APPENDIX E

FISH SURVEY REPORT

FINAL REPORT

SENSITIVE STATUS FISH SPECIES SURVEYS IN THE BIGHORN RIVER, WYOMING: WORLAND – MANDERSON RIVER SEGMENT

31 January 2006

Prepared for:

Westside Irrigation District preparation of EIS

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1.0 INTRODUCTION

In comments dated 27 Aug 2004 regarding the transfer of BLM land to the Westside Irrigation District (WID), Wyoming Game and Fish (WGFD) requested that sensitive species surveys be conducted for sturgeon chub (*Macrohybopsis gelida*), plains minnow (*Hybognathus placitus*), and western silvery minnow (*Hybognathus argyritis*) in the vicinity of the project area.

The sturgeon chub and western silvery minnow are classified by WGFD as Status 1 species that are physically isolated and/or exist at extremely low densities. The plains minnow is a Status 3 species that is widely distributed, but habitat conditions are declining or vulnerable. If these species are found, a detailed impacts assessment will be included in the EIS and consideration for the species will be included in a Mitigation and Monitoring Plan for the project, if needed.

To address concerns about effects of the WID project on aquatic resources, we sampled the Bighorn River for the presence of sturgeon chub, plains minnow, and western silvery minnow in the portion of the Bighorn River considered likely to be impacted by flow modification resulting from the project. The goals of this survey were to:

1) Identify presence and/or absence of the target species along the river's project area,
2) Qualitatively characterize macrohabitat of survey reaches of each study site,
3) Provide baseline data for use in the environmental impact analysis for the Westside project,
4) Provide baseline data for a before-after-comparison-investigation (BACI design) if needed and if target species or other sensitive species are documented, and
5) Provide insight and recommendations for mitigation and monitoring efforts in terms of water quality and quantitative measurement of micro- and macrohabitats, if needed, based on the overall impact analysis and permitting requirements.

2.0 METHODS

2.1 Study Period

Sampling took place between 28-31 August 2005, after the peak summer flow period (Wiley et al. 1995; based on post-dam construction hydrographs at Boysen Dam; also based on the suggestion by Mark Smith, Regional Fisheries Biologist, WGFD, Cody, pers. comm. 14 Feb 05). Suitable habitat for the target species is generally turbid, shallow water (<3ft [91cm]), with swift flows (~ 0.3-3 ft/sec [9-91 cm/sec]) over sand, gravel, or rock substrates, or shallow protected areas adjacent to such habitats. Late summer conditions were expected to create the maximum amount of suitable habitat in the study area. However, total discharge from Boysen Reservoir in August 2005 was 81367 cfs, and was much higher than the previous 5 years (August 2000-2004 ranged from 53576-65651 cfs; USBR Hydromet data for Boysen Reservoir, http://www.usbr.gov/gp/hydromet/).

2.2 Study Area

We defined this study area to start about 3.6 miles north of Worland and end at the bridge over the river at Manderson (Figure 1). The project study area was broken into three reaches, each approximately six river miles in length (Figure 1). These include (1) the upstream site (upstream of diversion-1, approximately half mile upstream of gravel pit), (2) impact-1 site (between diversion-1 and diversion-2), and (3) impact-2 site (diversion-2 to Manderson). Each site was surveyed for target fish species at 5 different river reaches. Sampling locations were chosen based on the availability of suitable habitat. We targeted reaches where swift, shallow flows occurred adjacent to slightly deeper side channel and/or pool habitats. Due to relatively high flow conditions compared to previous years, we did not find an abundance of suitable habitat, and our sampling locations represent the majority of ideal available habitat for the target species. River reaches surveyed that contained suitable habitat were all at least 100 meters long. However, distances seined were constrained by available habitat. Riffle habitats ranged from 5-25 meters, and pool and side channel habitat ranged from 15-100 meters in length.

2.3 Sampling Methods

Fish Communities. – Methods for sampling fishes followed those of Plafkin et al. (1989), and Barbour (1999). Fish were captured using a seine, and all seinable habitat was covered. Our large bag seine was 25 ft (7.6m) long and 6 ft (1.8m) deep. Mesh size was 3/16-in (7.5mm), and incorporated a 6 ft by 6 ft bag. We used a smaller 15-foot (4.6m) straight seine for sampling smaller areas of habitat, or areas with obstructions, and for kick-seining riffles. Fish were identified, counted, checked for anomalies, and returned to the water. Young-of-the-year fish were identified when possible and all unidentified fishes too small for correct identification (typically fish < 20 millimeters total length) were categorized to the nearest taxon possible (e.g., unidentified Cyprinid, Centrarchid, Ictalurid, or Notropis sp., Pimephales sp., etc.). No reach was sampled more than once in order to keep effort standard in terms of linear river coverage.

A seine haul was initiated from the downstream end of the reach and progressed upstream. In some cases, multiple haul-outs were necessary to cover the sample area, but no backtracking downstream occurred. All fishes were transferred to 5-gallon buckets filled with river water (at least four buckets were available along shoreline). Fishes were processed and returned to water after 50 meters of river was seined; however, all fish were returned to the river below the sampled reach before seining the upper reach so that no individuals would be recaptured. All fish were returned to the river via aquarium net or wet hand immediately after identification. Biologists were trained in species identification using comparative collections at the University of Wyoming and field guides such as Pflieger (1975), Eddy and Underhill (1978), and Baxter and Stone (1995). One biologist has extensive previous experience sampling lotic systems for non-game and game fishes.

Physical Macrohabitat Characterization. – Two to 4 transects per site were used to measure mean depth, velocity, and width for later use in the cross-sectional/incremental method if needed (Platts et al. 1983). Current velocity (m/s), depth (m), and substrate type, were measured at 20, 40, 50, 60, and 80% of the stream width at each transect (Platts et al. 1983). At depths less than 0.75 m, one measurement of the velocity was taken at 60% of the water depth (Buchanan and

Somers 1969; McMahon et al. 1996). At depths greater than 0.75 m, velocity was measured at 20% and 80% of the water depth (Buchanan and Somers 1969). Current velocity was measured using a Global Flow Probe Model FP101 flowmeter during the first two days, but the flowmeter broke, and we then estimated flow at the surface based on the time it took a floating object to travel a known distance. These same transects were used to visually estimate substrata coverage (%) using the modified Wentworth scale (Cummins 1962; bedrock or boulder = > 256 mm, cobble = 65 - 256 mm, pebble = 32 - 64 mm, gravel = 2 - 32 mm, sand = 0.0625 - 2 mm, silt = 0.0039 - 0.0625 mm, clay = < 0.0039 mm). Percent coverage of riffle, pool, and run was also visually estimated. Water temperature was measured in the sample area. GPS coordinates (UTM NAD27) were collected at the head of each survey reach and a unique label was given to the reach. A diagram of each sample site (except U-1) was drawn to show river morphology, hydrology, and relative location of sample areas.

3.0 RESULTS

We sampled 15 areas of suitable habitat, 5 in each river reach of the study area (Figure 2; coordinates in Table 1). We also conducted seine hauls in 2 smaller areas of potential habitat: one pool at the mouth of an inlet, and one pool associated with an oxbow. Seine hauls were conducted in riffles, pools, and in side channels adjacent to runs. Overall availability of riffle, run, and side channel/pool habitats varied among sample sites (see Appendix B for diagrams of sample sites).

Fish. -- No sturgeon chub, plains minnow, or western silvery minnow were found. A total of 1088 fish representing 13 species were captured, identified, and released (Table 2). We found both adults and juveniles for all but 4 of the species encountered (Tables 3-5). However, one of these species was young-of-the-year minnows less than 20 mm in length and were coded as unidentified minnow. These were most often, if not always, either sand shiners or flathead chubs, but close scrutiny was refrained in order to get these small, fragile individuals back in the river as soon as possible. Therefore, the actual total number of species is 12. Eleven species were observed in the upper reach where the most numerous fishes were fathead minnow (173), unidentified minnow (139), sand shiner (88), and river carpsucker (67), and to a lesser degree the remaining 8 species. Ten species were observed in the middle reach where the most numerous fishes were longnose dace (111), unidentified minnow (59), sand shiner (54), flathead chub (26), and to a lesser degree the remaining 7 species. Nine species were observed in the lower reach where the most numerous fishes were unidentified minnow (93), sand shiner (34), longnose dace (30), flathead chub (28), and to a lesser degree the remaining 6 species. Four sauger were observed, one adult (middle reach) and three juveniles all about 6 inches in length (one upper reach, two lower reach). Given the length of the juvenile saugers, it is likely that they are of the 2004 year-class (Figure 3).

Physical Measurements. – In the sampled areas, total river width ranged from 10 to 62 m. In some cases, total river width is the sum of more than one river channel where sampled areas were within braided river channels. Sampled river depths ranged from 0.15 to >1.5 m (too deep to measure with a hand-held staff in swift current). Water temperatures at sampled sites were 65-70°F. Current velocities ranged from 0 to >3.5 m/sec. Substrate types ranged from deep unconsolidated silt to gravel and pebble/cobble with some boulder sized materials (Figure 4). In

general, courser substrate types were found in areas with higher current velocities, while silt/sand sites generally had lower current velocities. Sample site physical characteristics are included in Appendix A.

4.0 DISCUSSION

No plains minnows, sturgeon chubs, or western silvery minnows were found in this study. Fish species encountered were generally representative of turbid, warm water rivers in northern Wyoming. We did not detect any shovelnose sturgeon, stonecats, or longnose suckers. Sturgeon are unlikely to be caught in a seine, so their absence does not mean they are absent from the Bighorn River. Adult longnose suckers may also be less vulnerable to seining gear, although we would have expected juveniles. However, at sites in all 3 reaches we were successful in catching 1 adult sauger and 3 juvenile sauger. We expected that we would catch stonecats if a somewhat abundant and reproducing population was present. The riffle areas surveyed throughout the study area varied in depth, substrate, and current speed. Longnose dace were common to all these areas, as was a prolific macroinvertebrate larvae-load including, but not restricted to, Hydropsychids (caddisfly sp.), Baetids (mayfly sp.), and Libellulids (dragonfly sp.). Therefore, if this area is known to harbor stonecats, then they were surprisingly absent. Strong currents due to the above-average river discharge for this time of year may have inhibited the efficiency of seining and kick-seining for this species.

Seining surveys conducted by WGFD between 2000 and 2002 did not detect sauger (M. Smith, pers. comm..). The results of our 2005 survey indicate that the Bighorn River segment between Worland and Manderson is used by both adult and juvenile sauger. While it is unknown as to the general population level of adult sauger in this river segment, it would appear that it is an important rearing area for juvenile sauger. It is also unknown if adult sauger spawn in this river segment or whether they use shoals or other suitable spawning habitat upstream or downstream.

Common shiners were not previously documented in the Bighorn River. Our identification of this species was based on big eyes and mouth, laterally compressed bodies, large diamond or crescent-shaped lateral line scales, strongly dipping lateral line, and lack of notable mid-line stripes. The adult size was indicative of medium-sized common shiners, which would be similar to very large adult emerald shiners (*Notropis atherinoides*). It is possible that these fish were emerald shiners; however they did not seem as slender and they lacked pigmentation indicative of emerald shiners (though chin pigmentation was not inspected). Loss of pigmentation is not uncommon during seining and handling, especially while being retained in a holding bucket.

The number of sites surveyed was lower than our original study plan, 15 instead of 30. Due to the atypical high river discharge, it would have been difficult to come up with more than 5 sites per reach that contained suitable habitat, especially having both riffle and pool and/or side channel. However, we feel that we did sample the majority of suitable habitat that was seinable, such as side channels and pools in proximity to riffles and strong runs. Attempts were also made to incorporate any stream morphologic feature that provided backwater-type habitat, either via small tributary or old river channel (see photographic examples of survey sites, Appendix C). Overall, survey results are representative of fish species using those habitats in the Bighorn River between Worland and Manderson, though no target species were detected.

If high flows precluded detection of stonecats, they may have also affected seining efficiency for sturgeon chubs, a species found in swift riffle currents with tight affinity to the stream substrate. Efforts were made upstream of the seine to disrupt upstream pebble and cobble while kick-seining, and macroinvertebrates and longnose dace were successfully captured even though currents were at times very swift. The sturgeon chub has not been collected in the Bighorn River drainage since the late 1960's.

