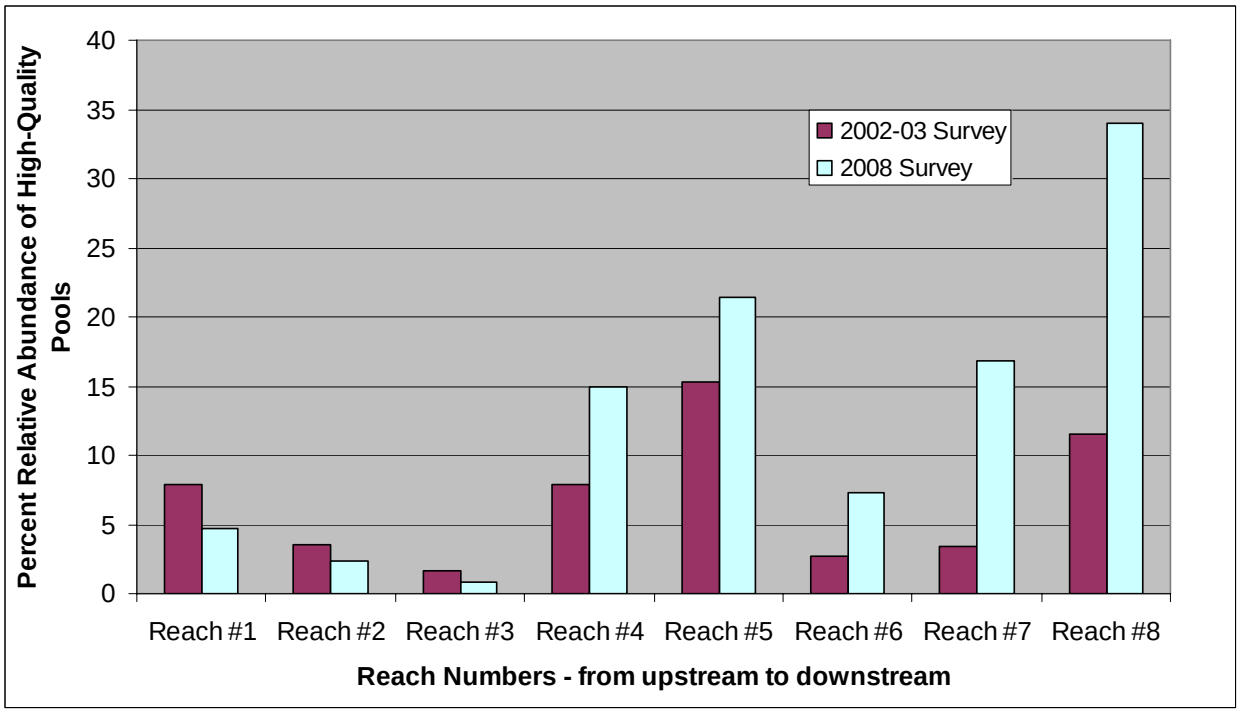

Figure 1. Percent Relative Abundance (PRA) of High Quality (Class-4+ and Class-5 Pools) within eight stream reaches on Rush Creek during the initial (2002/03) and the follow up (2008) pool surveys.

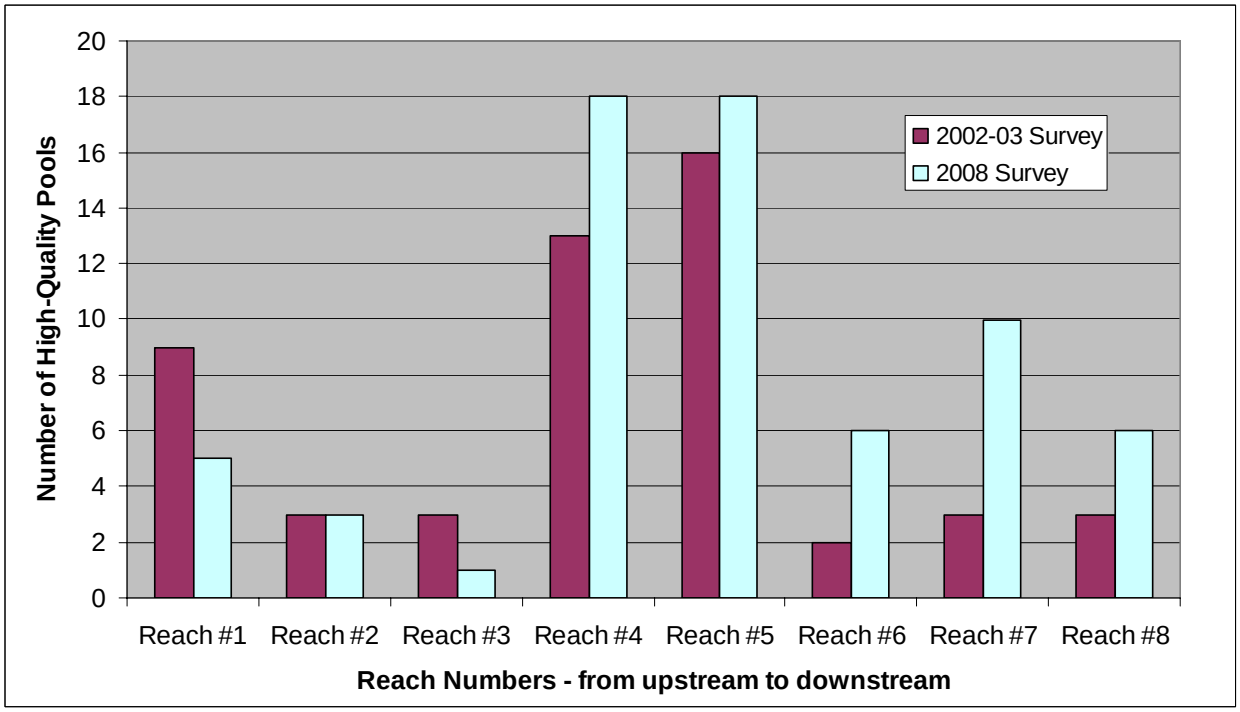

Figure 2. Total Numbers of High Quality (Class-4+ and Class-5 Pools) within eight stream reaches on Rush Creek during the initial (2002/03) and the follow up (2008) pool surveys.

The number of pools with residual depths between 2.0 ft and 2.9 ft at seven reaches on Rush Creek during 1991, 2002, and 2008 were compared to show the increase in these pools within survey reaches below the Narrows (Figure 3). Values for 1991 were taken from the Aquatic Habitat Data Base Appendix pages of the 1994 Trihey and Associates report. The number of pools with residual depths >3.0 ft also increased in the lower survey reaches (Figure 4).

The total numbers of deep pools at all four reaches of Rush Creek downstream of the Narrows increased from 1991 – 2008 (Figure 3 and 4). Reach #5 (from the exit of the 10-channel to the County Road Ford), which had the highest total number of high quality pools among the Rush Creek main-stem reaches during 2002 and 2008 (Figure 2), also had the highest number of deep pools during 1991 (Figure 3 and Figure 4). The largest increase in total numbers of deeper pools from 1991 through 2008 occurred at Reaches #6 and #7 (from the County Road Ford to Mono Lake). At the three reaches upstream of the Narrows, deeper pools were comparatively sparse during all of the surveys, with the lowest numbers being present during 1991, and the highest in 2002.

