



EDI ENVIRONMENTAL DYNAMICS INC.
Natural Resource Consultants

Routine Effectiveness Evaluations of Instream Restoration Treatments

Stony Creek and Corkscrew Creek

Prepared for:

SAI'KUZ FIRST NATION
RR #1 Site 12 Comp. 26
Vanderhoof, BC
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1.0 INTRODUCTION

The Sai'kuz First Nation conducted restoration activities from 1996 to 2000 on Stony and Corkscrew Creeks in the Nulki-Tachick Watershed. Extensive preliminary spawning and juvenile assessments identified limited stream complexity, cover and overwintering habitat in the form of deep pools (Irvine and McIntosh 2002). Restoration activities undertaken to address these issues included but were not limited to: increasing instream complexity by installing Large-Woody-Debris (LWD) structures, creating rearing pools, stabilizing reaches of Corkscrew Creek, restricting livestock access to riparian and instream habitats, extensive riparian planting and removal of fish barriers such as hanging culverts and decayed bridge structures. These restoration initiatives were intended to increase juvenile rainbow trout overwintering survival and increase the recruitment of wild rainbow into the Nulki-Tachick Watershed. EDI Environmental Dynamics Inc (*Environmental Dynamics*) was retained in October 2005 by the Sai'kuz First Nation to perform a Routine Effectiveness Evaluation (REE) of components of the instream restoration work and assess the relative success of riparian planting activity.

This document evaluates the effectiveness of watershed restoration works conducted within the Nulki-Tachick watershed on 3 tributaries to Corkscrew Creek, 3 individual reaches within Corkscrew Creek, and 1 reach on Stony Creek (Table 1). Field surveys were conducted between October 21 and October 27, 2005. All of the sites identified are located in Sai'kuz traditional territory. This area is located within the Ministry of Forests (MOF) Vanderhoof Forest District, and the Ministry of Water, Land and Air Protection (WLAP) Omineca-Peace Region (Appendix I Location Map: Figure1).

Table 1. Streams within the study area

Stream Name	Watershed	Watershed Code	TRIM Mapsheet No.
Stony Creek	Nulki-Tachick	180-271000	093F.089
Corkscrew Creek Reaches 4-6	Nulki-Tachick	180-271000-56200	093F.089
Fish Creek	Nulki-Tachick	180-271000-56200-31200	093F.089
Tributary III	Nulki-Tachick	180-271000-56200-39400	093F.089
Tributary IV	Nulki-Tachick	180-271000-56200-39400-0690	093F.089

Evaluation of the restoration works in each watershed was based on objectives contained in the post construction and restoration summary report “The Nulki-Tachick Watershed Restoration Project: 1995-2000 Summary” which was produced after the restoration works were completed. The principal objective of the restoration structures was increasing fish habitat through bank and channel stabilization and increasing habitat diversity and complexity (Irvine and McIntosh 2002). Sai'kuz was the main proponent for the installation and monitoring of the evaluated structures.

This project has been funded under the auspices of the provincial Forest Investment Account (FIA). Works conducted during the REE are as per the FIA Aquatic Restoration and Rehabilitation Standards outlined in the document “Guidelines for In-stream and Off-Channel Routine Effectiveness Evaluation” (FIA 2003). All performance objectives were scored on a four point system, which was used to rate how

well a restoration structure was or was not meeting predetermined objectives. Table 2 provides a general definition associated with each score value.

Table 2. Definitions of REE score values.

Score	Condition
4	Site conditions resulting from works are exceeding expectations and objectives.
3	Site conditions resulting from works are meeting expectations and objectives.
2	Site conditions resulting from works are failing expectations and objectives.
1	Site conditions resulting from works fail to meet objectives. Expectations are not met.

Source: FIA 2003

2.0 OBJECTIVES AND PERFORMANCE SUMMARY

A summary of the mean physical, biological and recommended maintenance values for each restored reach of Corkscrew and Stony creeks and/or tributaries to these creeks has been provided within Table 3. Mean physical and biological values were calculated across all structure types on the individual reach.

Table 3. Summary of mean performance ratings for all structures on within each restoration area.

