Fishery Interim Summary Report Series No. 09-01

Sandy River Restoration Project

By Forrest R. Bonney

Caring for Maine's Outdoor Future

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Maine Department of Inland Fisheries and Wildlife
Division of Fisheries & Wildlife

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JOB NO. F-027

SANDY RIVER RESTORATION

INTERIM SUMMARY REPORT (2006-2008)

SUMMARY

An 800-foot long reach of the upper Sandy River was restored in August 2006 to improve wild brook trout (*Salvelinus fontinalis*) habitat. A variety of techniques were used, including cabled logs to divert and concentrate flow, rock weirs with embedded root wads to create and maintain large pools and provide cover, and paired boulders to scour shallow pools and provide cover. Ten semi-permanent transects were established and measured prior to and after the construction phase. Two additional transects were established post-construction to monitor pool depths associated with the rock weirs. Additional evaluation methods included pebble counts to monitor changes in substrate size and electrofishing to determine changes in fish species diversity and abundance. As a result of high flows in October 2006, there was considerable displacement of logs and paired boulders, and three of the rock weirs were damaged. The two damaged weirs were repaired in October 2007 and have remained stable to date. Sampling will be repeated on an annual basis to determine the continued durability and effectiveness of the structures.

KEY WORDS: HABITAT EVALUATION, STREAM, HABITAT IMPROVEMENT, WATER QUALITY

INTRODUCTION

Downstream of Smalls Falls, an impassable upstream fish barrier located in Township D, the Sandy River supports populations of brook trout, brown trout (*Salmo trutta*), and smallmouth bass (*Micropterus dolomieui*). Atlantic salmon (*Salmo salar*) populations are being restored by the Atlantic Salmon Commission. The Sandy River above Smalls Falls – where this project is located - provides more suitable habitat for wild brook trout due to the absence of interspecific competition from these species, and because of colder water temperatures. However, this section of river is physically degraded in that it is overwidened and lacks deep pools that provide important brook trout habitat. Reaches that abut Route 4 have been straightened and have lost floodplain function. Meander has been truncated by road fill at both the upper and lower ends of the study area. This restoration effort was implemented to determine whether a variety of techniques are effective in improving brook trout habitat and, ultimately, increasing their abundance. This report presents the results of the 2006 pre-construction and 2006-2008 post-construction monitoring at the Sandy River in Sandy River Plantation, Franklin County.

STREAM RESTORATION

The reach chosen for restoration is Rosgen B3, indicating a relatively steep gradient with a predominately cobble substrate. The restoration goal is to enhance adult brook trout habitat by increasing water depth through the creation of pools and reducing the width to depth ratio to concentrate the flow.

Stream restoration work was completed mid-August 2006 by staff of the Engineering Division, Maine Dept. of Inland Fisheries and Wildlife, in the reach downstream of the Route 4 bridge (river mile 63) in Sandy River Plantation (Figure 1). Field Geology Services prepared the design and provided construction oversight. An 800-foot section of this shallow, over-widened reach of channel received a number of treatments for the benefit of aquatic life, including brook trout:

- Two cabled logs were placed on a midchannel bar located in an over-widened area in the upper section of the restoration reach to divert the flow and form a single channel.
- Four rock weirs were constructed in the middle section to create and maintain large pools. These structures are comprised of large (3-5 foot) boulders arranged in a V shape with the apex directed upstream. From the cross-sectional perspective, these structures grade downward from bank full elevation toward the center, directing water into the center of the structure, resulting in a scour pool several feet deep. Root wads were incorporated into each of the weirs to encourage additional scour and create habitat complexity favored by macroinvertebrates and brook trout. Of the techniques employed, rock weirs are the most technically challenging to construct, but also yield the deepest pools. These pools benefit primarily the adult life stage of brook trout.
- Four paired boulder clusters were situated in the lower part of the treatment reach. The concentrated flows between the boulders create a variety of microhabitat niches, including small pools and cover, which benefit both macroinvertebrates and brook trout. Three of the paired boulder clusters were constructed with an associated root wad; the fourth consisted of two boulders atop two boulders but no root wad.

This project cost $9,971 for planning and construction oversight and $1,090 for materials (trucking of boulders and purchase and delivery of trees with attached root wads). Boulders were donated by the Maine Department of Transportation from their Route 4 rebuilding project. Construction (including personnel and the use of truck and excavator, valued at $3,430) was provided by the Engineering Division of the Maine Department of Inland Fisheries and Wildlife. The total cost of the project was $14,491, or about $18.00/lineal foot of treated river. Repair of two failed rock weirs in October of 2007 cost an additional $840 for larger (>4-foot) boulders; the Engineering Division replaced the boulders at no out-of-pocket expense.

Monitoring Methods

Recording thermometers deployed one mile upstream of the restoration site in 2005 and 2006 indicated that water temperatures are suitable for brook trout (Tables 1 and 2) and instantaneous water quality sampling conducted during the summers of 2006 and 2007 indicated suitable water quality for brook trout (Table 3). Prior to restoration efforts, the reach was determined to be Rosgen stream type B3 with a Fair Pfankuch stability rating (Table 4).

Standard methods for physical stream measurements (Harrelson et al. 1994) are being used to monitor the response to restoration efforts of this reach of the Sandy River. This procedure consists of measuring cross sectional profiles including thalweg depth and location, water elevation at the time of the survey, top of bank elevations, and bankfull elevations. The relative elevations of these transects to each other was also established. In addition, pebble counts were conducted at transect sites to determine substrate size and changes over time. Twelve of these semi-permanent transects were established in the study reach over a distance of 1,186 feet (Table 5; Figure 2). The uppermost and lowermost transects extend 159 feet upstream and 272 feet downstream of the active treatment area to serve as controls. Transects 3, 5, 6, 7, 8, and 9 are between treatment sites and therefore also serve as controls. Two new transects (4a at Weir No. 3 and 5a at Weir No. 4) were established post-construction to monitor changes within these treatment sites. Weir No. 2 was constructed at the site of Transect 4. There is no transect at Weir No. 1. Results of measurements taken in 2006 (pre- and post-restoration) and in 2007-2008 are presented in Appendix A (cross sectional profiles) and Table 6 (pebble counts). A number of channel dimensions, including mean depths, thalweg depths, cross sectional areas, and width-to-depth ratios were calculated from transect data (Table 7 and Appendix B). Transects were also photographed from both upstream and downstream perspectives (Appendix C). The structures were also photographed annually (Appendix D). Maximum water depths at the transects were calculated (Table 8) to provide a comparison between control and treatment areas. Representative reaches were electrofished to determine fish species presence and abundance (Table 9) and, as an indicator of water quality, aquatic insects were collected prior to restoration at five locations with a 500-micron mesh kick net (Figure 3).

Results and Discussion

All measurements were successfully accomplished except that pebble counts were not repeated immediately post-construction due to time constraints and were not collected in some of the deeper-water transects.

Several structures failed or were displaced during high flows that occurred in October 2006:

- Of the two logs cabled and weighted mid-channel in an effort to narrow the channel, the upper log attachment failed and the log was washed downstream next to the lower log, where both continued to trap sediment and woody material but are not diverting flow as intended. The situation could likely be remedied by the placement of additional logs secured by larger boulders.
- Rock Weir No. 1 (furthest upstream) had some top boulders moved out of place with the footer rocks below still concentrating flow in the center of the channel. The top boulders moved into the pool downstream and are providing additional habitat complexity. Consequently, no effort was made to repair this weir.
- Rock Weir No. 2 remained intact but was undermined somewhat due to scour, rendering it unstable. It was reinforced in October 2007 by adding boulders for stability where excessive scour had occurred and has remained stable through the fall of 2008.
- Rock Weir No. 3 withstood high flows and needed no repair through the fall of 2008.
- Rock Weir No. 4 (furthest downstream) collapsed when its rocks were carried out of position by high flows in October 2006 and was rebuilt in October 2007 with larger boulders and remained stable through the fall of 2008.
- The top pair of boulders in the third of the four sets of paired bounders (comprised of boulders atop boulders; no root wad) collapsed under high flows but the lower boulders remained clustered and effective in scouring a small pool. The other three sets of paired boulders remained essentially in place and effective in scouring small pools and in trapping large woody debris.

Measurements taken at transects reflect differences in widths and depths along the reach. There were few changes over time in measurements taken at the control transects. There were no changes in bankfull widths; only minor changes (typically less than 4 inches) in mean depths or thalweg depths; and only minor changes (from 0 to 14%) in width-to-depth ratios.

Transects located at treatments sites showed more change. Transect 2, located at an overwidened reach where the logs were placed, showed considerable change – but no trends - from 2006-2008, indicating continued instability. At Transects 4, 4a, and 5a, which bisect the pools below the rock weirs, bankfull widths were intentionally reduced to desirable dimensions during weir construction, and have retained those narrower values. Because Weir No. 2 was constructed at the site of Transect 4, pre-construction measurements are available, and confirm that the presence of the weir resulted in greater mean and thalweg depths that have continued to increase due to scouring. Weir 3 depths have continued to increase modestly, and Weir 4 depths increased after it was rebuilt in 2007. Maximum water depths at the transects ranged from 3 to 4.8 feet in the pools associated with the weirs, compared to two feet or less at most other transects. Pools associated with the paired boulders were smaller and shallower, ranging from 1.2 to 1.7 feet in depth. Nonetheless, these depths represent an increase of a half foot compared to maximum depths of nearby control transects. Raleigh (1982) rates maximum depths of 1.5 ft and greater ideal for adult brook trout.

The abundance of Ephemeroptera (mayflies), Plecoptera (stoneflies) and Trichoptera (caddisflies) – which are intolerant of pollution - confirms good water quality. Changes in substrate size and electrofishing results are as yet inadequate to determine trends in abundance. We note, however, that a high proportion of brook trout were captured in the pools of the rock weirs, specifically proximate to the root wads.