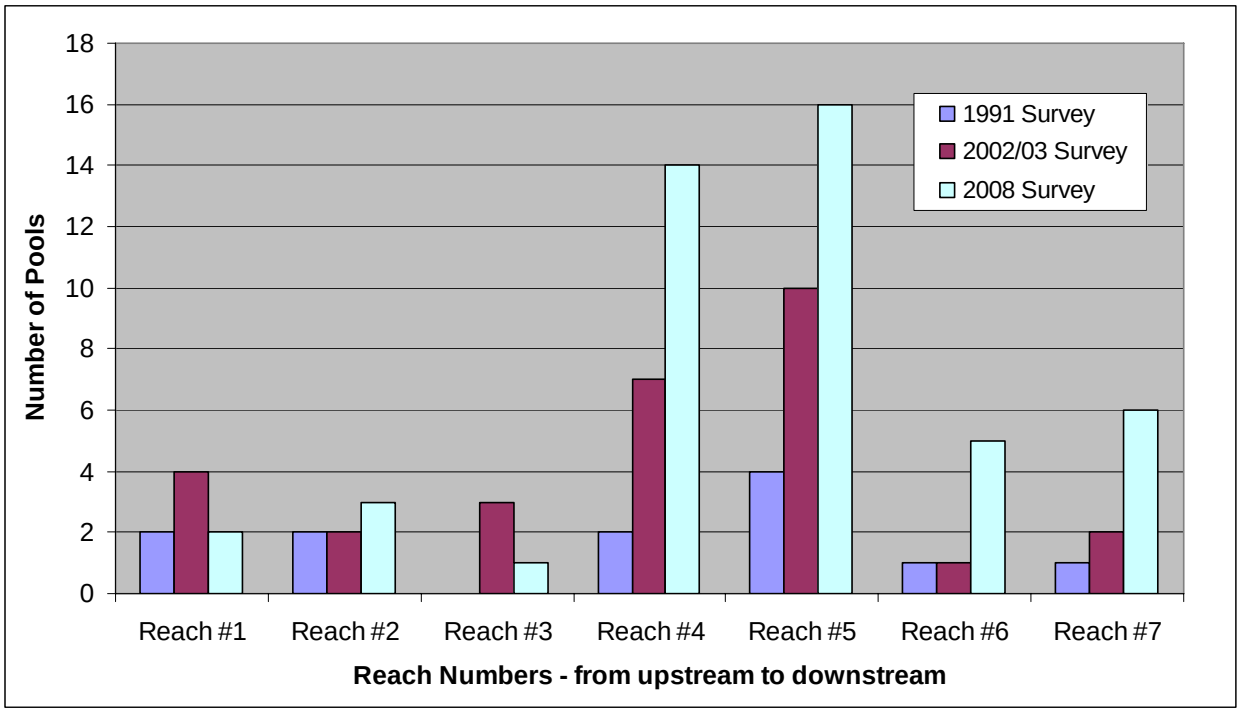

Figure 3. Total Numbers of Pools with Residual Depths ranging from 2.0-2.9 ft within seven stream reaches on Rush Creek during the 1991 Trihey survey, the initial 2002/03 pool survey and the follow up 2008 pool survey.

The PRA of pools with residual depths greater than 2.0 ft were about three to six times higher in 2008 than recorded in 1991 in survey Reaches #4 - #6 in Rush Creek downstream of the Narrows between 1991 and 2008 (Figure 5). At Reach #7 – between the County Road culvert and Mono Lake – the increase in high quality pools was even greater. Here, the PRA of pools with residual depths greater than 2.0 ft increased from being just 1.3% of the total reach length in 1991, to 24.7% of the reach's length in 2008 – a 19-fold increase. About two-thirds of these relatively new pools had residual depths greater than 3.0 ft (Figure 3 and Figure 4). During 2008, only

Reach #5 had a higher PRA of deep pools (30.3%). This reach, between the exit of the 10-channel and the County Road Ford, also had the highest PRA of these deeper pools in both 1991 and 2002 (Figure 5). Reach #5 has therefore consistently contained the highest PRA of deeper pool habitat on Rush Creek throughout the past eighteen years.

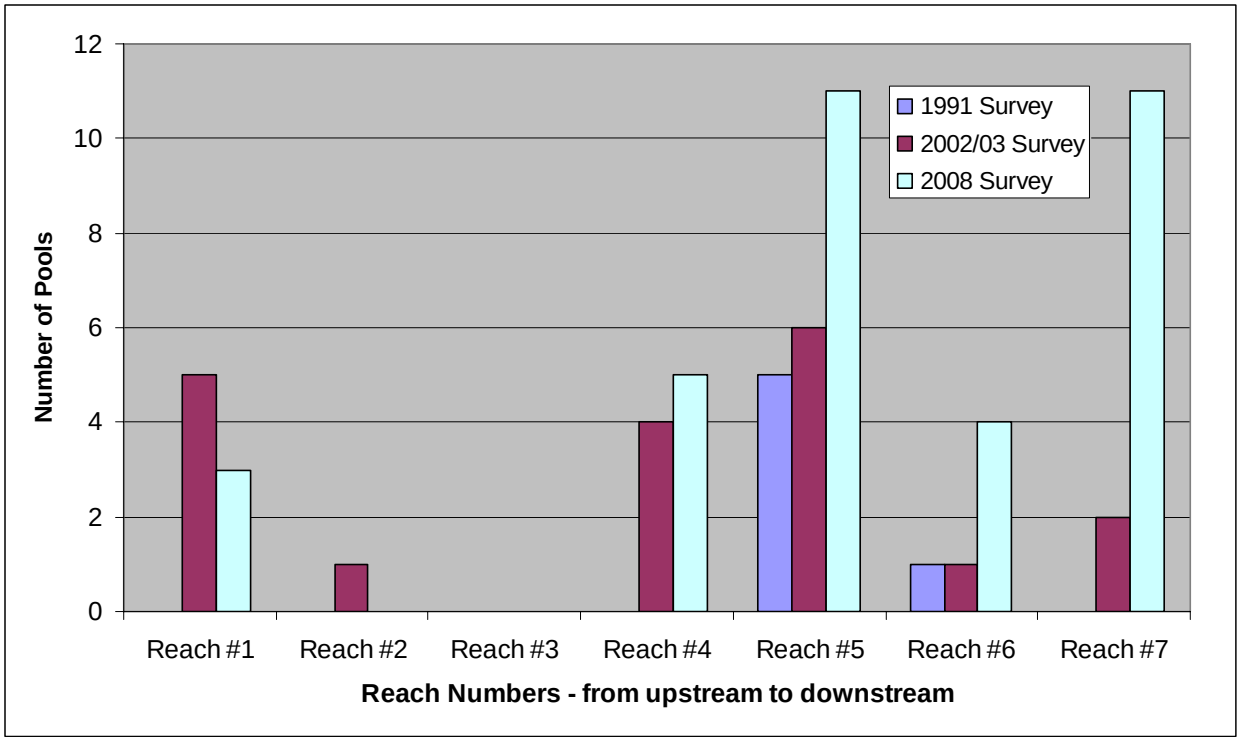

Figure 4. Total Numbers of Pools with Residual Depths Greater than 3.0 ft within seven stream reaches on Rush Creek during the 1991 Trihey survey, the initial 2002/03 pool survey and the follow up 2008 pool survey.

HGR habitat dominated the three reaches above the Narrows, with the PRA of this habitat-type accounting for 85.6, 83.7 and 93.4% of the total lengths of Reaches #1, #2 and #3, respectively (Table 3). Within the main-channel reaches downstream of the Narrows (Reaches #4 - #7), HGRs were still the most common habitat-type, but accounted for much less (36.1 to 62.2%) of the total length of these reaches. The 10-Channel was a unique reach, in that High Quality Pools (PRA 34.1%) were the most common habitat-type.

LGR habitat was uncommon (PRA <10%) on Rush Creek, except at Reach #7 where it made up 22.2% of the reach length (Table 3 and Figure 6). LGR habitat was particularly prevalent within the final 1,500 ft of stream above Mono Lake (Appendix B). The PRA of Glide/Run habitat was fairly low at the reaches above the Narrows, accounting for only 2.9, 9.9 and 1.3% of the total lengths of Reaches #1, #2, and #3, respectively. At the main-channel reaches downstream of the Narrows, the PRA of this habitat-type was higher, ranging from 11.1% at Reach #4 to 26.2% at Reach #6.

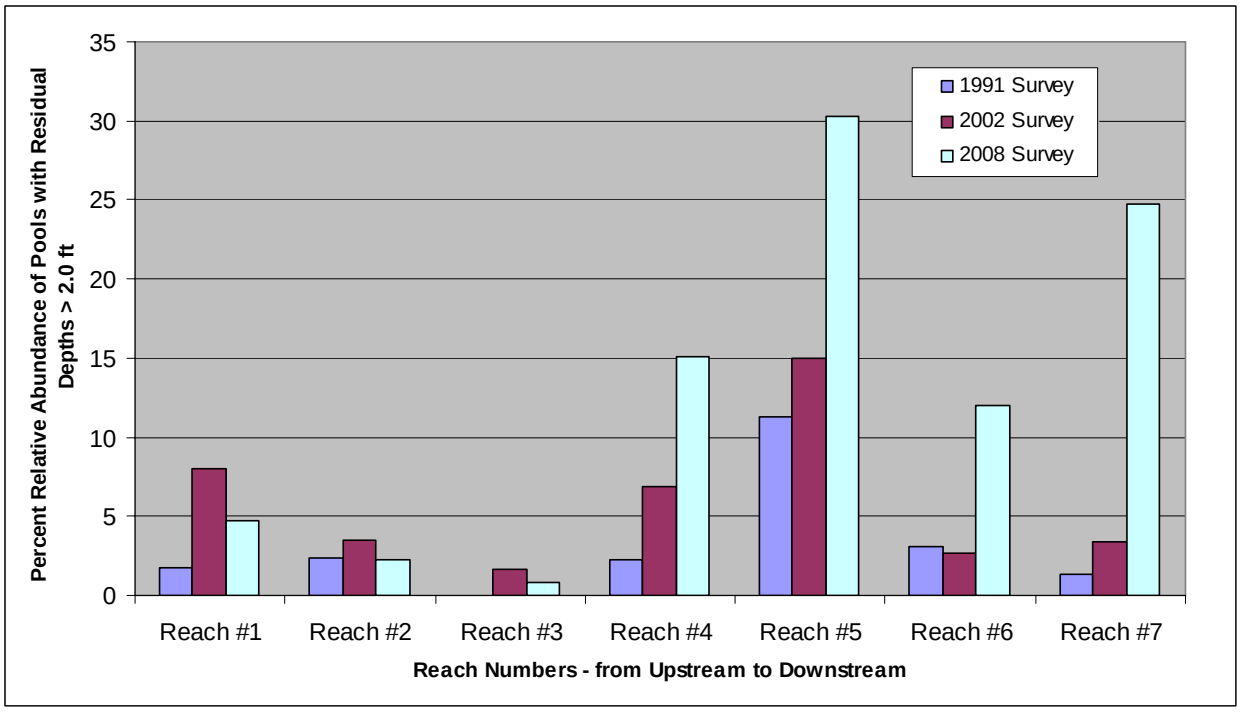

Figure 5. PRA of Pools with Residual Depths >2.0 ft at seven reaches on Rush Creek during 1991, 2002 and 2008.