Sub-Basin and Reach	Mean Physical Performance of all Structures	Mean Biological Performance of all Structures	Mean Maintenance Recommendation of all Structures
Tributary III, Reach 1	3	3	3.7
Fish Creek, Reach 2	3	3.4	3.8
Fish Creek, Reach 3	3	3	4
Corkscrew Creek, Reach 4	2.9	2.9	3.3
Corkscrew Creek, Reach 5	3	3	3.8
Corkscrew Creek, Reach 6	3	3	3.5
Stony Creek, Reach 2	3	3	3.4

2.1 Tributary III, Reach 1:

Overall objectives associated with the restoration works conducted on Reach 1 of Tributary III included:

- Stabilizing of the stream bank
- Improving cover for fish.

A total of 3 structures were evaluated for physical and biological performance (Table 4). The pooled mean for the associated physical performance objective for the structure types evaluated was 2.8 ± 0.4 , and the biological performance objective was 3.3 ± 0.5 (Figure 2). The individual structures in this reach were: single log deflector (n=1), lateral debris jam (n=1) and lateral deflector (n=1). The physical and biological performance for each structure is summarized in Figure 3. Tables and figures referenced within this section can be viewed in Appendix II – Tributary III, Reach 1. Photos of each structure are contained in Appendix XI.

The overall structural condition and stability was rated very high for the channel stabilizing structures.

Overall, the restoration works on Reach 1 of Tributary III were meeting the initial project objectives of channel stabilization and stream cover. The structures were helping to stabilize the stream channel and to confine the stream within its banks.

2.2 Fish Creek, Reach 2:

Overall restoration objectives associated with the works conducted on Reach 2 of Fish Creek included:

- Increasing stream cover.
- Increasing holding habitat for fish.

The physical and biological performance was evaluated for the 5 structures within Reach 2 (Table 5). The pooled mean physical performance for all structure types was $3.1 \pm .32$, while the pooled mean biological performance for all structure types was 3.4 ± 0.5 (Figure 4). The 5 structures were divided into 2 separate structure categories comprised of lateral debris deflector (n=2) and lateral deflectors (n=3). A summary of the physical and biological performance for each structure type is illustrated in Figure 5. Tables and figures referenced within this section can be viewed in Appendix III – Fish Creek Reach 2.

The overall structural condition and stability was rated very high for the channel stabilizing structures (Mean maintenance $3.8 \pm .45$). Overall, the watershed restoration works installed on Reach 2 were meeting the initial project objectives. Bank stabilizing structures appeared to be limiting further bank erosion in numerous areas. One of the project objectives outlined for the works conducted at this reach was to increase the stream cover and holding habitat. Site photos in Appendix XI show how the structures are meeting their objectives by creating holding habitat and cover within this reach.

2.3 Fish Creek, Reach 3:

Overall restoration objectives associated with the works conducted on Reach 3 of Fish Creek included:

- Increasing the stability of the stream channel.
- Increasing stream cover.

A total of 2 structures located within Reach 3 were evaluated for physical and biological performance (Table 6). The pooled mean physical performance and biological performance for all structure types were both the same at 3 ± 0 (Figure 6). The 2 structures were triangular deflector (n=1) and single cover log (n=1). In addition, a plateau arch culvert that had replaced a hanging culvert was inspected and found to be functioning well. A summary of the physical and biological performance for each structure type is illustrated by Figure 7. Tables and figures referenced within this section can be viewed in Appendix IV – Fish Creek Reach 3.

The overall structural condition and stability was rated very high for the channel stabilizing structures (Mean maintenance 4 ± 0). The structures installed in Reach 3 were functioning well and meeting their overall objectives.

2.4 Corkscrew Creek, Reach 4:

Overall restoration objectives associated with the works conducted on Reach 4 of Corkscrew Creek included:

- Increasing the stability of the stream bank.

A total of 8 structures located within Reach 4 were evaluated for physical and biological performance (Table 7). The pooled mean physical performance and biological performance for all structures was $3 \pm .34$ and $3 \pm .20$ respectively (Figure 8). The 8 structures were triangular deflector (n=2), LWD Revetment (n=1), triple log deflector (n=1), bank pull-back (n=1), debris catcher (n=1), down stream “V” (n=1), lateral deflector (n=1). A summary of the physical and biological performance for each structure type is illustrated by Figure 9. Tables and figures referenced within this section can be viewed in Appendix V – Corkscrew Creek Reach 4.