The plains minnow prefers slower water and side pools of turbid streams (Baxter and Stone 1995). Baxter and Stone (1995) cite habitat preferences for the western silvery minnow in Wyoming based upon seminal works on fishes in Kansas (Cross 1967) and Canada (Scott and Crossman 1973), simply stating a preference for sluggish flow and silted bottoms of large rivers. Pflieger (1975) states that the plains and western silvery minnows occur at the same localities but tend to be segregated ecologically; the plains minnow predominates in the river channel where there is a sandy bottom and some current, whereas the western silvery minnow is more abundant in protected areas with little current and a silt bottom, including quiet lower reaches of tributaries. Sluggish flow and silted bottom habitats of the Bighorn River during August 2005 were likely deeper than normal, we noted several backwater areas with soft substrate during reconnaissance with canoe that were too deep to seine. We did survey several other backwater silty areas where we were successful seining all sauger. Habitats of tributaries far away from the main river could possibly have provided suitable habitat for *Hybognathus* species during high discharge of the main river as well. It is believed that the western silvery minnow may have been extirpated since the time of the construction of the Big Horn Reservoir (Baxter and Stone 1995).

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Table 1. UTM coordinates (UTM zone 13, NAD 27) of sampling locations on the Bighorn River, Wyoming, 28-31 August 2005.

Reach	Site	Date Sampled	Easting	Northing
Upper	U-1	28 Aug	265341	4883590
Upper	U-2	28 Aug	265214	4884412
Upper	U-3	31 Aug	265496	4885226
Upper	U-4	31 Aug	265248	4886942
Upper	U-5	31 Aug	265862	4888922
Middle	M-1	29 Aug	265784	4890457
Middle	M-2	29 Aug	265850	4891943
Middle	M-3	29 Aug	266232	4893767
Middle	M-4	29 Aug	266793	4895994
Middle	M-5	29 Aug	267143	4897151
Lower	L-1	30 Aug	267231	4898434
Lower	L-2	30 Aug	266311	4899727
Lower	L-3	30 Aug	265198	4902093
Lower	L-4	30 Aug	264431	4903633
Lower	L-5	30 Aug	264682	4904614
Middle	Inlet 1	29 Aug	265859	4892949
Middle	Oxbow	29 Aug	265964	4893304

Table 2. List of fish species caught by seining in the Bighorn River, Wyoming, 28-31 August 2005.

Code	Common Name	Scientific Name
RICA	River carp sucker	*Carpiodes carpio*
FAMI	Fathead minnow	*Pimephales promelas*
SASH	Sand shiner	*Notropis stramineus*
CHCA	Channel catfish	*Ictalurus punctatus*
YEPE	Yellow perch	*Perca flavescens*
WHSU	White sucker	*Catostomus commersoni*
LODA	Longnose dace	*Rhinichthys cararactae*
FLCH	Flathead chub	*Platygobio gracilis*
COSH*	Common shiner	*Notropis cornuta*
SHRE	Shorthead redhorse	*Moxostoma macrolepidotum*
SAUG	Sauger	*Stizostedion canadense*
COCA	Common carp	*Carassius carassius*
UNMI	Unidentified minnow	

* Possibly emerald shiners that were mis-identified.

Table 3. Summary of fish captures by age and location in the UPPER REACH.

	U1 pool/side channel	U1 riffle	U2 pool/side channel	U2 riffle	U3 pool/side channel	U3 riffle	U4 pool/side channel	U4 riffle	U5 pool/side channel	U5 riffle	Total by species/age	Total by species
RICA adult	2										2	67
yoy	65										65	
FAMI adult	170		3								173	173
yoy											0	
UNMI adult											0	139
yoy	90		16		11				4		139	
SASH adult	52		7		14						74	88
yoy	9		1		3						14	
CHCA adult						18					0	1
yoy	1					1					1	
YEPE adult	2					1					2	2
yoy											0	
WHSU adult											0	40
yoy	16		23		1						40	
LODA adult		6		8							14	52
yoy		13		25							38	
FLCH adult			4		1				2		20	20
yoy											0	
COSH* adult			4			13					4	5
yoy			1								1	
SHRE adult											2	5
yoy					3						3	
SAUG adult											1	1
yoy						2					0	
COCA adult											0	0
yoy						1					0	
Totals by site	**407**	**19**	**59**	**33**	**33**	**0**	**36**	**0**	**6**	**0**		

* Possibly emerald shiners that were mis-identified.

Table 4. Summary of fish captures by age and location in the MIDDLE REACH.

		M1		M2		M3		M4		M5			
		pool/side channel	riffle	pool/side channel	riffle	pool/side channel	riffle	pool/side channel	riffle	pool/side channel	riffle	Total by species/age	Total by species
RICA	adult											0	0
	yoy											0	
FAMI	adult											1	1
	yoy											0	
UNMI	adult											0	59
	yoy	12	1			21	2	20		1	2	59	
SASH	adult	2		7		13		28		3		53	54
	yoy					1						1	
CHCA	adult		1									0	3
	yoy	1	1	1								3	
YEPE	adult											0	0
	yoy											0	
WHSU	adult											0	2
	yoy							2				2	
LODA	adult	1	5		3		8	1	1			19	111
	yoy				9	1	39		10		11	92	
FLCH	adult	3		3		13		3		2		24	26
	yoy	1						1				2	
COSH*	adult	6	1					1				8	12
	yoy	4										4	
SHRE	adult									1		2	8
	yoy					2		4				6	
SAUG	adult											1	1
	yoy		1									0	
COCA	adult							4				4	6
	yoy		1					2				2	
Totals by site		**30**	**29**	**15**	**12**	**51**	**49**	**66**	**11**	**7**	**13**		

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* Possibly emerald shiners that were mis-identified.

Table 5. Summary of fish captures by age and location in the LOWER REACH and two ADDITIONAL SITES.

		L1		L2		L3		L4		L5		Add. Site - Inlet 1	Add. Site - Oxbow		
		pool/ side channel	riffle	pool/ side channel	riffle	pool/ side channel	riffle	pool/ side channel	riffle	pool/ side channel	riffle	pool/ side channel	stream outlet	Total by species/ age	Total by species
RICA	adult													0	0
	yoy													0	
FAMI	adult							1				1		2	8
	yoy											6		6	
UNMI	adult													0	93
	yoy	3	8	29	17	13	2	5		15	1			93	
SASH	adult			3	3	4		1		5		2		18	34
	yoy		1	4	6	4				1				16	
CHCA	adult													0	1
	yoy									1				1	
YEPE	adult													0	0
	yoy													0	
WHSU	adult					2								2	8
	yoy					5	1							6	
LODA	adult		1											2	30
	yoy		3	1	9						4	1		28	
FLCH	adult		1	7	1	5		3						17	28
	yoy		1			1							10	11	
COSH*	adult					10								0	0
	yoy													0	
SHRE	adult													0	7
	yoy			3	1	1		1				1		7	

Table 5. Summary of fish captures by age and location in the LOWER REACH and two ADDITIONAL SITES.

		L1		L2		L3		L4		L5		Add. Site - Inlet 1	Add. Site - Oxbow		
		pool/ side channel	riffle	pool/ side channel	riffle	pool/ side channel	riffle	pool/ side channel	riffle	pool/ side channel	riffle	pool/ side channel	stream outlet	Total by species/ age	Total by species
SAUG	adult	2												2	2
	yoy													0	
COCA	adult												1	1	1
	yoy													0	
Totals by site		**5**	**15**	**47**	**37**	**34**	**14**	**11**	**0**	**22**	**5**	**11**	**11**		

* Possibly emerald shiners that were mis-identified.

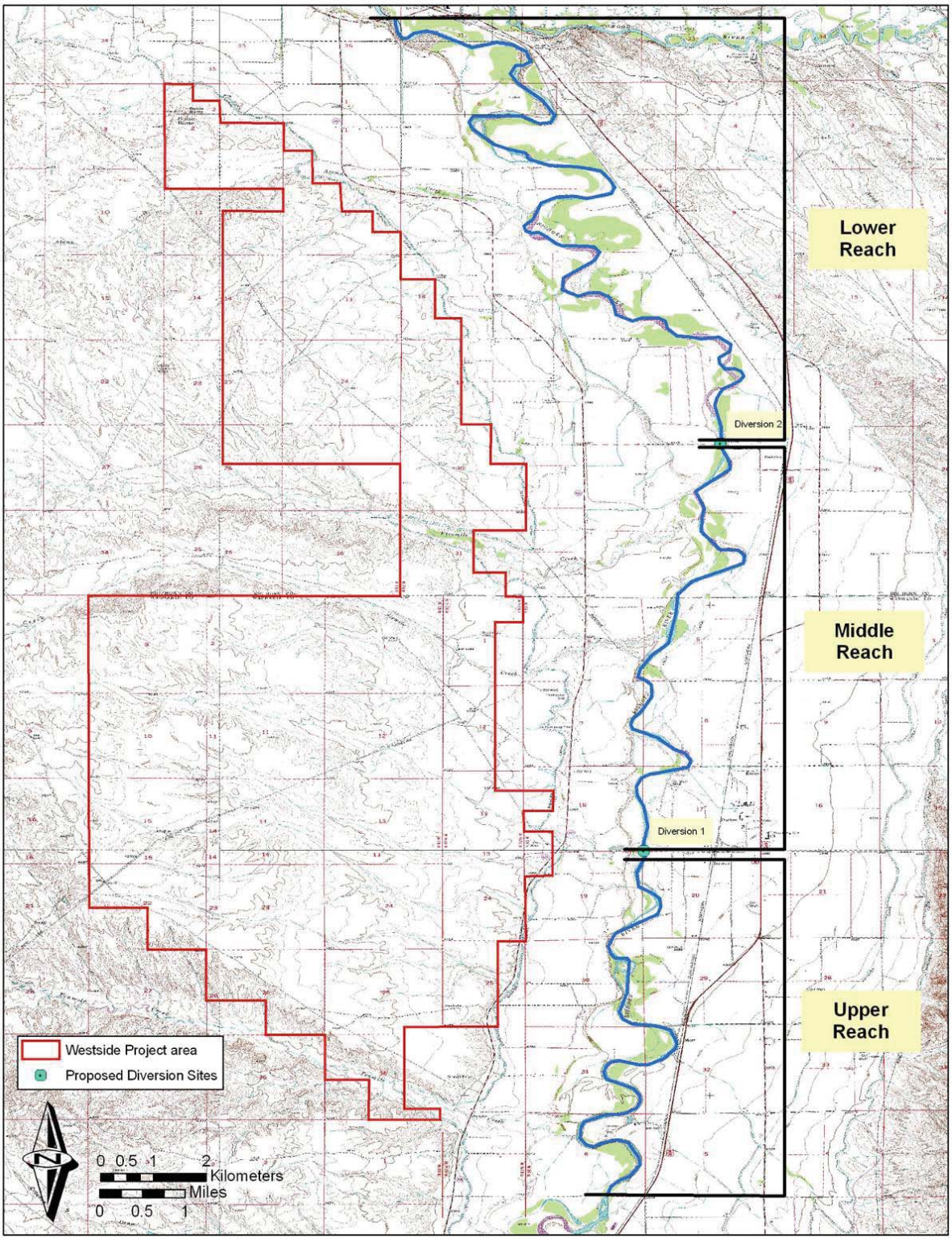

Figure 1. General sampling area on the Bighorn River in Washakie and Big Horn Counties for the Westside Irrigation District (WID) EIS.