The PRA of "All Pool" habitat (the last column in Table 3) was low above the Narrows, accounting for only 10.5, 4.6 and 2.6% of the total lengths of Reaches #1, #2 and #3, respectively. Downstream of the Narrows, "All Pool" habitat was much more prevalent – ranging from 20.0 to 39.6% of Reaches #4 - #8. Interestingly, the PRA of high quality (Class 4/5 pools) was higher than the PRA of lower quality (Class 2/3 pools) throughout the Rush Creek "Bottomlands", except at Reach #6.

Appendix A contains a spreadsheet of the 2008 Rush Creek habitat typing data set.

Table 3. Length, percent relative abundance (PRA) and numbers of habitat units at eight stream reaches on Rush Creek during 2008.

Reach Information			Type of Habitat Unit						
#	Name		All Units Combined	HGR	LGR	Glide/ Run	Class 2-3 Pools	Class 4-5 Pools	All Pools
1	Gorge	Length (ft)	4,628	3,961	49	134	265	219	484
		PRA	100%	85.6%	1.1%	2.9%	5.7%	4.7%	10.5%
		# of Units	32	16	1	2	8	5	13
2	Gorge to Highway 395	Length (ft)	6,729	5,632	122	663	155	157	312
		PRA	100%	83.7%	1.8%	9.9%	2.3%	2.3%	4.6%
		# of Units	31	15	1	8	4	3	7
3	Highway 395 to Narrows	Length (ft)	9,175	8,572	213	126	167	77	244
		PRA	100%	93.4%	2.3%	1.3%	1.8%	0.8%	2.6%
		# of Units	20	10	3	2	4	1	5
4	Narrows to 10-Channel Exit	Length (ft)	8,050	5,009	636	893	407	1,205	1,612
		PRA	100%	62.2%	7.9%	11.1%	5.1%	15.0%	20.0%
		# of Units	82	35	7	10	12	18	30
5	10-Channel Exit to Co. Rd. Ford	Length (ft)	6,362	2,455	513	1,328	602	482	1,966
		PRA	100%	38.6%	8.1%	20.9%	9.5%	21.4%	30.9%
		# of Units	86	31	6	20	11	18	29
6	Co. Rd. Ford to Co. Rd. Culvert	Length (ft)	4,430	2,327	125	1,032	623	323	946
		PRA	100%	52.5%	2.8%	23.3%	14.1%	7.3%	21.4%
		# of Units	51	23	2	9	11	6	17
7	Co. Rd. Culvert to Mono Lake	Length (ft)	4,969	1,797	1,101	805	453	833	1,286
		PRA	100%	36.1%	22.2%	16.2%	9.1%	16.8%	25.9%
		# of Units	49	10	12	9	8	10	18
8	10-Channel Split	Length (ft)	1,525	433	88	400	86	518	604
		PRA	100%	28.4%	5.8%	26.2%	5.6%	34.1%	39.6%
		# of Units			2	3	1	2	8
	TOTAL RUSH CK SURVEY	Length (ft)	45,868	30,186	2,847	5,381	2,758	4,696	7,454
		PRA	100%	65.8%	6.2%	11.7%	6.0%	10.2%	16.2%
		# of Units	372	145	35	65	60	67	127

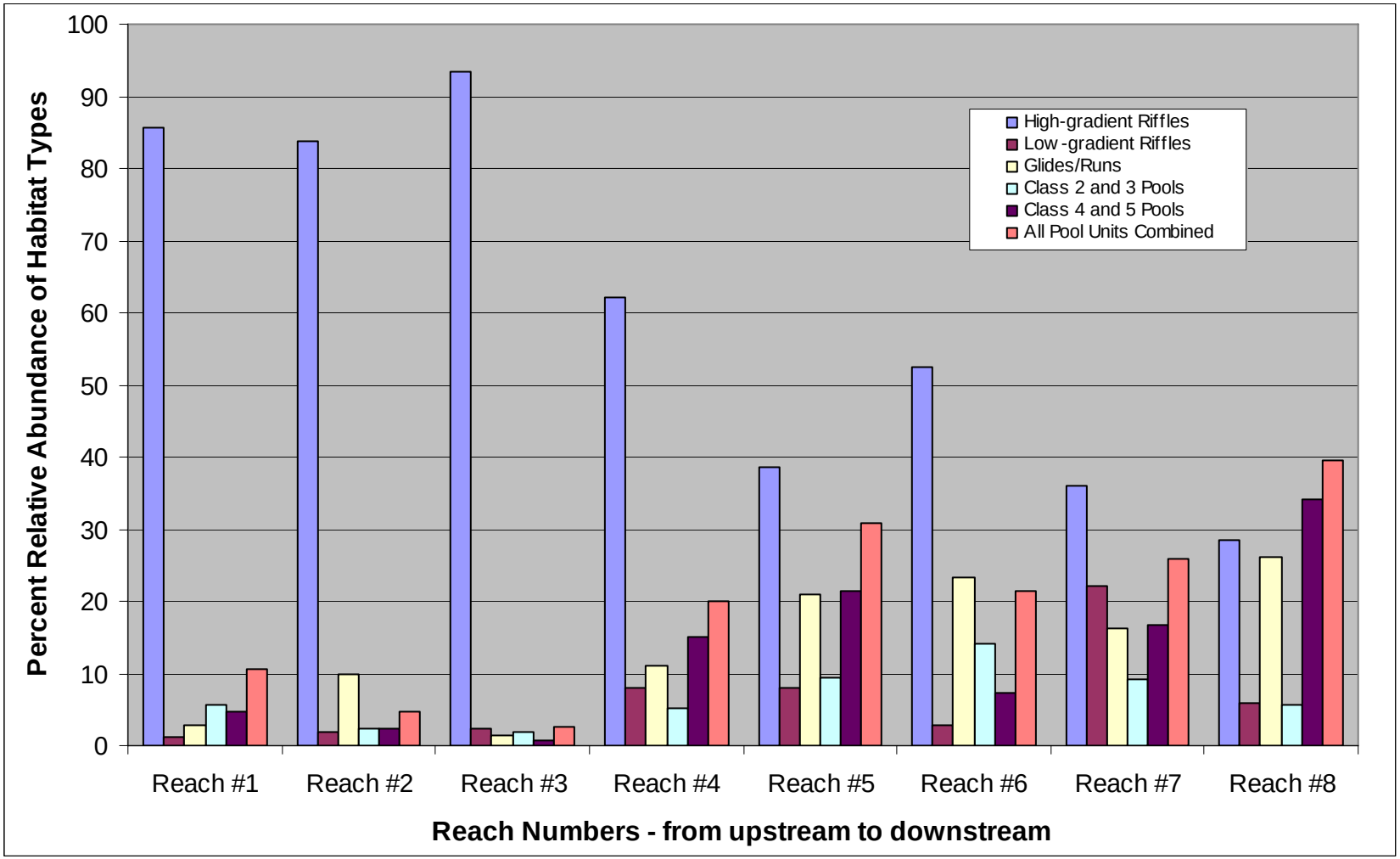

Figure 6. PRA of High Gradient Riffles (HGR), Low Gradient Riffles (LGR), Glide/Runs, Class 2 and 3 Pools, and Class 4 and 5 ("High Quality") Pools at eight reaches on Rush Creek during 2008. An "All Pool" subtotal is also on the far right of the graph.

Lee Vining Creek

In Lee Vining Creek, nearly 10,000 ft of channel was habitat typed (Table 4). We divided the surveyed reach into three reaches, based primarily on channel slope and confinement. Reach #1 started within the extensive HGR section just east of the town of Lee Vining, Reach #2 started where the A-4 Channel diverged from the main channel, and Reach #3 started at the County Road Ford (Table 4).

Throughout the study area, high gradient riffles (HGR) were, by far, the dominant habitat-type, accounting for over ¾ of the total stream length (Table 4 and Figure 7). More specifically, HGR habitat comprised 95.2, 74.9 and 66.6% of the total lengths of Reaches #1, #2 and #3, respectively. There was no low gradient riffle (LGR) habitat at any of the reaches. Glide/Run habitat ranged from 4.8% of the total length of Reach #1, to 16.5% of the length of Reach #2. The PRA of "All Pool" habitat ranged from 0.0% of Reach #1 to 22.4% of Reach #3. The PRA of "High Quality" pool habitat was very low on Lee Vining Creek, comprising only 3.4% of the total study area (Table 4); and accounting for only 0,0, 1.6 and 8.6% of the total lengths of Reaches #1, #2 and #3, respectively.