Recommendations

The monitoring methods used have been variably successful for tracking the efficacy of the various techniques used. Randomly placed transects and transects positioned through the pools of the rock weirs are effective in monitoring general trends in channel morphology and the performance of the rock weirs. Monitoring the stability and performance of the logs and paired boulders has proved more difficult, however, and – given the lack of staffing to conduct detailed physical monitoring – we opted to rely on a visual record by keeping detailed photographic records of these sites. Rock weirs constructed of suitably-sized boulders resisted high flows and accomplished their stated goal of increasing water depth and adult brook trout habitat. Paired boulders were successful in scouring small pools, providing shade, and recruiting large woody debris.

Biological indicators of change, including relative fish species and insect abundance, vary greatly under natural conditions and, given the lack of extensive pre-treatment data, it may not be able to demonstrate a cause-and-effect relationship resulting from the restoration effort. Nonetheless, these efforts are worth conducting, if only to document changes in species composition and habitat preference for the improved sites.

Acknowledgements

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Transect measurements and pebble counts were conducted with the invaluable assistance of members of the Rangeley Region Guides and Sportsmen's Association: Mary-Ellen Moroney, Patty Gagnon (in memory), Lyn Hewey, and Greg Silloway. Ethan Tracey and Troy Thompson assisted with electrofishing and data collection. The project was designed by Dr. John Field of Field Geology Services, who oversaw its implementation. John Field and Dave Howatt reviewed the report.

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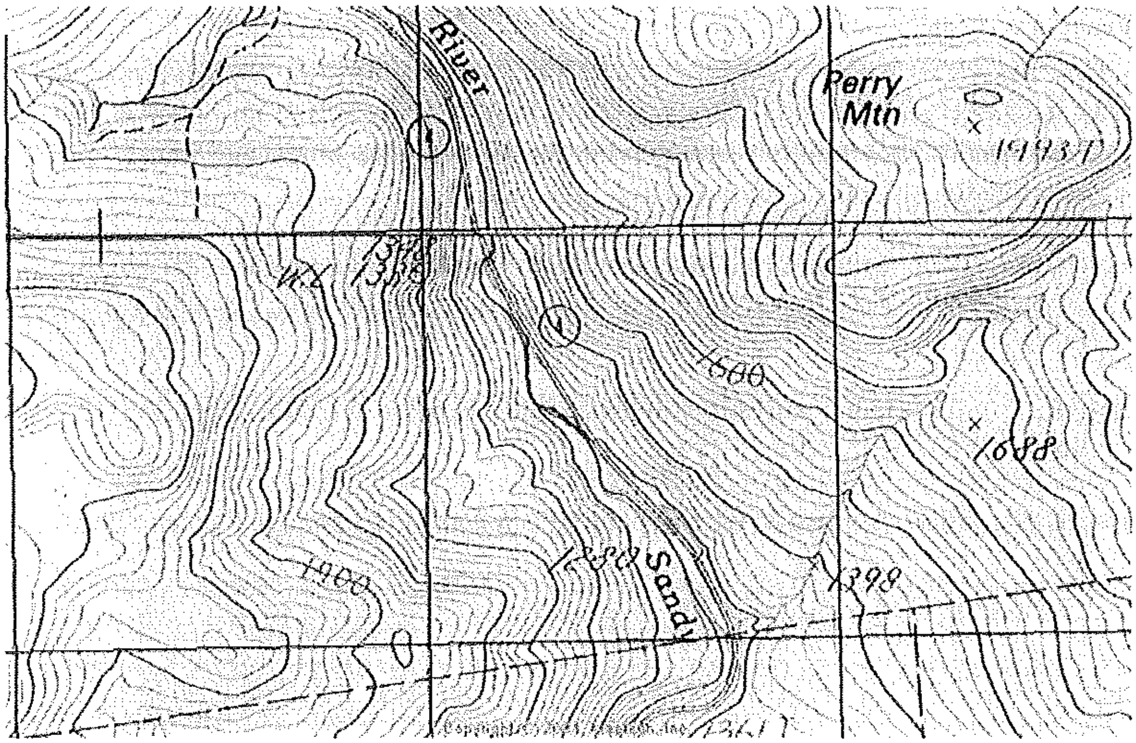


Figure 1. Sandy River restoration site (bolded), Sandy River Plt., Franklin Co.

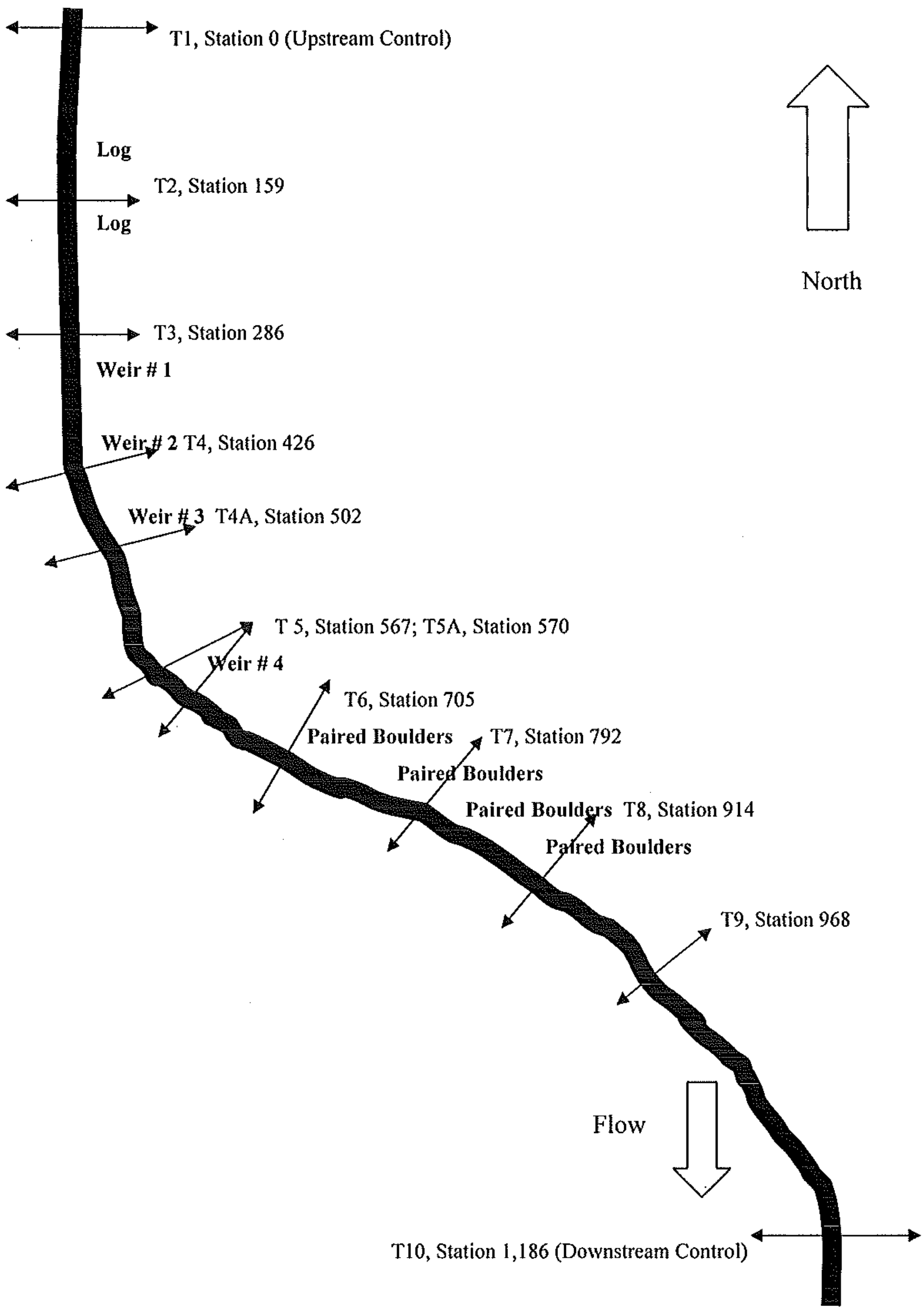


Figure 2 . Schematic of Sandy River restoration reach, transects, and treatments.

Table 1. Monthly averages of summer water temperatures (°F) recorded at Sandy River approximately one mile upstream of restoration site at river mile 64.

Year	Statistic	Month		
		June	July	August
2005	Minimum	50	59	59
	Mean	62	66	62
	Maximum	74	72	66
2006	Minimum	52	61	54
	Mean	60	66	62
	Maximum	68	73	72

Table 2. Average water temperatures, river mile 64, Sandy River, July and August only.

		Number of days in July and August that:					
	Daily mean	Min. temperature		Mean temperature		Max. temperature	
Year	temp °F	GE 68°F	GE 77°F	GE 68°F	GE 77°F	GE 68°F	GE 77° F
2005	64	2	0	9	0	13	0
2006	64	2	0	12	0	21	0

Table 3. Instantaneous water quality sampled in conjunction with electrofishing.

Date	Temperature °F	Dissolved oxygen	pH	Conductivity	Alkalinity
8/1/2006	68	8.6	6.6	.	5
7/16/2007	65	7.1	6.6	30	8
8/20/08	55	8.7	5.8	32	12

Table 4. Sandy River reach classification at midsection of restoration reach.

Bankfull width (ft.)	Mean depth (ft.)	W/D ratio	Entrench-ment ratio	Slope (%)	Predominant channel material	Rosgen stream type	Pfankuch stability rating
34	1.4	24	1.5	2.2	Cobble	B3	62 (Fair)

Table 5. Relative location of transects and restoration projects.