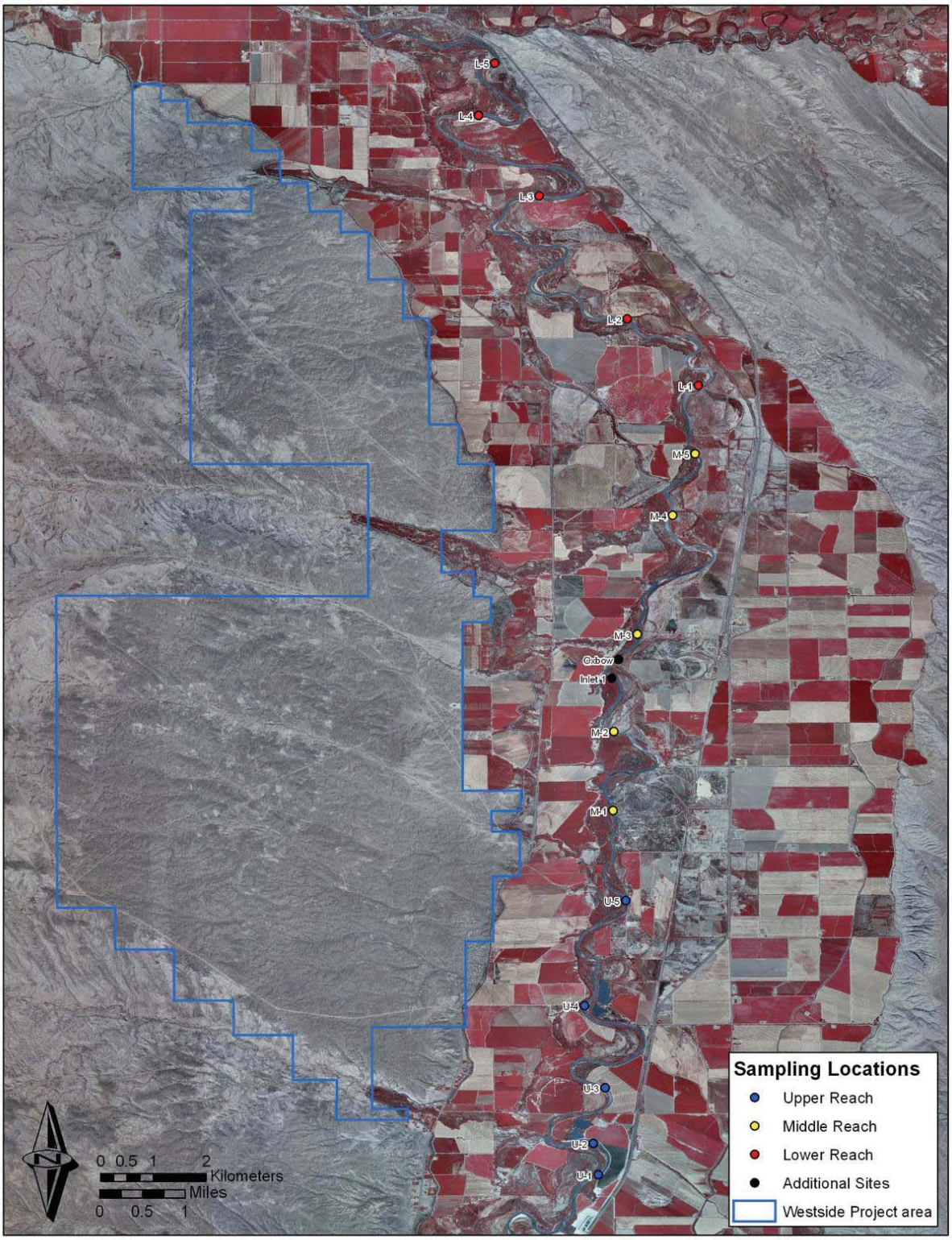

Figure 2. Seining locations on the Bighorn River, 28-31 August 2005.

Figure 3. Juvenile sauger captured and released on the Bighorn River, 28-31 August 2005.

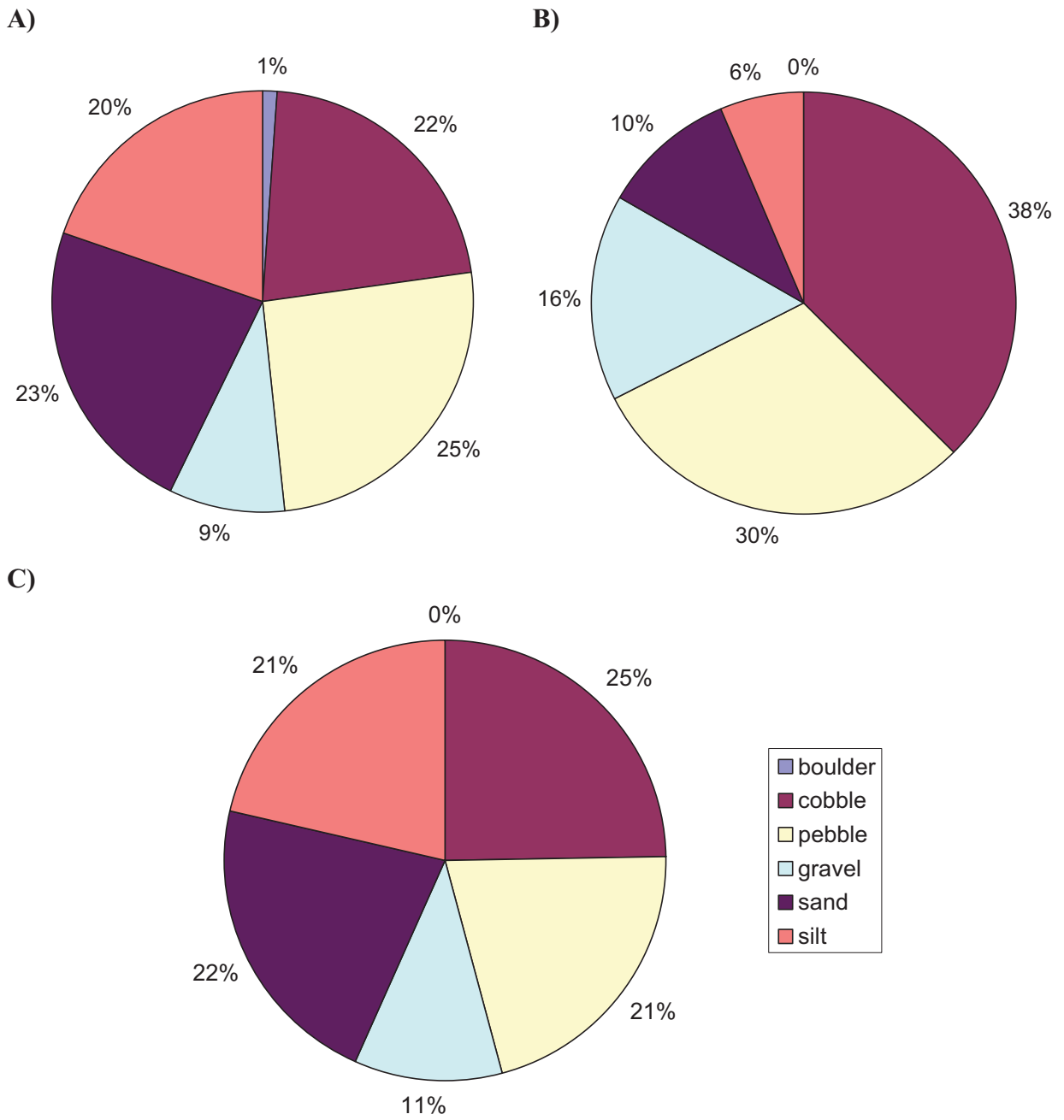

Figure 4. Average substrate composition at the A) upper reach sites, B) middle reach sites, and C) lower reach sites. Site-by-site substrate descriptions are in Appendix A.

Appendix A. Physical characteristics of sample sites.

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Physical Characteristics at sampling sites in the UPPER REACH, Bighorn River, 28-31 Aug 2005.

				20% Stream Width								40% Stream Width								60% Stream Width								80% Stream Width								100% Stream Width							
						substrate								substrate								substrate																substrate						
Site	Date	tran.	wid (m)	dep (m)	curr. (m/s)	BO	CO	PE	GR	SA	SI	dep (m)	curr. (m/s)	BO	CO	PE	GR	SA	SI	dep (m)	curr. (m/s)	BO	CO	PE	GR	SA	SI	dep (m)	curr. (m/s)	BO	CO	PE	GR	SA	SI	dep (m)	curr. (m/s)	BO	CO	PE	GR	SA	SI
U-1	28-Aug	1	44.6	0.15	3.1cfs		15	70	15			0.25	2.8cfs		40	45		15		0.35	3.4cfs		50	40	10			0.45	4.6cfs		50	40	10			0.4	2.9cfs		60	10	30		
U-1	28-Aug	2	24	0.9	4.4cfs		20	60	10	10		0.9	2.2cfs		20	60	10	10		0.95	2.9cfs		30	60	10			0.8	substrate 1.8cfs		15	50	20	15		0.6	0						100
U-1	28-Aug	3	27	1.3	2.7cfs		30	60	10			1.2	2.7cfs		20	50	30			1.05	1.9cfs				20	80		0.8	0					50	50	0.7	0					20	80
U-1	28-Aug	4	26	1.4	1.7cfs		60	40				1.25	1.5cfs		70	20	10			1.05	1.3cfs		40	40	20			1	1.2cfs					100		0.9	0.6cfs			10		20	70
U-2	28-Aug	1	42	0.65	3.3cfs		10	50	40			0.6	3.3cfs		20	60	20			0.55	0.67			70	30			0.45	0.8		10	50		40		0.3	0.8		40	35	10	15	
U-2	28-Aug	2	43	0.5	1		25	75				0.4	3.3cfs			50	30	20		0.5	3.3cfs		50	40	10			0.55	3.3cfs		60	25		15		0.45	3.3cfs		15	60	15	10	
U-2	28-Aug	3	35.5	0.45	0.8			90	10			0.5	0.91		20	60	10	10		0.7	1		30	50		20		0.7	1			60	10	10		0.4	1			50		40	
U-2	28-Aug	4	40	1.3	0.33			30	20	10	40	1.2	0.5						100	0.8	0.67		10	60	20	10		1	0.67	20	15	55	15	15		0.9	0.57	10	10	20		70	
U-3	31-Aug	1	26	0.6	0.48		20			40	40	0.75	0.5		60	10	20	10		0.8	0.63		50			50		0.9	0.71		30			70			0.67					100	
U-3	31-Aug	2	28	0.7	0.67				10		90	0.9	0.67		10			90		1.1	0.67		50			50		1.3	0.67		15		10	75	1	1.3	0.6		70	20	10		
U-4	31-Aug	1	25	0.45	0.44		20			40	40	0.5	0.5		50			50		0.65	0.49					100		1.3	0.67		20			80		>1.5	too swift and deep to measure						
U-4	31-Aug	2	23	0.45	0						100	0.5	0						100	0.75	0.53				10		90	1.15	0.71		50	40	10			1.3	too swift and deep to measure						
U-5	31-Aug	1	10	0.9	0.43		100					1.1	0.67				10	90		1	0.45						100	0.9	0.44						100									
U-5	31-Aug	2	10	0.7	0.43						100	0.9	0.48				20		80	1.1	0.5				50	50		0.8	0.42	80	20												

Appendix A. Physical characteristics of sample sites.

Physical Characteristics at sampling sites in the MIDDLE REACH, Bighorn River, 28-31 Aug 2005.

				20% Stream Width								40% Stream Width								60% Stream Width								80% Stream Width								100% Stream Width							
						substrate								substrate								substrate																substrate					
Site	Date	tran.	wid (m)	dep (m)	curr. (m/s)	BO	CO	PE	GR	SA	SI	dep (m)	curr. (m/s)	BO	CO	PE	GR	SA	SI	dep (m)	curr. (m/s)	BO	CO	PE	GR	SA	SI	dep (m)	curr. (m/s)	BO	CO	PE	GR	SA	SI	dep (m)	curr. (m/s)	BO	CO	PE	GR	SA	SI
M-1	29-Aug	1	37	0.95	1		20	60	20			0.7	0.95		40	40	20			0.55	0.8		30	30	40			0.25	0.91		40	45	15			0.45	0			25	15		
M-1	29-Aug	2	49.5	0.75	1.43		50	30	20			0.65	1.18		20	65	15			0.3	0.87		50	25	15	10		0.35	0.67		55	25	20			0.75	0.4	60	30	50	10	10	
M-1	29-Aug	3	47	0.7	1.11			50	50			0.35	0.91			25	75			0.2	0.5			25	10	15	50	0.55	0.48			20		40	40	1	0.57		50	15	20	15	
M-2	29-Aug	1	50	0.4	1.25		40	40	20			0.5	1.33		30	40	30			0.6	1.67		45	45	10			0.4	0.95		70	20		10		0.45	1				10		
M-2	29-Aug	2	31	1	1		40	50	10			0.9	0.91		20	50	30			0.8	0.71		60	20	10	10		0.6	0.5					100		0.6	0.4	90	20			40	40
M-2	29-Aug	3	31	0.9	1		60	20	20			0.7	0.83		60	20	20			0.6	0.67		40	20	20	20		0.65	0.59		50			50		0.45	0.5		20	55	15	10	
M-3	29-Aug	1	56.5	0.6	1.33		20	70	10			0.65	0.56		60	20	20			0.3	0.91		50	20		30		0.3	0.95			80	20			0.45	0.67			60	40		
M-3	29-Aug	2	36	0.6	0.95		50	25	25			0.7	0.91		50	40	10			0.9	1		60	30	10			0.6	0.95		30	55	15			0.45	0.5		50	25		25	
M-3	29-Aug	3	36	0.8	0.91		50	35	15			1	1		30	40	30			0.9	0.91		30	30	30	10		0.9	0.65		50	30	10	10		0.7	0.4		10			45	45
M-4	29-Aug	1	52	0.25	0		40				60	0.4	0			30	70			0.85	0.8		70	30				0.5	0.91		80	20				0.5	0.8		50	20		30	
M-4	29-Aug	2	62	0.3	0.2						100	0.35	0.25					20	80	0.65	0.95		65	20		15		0.5	1			20		20		0.35	0.95		20	60	20		
M-5	29-Aug	1	45	0.9	0.74		60	20	20			1	1		70	30				1	0.91		65	20	15			0.5	0.77	60	60		20	20		0.35	0.67		10	70	20		
M-5	29-Aug	2	45	0.3	0.61			20		80		0.45	0.91		30	45	25			0.65	0.95		65	10	15	10		0.7	0.67		65	15	10	10		0.65	0.67		60	20	20		

Appendix A. Physical characteristics of sample sites.