The final column of Table 4 shows the density of pocket pools (number per 100 feet of stream length) at each reach. The density of these small "pocket" habitats was highest at Reach #1 (6.32/100 ft) and lowest at Reach #3 (0.87/100 ft). The density of pocket pools at Reach #2 (2.71/100 ft) was nearly identical to the Lee Vining study area mean (2.92/100 ft).

Appendix B contains a spreadsheet of the 2008-09 Lee Vining Creek habitat typing data set.

Table 4. Length, percent relative abundance (PRA) and numbers of habitat units at three stream reaches on Lee Vining Creek, 2009.

Reach Information		Type of Habitat Unit							
		All Units Combined	**HGR**	**LGR**	**Glides and Runs**	**Class 2-3 Pools**	**Class 4-5 Pools**	**All Pools**	**Pocket pools/100 ft**
Reach #1 – Behind Town to Top of A-Channel	Length (ft)	2,169	2,065	0	104	0	0	0	6.32
	PRA	100%	95.2%	0.0%	4.8%	0.0%	0.0%	0.0%	
	# of Units	7	4	0	3	0	0	0	
Reach #2 – Top of A-Channel to County Road Ford	Length (ft)	4,693	3,515	0	775	327	76	403	2.71
	PRA	100%	74.9%	0.0%	16.5%	7.0%	1.6%	8.6%	
	# of Units	50	24	0	16	9	1	10	
Reach #3 – County Road Ford to Mono Lake	Length (ft)	3,058	2,037	0	337	422	262	684	0.87
	PRA	100%	66.6%	0.0%	11.0%	13.8%	8.6%	22.4%	
	# of Units	39	18	0	6	10	5	15	
TOTAL LEE VINING CK SURVEY	Length (ft)	9,920	7,617	0	1,216	749	338	1,087	2.92
	PRA	100%	76.8%	0.0%	12.3%	7.6%	3.4%	11.0%	
	# of Units	96	46	0	25	19	6	25	

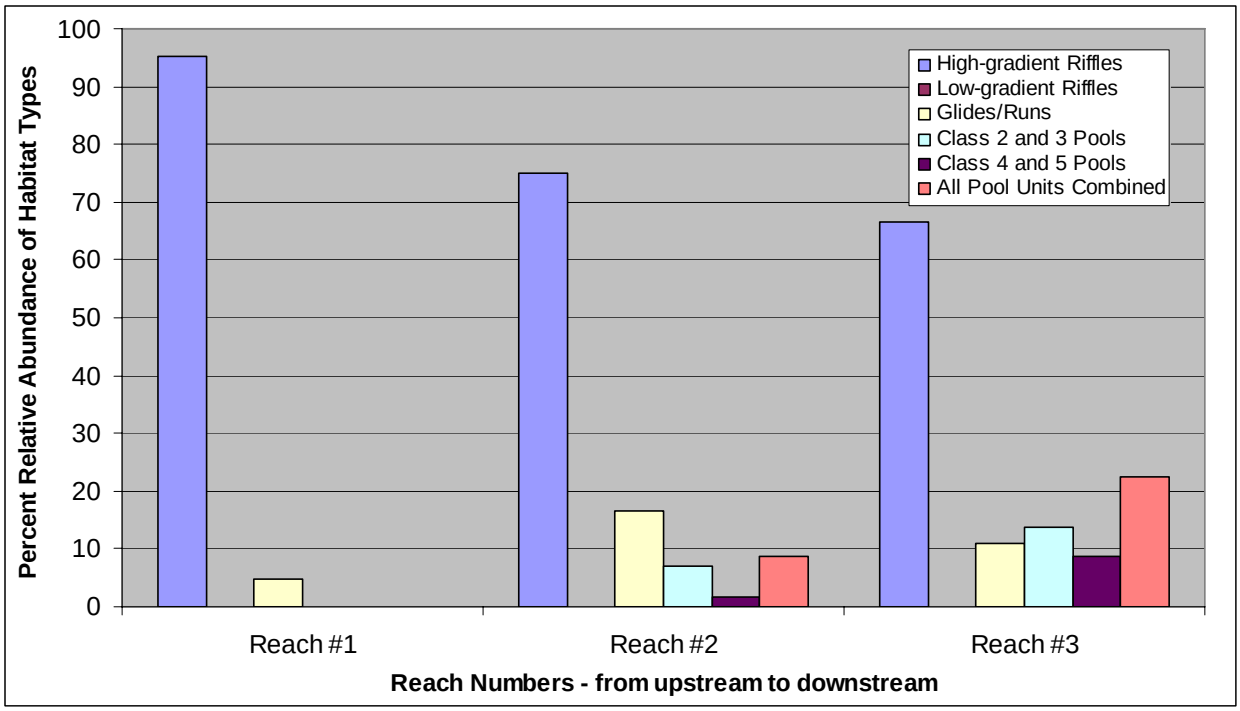

Figure 7. PRA of High Gradient Riffles (HGR), Low Gradient Riffles (LGR), Glide/Runs, Class 2 and 3 Pools and Class 4 and 5 ("High Quality") Pools at three reaches on Lee Vining Creek during 2008. An "All Pool" subtotal is also on the far right of the graph.

DISCUSSION

The 2002/03 and 2008 pool surveys on Rush Creek documented a dramatic increase in the numbers and the Percent Relative Abundance (PRA) of High Quality pool habitats throughout Rush Creek downstream of the Narrows (Figures 1 and 2). The 2008/09 habitat typing surveys on Rush and Lee Vining creeks allowed for comparison of habitat-types between the streams and among the reaches on each stream; these surveys also provided a basis for selection of the Instream Flow Study (IFS) sub-reaches on these streams.

High gradient riffles dominate Rush Creek above the Narrows (Reaches #1 - #3) as well as on Lee Vining Creek above the County Road Ford (Reaches #1 - #2), with the PRA of this habitat-type ranging from 75 – 95% of the total stream lengths of these reaches. Relatively high stream gradients (2-4%) and larger substrate sizes hamper the development of larger, deeper pools in these reaches of Rush, and especially Lee Vining, creeks.

On Rush Creek downstream of the Narrows (Reaches #4 - #8) and on Lee Vining Creek downstream of the County Road Ford (Reach #3), riffle habitat was less dominant, and total pool habitat ranged from about 20-40% of the total reach lengths. Stream gradients were lower in these reaches, averaging about 1% on Rush Creek and 2% on Lee Vining Creek. Substrate sizes were also generally smaller, which has also aided in the development of pool habitats on these reaches.

The impressive evolution towards more deeper, high quality pool habitat in the Rush Creek Bottomlands between 1991 and 2008; i.e., a three to 19-fold increase in the PRA of deeper, higher quality pools (Figures 5) is, largely, a testament to the maturation of the stream's riparian community, in conjunction with the Stream Restoration Flows prescribed for wetter year types by Order 98-05. Twenty-five years ago, there was hardly any riparian vegetation along Rush Creek. The density and diameter of willow clusters and cottonwood trees have dramatically increased over the past two decades, which has increased the stability and cohesiveness of the stream banks. The erosive force of high stream discharge rates cutting into the roots of now-stable willow clusters has, in turn, caused the prolific natural development of deeper and larger "lateral scour" pools throughout the Rush Creek Bottomlands.

Upstream of the Narrows (Reaches #1 - #3), the numbers and PRA of high quality pools were consistently much lower than were found downstream of the Narrows (Figures 1 – 5). The highest numbers and PRA of these pools were found in 2002, with a noticeable drop occurring in 2008. In the late 1990s, a number of pools were excavated with heavy machinery and seeded with habitat elements (root wads and boulders) throughout Rush Creek. These structures were responsible for the noticeable, but slight, increase in the PRA of deeper, high quality pools that was evident between 1991 and 2002 (Figures 3 –5). The ephemeral nature of this artificial habitat was evident during the 2008 survey, particularly within Reach #2, which found a reduction in the PRA of high quality pools compared to 2002 (Figure 1). Reach #2 contains three of the excavated "Trihey" pools which are within our Upper Rush annual electro-fishing monitoring reach. The high runoff flows of 2005 and 2006 moved most of the root wads closer to the stream's edge and partially filled these pools with sediment. This resulted in a 33% reduction in the mean lengths, and an 18% reduction in the mean residual depths, of these pools between 2002 and 2008. Please refer to Appendices A and C to examine changes in mean lengths and residual depths.

Because of the dynamic nature of the Rush Creek channel downstream of the Narrows, we suspect that further evolution of pool habitat will occur during future high-flow events. Thus, we have scheduled an additional pool-habitat typing survey to occur the summer after the next high-flow event or by the summer of 2011. We also recommend pools surveys beyond the year 2012 are included in a long-term monitoring plan as a part of the upcoming Synthesis Report.