The overall structural condition and stability was rated effective for the channel stabilizing structures (Mean maintenance 3.3 ± 1.12). Most structures installed in Reach 4 were functioning well and meeting their overall objectives; however a triangular deflector (site 99-06) showed signs of decay necessitating replacement of the structural logs.

2.5 Corkscrew Creek, Reach 5:

Overall restoration objectives associated with the works conducted on Reach 5 of Corkscrew Creek included:

- Increasing the stability of the stream bank.
- Increasing stream cover.

A total of 23 structures located within Reach 5 were evaluated for physical and biological performance (Table 8). The pooled mean physical performance for all structure types was $3.1 \pm .34$, while the pooled mean biological performance for all structure types was 3.1 ± 0.42 (Figure 10). The 23 structures were triangular deflector (n=3), lateral deflector (n=3), opposing single log deflectors (n=1), lateral debris jam (n=5), triple log deflector (n=3), debris catcher (n=2), single cover log (n=1), boulder cluster (n=4). A summary of the physical and biological performance for each structure type is illustrated by Figure 11. Tables and figures referenced within this section can be viewed in Appendix VI – Corkscrew Creek Reach 5.

The overall structural condition and stability was rated effective for the channel stabilizing structures (Mean maintenance $3.8 \pm .52$). Restoration structures installed in Reach 5 were functioning well and meeting their overall objectives. A lateral deflector (site 98-05) was found to be functioning above expectations; the bar adjacent to the deflector was able to establish vegetation as a result of the structure.

2.6 Corkscrew Creek Reach 6:

Overall restoration objectives associated with the works conducted on Reach 6 of Corkscrew Creek included:

- Increasing the stability of the stream bank.
- Increasing stream cover.

A total of 5 structures located within Reach 6 were evaluated for physical and biological performance (Table 9). The pooled mean physical performance for all structure types was $2.8 \pm .60$, while the pooled mean biological performance for all structure types was $3 \pm .40$ (Figure 12). The 5 structures were triple log deflector (n=1) and triangular deflector (n=4). A summary of the physical and biological performance for each structure type is illustrated in Figure 13. Tables and figures referenced within this section can be viewed in Appendix VII – Corkscrew Creek Reach 6.

The overall structural condition and stability was rated effective for the channel stabilizing structures (Mean maintenance $3.5 \pm .55$). Restoration structures installed in Reach 5 were functioning well and meeting their overall objectives. A triangular deflector (site 99-04) was found to be ineffective at low water however the structure was deemed to be effective in high water.

2.7 Stony Creek Reach 2:

Overall restoration objectives associated with the works conducted on Reach 2 of Stony Creek included:

- Increasing the stability of the stream bank.
- Increasing stream cover.

A total of 5 structures located within Reach 6 were evaluated for physical and biological performance (Table 10). The pooled mean physical performance and biological performance for all structure types was both the same at 3 ± 0 (Figure 14). The 5 structures were triple log deflector (n=1), debris catcher (n=2), single cover log (n=1) and log-boulder reef (n=1). A summary of the physical and biological performance for each structure type is illustrated in Figure 15. Tables and figures referenced within this section can be viewed in Appendix VIII – Stony Creek Reach 2.

The overall structural condition and stability was rated effective for the channel stabilizing structures (Mean maintenance $3.4 \pm .54$). Restoration structures installed in Reach 2 of Stony Creek were functioning well and meeting their overall objectives. A few maintenance issues were identified during the evaluation. A cable had come loose on a debris catcher (site 98-01) as a result of rot. Rotten wood (site 98-02), cable corrosion (site 98-03) and silt build up (site 98-04) were identified as possible issues that could jeopardize the long term integrity of the structures.

3.0 FISH SAMPLING RESULTS

Two fish sampling methods used during the watershed evaluation: backpack electrofisher and minnow traps. The field crew employed the method they deemed most appropriate for a particular site. There were a total of 53 minnow traps set and 16 sites were electrofished. A total of 239 fish were captured at all sites (Table 11).

Table 11. Species, range and total fish captured by each sampling method in all sites.