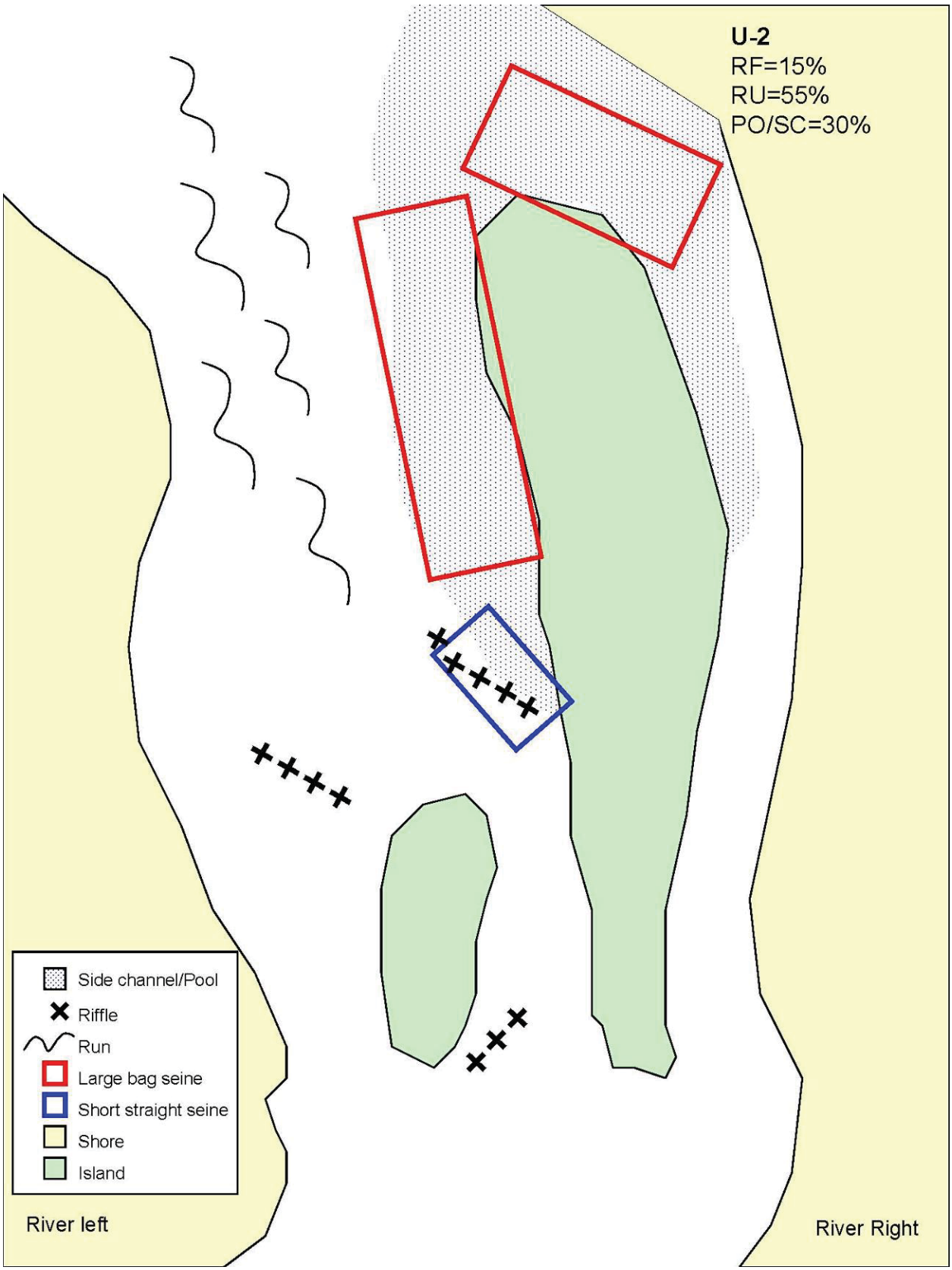
Physical Characteristics at sampling sites in the LOWER REACH, Bighorn River, 28-31 Aug 2005.

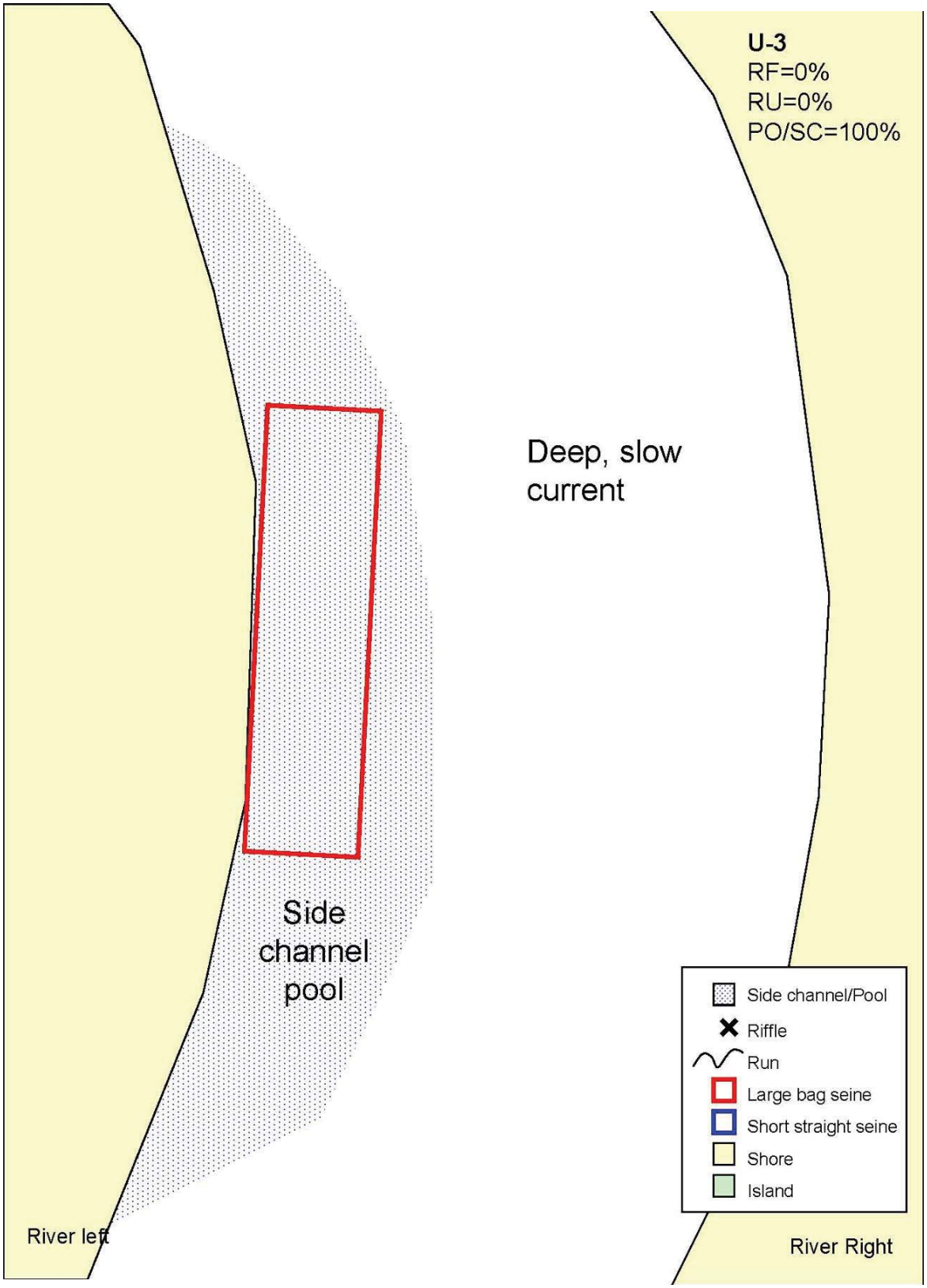
				20% Stream Width								40% Stream Width								60% Stream Width								80% Stream Width								100% Stream Width							
						substrate								substrate								substrate																					
Site	Date	tran.	wid (m)	dep (m)	curr. (m/s)	BO	CO	PE	GR	SA	SI	dep (m)	curr. (m/s)	BO	CO	PE	GR	SA	SI	dep (m)	curr. (m/s)	BO	CO	PE	GR	SA	SI	dep (m)	curr. (m/s)	BO	CO	PE	GR	SA	SI	dep (m)	curr. (m/s)	BO	CO	PE	GR	SA	SI
L-1	30-Aug	1	30	1.25	1			85				1.2	fast		100					1	0.91		30	50	20			0.8	0.91		50	50				0.55	0						100
L-1	30-Aug	2	35	>1.5	fast	15	100					1.2	0.59		10	50	40			0.65	0						100	0.4	substrate 0						100	0.3	0						100
L-1	30-Aug	3	30	1.3	fast		100					1.2	fast		50	50				1.15	0.71			40	60			0.7	0						100	0.3	0						100
L-2	30-Aug	1	26	0.4	0.67			20		80		0.75	0.67		10	40		50		0.9	0.87		10	40		50		1.05	0.83		10	45	30	15		1.45	0.77		70	30			
L-2	30-Aug	2	23	0.45	0.4					50	50	0.85	0.61					100		1.15	0.45		30	20		50		1.3	0.67		30	50	20			>1.5	0.77		70	30			
L-2	30-Aug	3	30	0.25	1			30				0.4	1		60	25	15			0.55	0.87			50	40	10		0.8	0.91		30	50	20			0.9	1		10	55	20	15	
L-3	30-Aug	1	18	0.35	0	70					100	0.6	0.5					50	50	0.8	0.91		10	60		30		1	1		20	60	20			1.2	1		80	10	10		
L-3	30-Aug	2	20	0.7	0.48						100	1	0.67					80	20	1.1	0.67		60	30	10			1.1	0.63		80	20				1.1	0.91		70	10	20		
L-3	30-Aug	3	25	0.35	0.87		70	15	15			0.2	0.95			50	50			0.2	1.11			50	50			0.35	1.11		50	20	30			0.4	1.05		50	50			
L-4	30-Aug	1	28	0.65	0.61					30	70	0.75	0.59			20		80		1.1	0.95			30	50	20		0.45	0.67				30		70	0.2	0.48						100
L-4	30-Aug	2	34	0.65	0.87			30	30	40		0.7	0			30	30	40		0.8	1			60	40			0.8	1		70	20	10			0.5	0.57					30	70
L-5	30-Aug	1	35	0.4	0						80	0.55	0.5		40	40	20			0.9	0.91		50	20	30			1.2	1					100										
L-5	30-Aug	2	40			20						0.7	0.33					80	20	0.85	0.67					100		1.1	0.77					100		1	1.11		70		20	10	
L-5	30-Aug	3	40	0.65	0.33					20	80	0.7	0.5					100		0.7	0.59					100		0.8	0.67		80	10	10			0.95	0.67					80	20