IFS Sub-Reach Selection

Because Reach #5 on Rush Creek – from the exit of the 10-Channel downstream to the County Road Ford – has consistently contained the highest PRA of High Quality Pools among the Rush Creek main channel reaches, and thus represents the desired future condition for fish habitat in the Rush Creek Bottomlands, we decided to focus much of our Instream Flow Study (IFS) efforts there. We ultimately evaluated two IFS sub-reaches within Reach #5, along with the entire length of the 10-Channel (Reach 8). We also decided to evaluate a portion of Reach #6, which has a less stable stream channel, and thus a higher percentage of "new" pools.

Because of the paucity of Class 3, 4 and 5 pools on Reaches #1 and #2 of Lee Vining Creek, we decided to map most of the pool habitats in these reaches during the IFS. Two contiguous IFS sub-reaches were selected within Reach 3, since this reach contained the majority of the pool

habitat on Lee Vining Creek. Because the density (number/100 ft) of pocket pools in Reach #2 was similar to the stream-wide mean (Table 4), we chose to conduct the IFS pocket pool survey within this reach.

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APPENDIX A: RUSH CREEK HABITAT SURVEY JULY 18 - 21, 2008								(With 9/12&13 additions)
Habitat Type	**Start Distance**	**Unit Length(ft)**	**Max Depth(ft)**	**Residual Depth(ft)**	**LAT. N 37**	**LONG. W 119**	**Width (ft)**	**COMMENTS**
HGR-1	0	688			0.86933	0.10598	26	start survey
P5-1	688	21	5	3.5	0.87131	0.10741	22	
HGR-2	709	42						
PO-1	751	30	3.2	1.3				Class 2
HGR-3	781	84						
LGR-1	865	49					24	
HGR-4	914	26						
P5-2	940	76	5	3.4	0.87248	0.10741	25	
HGR-5	1016	35						
PO-2	1051	35	3.5	1.3				Class 3 (P5 in '02?)
HGR-6	1086	329						
PO-3	1415	37	2.8	1.1				Class 2
HGR-7	1452	428						
PO-4	1880	30	3.1	1.7			29	Class 3
HGR-8	1910	125						
P5-3	2035	45	4	2.7	0.8743	0.10887	29	
HGR-9	2080	320						
P4-1	2400	36	3.9	2.5	0.87515	0.10816	27	
HGR-10	2436	144						
PO-5	2580	38	3	0.8				Class 2
HGR-11	2618	89						
P5-4	2707	41	4.2	3.3	0.87589	0.10812		
HGR-12	2748	237						
PO-6	2985	36	3.2	1.1				Class 2/3
HGR-13	3021	407						
PO-7	3428	36	3	1				Class 2/3
HGR-14	3464	316						
GL-1	3780	86	2.7	n/m				
HGR-15	3866	584						
GL-2	4450	48	2.2	n/m				
HGR-16	4498	130						
PO-8	4628	23	2.8	1.8	0.87899	0.10403		Class 3
HGR-17	4651	1129						
GL-3	5780	37	2.2	n/m				
PO-9	5817	35	3.1	2.4				Class 3 (Vert.Erod. LB)
HGR-18	5852	148						
GL-4	6000	80	1.8	n/m				
HGR-19	6080	129						
PO-10	6209	39	2.8	1.4				Class 2/3
HGR-20	6248	110						
P4-2	6358	52	3.4	2.3	0.8815	0.09968	26	Ditch Fish spawned in p.tail
HGR-21	6410	150						
Top UPRU	6450	n/a						
GL-5	6560	61	1.8	n/m				
HGR-22	6621	339						
P4-3	6960	60	3.7	2.3	0.88249	0.09801		Up. Trehey RW pool
HGR-23	7020	183						
GL-6	7203	69	2.6	n/m				
HGR-24	7272	158						
PO-11	7430	42	3.1	1.9				Class 3 (2nd Trehey RW)
HGR-25	7472	214						

Habitat Type	Start Distance	Unit Length	Max Depth	Residual Depth	LAT. N 37	LONG. W 119	Width	COMMENTS
LGR-2	7686	122						
P4-4	7808	45	3.7	2.6	0.88358	0.09606	28	Lower Treyhey RW pool
HGR-26	7853	414						
Bot UPRU	7939	n/a			0.88378	0.09573		Chan. Splits-take RC
PO-12	8267	39	2.7	1.5			16	Class 2/3
HGR-27	8306	20						
GL-7	8326	50	1.9	n/m				
HGR-28	8376	963						
Chan rtn	9175	n/a						Back to one chan.
GL-8	9339	123	2.3	n/m			22	
HGR-29	9462	305						
GL-9	9812	60	2.7		0.88832	0.09358	17	La/Lo also for old 395 br.
HGR-30	9872	723						
GL-10	10595	183	2.7	n/m				
HGR-31	10778	809						
395 br	11357	n/a						Bot of lower control grade
PO-13	11587	37	2.6	1.5	0.89228	0.09082		Class 2/3
HGR-32	11624	273						
PO-14	11897	30	2.5	1.1	0.89266	0.08987		Class 2
HGR-33	11927	110						
PO-15	12037	36	2.4	1.2	0.89307	0.08972		Class 2/3
HGR-34	12073	1682						
LGR-3	13755	75						
HGR-35	13380	261						
PO-16	14091	64	2.4	1.6	0.89823	0.08824		Class 2/3
HGR-36	14155	250						
LGR-4	14405	75						
HGR-37	14480	1470						
GL-11	15950	52	2.4	n/m				
HGR-38	16002	1446						
P4-5	17448	77	2.9	2.2	0.90585	0.0838		
HGR-39	17525	1035						
Parker Cr	17630	n/a			0.90631	0.08389		
LGR-5	18560	83						
Art. Chan.	18636	n/a						Upper end (on RB bl gr. op)
HGR-40	18643	600						
GL-12	19243	74	2.7	n/m				
HGR-41	19317	1282						
Art. Chan.	20433	n/a						Lower end(no flow on 7/19)
Walker Cr	20532	n/a			0.91345	0.08008		(The Narrows)
PO-17	20599	18	2.5	1.1	0.91362	0.08007		Class 2/3
HGR-42	20617	73						
P4-6	20690	25	4.3	2.8	0.91389	0.07999		Up. Narrows pool (Code 28)
HGR-43	20715	115						
P4-7	20830	30	3.5	2.1	0.91436	0.07975		Lo.Narrows pool
HGR-44	20860	23						
PO-18	20883	20	2.9	1.2	0.91438	0.07969		Class 2/3
HGR-45	20903	57						
PO-19	20960	41	3	1.4	0.91446	0.07944		Class 3
GL-13	21001	64	n/m	n/m				
HGR-46	21065	490						
LGR-6	21555	120						
HGR-47	21675	207						
LGR-7	21882	93						
HGR-48	21975	440						

Habitat	Start	Unit	Max	Residual	LAT.	LONG.	Width	COMMENTS
Type	Distance	Length	Depth	Depth	N 37	W 119		
PO-20	22415	36	2.3	1.1	0.91673	0.07537		Class 3 (Abun. Cover)
HGR-49	22451	54						
P4-8	22505	75	2.6	2	0.9166	0.07506		
HGR-50	22580	85						
P5-5	22665	51	3.7	2.8	0.91662	0.07454		"Big Fish Pool" (Code 28)
HGR-51	22716	69						
P4-9	22785	59	3.2	2.4	0.91692	0.07437		
HGR-52	22844	51						
P5-6	22895	93	3.4	2.7	0.91708	0.07399		
HGR-53	22988	72						
P5-7	23060	93	3.5	2.8	0.91735	0.07384	26	
HGR-54	23153	135						
P5-8	23288	59	4.5	3.3	0.918	0.07353		
HGR-55	23347	199						
LGR-8	23546	131						
HGR-56	23677	108						
P5-9	23785	74	4.3	3.1	0.91932	0.07325	27	
HGR-57	23859	105						
PO-21	23964	36	2.8	1.3	0.91968	0,07298		Class 2/3
HGR-58	24000	60						
PO-22	24060	46	2.6	1	0.91975	0.07287		Class 2
HGR-59	24106	57						
GL-14	24163	180	2.6	n/m				
HGR-60	24343	160						
P4-10	24503	70	3.2	1.5	0.92085	0.07196		
HGR-61	24573	112						
P5-10	24685	45	4.7	4	0.92132	0.07191	30	
HGR-62	24730	138						
LGR-9	24868	125						
HGR-63	24993	75						
P4-11	25068	71	3.8	2	0.92178	0.07059		
HGR-64	25139	99						
GL-15	25238	49	2	n/m				
PO-23	25287	23	3.2	1.2	0.92206	0.07007		Class 2 (exposed)
GL-16	25310	37	2.6	n/m				
HGR-65	25347	96						
P4-12	25443	78	3.8	2.6	0.92249	0.07024		Cover <50%
HGR-66	25521	250						
PO-24	25771	23	2.7	1.8	0.9231	0.0698		Class 3 (but high vel.)
HGR-67	25794	31						
GL-17	25825	63	3.2	2.2				High velocity
LGR-10	25888	109						
HGR-68	25997							
PO-25	26035	45	2.8	1.6	0.92378	0.0698		Class 2/3
HGR-69	26080	63						
GL-18	26143	121	2.5	1.3				
HGR-70	26264	394						
Art. Chan.	26360	n/a			0.9246	0.0692		Up. End "8 Chan
GL-19	26658	69	2.1	1.2				
HGR-71	26727	449						
PO-26	27176	35	2.5	1.3	0.92638	0.06734		Class 2/3
HGR-72	27211	117						
P4-13	27328	38	3.3	2.2	0.92676	0.06704		
LGR-11	27366	35						
P5-11	27401	81	4	2.8	0.92687	0.06712		Ex. Cover