Transect	Station, feet	Left pin Elev.	Flow type	GPS coordinates, left pin North	West	Comment
1	0	100.33	Riffle	19T0379297	4969931	Control
	25		Riffle			Begin gravel bar
	50		Run			Begin run
	84		Riffle			End bar; begin riffle
	98		Riffle			Begin split channel
	118		Riffle			Begin **Log 1**, right
2	159	95.95	Riffle	19T0379299	4969899	**Log 2**, right
	230		Riffle			End split ch, beg. agg.
	270		Riffle			End aggradation
3	286	96.96	Riffle	19T0379292	4969858	
	298		Riffle			**Weir 1** apex
	302		Pool			Begin **weir pool**
	314		Pool			End **weir pool**
	401		Riffle			Trib, right
	410		Riffle			
	413		Riffle			**Weir 2** apex
	414		Pool			Begin **weir pool**
4	420	88.47	Pool	.	.	**Weir pool**
	427		Pool			End **weir pool**
	499		Riffle			**Weir 3** apex
4a	502		Pool	.	.	Begin **weir pool**
	511		Pool			End **weir pool**
5	562	86.55	Riffle	19T0379327	4969784	At access area
	565		Riffle			**Weir 4** apex
5a swing	570	86.55	Pool	.	.	Weir **pool**
	583		Pool			End **weir pool**
	690		Pool			**Boulders 1**, begin pool
6	699	83.49	Riffle	19T0379372	4969757	Rock outcropping, rgt
	701		Pool			End pool
	714		Run			Begin run
	758		Run			**Boulders 2**, end run
	760		Pool			Begin pool
	767		Pool			End pool
7	792	82.87	Riffle	19T0379390	4969747	Large boulder, left
	803		Riffle			**Boulders 3**[1]
	805		Pool			Begin pool
	812		Pool			End pool
	856		Riffle			**Boulders 4**
	861		Pool			Begin pool
	867		Pool			End pool
8	914	78.87	Riffle	19T0379422	4969727	
9	968	78.34	Riffle	19T0379431	4969712	
	1,040		Riffle			Rt. 4 culvert
10	1,186	74.70	Riffle	19T0379446	4969658	Control; End

[1] Boulders atop boulders; no root wad.

Table 6. Pebble Counts conducted in immediate transect area. Percent of dominant substrate types and average particle sizes (D50) are bolded.

		Percent					Particle size indices (mm)				
Transect	Year	Sands	Gravels	Cobble	Boulder	Bedrock	D16	D35	**D50**	D84	D95
1	2006	0	**66**	32	2	0	7	17	**32**	150	210
Control	2007	8	**54**	33	5	0	3	14	**35**	120	225
	2008	10	**58**	27	5	0	3	10	**24**	100	225
2	2006	2	39	**53**	7	0	15	45	**65**	150	250
Logs	2007	18	**58**	18	6	0	2	7	**14**	90	225
	2008	17	**54**	23	6	0	2	7	**20**	110	275
3	2006	0	**46**	42	12	0	25	45	**55**	175	300
Above	2007	10	**60**	25	5	0	3	17	**27**	115	225
weirs	2008	7	**67**	21	5	0	5	15	**27**	85	125
4	2006	0	**48**	**48**	4	0	12	35	**55**	95	175
Pool,	2007	7	**57**	20	15	0	5	9	**22**	200	450
Weir 2	2008	.	.	.	.	.	.	.	.	.	.
4a Pool,	2007	12	**61**	18	9	0	3	9	**18**	150	350
Weir 3	2008	.	.	.	.	.	.	.	.	.	.
5	2006	2	**55**	35	8	0	10	28	**45**	125	180
Between	2007	12	**61**	24	3	0	3	9	**18**	125	200
weirs	2008	17	**48**	25	10	0	2	9	**24**	160	400
5a Pool,	2007	4	**56**	29	11	0	6	18	**35**	160	400
Weir 4	2008	.	.	.	.	.	.	.	.	.	.
6	2006	0	42	**45**	13	0	20	48	**60**	200	350
Between	2007	3	**49**	41	7	0	5	18	**50**	160	260
boulders	2008	6	**56**	36	5	0	10	27	**40**	115	230
7	2006	3	33	**44**	20	0	18	55	**75**	260	350
Between	2007	8	**61**	26	5	0	3	15	**30**	100	225
boulders	2008	9	**50**	36	5	0	3	15	**37**	130	235
8	2006	2	**60**	37	1	0	14	30	**40**	95	160
Below	2007	4	**53**	40	3	0	5	10	**30**	125	200
boulders	2008	7	**53**	36	4	0	3	16	**34**	120	200
9	2006	0	32	**53**	16	0	30	60	**80**	260	600
Control	2007	5	**49**	43	3	0	5	28	**50**	130	225
	2008	9	**58**	29	7	0	3	14	**30**	110	125
10	2006	1	**62**	33	4	0	7	15	**27**	100	175
Control	2007	9	**62**	22	7	0	3	12	**24**	110	250
	2008	15	**50**	30	6	0	2	9	**24**	95	200

Table 7. Channel dimensions at transects.

Transect, treatment	Year	Bankfull width	Mean depth	Thalweg depth	Cross sectional area	Width to depth ratio
1	2006	30	3.58	4.23	107	8
Control	2007	30	3.83	4.57	115	8
	2008	30	3.54	4.28	106	8
2	2006	56	0.81	1.64	45	69
Logs	2007	56	0.93	2.17	52	60
	2008	56	0.73	2.09	41	77
3	2006	33	1.64	3.12	54	6
Above	2007	33	1.54	3.30	51	6
weirs	2008	33	1.72	2.91	57	6
4	2006Before	30	2.57	3.75	77	12
Pool,	2006After	27	3.19	5.01	86	8
Weir 2	2007	27	3.72	5.77	100	7
	2008	27	3.84	5.56	104	7
4a	2006After	24	2.35	4.77	56	10
Pool,	2007	26	2.39	4.83	62	11
Weir 3	2008	26	2.83	5.91	74	9
5	2006	39	2.16	3.11	84	18
Between	2007	39	2.10	3.43	82	19
weirs	2008	39	2.10	3.21	82	19
5a	2006After	34	3.25	5.39	111	10
Pool,	2007	34	2.85	5.03	97	12
Weir 4	2008	34	3.51	6.54	119	10
6	2006	38	2.25	2.92	86	17
Between	2007	38	2.25	3.28	86	17
boulders	2008	38	2.30	3.35	87	17
7	2006	46	1.92	3.80	88	24
Between	2007	46	2.16	4.05	99	21
boulders	2008	46	1.88	3.56	86	24
8	2006	47	1.23	2.27	58	38
Below	2007	47	1.24	2.30	58	38
boulders	2008	47	1.40	2.43	66	34
9	2006	33	1.31	2.46	43	25
Control	2007	33	1.34	2.13	44	25
	2008	33	1.28	2.33	42	26
10	2006	42	1.32	2.23	55	32
Control	2007	42	1.50	2.47	63	28
	2008	42	1.41	2.48	59	30

Table 8. Maximum water depths in feet at transects. Transects through treatment areas[2] are bolded.

	Transect No.											
Year	1	2	3	4	4a	5	5a	6	7	8	9	10
2006B	1.23	2.28	2.04	1.90	.	1.40	.	1.98	2.54[3]	1.34	1.71	2.31
2006A				**3.03**	**3.52**		**3.14**					
2007	0.93	1.53	1.15	**4.52**	**4.80**	0.73	**1.90**[4]	**2.47**	3.15	1.38	.	2.42
2008	0.63	0.9	0.74	**2.20**	**2.83**	0.87	**2.65**	**0.84**	1.01	0.59	0.53	0.71

Table 9. Coarse woody debris recruitment at structures.

Year	Logs	Weir 1	Weir 2	Weir 3	Bldrs. 1	Bldrs. 2	Bldrs. 3	Bldrs. 4
2008	2 logs	Branches	0	2 logs	0	Branches	0	Branches

Table 10. Maximum water depths of pools scoured by paired boulders.

Year	Boulders 1	Boulders 2	Boulders 3	Boulders 4
2008	1.3	1.7	0.5 (Failed)	1.2

Table 11. Fish species occurrence and abundance determined by one-run electrofishing. Treatment reaches are bolded.

				Fish species abundance[5]							
		Length	Area	Brook trout[6]				Other fish species[7]			
Date	Transects	(ft.)	(ft.^{2})	Small	Mid	Legal	All	BND	CCB	SCL	WHS
8/1/06	6-9	300	8,700	3.2	1.6	0.1	4.9	4.9	0	0	0
7/16/07	**4-5a**	**136**	**2,992**	**0.9**	**2.7**	**0**	**3.6**	**2.7**	**0.3**	**0**	**0**
7/18/07	**5a-6**	**140**	**2,450**	**2.2**	**4.4**	**0**	**6.6**	**4.8**	**0**	**0**	**0**
8/8/07	9-10	200	7,880	0.1	0.9	0.6	1.6	1.6	0.2	0	0
8/20/08	**4-5a**	**136**	**2,992**	**1.8**	**1.2**	**0.3**	**3.3**	**2.1**	**0**	**0**	**0**
8/20/08	**5a-6**	**140**	**2,450**	**1.8**	**3.3**	**0**	**5.1**	**2.2**	**0**	**0**	**0.4**
8/20/08	9-10	200	7,880	0.5	0.5	0.3	1.3	0.3	0	0	0

[2] Transects 4, 4a, and 5a are through pools created by rock weirs; Transect 6 is through pool created by paired boulders.
[3] Natural pool formed by boulder embedded in bank.
[4] Filled-in pool at failed rock weir.
[5] Number per 100 yd.^{2}
[6] Small = <3.5" (young of year); mid = 3.5 to 6"; legal = 6" and longer.
[7] BND = blacknose dace; CCB = creek chub; SCL = slimy sculpin; WHS = white sucker. Species listed but not sampled are known to be present in the drainage.