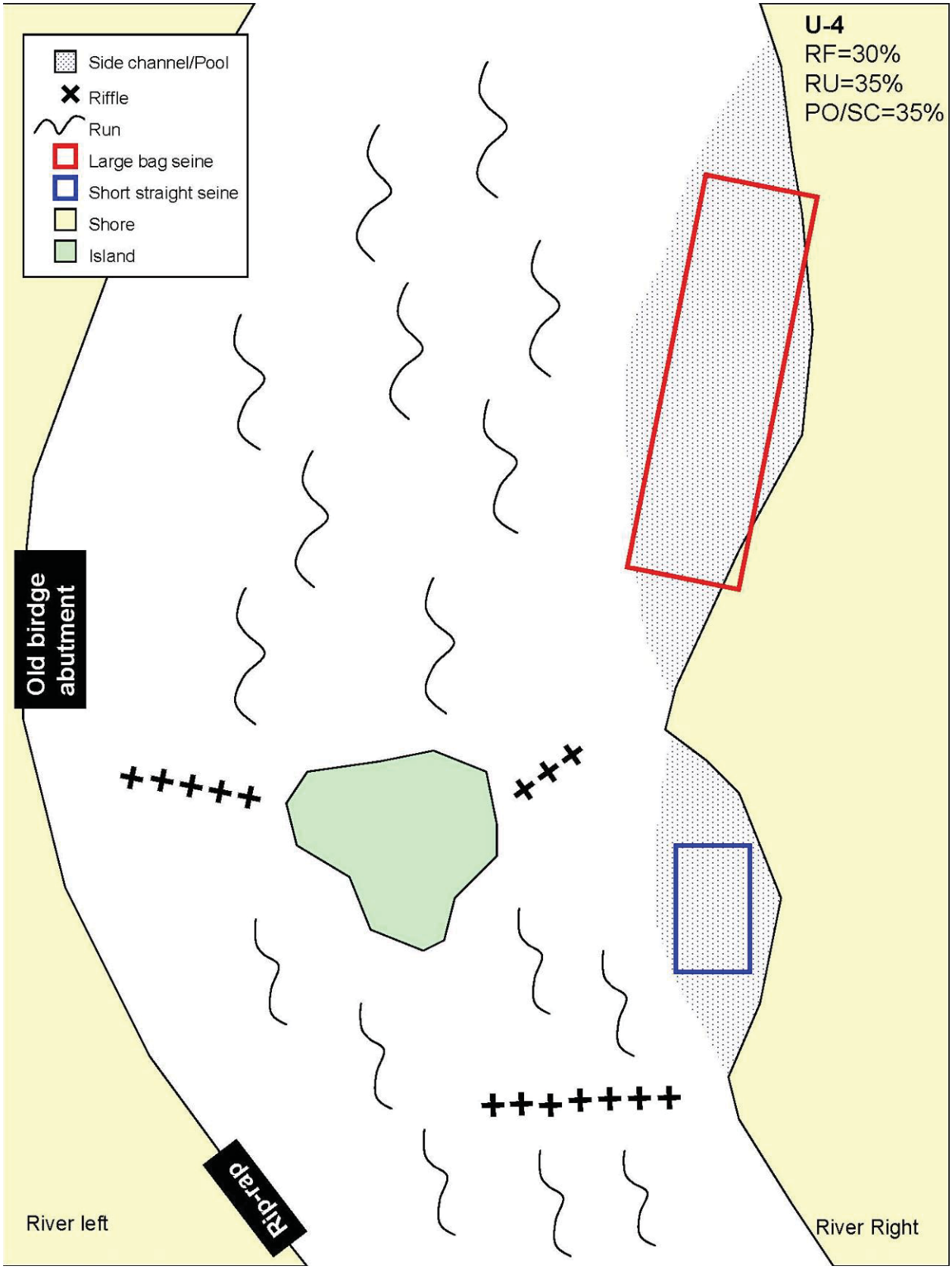
Appendix B. Diagrams and photos of sample sites.

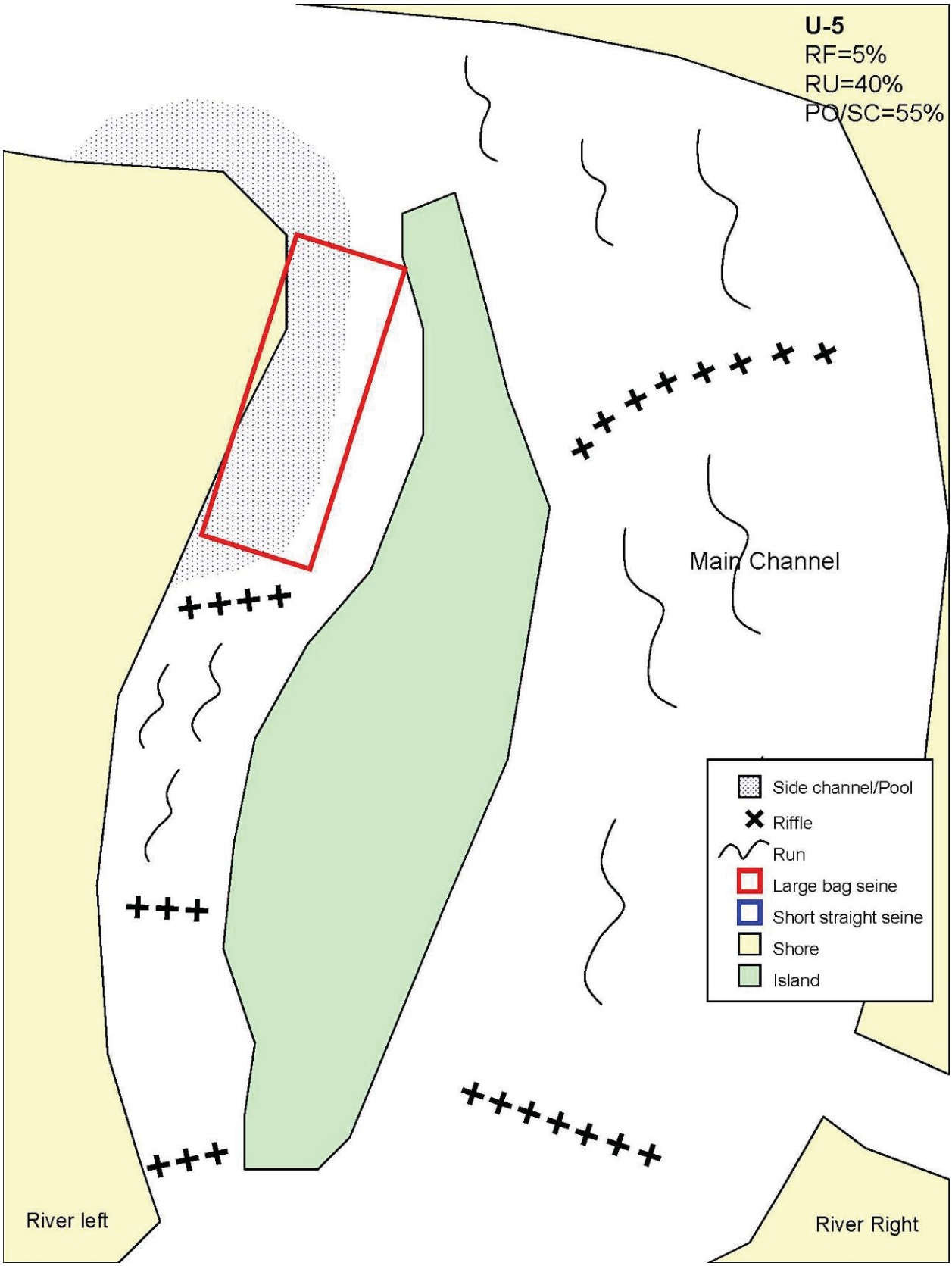
U-1
No site diagram or pictures available.

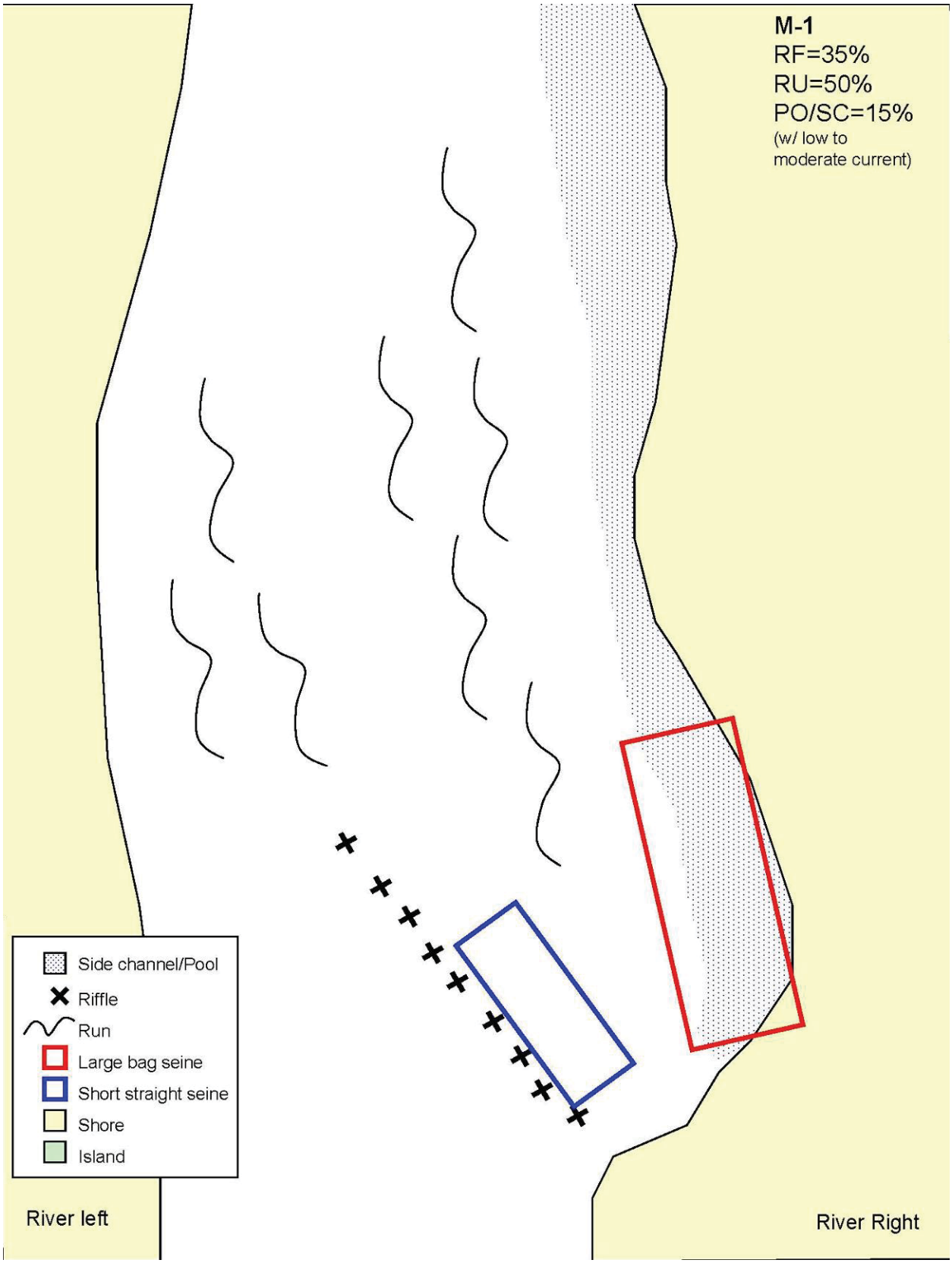
This sampling site was located on the inside of a gently curving river bend. The large bag seine was used along 100m of side channel habitat. The short straight seine was used along 20 meters of riffle habitat just upstream of the side channel.

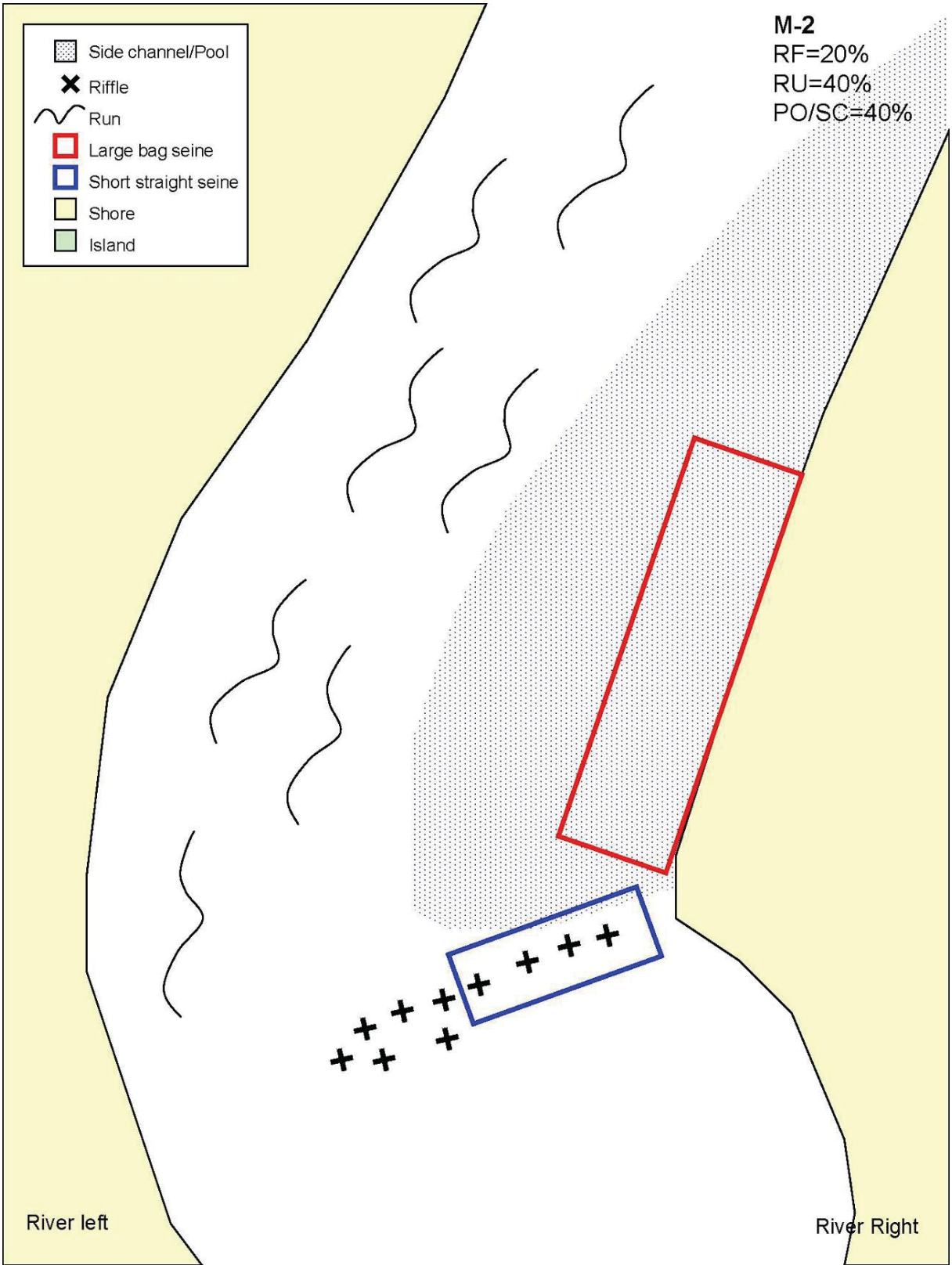

U-2
RF=15%
RU=55%
PO/SC=30%
Side channel/Pool
Riffle
Run
Large bag seine
Short straight seine
Shore
Island
River left
River Right