Habitat Type	Start Distance	Unit Length	Max Depth	Residual Depth	LAT. N 37	LONG. W 119	Width	COMMENTS
Chan Split	27482	n/a						Begin "New Chan" sec.
HGR-73	27482	265						
GL-20	27747	68	n/m					
P5-12	27815	59	6.1+	4.8+	0.92794	0.06713		New corner pool
HGR-74	27874	83						
P4-14	27957	59	3.5	2.3	0.92801	0.06664	15	
LGR-12	28016	23						
PO-27	28039	34	3.5	2.4	0.92815	0.06654		Class 3+
HGR-75	28073	134						Many pocket pools
GL-21	28207	65	3	1.8				
P5-13	28272	145	4.2	3.4	0.92846	0.06606		3 conn. Pools
Gl-22	28417	177	2.5	1.7				
HGR-76	28594	38						
PO-28	28632	50	3.1	2.3	0.92935	0.06596		Class 2/3
Chan exit	28682	n/a						"10 Chan" Exit
HGR-77	28682	310						
Top LORU	28784	n/a						Start of old efish sec.
Chan rtn	28992							End "New Chan" sec
PO-29	28992	30	2.7	1.5	0.93001	0.06688		Class 3
GL-23	29022	85	1.9	1.4				
HGR-78	29107	150						
GL-24	29257	95	2.4	1.8				
HGR-79	29352	83						
P5-14	29435	82	4.2	3.7	0.93072	0.06754		
HGR-80	29517	28						
P4-15	29545	50	3.1	2.6	0.93065	0.06728		
HGR-81	29595	71						
GL-25	29666	96	2.2	1.6				
LGR-13	29762	31						
P4-16	29793	60	3.4	2.8	0.93105	0.6678		
HGR-82	29853	95						
GL-26	29948	34	1.6	1.1				
PO-30	29982	55	2.8	2.3	0.93124	0.06737		Class2/3
HGR-83	30037	17						
P5-15	30054	74	3.7	3	n/m	n/m		
Bot LORU	30128	n/a						End of old efish sec.
HGR-84	30128	66						
GL-27	30194	59	2.2	1.7				
HGR-85	30253	15						
PO-31	30268	55	2.7	2.1	0.93183	0.06784		Class2/3
GL-28	30323	85	2.7	2				
LGR-14	30408	135						
HGR-86	30543	96						
GL-29	30639	67	1.5	n/m				
LGR-15	30706	92						
PO-32	30798	40	2.8	1.1	n/m	n/m	11	Class 2
GL-30	30838	15	n/m					
P4-17	30853	63	3.5	2.9	0.93312	0.06674		
LGR-16	30916	35						
P5-16	30951	62	4.1	3.1	0.93334	0.06664		At Chan Confl.
Chan rtn	30980	n/a						"10 Chan" Return
HGR-87	31013	52						
GL-31	31065	63	2.7	1.7				
HGR-88	31128	20						
P4-18	31148	128	4	2.8	0.93368	0.06715		Long p.tail

Habitat Type	Start Distance	Unit Length	Max Depth	Residual Depth	LAT. N 37	LONG. W 119	Width	COMMENTS
Str ga sta	31252	n/a						Mc&Trush Staff Gauge
LGR-17	31276	152						
PO-33	31428	84	3.5	2.2	0.9342	0.0676		Class 3+
HGR-89	31512	167						
P5-17	31679	159	5.3+	4.2+	0.93449	0.06763		3 conn. Pools
HGR-90	31838	133						
GL-32	31971	129	2.5	n/m				
P5-18	32100	60	5.5+	4.1+	0.93588	0.06736		
HGR-91	32160	18						
P5-19	32178	52	5.3+	4.1+	0.93594	0.06756		
HGR-92	32230	35						
PO-34	32265	58	3.4	2.3	0.93599	0.0678		
HGR-93	32323	54						
GL-33	32377	32	2.5	n/m				
HGR-94	32409	88						
GL-34	32497	87	1.7	0.8				
HGR-95	32584	210						
P4-19	32794	108	3.8	2.2	0.93694	0.06707		Abun.cover (SWD&OHV)
HGR-96	32902	163						
P5-20	33065	64	4	3	0.9367	0.06636		7/21 Water T=72F@1350
HGR-97	33129	30						
P5-21	33159	66	4.2	2.9	0.93701	0.06643		Code 29 surg. Site
GL-35	33225	63	n/m					
HGR-98	33288	89						
P5-22	33377	69	4.4	3.2	0.93774	0.0659		
HGR-99	33446	43						
P4-20	33489	73	3.8	2.5	0.93772	0.06599		
HGR-100	33562	51						
PO-35	33613	31	3.8	2	0.93806	0.06618		Class 3+
Gl-36	33644	60	2.5	n/m				
PO-36	33704	62	3.9	2.7	0.93826	0.066		Class 3
Gl-37	33766	54	2.6	1.3				
HGR-101	33820	89						
PO-37	33909	46	3.8	2.7	0.93798	0.06556		Class 2-poor cover
HGR-102	33955	31						
GL-38	33986	23	3	n/m				
P5-23	34009	91	4.3+	3.1+	0.93786	0.06525		
HGR-103	34100	43						
PO-38	34143	98	3.6	2.4	0.93807	0.06493		Class 3
HGR-104	34241	131						
PO-39	34372	43	3.8	2.6	0.93841	0.06435		Class 3+
HGR-105	34415	32						
P5-24	34447	63	4.5	3.3	0.93847	0.06452		
Gl-39	34510	110	3	1.8				
LGR-18	34620	68						
GL-40	34688	48	2.3	1.1				
HGR-106	34736	25						
GL-41	34761	65	2.8	1.8				
HGR-107	34826	20						
P5-25	34846	40	4.7+	3.5+	n/m	n/m		
GL-42	34886	58	2.4	1.2				
Ford 3	34944	n/a						Top of old efish sec.
HGR-108	34944	24						
PO-40	34968	77	3.2	2.5	0.93971	0.06439		Class 3
HGR-109	35045	89						

Habitat Type	Start Distance	Unit Length	Max Depth	Residual Depth	LAT. N 37	LONG. W 119	Width	COMMENTS
Gl-43	35134	137	2.8	1.8				
HGR-110	35271	102					21	
P5-26	35373	79	4.5	3.4	0.94055	0.06454	30	
HGR-111	35452	29					20	
PO-41	35481	93	3.5	2.5	0.94083	0.06435		Class 3+
HGR-112	35574	163						
GL-44	35737	137	2.9	1.9				
HGR-113	35874	213						
PO-42	36087	64	3.2	2	0.94228	0.06387		Class 2/3
LGR-19	36151	59						
HGR-114	36210	22					26	
P5-27	36232	55	4.4	3.3	0.94267	0.06374	22	
HGR-115	36287	82	n/m				20	
PO-43	36369	56	3.1	1.9	0.94285	0.06385		Class 2
HGR-116	36425	296						
Top New	36721	n/a						Top of new efish sec.
GL-45	36721	145	2.5	1.5				
HGR-117	36866	131					42	
P5-28	36997	33	4.5	3.5	0.94416	0.0631	36	
HGR-118	37030	21					26	
P4-21	37051	65	4.1	2.9	0.94408	0.06305		
GL-46	37116	75	2.8	1.6				
HGR-119	37191	29					22	
P5-29	37220	41	4.8	3.5	0.94424	0.06262	29	
HGR-120	37261	142					21	
PO-44	37403	54	3.7	2	0.94427	0.06201		Class 2/3
GL-47	37457	230	2.5	1				
Bot New	37579	n/a						Bot. of new efish sec.
HGR-121	37687	80						
PO-45	37767	97	3.1	2.2	0.94477	0.06143		Class 2/3
LGR-20	37864	66						
Bot Old	37930	n/a						
HGR-122	37930	18						
PO-46	37948	28	3.4	2.1	0.94518	0.06149		Class 2
HGR-123	37976	133						
PO-47	38109	58	3.1	2.3	0.94534	0.06095		Class 2
HGR-124	38167	246						
PO-48	38413	37	3.3	2	0.94607	0.06054		Class 2- High Velocity!
GL-48	38450	23	2.5	1.4				High Velocity
P4-22	38473	50	3.7	2.5	0.94613	0.06036		
HGR-125	38523	26						
GL-49	38549	111	2.8	1.7				
HGR-126	38660	217						
GL-50	38877	98	2.9	1.9				
HGR-127	38975	72						
GL-51	39047	76	3.6	2.3				High Velocity
HGR-128	39123	61						
PO-49	39184	27	3.5	2.1	0.94701	0.05885		Class 2/3- High Velocity
HGR-129	39211	25						
PO-50	39236	32	4.1	2.4	0.94711	0.05846		Class 2 - small & no cover
HGR-130	39268	106					24	
Cul. Top	39374							Top CORD Cul
Cul Bot	39428							Bot CORD Cul- Tot. Ln 54ft
P5-30	39428	42	4.4	3.1	0.94761	0.05808	71	Wide Culvert Plunge Pool
HGR-131	39470	163					18	