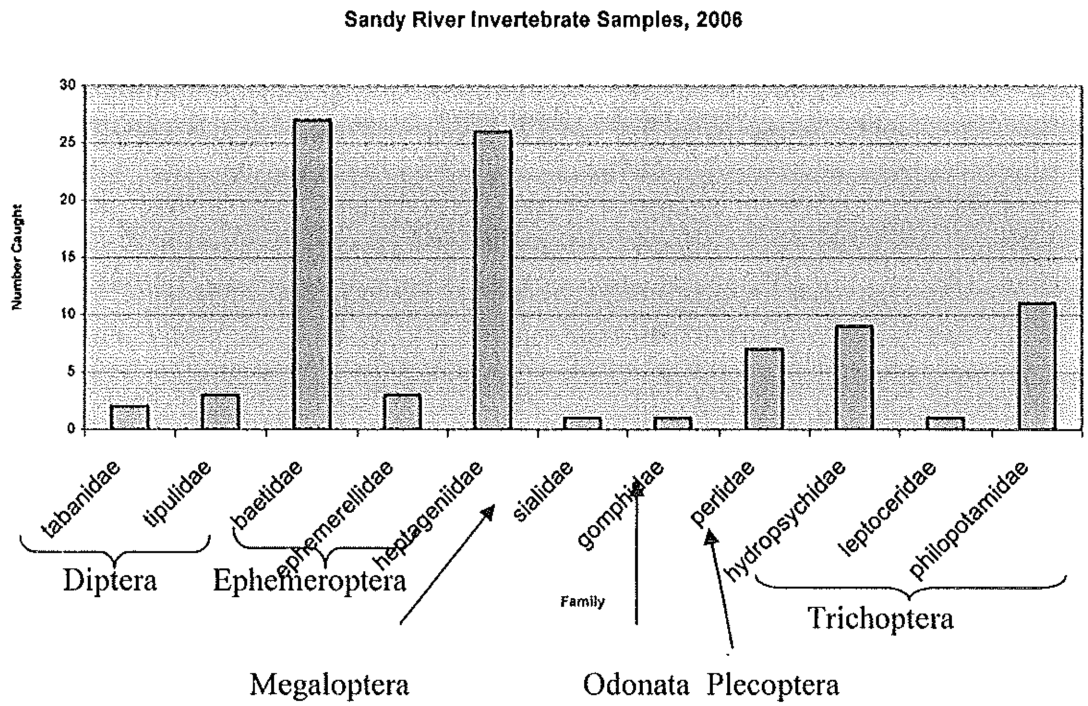
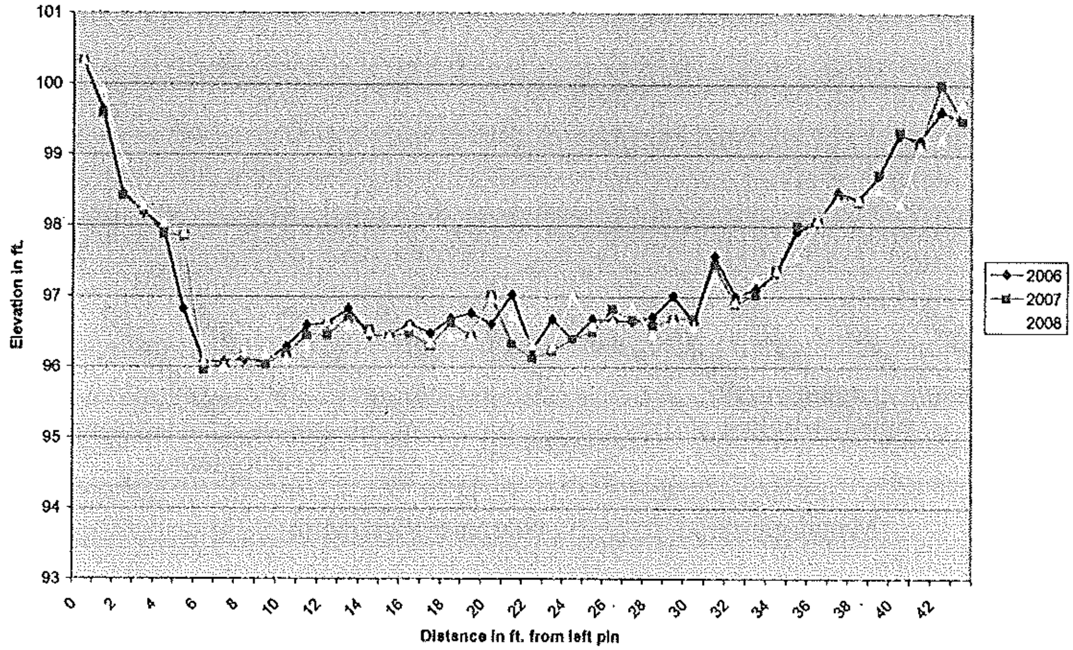


Figure 3. Families and orders of aquatic insects collected at Sandy River restoration site, 2006.