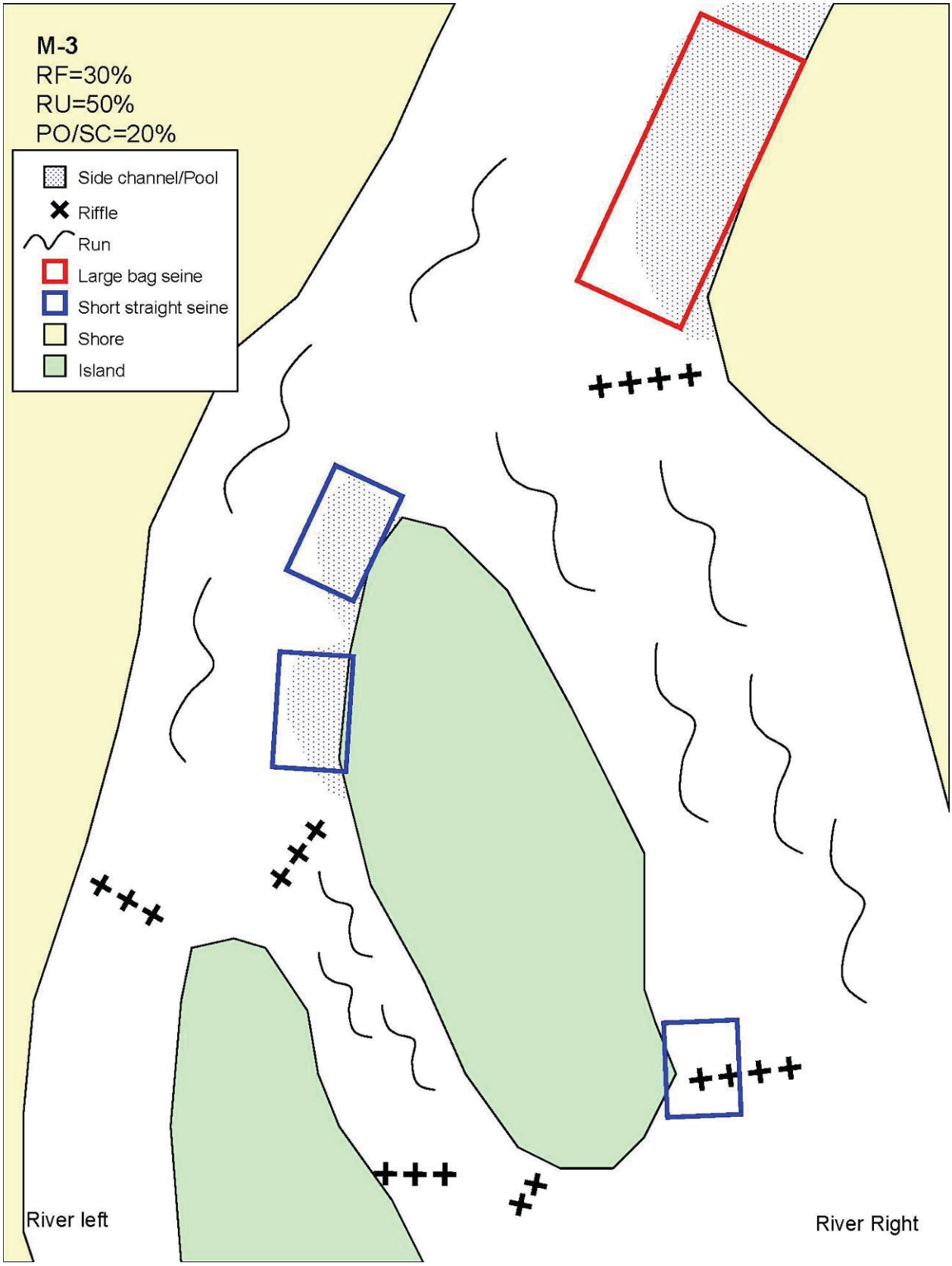

U-3
RF=0%
RU=0%
PO/SC=100%
Deep, slow current
Side channel pool
River left
River Right
Side channel/Pool
Riffle
Run
Large bag seine
Short straight seine
Shore
Island

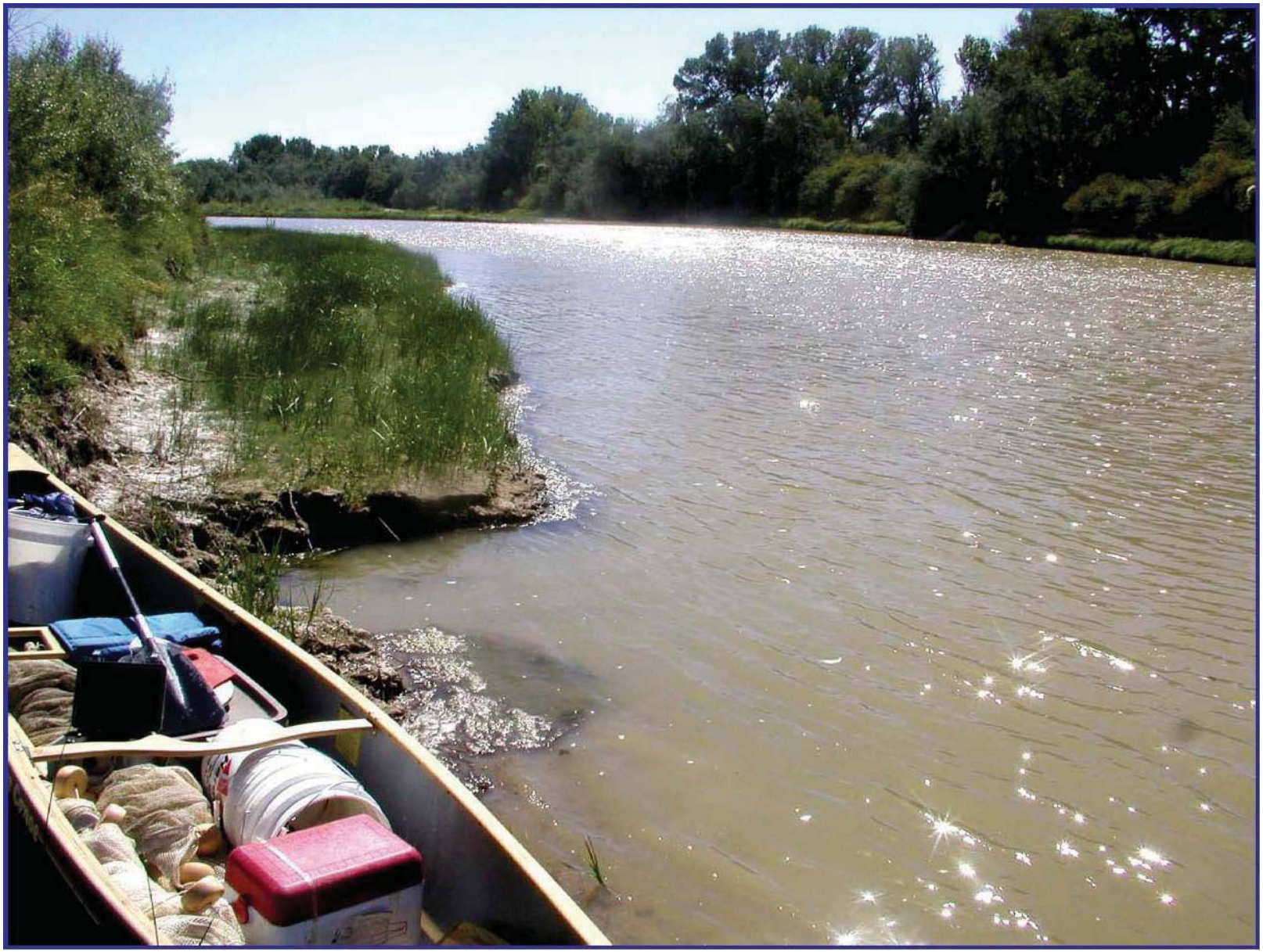

Side channel/Pool
Riffle
Run
Large bag seine
Short straight seine
Shore
Island
U-4
RF=30%
RU=35%
PO/SC=35%
Old birdge abutment
Rip-rap
River left
River Right

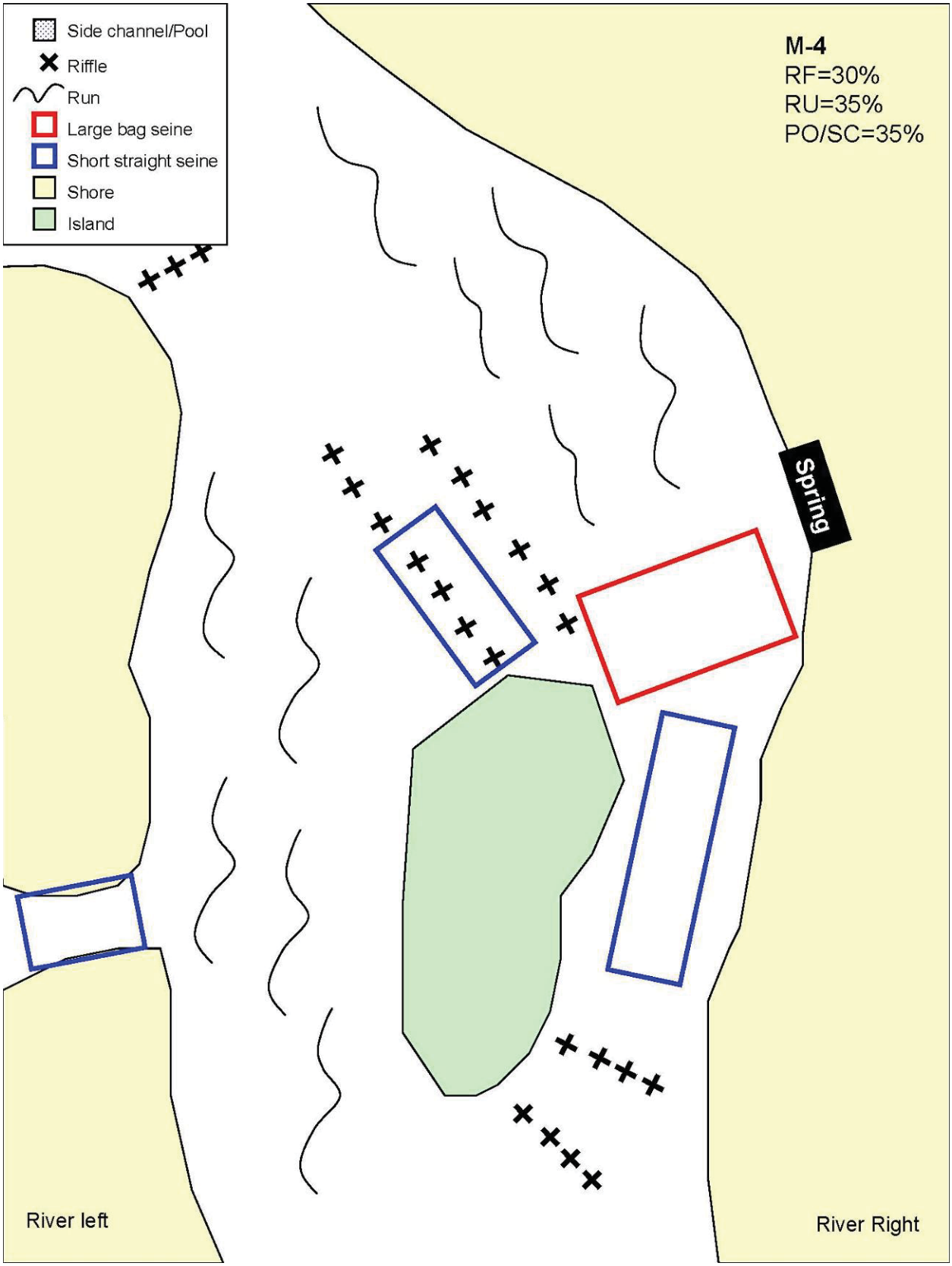

U-5
RF=5%
RU=40%
PO/SC=55%
Main Channel
Side channel/Pool
Riffle
Run
Large bag seine
Short straight seine
Shore
Island
River left
River Right