Habitat Type	Start Distance	Unit Length	Max Depth	Residual Depth	LAT. N 37	LONG. W 119	Width	COMMENTS
PO-51	39633	57	3.4	1.9	0.94811	0.0584		Class 3
GL-52	39690	90	2.9	1.7				
HGR-132	39780	165						
GL-53	39945	142	3.1	1.9				
HGR-133	40087	151					19	
P5-31	40238	108	5.1	3.7	0.94941	0.0591	32	Long "S" pool
HGR-134	40346	297					28	
GL-54	40643	65	2.6	1.4				
HGR-135	40708	48						
PO-52	40756	76	3.8	2.6	0.95003	0.05804		Class 3
HGR-136	40832	26						
P5-32	40858	67	4.7	3.3	0.95019	0.05771		9/12Water T= 69F@ 1600
LGR-21	40925	206						
GL-55	41131	95	2.2	1				
LGR-22	41226	119						
PO-53	41345	53	3.8	2.6	0.95068	0.05613		Class 3- 2ft UCB for 20ft
LGR-23	41398	125						
GL-56	41523	55	2.3	1.1				
PO-54	41578	29	3.4	2.2	0.95126	0.05601		Class 2
HGR-137	41607	111					20	
P5-33	41718	70	4.3	3.4	0.95127	0.05549	24	
HGR-138	41788	264					32	9/13 Water T= 55F@ 0900
P5-34	42052	59	5.1	4.1	0.9516	0.0547	36	
HGR-139	42111	64					19	
P5-35	42175	115	5.2	4	0.95187	0.05445	27	Long "S" pool
LGR-24	42290	69					26	
GL-57	42359	146	2.6	1.4				
PO-55	42505	68	4.5	3.3	0.95233	0.05379		Class 3-no cover & narrow
LGR-25	42573	86						
HGR-140	42659	154					17	
P5-36	42813	62	5	3.8	0.95291	0.05295	23	
LGR-26	42875	68					19	
GL-58	42943	53	3.2	1.8				
LGR-27	42996	59						
GL-59	43055	56	2.9	1.7				
LGR-28	43111	67						
PO-56	43178	47	4.2	2.8	0.95385	0.05328		Class 3- little cover
LGR-29	43225	38					26	
P5-37	43263	106	4.7	3.5	0.95417	0.05341	36	
LGR-30	43369	75					28	9/13 Water T=60F@1145
P5-38	43444	71	4.6	3.2	0.95438	0.05305	29	
GL-60	43515	103	2.6	1.6			29	
P5-39	43618	133	4.2	3.2	0.95506	0.05332	45	
LGR-31	43751	47					28	
PO-57	43798	81	3.2	2.1				Class 2-little cover
LGR-32	43879	142						
PO-58	44021	42	3	2.2	0.95576	0.05257		Class 2-little cover
Chan Split	44063	n/a						Start "delta"-many LGRs
Mono Lk	44343	n/a						end mainstem survey
"10" Chan								Chan exits RuCr @28682'
HGR-1	0	25						
PO-1	25	43	2.8	2				Class 2/3
HGR-2	68	47						

Habitat Type	Start Distance	Unit Length	Max Depth	Residual Depth	LAT. N 37	LONG. W 119	Width	COMMENTS
GL-1	115	90	2.8	1.9				
HGR-3	205	159						
PO-2	364	43	3.6	2.6	0.93021	0.06499		Class 2 -exposed
LGR-1	407	18						
GL-2	425	177	2.8	1.7				Start "Little Ditch"
P4-1	602	63	3.8	2.9	0.9308	0.06449		
LGR-2	665	20						
P5-1	685	52	4.6	3.9	0.93091	0.06517		
HGR-4	737	5						
P4-2	742	78	4	2.9	0.93105	0.06512		
GL-3	820	25						
P4-3	845	115	4	2.7	0.93126	0.06531		
LGR-3	960	50						
P5-2	1010	80	4.3	3.4	0.93133	0.06583		
GL-4	1090	10						
P5-3	1100	130	6.1	4.8	0.93141	0.06622		
GL-5	1230	98	3	1.9				End "Little Ditch"
HGR-5	1328	197						
End 10 ch	1525							str. splits into mult. Chans.

APPENIDX B: LEE VINING CREEK HABITAT SURVEY									
Habitat	**Start**	**Unit**	**Max**	**Residual**	**LAT.**	**Long.**	**No.of Poc.**	**COMMENTS**	
Type	**Distance**	**Length(ft)**	**Depth(ft)**	**Depth(ft)**	**N 37**	**W 119**	**Pools**		
							(in HGRs)		
HGR-1	0	537			0.95751	0.1163	46	gps is survey start	
GL-1	537	36	2.8	1.3					
HGR-2	573	600					37		
chan split	636								
chan rtn	742								
chan split	1025								
GL-2	1173	38	2.5	1.4				major stream braiding	
HGR-3	1211	511					36		
chan rtn	1244								
chan rtn	1402								
GL-3	1722	30	2	1.2					
HGR-4	1752	417					18		
chan split	2169				0.96294	0.11669		A-chan exit	
GL-4	2169	44	1.8	0.8					
HGR-5	2213	496					13	Start Pocket Pool Survey	
GL-5	2709	41	2.1	1.1					
HGR-6	2750	474					22		
PO-1	3224	38	2	1.1	0.96545	0.11528		Class 1	
HGR-7	3262	91					5		
sect. Top	3323							top old UPLV efish sec.	
GL-6	3353	26	1.5	0.8					
HGR-8	3379	182					6		
GL-7	3561	44	1.8	1.1					
HGR-9	3605	86					3		
GL-8	3691	18	1.9	1.2					
HGR-10	3709	20					0		
PO-2	3729	48	2.6	1.9	0.96669	0.11547		Class-3 (cot.wood);IFS Unit	
HGR-11	3777	68					7	p.pools quite large	
GL-9	3845	34	2.3	1.2					
HGR-12	3879	29					3		
PO-3	3908	26	2.4	1.1	0.96708	0.11513		Class-2(efish mid pool)	
HGR-13	3934	23					1		
GL-10	3957	57	2.3	1.4					
HGR-14	4014	41					0		
chan split	4045								
PO-4	4055	29	2.2	1.5	0.96754	0.11485		Class-2	
HGR-15	4084	330					14		
chan split	4201								
A chan rtn	4287							A chan rtn	
sect. Bot.	4324							bot old UPLV efish sec.	
P5-1	4414	76	3	2	0.96833	0.11407		Huge UCBs!	s! IFS Unit
HGR-16	4490	187							
chan split	4555							End Pocket Pool Survey	
chan rtn	4659								
GL-11	4677	45	2.1	1.1					
HGR-17	4722	63					1		
GL-12	4785	38	2	1.1					
HGR-18	4823	17					0		
PO-5	4840	32	2.2	1.2				Class-2 (no gps)	
HGR-19	4872	470					20	300 sqft of spawn.grav	
sect. Top	5202				0.97012	0.1132		top LOLV efish sec.	

Habitat Type	Start Distance	Unit Length(ft)	Max Depth(ft)	Residual Depth(ft)	LAT. N 37	Long. W 119	No.of Pools	COMMENTS
PO-6	5342	27	2.5	1.4	0.97038	0.11285		Class-2 (<1/2 chan width)
HGR-20	5369	58					3	
PO-7	5427	60	2.3	1.3	0.97071	0.11276		Class-3;efish pool; IFS UNIT
HGR-21	5487	207					14	
GL-13	5694	59	2.2	1				
HGR-22	5753	69					3	
PO-8	5822	37	2.4	1.4				Class-2; bot.old sec.
GL-14	5859	38	1.8	0.6				
HGR-23	5897	80					2	
GL-15	5977	116	2.3	1.3				IFS Unit
sec. Bot.	6042							Bot new LOLV efish sec.
HGR-24	6093	94					1	
chan.split	6117							
GL-16	6187	60	2	1.1				
chan.split	6237							major braiding (3-4 chans.)
HGR-25	6247	177					3	
GL-17	6424	26	1.7	0.4				
HGR-26	6450	22					1	
GL-18	6472	41	2.5	1.3				
HGR-27	6513	89					2	
GL-19	6602	88	2.3	1				
HGR-28	6690	142					3	
chan.split	6757							
PO-9	6832	30	2.6	1.5	0.97354	0.11035		Class-2
CoRd ford	6862							road crossing
chan rtn	6862							
HGR-29	6862	140					6	
GL-20	7002	71	2.3	1.2				
HGR-30	7073	119					4	
chan split	7122							"Rock Fairy" art. Chan.
PO-10	7192	50	2.5	1.3	0.97392	0.10922		Class-3; IFS Unit #1
HGR-31	7242	13					0	
P5-2	7255	37	3.8	2.7	0.97392	0.10905		nice UCB on RB;IFS Unit #2
HGR-32	7292	30					2	
GL-21	7322	30	2	0.9				
HGR-33	7352	60					0	
PO-11	7412	49	2.8	1.9	0.97422	0.10871		Class-3; IFS Unit #3
HGR-34	7461	11					0	
PO-12	7472	37	3.1	2	0.97432	0.10861		Class-2; IFS Unit #4
HGR-35	7509	139					3	IFS Units #5 & 6 (poc. pools)
GL-22	7648	35	2.4	1				
PO-13	7683	49	3.1	1.9	0.97456	0.10799		Class-3; IFS Unit #7
HGR-36	7732	36					0	
PO-14	7768	41	3.1	2	0.97457	0.1077		Class-3; IFS Unit #8
HGR-37	7809	163					4	
PO-15	7972	32	3	1.8	0.97503	0.10745		Class-2
HGR-38	8004	73					2	
GL-23	8077	50	2.3	0.8				
PO-16	8127	46	3	1.9	0.97538	0.10689		Class-3
HGR-39	8173	42					0	
PO-17	8215	21	2.7	1.6	0.9754	0.10689		Class-2
HGR-40	8236	32					0	
PO-18	8268	59	3	2	0.97543	0.10665		Class-3; IFS Unit #9
HGR-41	8327	508						