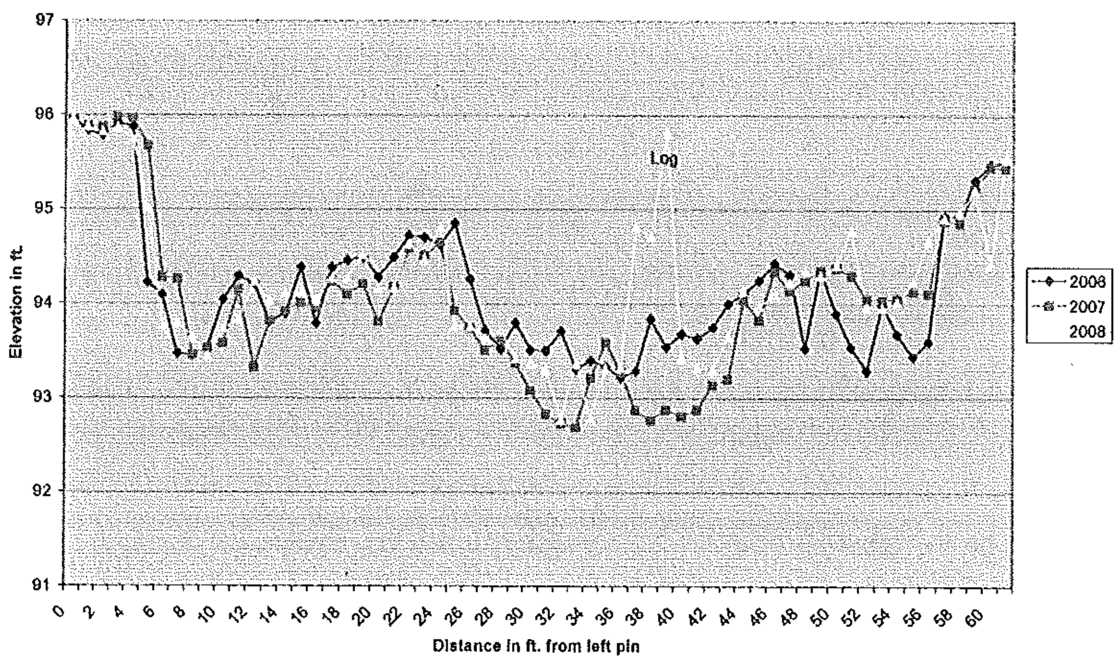
Appendix A

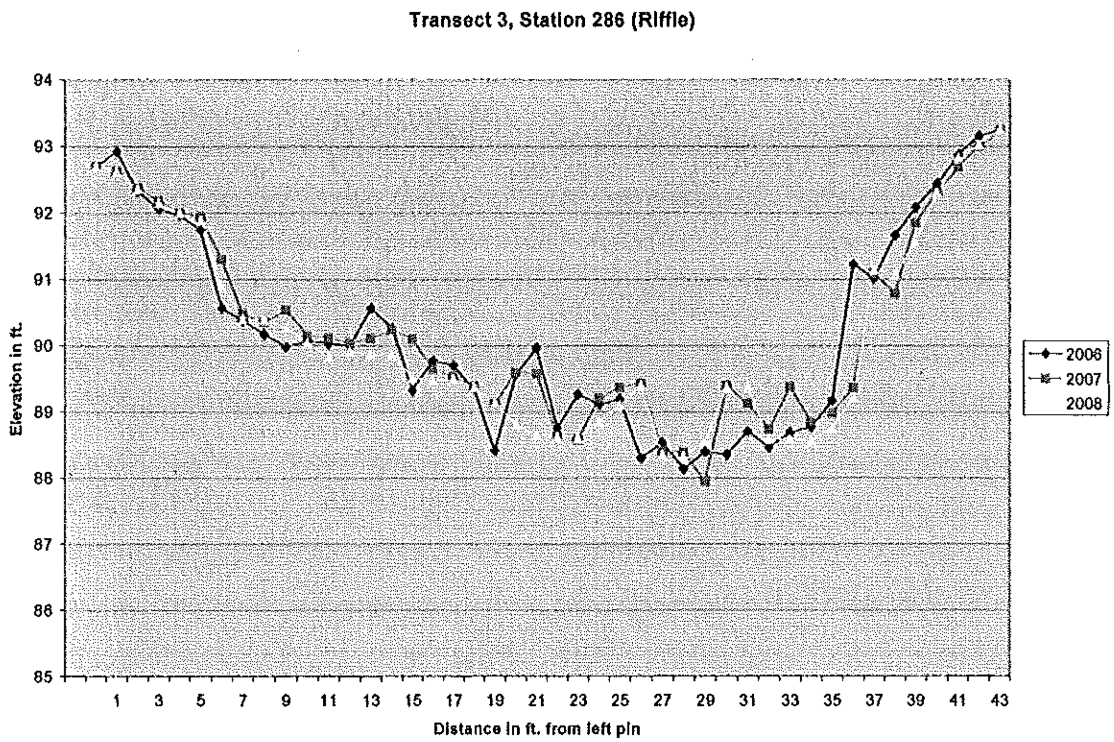
Transect profiles

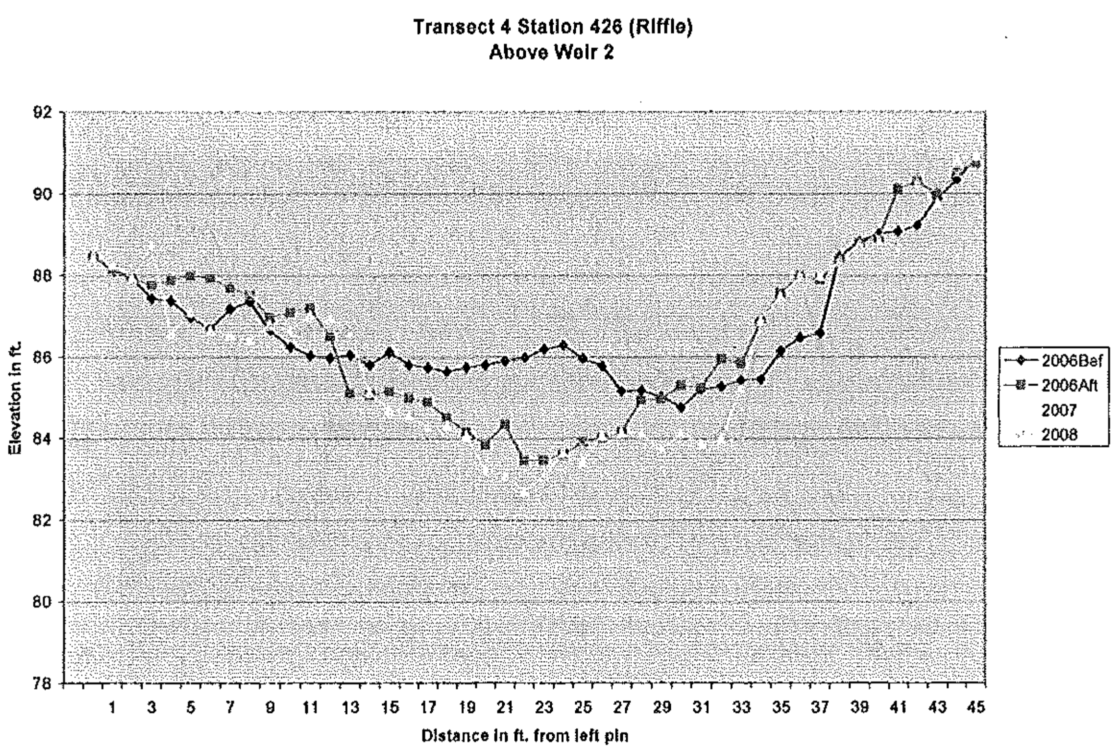
Transect 1 Station 1 (Riffle) Control

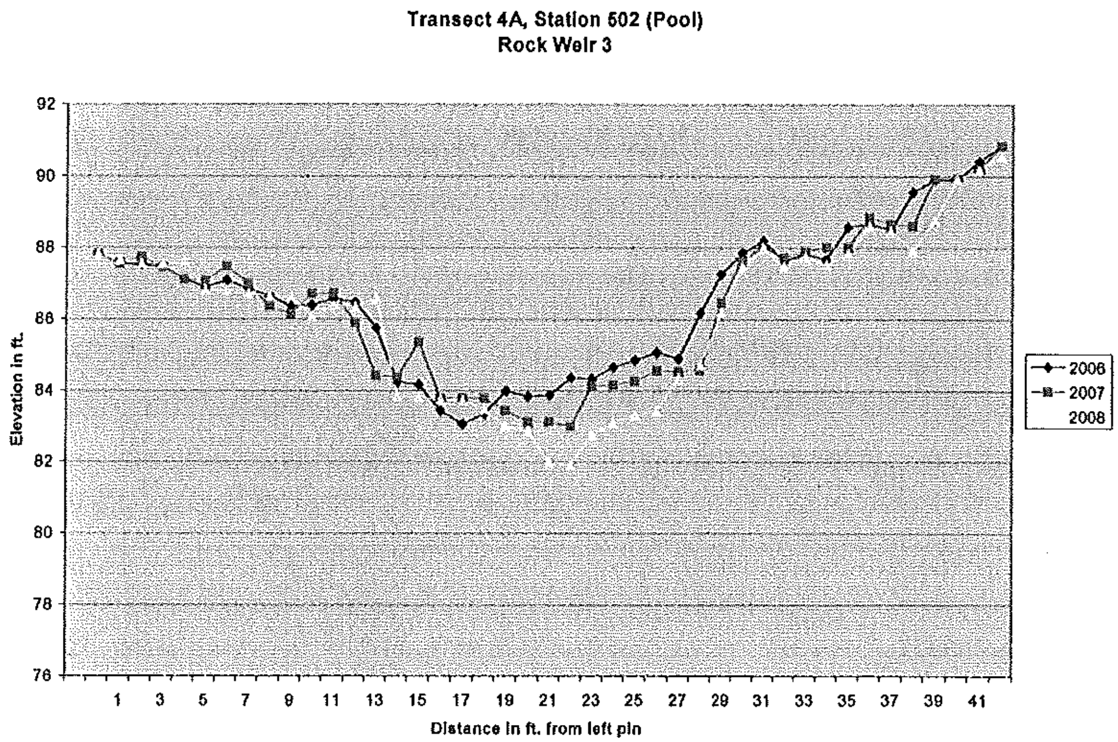


Transect 2 Station 159 (Riffle)
Logs

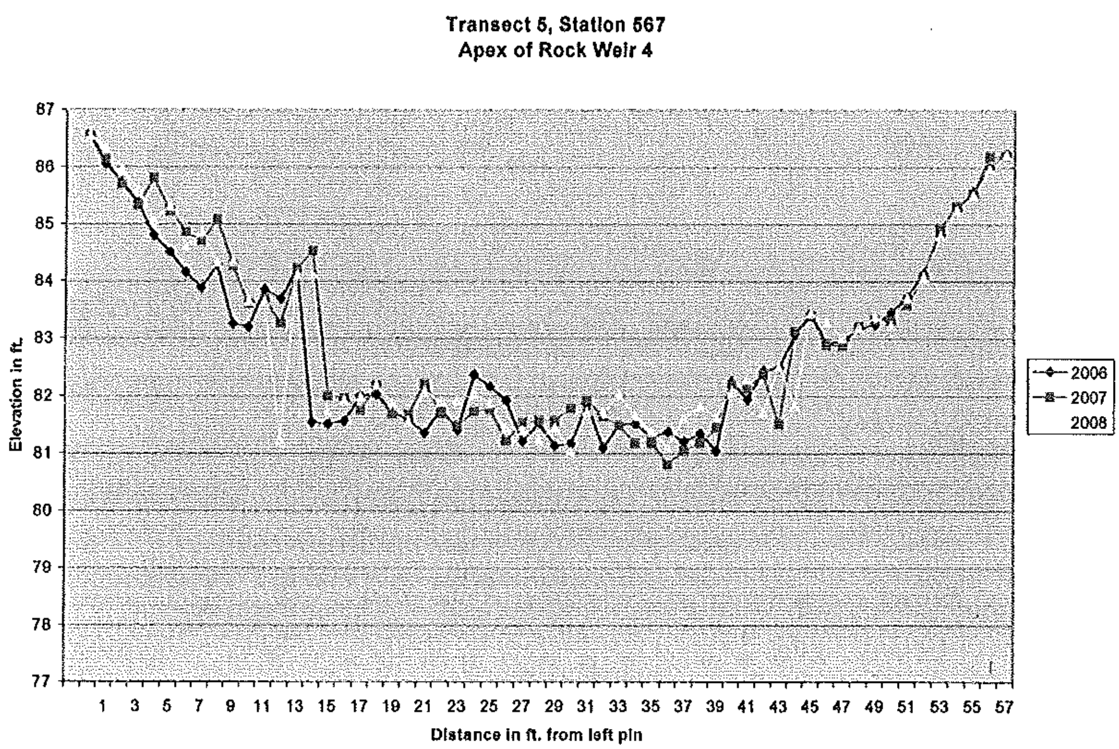



Transect 3, Station 286 (Riffle)
Elevation in ft.
Distance in ft. from left pin
2006
2007
2008


Transect 4 Station 426 (Riffle)
Above Weir 2
Elevation in ft.
Distance in ft. from left pin
2006Bef
2006Aft
2007
2008