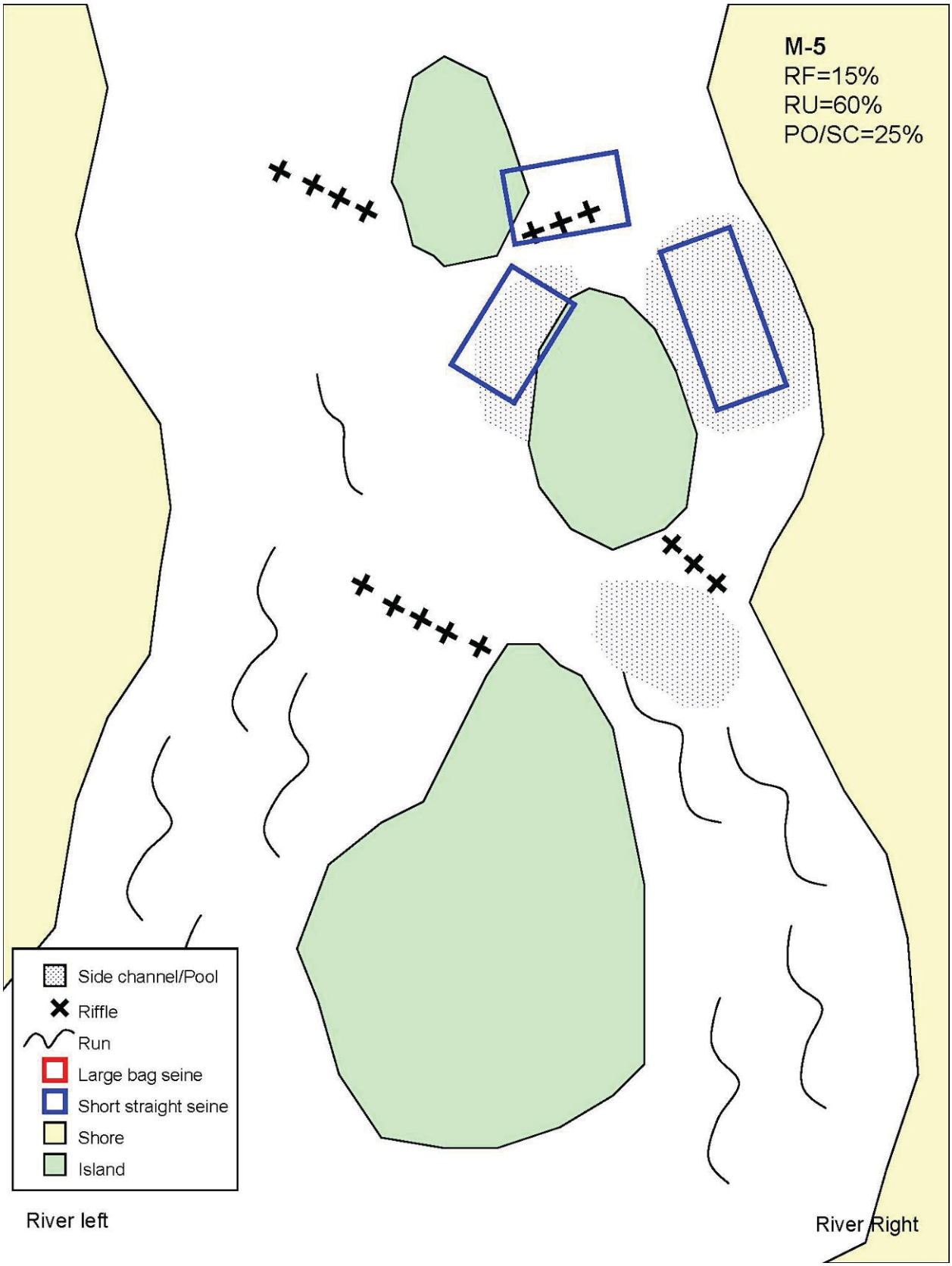

M-1
RF=35%
RU=50%
PO/SC=15%
(w/ low to moderate current)
Side channel/Pool
Riffle
Run
Large bag seine
Short straight seine
Shore
Island
River left
River Right

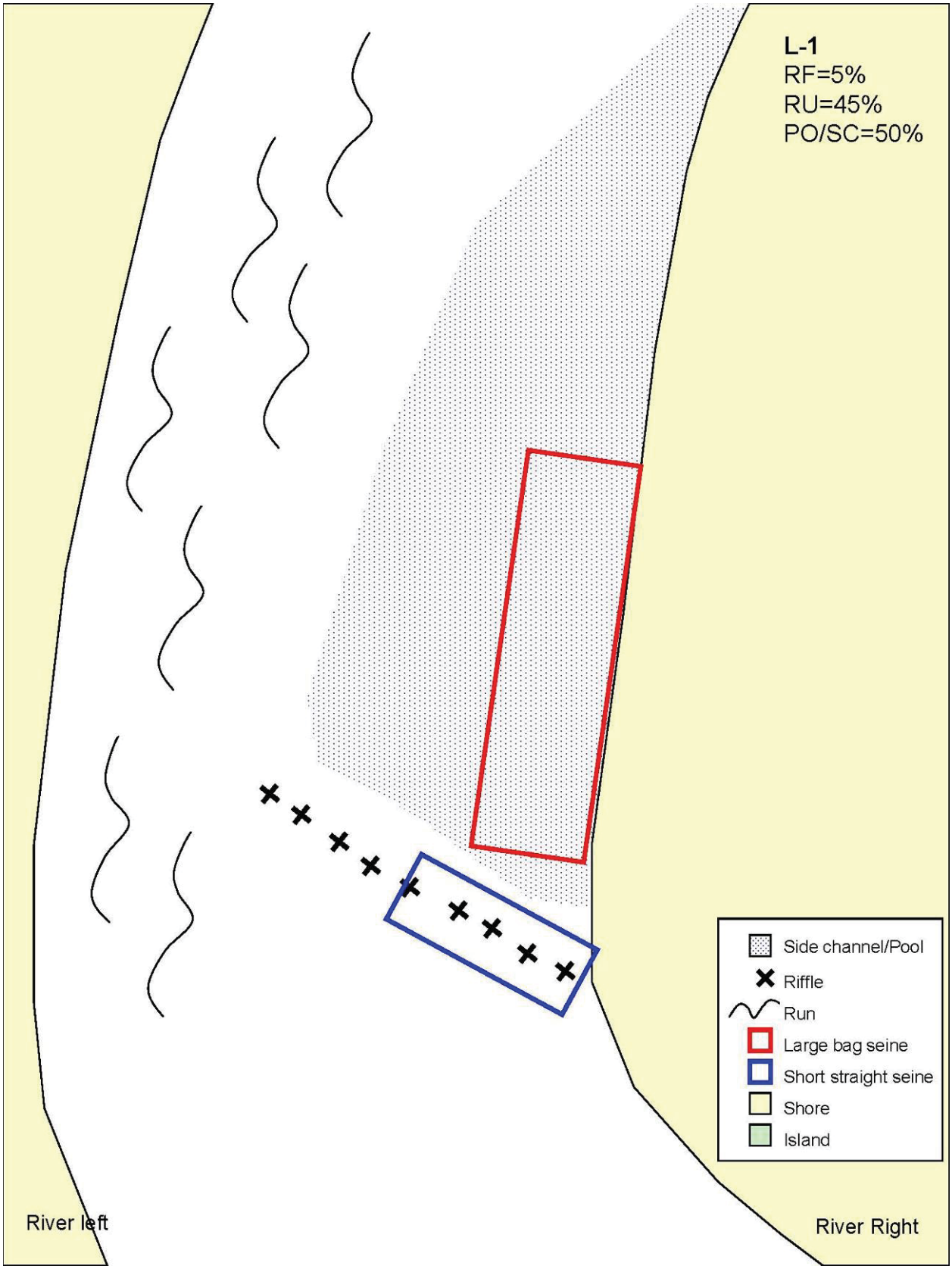

Side channel/Pool
Riffle
Run
Large bag seine
Short straight seine
Shore
Island
M-2
RF=20%
RU=40%
PO/SC=40%
River left
River Right

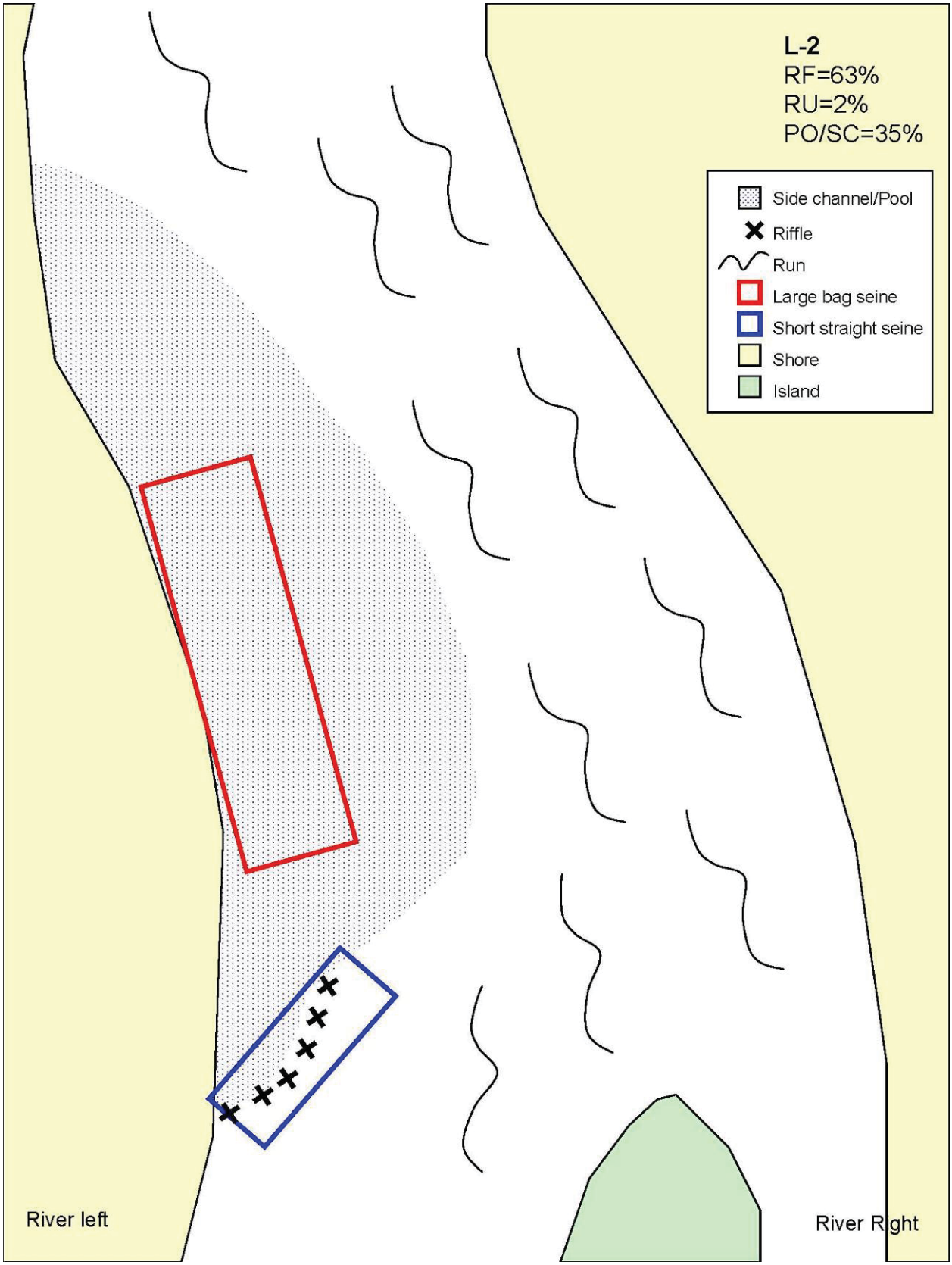

M-3
RF=30%
RU=50%
PO/SC=20%
Side channel/Pool
Riffle
Run
Large bag seine
Short straight seine
Shore
Island
River left
River Right