Species	Fork Length Range (mm)	Total Capture by Electrofisher	Total Capture by Minnow Trap	Total Capture all Methods
Rainbow trout	32-140	117	107	224
Northern pikeminnow	n/a	0	12	12
Slimy sculpin	88	1	0	1
Redsided shiner	85-97	2	0	2
Total fish captured		120	119	239

Although a total of 239 fish were captured, individual fish information (length and weight) was only collected for 162 rainbow trout. Fork length frequencies for each sampling method indicate that minnow traps tended to capture larger fish; 28% of the total fish captured by minnow trap were smaller than 60 mm while 62 % of the total fish captured by electrofisher were less than 60 mm (Appendix IX). Length and weight comparisons for the sampled fish indicate a positive linear relationship; that is, weight increases as length increases (Appendix X).

4.0 CONCLUSIONS

Corkscrew and Stony Creek have been impacted by past forest practices and agricultural activities (Irvine and McIntosh 2002). It can take decades for a disturbed stream to resemble stable naturalized conditions but it is important to remember that some of the structures evaluated have already been exposed to as many as 10 freshet events. The overall habitat complexity of the three tributaries, Corkscrew Creek and Stony Creek has been improved by the structures.

Channel morphological processes are currently in a transitional phase as a result of the instream works. Additional monitoring effort will be required to fully determine the effectiveness of the installed structures in improving channel stability and fish production. Based on previous information and photographs of the streams prior to the restoration works, trends towards improved channel stability and improved fish habitat complexity are already noticeable (Appendix XI). Bank stabilizing structures generally appear to be helping reduce lateral stream migration and subsequent channel widening, thus reducing sediment input from bank erosion. Bar stabilizing structures have generally increased sediment storage on bars while promoting riparian recovery. Sill logs, log triangles and other pool forming structures have typically increased or enhanced the rearing and holding potential of the streams by increasing pool frequency and residual pool depth through the promotion of scour activity.

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The following photos are representative of some of the changes observed within Corkscrew Creek. Most indicate improved channel stability and increased habitat complexity.



Corkscrew Creek, Reach 4 (Site 98-02) prior to revetment project. Photo taken downstream.



Corkscrew Creek, Reach 4 (Site 98-02) during revetment project. Photo taken upstream.



Corkscrew Creek, Reach 4 (Site 98-02) following revetment project in 2005. Photo taken upstream.



Corkscrew Creek, Reach 5 (Site 98-02) prior to construction of stabilizing structure.



Corkscrew Creek, Reach 5 (Site 98-02) at time of construction of stabilizing structure.



Corkscrew Creek, Reach 5 (Site 98-02) as of 2005. Note established grasses as indicator of stabilization.



Corkscrew Creek, Reach 5 (site 98-05) at time of construction.



Corkscrew Creek, Reach 5 (site 98-05) at time of construction. Note lack of establish vegetation on the bar.



Corkscrew Creek, Reach 5 (site 98-05). Photo taken in 2005. Note established vegetation on the bar and along left bank as an indicator of increased site stability.



Corkscrew Creek, Reach 5 (site 98-05). Photo taken in 2005. Note established vegetation on the bar as an indicator of increased site stability.

5.0 RECOMMENDATIONS

Overall, the physical and biological performances in conjunction with the mean maintenance values indicate that the restoration works on the identified tributaries and reaches of Corkscrew and Stony Creek were meeting the expectations of the objectives (Table 3). As rot was identified in a few structures, maintenance of these particular sites is therefore recommended. In addition, as some ballast boulders were suspended off the bottom, posing both a safety and structural risk. It is recommended that the cables be extended to permit the ballast rock to settle to the substrate as initially intended. Fish sampling techniques undertaken during this evaluation should be repeated in subsequent years in order to compare physical trends in the data over time (i.e. condition factor of juvenile rainbow trout). Evaluations of the structures should also be scheduled in subsequent years. If upon further monitoring, the mean physical and biological values substantially decrease for any one stream, then remedial works should be considered.

6.0 REFERENCES

- Forest Investment Account. April 2003.** Guidelines for In-stream and Off-Channel Routine Effectiveness Evaluation. British Columbia Provincial Government, Victoria, BC.
- Irvine C. and McIntosh S. March 2002.** The Nulki-Tachick Watershed Restoration Project: 1995-2000 Summary. Prepared for Forest Renewal BC and the BC Ministry of Environment Lands and Parks. Prince George BC.
- Van Schubert, R.M. 2002.** Table River Watershed 2001 Instream Restoration Summary Report. Prepared for Canadian Forest Products Ltd., Prince George, BC. Prepared by EDI Environmental Dynamics Inc., Prince George, BC.