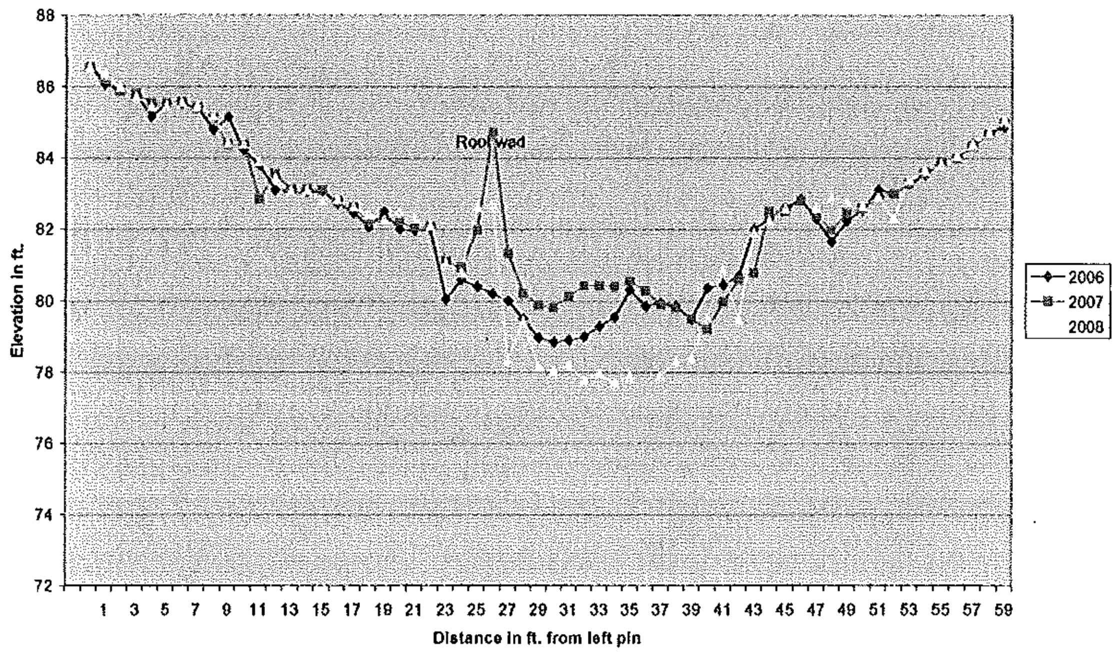


Transect 4A, Station 502 (Pool)
Rock Weir 3
Elevation in ft.
92
90
88
86
84
82
80
78
76
1 3 5 7 9 11 13 15 17 19 21 23 25 27 29 31 33 35 37 39 41
Distance in ft. from left pin
2006
2007
2008

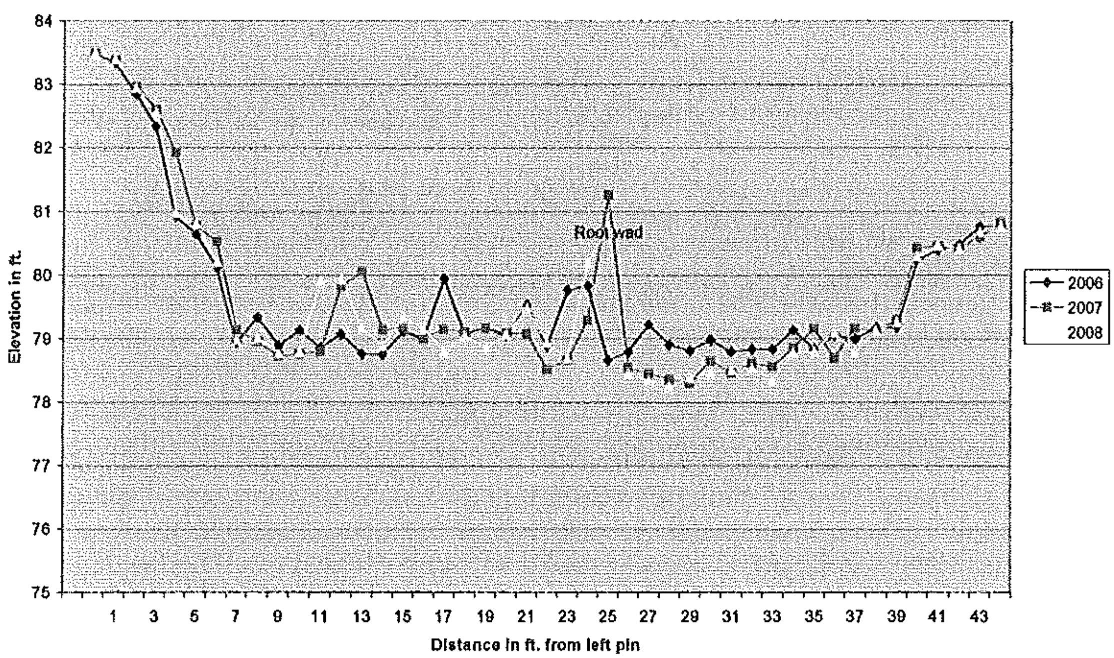


Transect 5, Station 567
Apex of Rock Weir 4
Elevation in ft.
87
86
85
84
83
82
81
80
79
78
77
1 3 5 7 9 11 13 15 17 19 21 23 25 27 29 31 33 35 37 39 41 43 45 47 49 51 53 55 57
Distance in ft. from left pin
2006
2007
2008

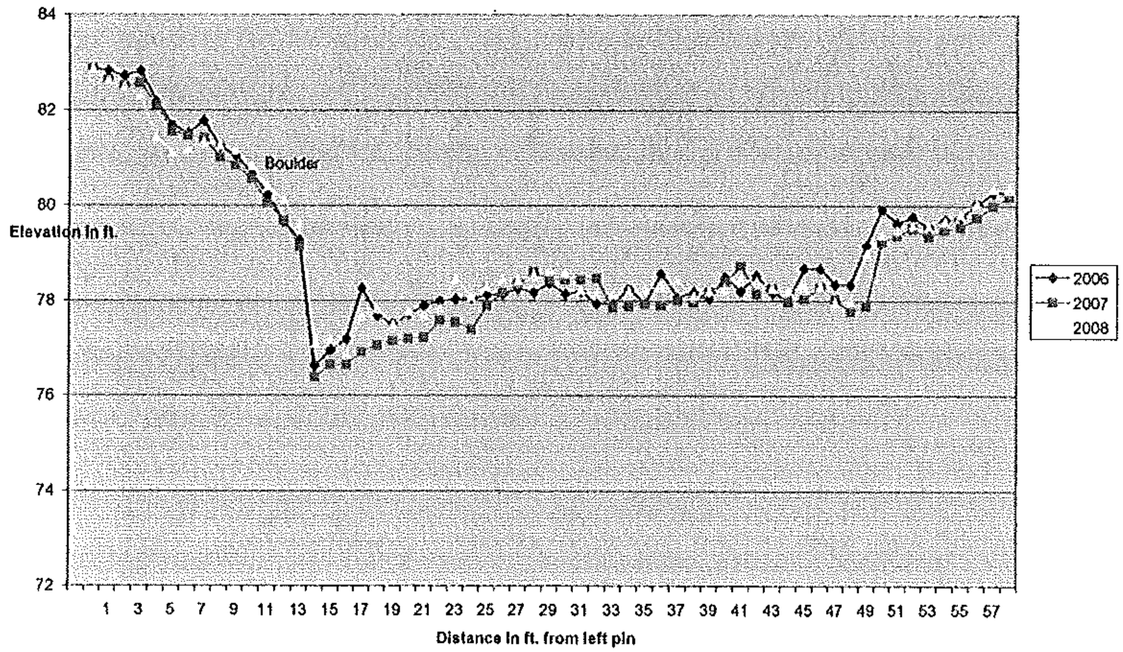
Transect 5A, Station 570 (Pool)
RockWeir 4



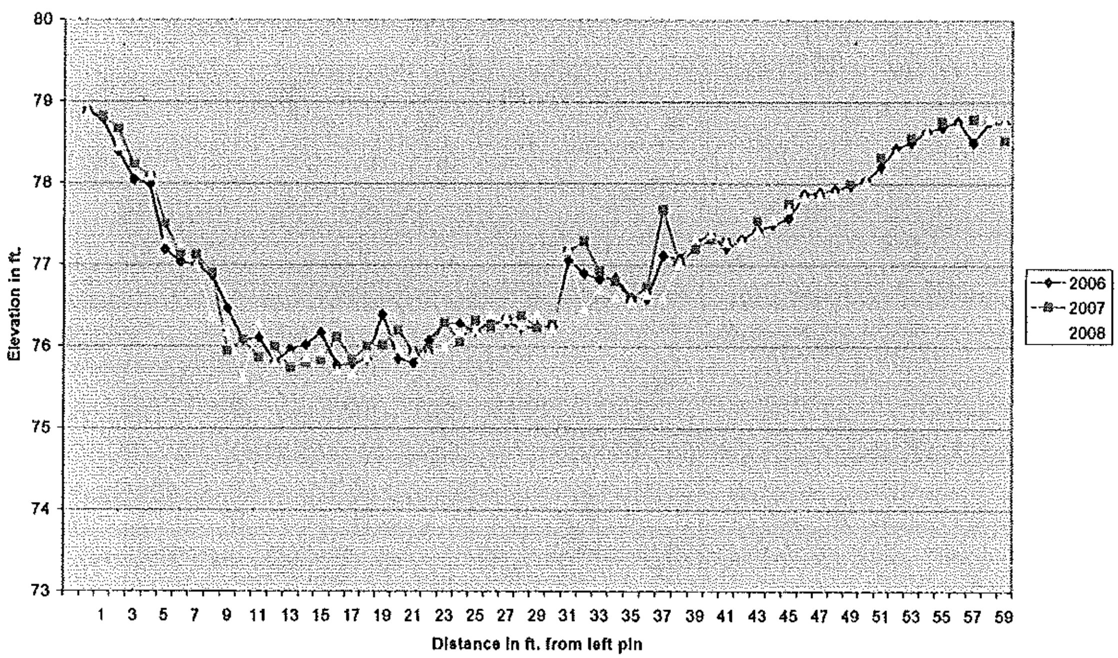
Transect 6 Station 705 (Riffle)
Paired Boulders