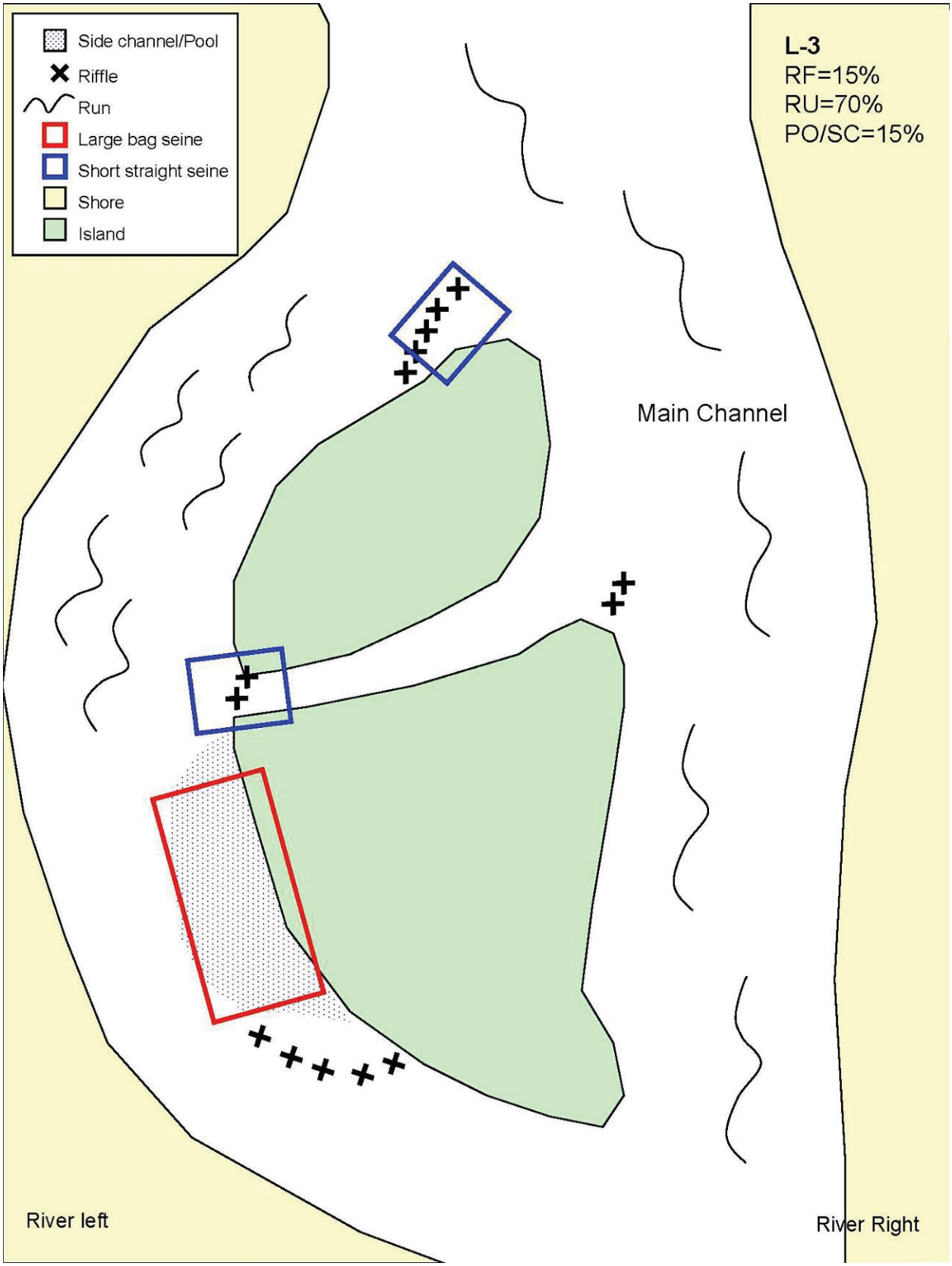


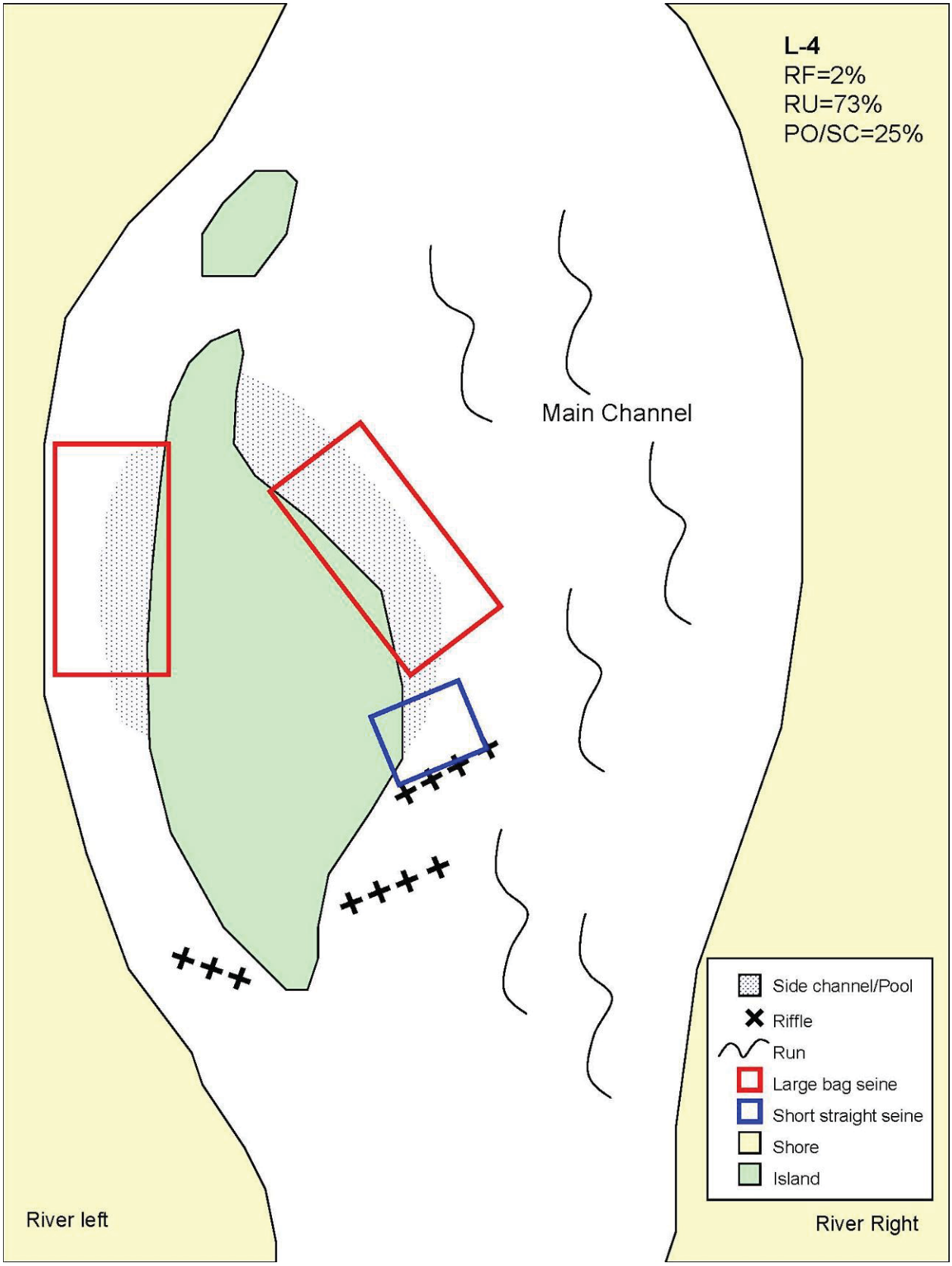

Side channel/Pool
Riffle
Run
Large bag seine
Short straight seine
Shore
Island
M-4
RF=30%
RU=35%
PO/SC=35%
Spring
River left
River Right

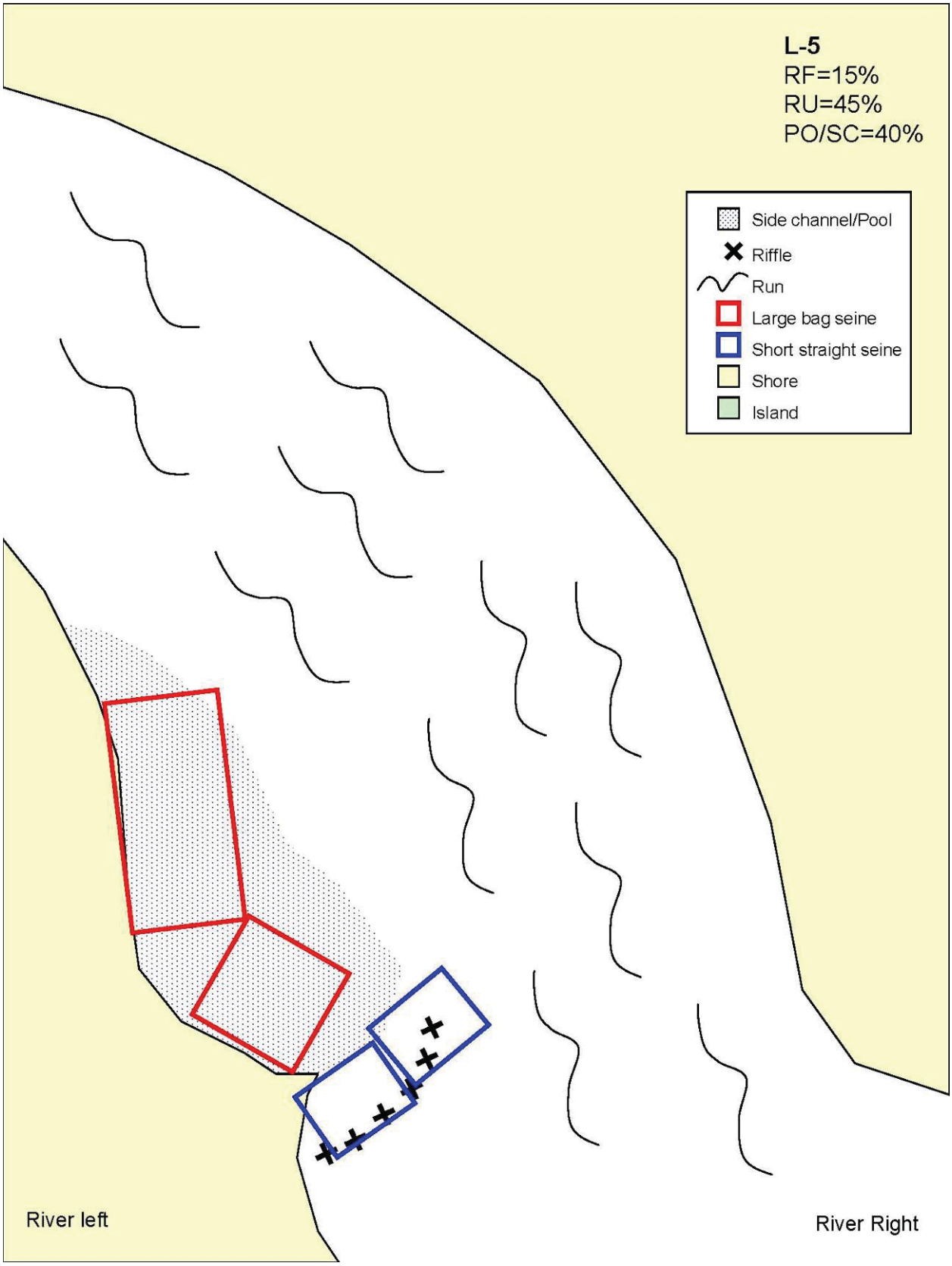

M-5
RF=15%
RU=60%
PO/SC=25%
Side channel/Pool
Riffle
Run
Large bag seine
Short straight seine
Shore
Island
River left
River Right


L-1
RF=5%
RU=45%
PO/SC=50%
Side channel/Pool
Riffle
Run
Large bag seine
Short straight seine
Shore
Island
River left
River Right


L-2
RF=63%
RU=2%
PO/SC=35%
Side channel/Pool
Riffle
Run
Large bag seine
Short straight seine
Shore
Island
River left
River Right


Side channel/Pool
Riffle
Run
Large bag seine
Short straight seine
Shore
Island
L-3
RF=15%
RU=70%
PO/SC=15%
Main Channel
River left
River Right


L-4
RF=2%
RU=73%
PO/SC=25%
Main Channel
Side channel/Pool
Riffle
Run
Large bag seine
Short straight seine
Shore
Island
River left
River Right


L-5
RF=15%
RU=45%
PO/SC=40%
Side channel/Pool
Riffle
Run
Large bag seine
Short straight seine
Shore
Island
River left
River Right