Appendix I
Site Location Map

Appendix II

Reach 1 Tributary III
Summary of performance ratings

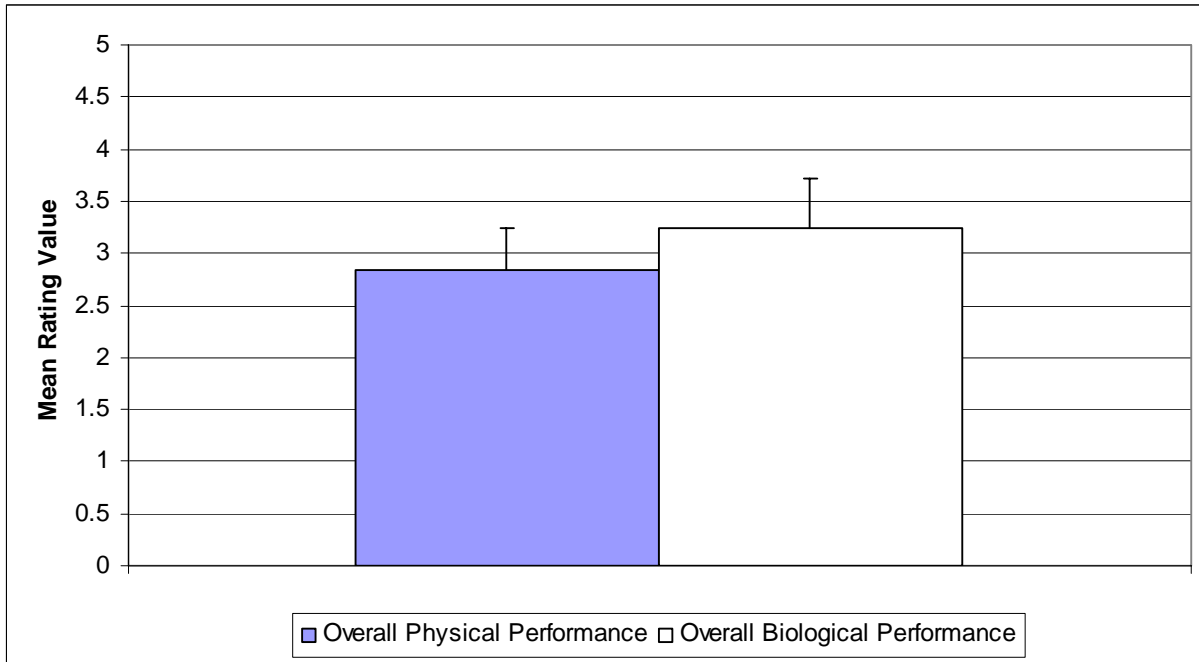


Figure 2. Summary of performance ratings across all structure types on Tributary III Reach 1 (\pm one standard deviation).