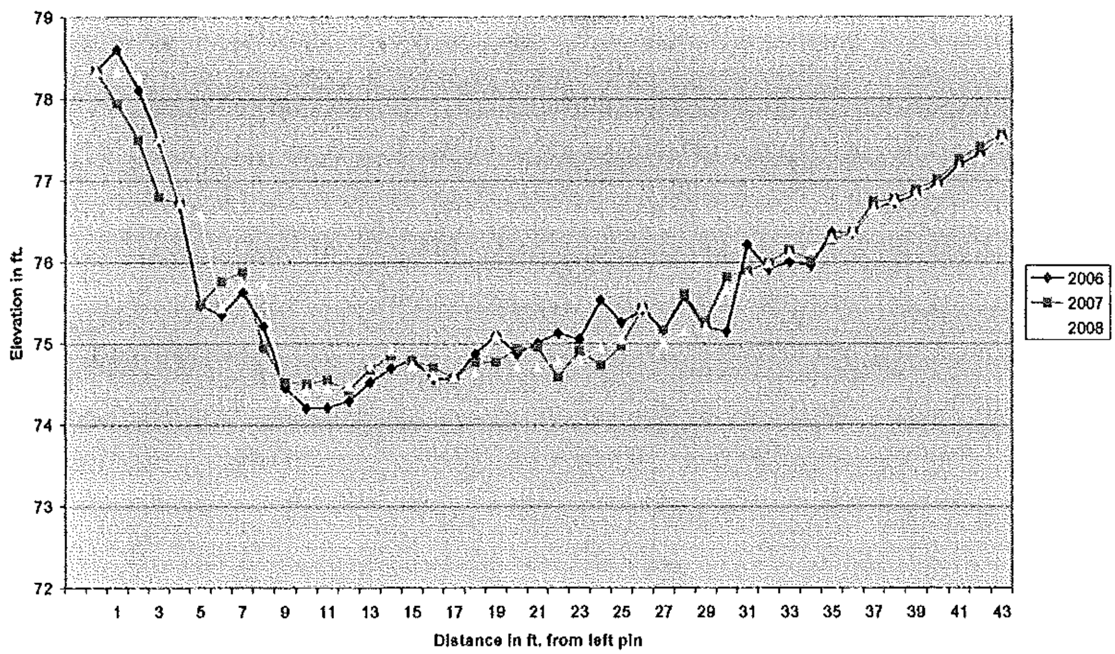
Transect 7, Station 792 (Riffle)
Between 2nd and 3rd set of paired boulders



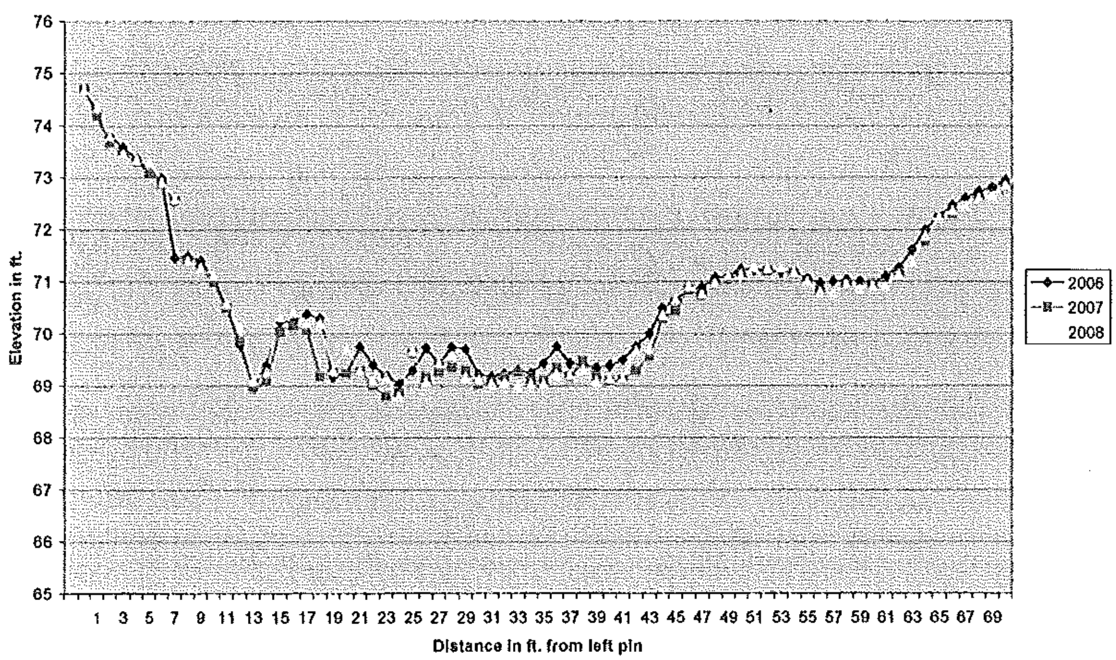
Transect 8, Station 914 (Riffle)
Paired Boulders