Habitat Type	Start Distance	Unit Length(ft)	Max Depth(ft)	Residual Depth(ft)	LAT. N 37	Long. W 119	No.of Pools	COMMENTS
chan. Rtn	8592							major braiding
chan.split	8672							
chan.split	8735							
chan. rtn	8800							
GL-24	8835	101	2.1	1.3				water t. 38F@0900(4/27/09)
HGR-41	8936	304					3	
P4-1	9240	49	3.3	2.2	0.97683	0.10451		nice UCB on RB;IFS Unit #10
HGR-42	9289	68					1	IFS Unit #11 = alcove pool
P4-2	9357	35	3.5	2.4	0.97701	0.10442		IFS Unit #12
HGR-43	9392	48					1	
P4-3	9440	101	3.4	2.6	0.97719	0.10407		lagest pool on LV; IFS Unit
HGR-44	9541	96					0	
chan.split	9545							major braiding here to lake
GL-25	9637	50	1.8	1				
P4-4	9687	40	3.1	2.4	0.97686	0.10342		good willow cover on RB
HGR-45	9727	27					0	
PO-19	9754	38	2.2	1.3	0.97696	0.10324		Class-2 (exposed)
HGR-46	9792	128					0	
cr. Mouth	9920				0.97684	0.10247		Mono Lake shore

Appendix C. Locations of class-4 and class-5 pools, as well as other stream landmarks, and summaries of dimensional and water velocity measurements collected at the pools.

Pool Number or other Stream Feature	Distance Below MGORD		Lat.	Long.	Pool Depth (ft)		Pool Dimensions (ft)		Water Velocity (cfs)	
	(km)	(ft)	N37	W119	Maximum	Residual	Length	Width	Maximum	Mean
Class 5 No. 1	0.22	717	52.283	06.387	5.1	4.2	54	29	3.2	1.3
Class 4 No. 1	0.37	1200	52.354	06.388	3.6	2.5	69			
Class 5 No. 2	0.39	1284	52.367	06.396	3.8	3.0	44	24	3.8	2.1
Class 4 No. 2	0.40	1298	52.367	06.396	3.2	2.4	32			
Class 4 No. 3	0.54	1786	52.447	06.438	3.2	2.4	40			
Class 5 No. 3	0.63	2060	52.470	06.472	3.8	3.0	43	29	2.6	1.2
Class 4 No. 4	0.79	2585			3.3	2.3	25			
Class 5 No. 4	0.82	2700	52.560	06.428	4.1	3.2	44	27	2.7	1.1
Class 4 No. 5	0.85	2780	52.571	06.432	4.5	3.5	18			
Class 4 No. 6	1.74	5698	52.878	06.033	3.1	2.3	46			
Start of Up. Rush Sec.	1.96	6444	52.917	05.893						
Class 5 No. 5	2.10	6875	52.955	05.823	2.9	2.3	72	28	2.7	1.8
Class 5 No. 6	2.23	7300	52.990	05.774	3.6	2.9	52	32	1.7	1.0
Class 5 No. 7	2.34	7685	53.019	05.705	3.9	3.2	111	30	1.9	1.1
End of Up. Rush Sec.	2.37	7768	53.032	05.685						
Hwy 395 Bridge (upper)	3.36	11013								
Hwy 395 Bridge (lower)	3.45	11310								
Class 4 No. 7	4.40	14420	53.900	05.244	2.5	2.0	68			
Class 4 No. 8	5.41	17750	54.357	04.969	2.6	2.0	42			
Mouth of Parker Cr.	5.45	17870	54.379	04.975						
Class 4 No. 9	6.30	20660	54.706	04.757	3.2	2.2	38			
Mouth of Walker Cr.	6.36	20850	54.814	04.745						
Class 4 No. 10	6.38	20915	54.824	04.743	3.3	2.1	32			
Class 4 No. 11	6.93	22730	55.008	04.468	2.2	1.8	30			
Class 5 No. 8	7.02	23016	55.005	04.416	3.8	2.8	68	26	4.1	3.1
Class 4 No. 12	7.05	23135	55.022	04.403	3.5	2.8	38			
Class 5 No. 9	7.13	23375	55.049	04.373	4.1	2.9	70	22	3.3	2.3
Class 5 No. 10	7.33	24050	55.150	04.335	4.6	3.3	44	24	3.2	2.4

Appendix C (continued).

Pool Number or other Stream Feature	Distance Below MGORD		Lat.	Long.	Pool Depth (ft)		Pool Dimensions (ft)		Water Velocity (cfs)	
	(km)	(ft)	N37	W119	Maximum	Residual	Length	Width	Maximum	Mean
Class 5 No. 11	7.35	24110	55.157	04.329	4.1	3.3	56	23	2.8	1.7
Class 4 No. 13	7.49	24560	55.222	04.288	3.2	2.2	52			
Class 5 No. 12	7.61	24950	55.275	04.259	3.6	2.8	72	24	3.5	2.6
Class 4 No. 14	7.65	25090	55.291	04.238	3.2	1.8	46			
Class 5 No. 13	7.95	26070	55.407	04.137	4.5	3.2	37	36	3.3	1.0
Class 4 No. 15	8.41	27600	55.604	03.973	3.6	2.1	30			
Class 5 No. 14	8.45	27725	55.621	03.972	4.5	3.2	54	14	3.8	3.2
Start of Low. Rush Sec.	8.80	28860								
Class 4 No. 16	8.98	29470	55.819	03.995	3.5	2.5	40			
Class 4 No. 17	9.06	29720	55.834	03.975	3.3	2.3	38			
Class 4 No. 18	9.13	29945	55.867	03.953	3.4	2.2	46			
Class 5 No. 15	9.22	30250	55.886	04.003	3.9	3.1	45	17	2.9	2.7
End of Low. Rush Sec.	9.23	30285	55.892	04.005						
Class 4 No. 19	9.44	30948	55.999	04.004	3.7	2.6	54			
Class 5 No. 16	9.66	31669	56.090	04.068	5.4	4.6	166	43	1.6	0.8
Class 4 No. 20	9.80	32128	56.160	04.048	4.0	2.8	38			
Class 5 No. 17	9.81	32193	56.156	04.051	4.9	4.1	68	22	1.2	1.2
Class 4 No. 21	9.87	32387	56.167	04.073	3.5	2.4	41			
Class 5 No. 18	10.01	32833	56.215	04.032	5.1	4.2	62	26	2.1	1.5
Class 5 No. 19	10.13	33235	56.218	03.981	4.1	3.3	78	18	1.8	1.0
Class 4 No. 22	10.19	33431	56.263	03.959	3.0	2.3	58			
Class 4 No. 23	10.29	33749	56.293	03.960	3.4	2.3	68			
Class 4 No. 24	10.48	34375	56.292	03.880	3.5	2.4	72			
Class 5 No. 20	10.53	34542			5.2	4.2	58	38	2.1	0.9
Class 4 No. 25	10.62	34835	56.335	03.863	3.5	2.6	38			
Start of Co. Rd. Sec.	10.73	35205	56.381	03.834						
Class 4 No. 26	10.82	35505			3.9	2.9	51			
End of Co. Rd. Sec.	11.51	37756								
Class No. 21	11.67	38278			4.2	3.1	62	36	1.3	0.7
Co. Rd. Culvert	11.99	39327								
Class 4 No. 27	12.00	39360			4.0	2.9				
Class 4 No. 28	12.40	40685			3.8	2.5	58			
Class 4 No. 29	12.97	42547			4.6	3.2	54			
Mono Lake	13.40	43956								