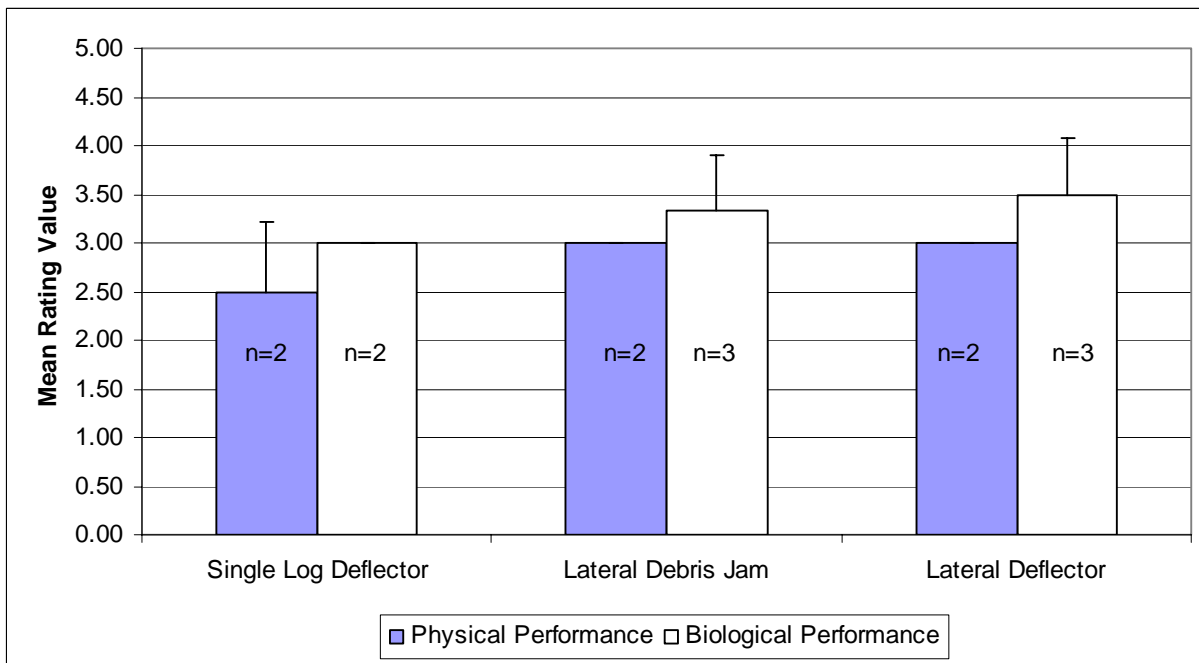


Figure 3. Summary of performance ratings for individual structures on Tributary III Reach 1 (\pm one standard deviation).

Appendix III

Reach 2 Fish Creek
Summary of performance ratings

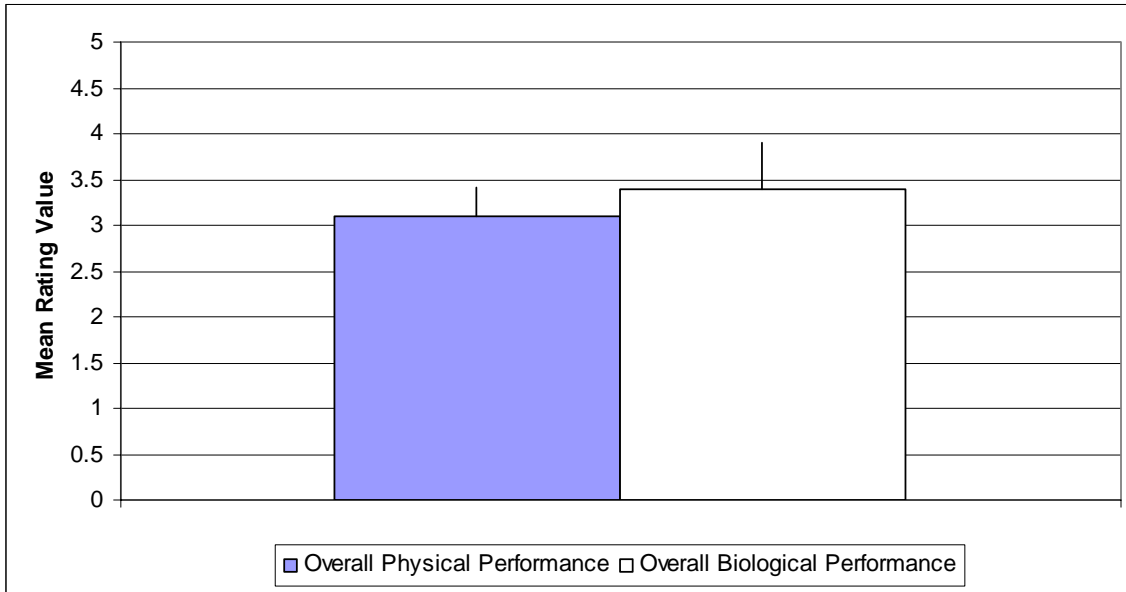


Figure 4. Summary of performance ratings across all structure types on Fish Creek Reach 2 (\pm one standard deviation).