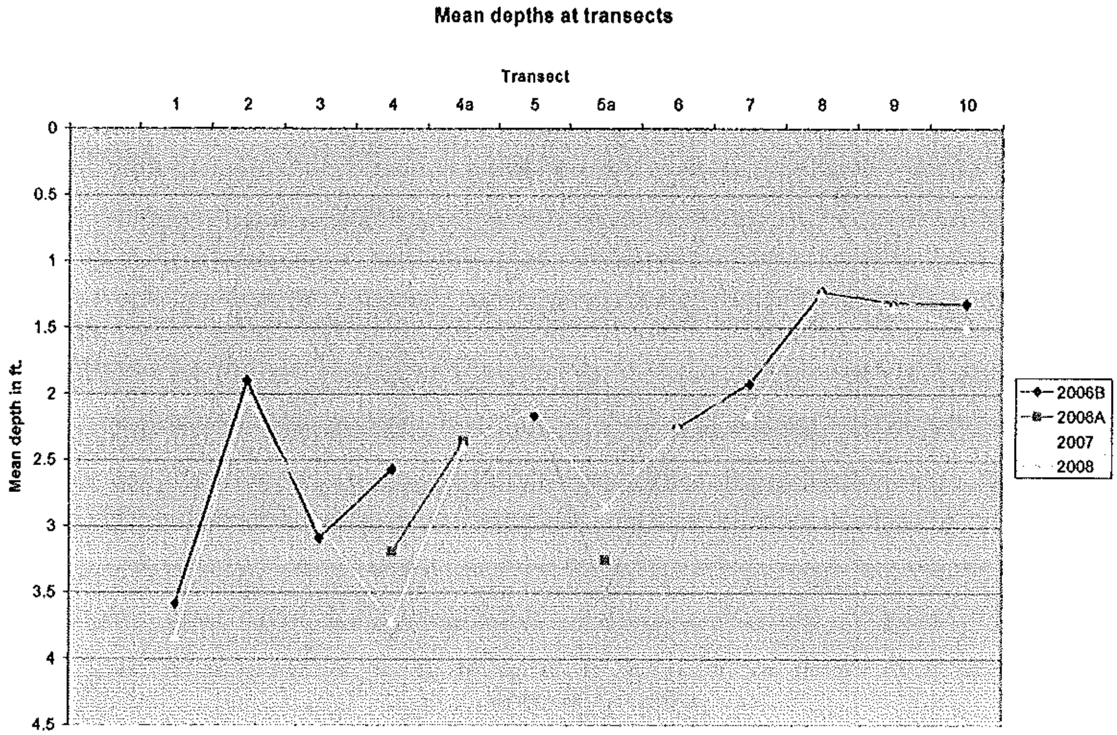
Transect 9 Station 968 (Riffle)
Control

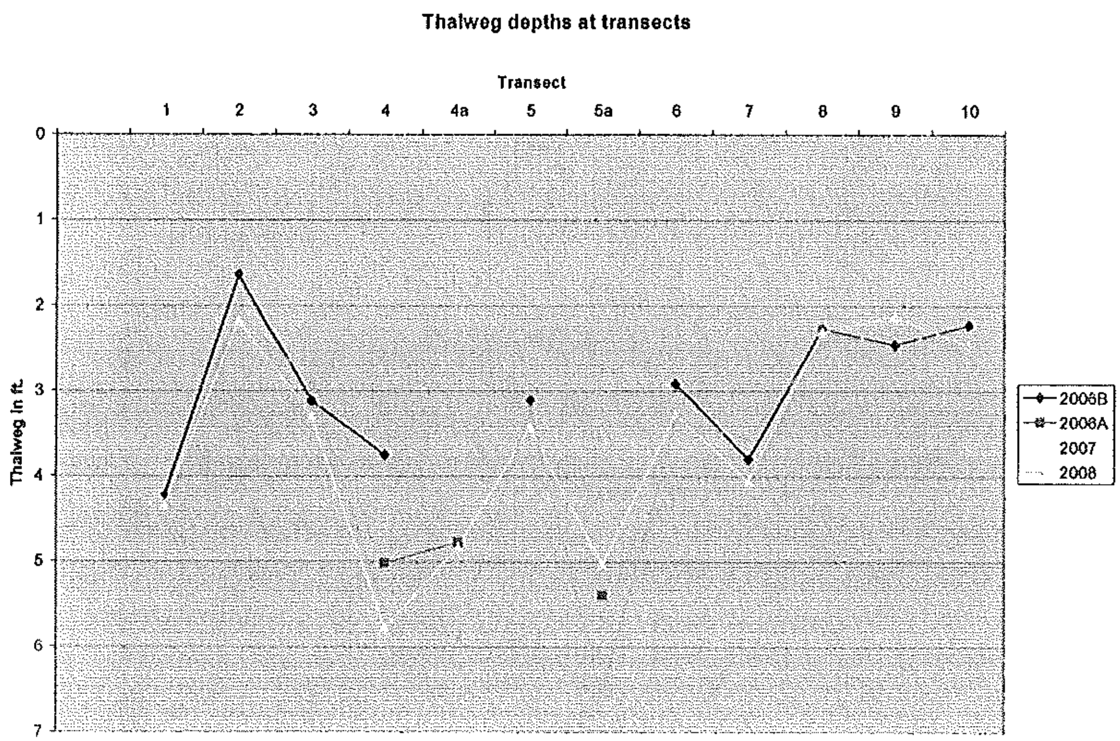


Transect 10 Station 1,186 (Riffle)
Control



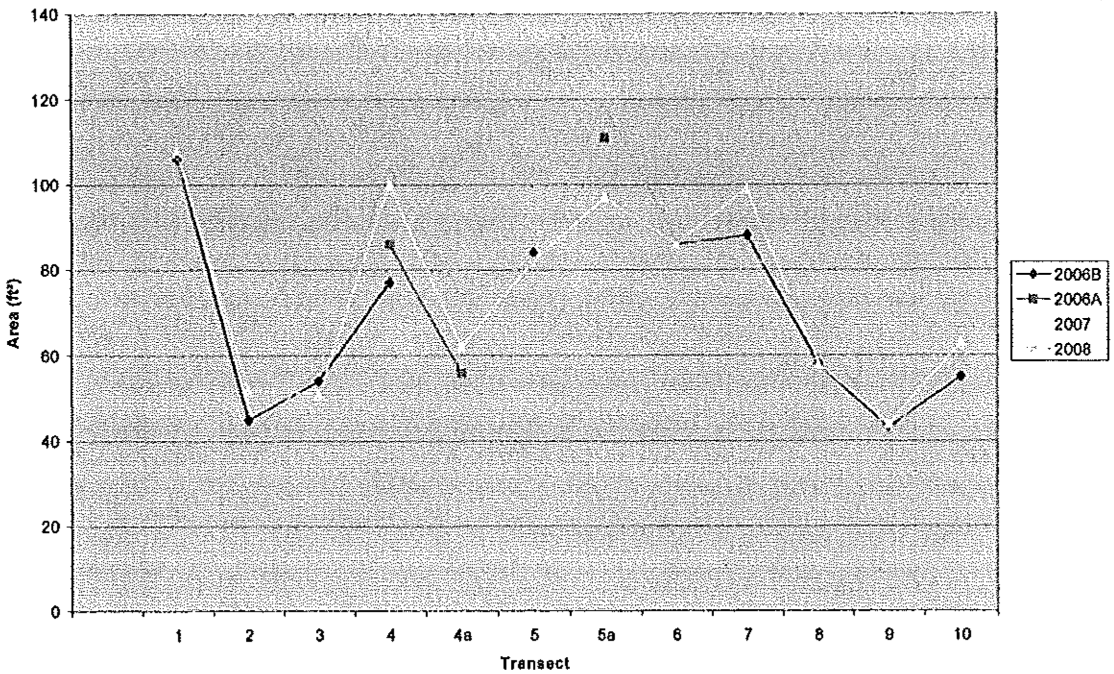
Appendix B[8]
Stream Channel Dimensions



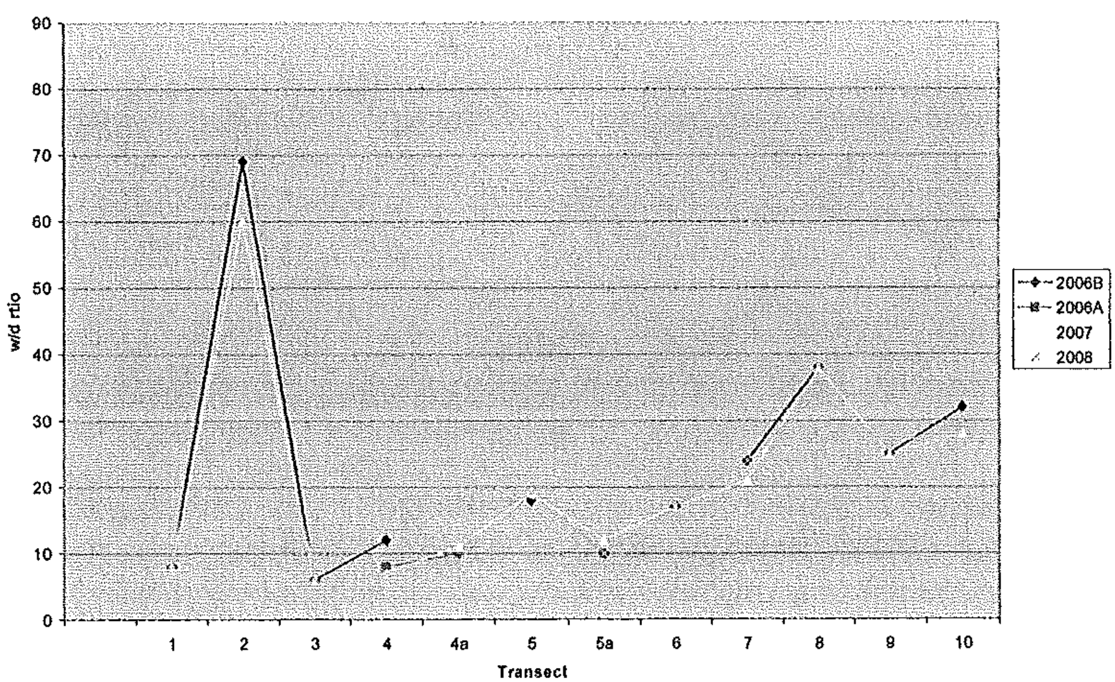


[8] "B" after year indicates that measurements were taken before restoration; "A" indicates after restoration.

Cross sectional area



Width to depth ratio



Appendix C
Photos of Sandy River transects 1-10

Transect 1 (Station 0, Control Area) looking upstream, July 2006. U.S. Route 4 is to right.

Transect 1 (Station 0, Control Area) looking upstream, September 2006.

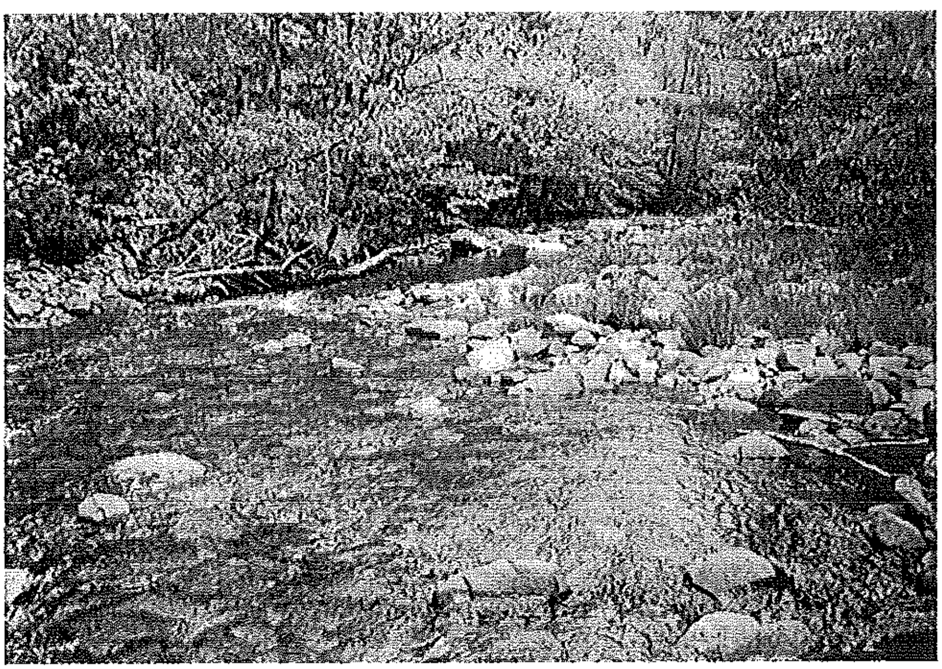
Transect 1 (Station 0, Control Area) looking upstream, August 2007.

Transect 1 (Station 0, Control Area) looking upstream, June 2008.

Transect 1 (Station 0, Control Area) looking downstream, July 2005.

Transect 1 (Station 0, Control Area) looking downstream, September 2006.

Transect 1 (Station 0, Control Area) looking downstream, August 2007.



Transect 1 (Station 0, Control Area) looking downstream, June 2008.

Transect 2 (Station 159, Project Area) looking upstream, July 2005.

Transect 2 (Station 159, Project Area) looking upstream, September 2006, showing uppermost of 2 cabled logs placed diagonally to divert flow, thereby narrowing channel.

COOPERATIVE

STATE FEDERAL

PROJECT

This report has been funded in part by the Federal Aid in Sport Fish Restoration Program. This is a cooperative effort involving federal and state government agencies. The program is designed to increase sport fishing and boating opportunities through the wise investment of anglers' and boaters' tax dollars in state sport fishery projects. This program which was funded in 1950 was named the Dingell-Johnson Act in recognition of the congressmen who spearheaded this effort. In 1984 this act was amended through the Wallop-Breaux Amendment (also named for the congressional sponsors) and provided a threefold increase in Federal monies for sportfish restoration, aquatic education and motorboat access.

The Program is an outstanding example of a "user pays-user benefits", or "user fee" program. In this case, anglers and boaters are the users. Briefly, anglers and boaters are responsible for payment of fishing tackle excise taxes, motorboat fuel taxes, and import duties on tackle and boats. These monies are collected by the sport fishing industry, deposited in the Department of Treasury, and are allocated the year following collection to state fishery agencies for sport fisheries and boating access projects. Generally, each project must be evaluated and approved by the U.S. Fish and Wildlife Service (USFWS). The benefits provided by these projects to users complete the cycle between "user pays — user benefits".

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