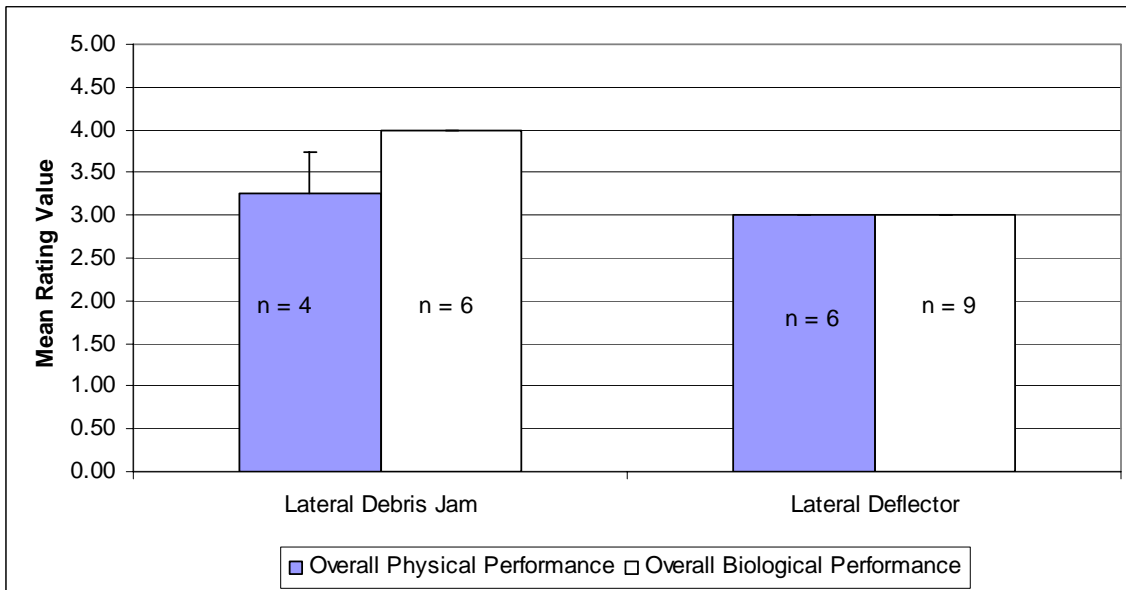


Figure 5. Summary of performance ratings for individual structures on Fish Creek Reach 2 (\pm one standard deviation).

Appendix IV

Reach 3 Fish Creek
Summary of performance ratings

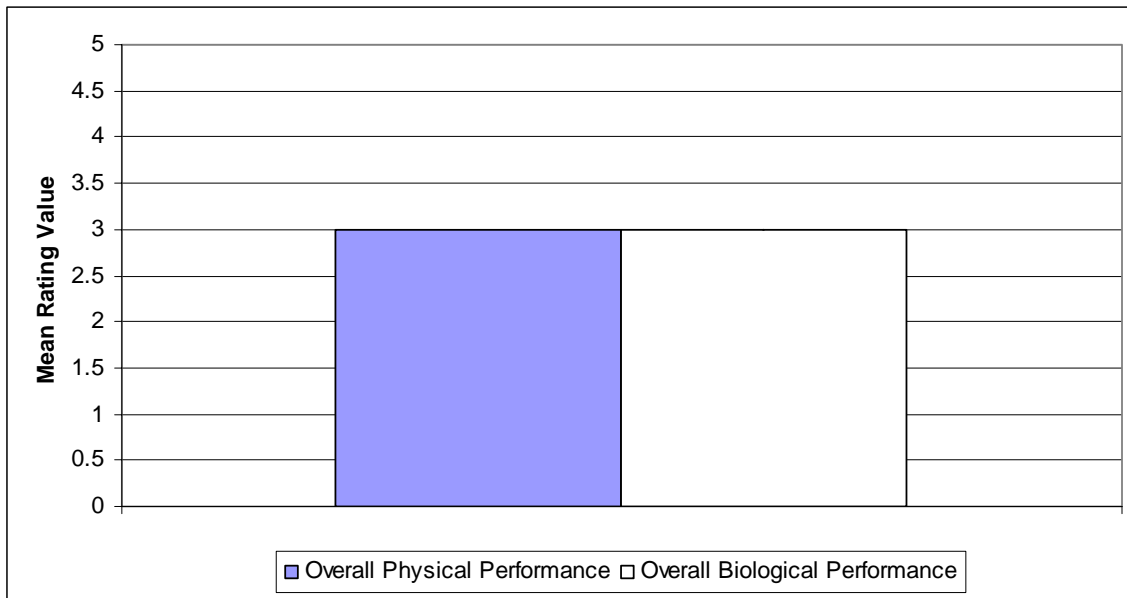


Figure 6. Summary of performance ratings across all structure types on Fish Creek Reach 3 (\pm one standard deviation).

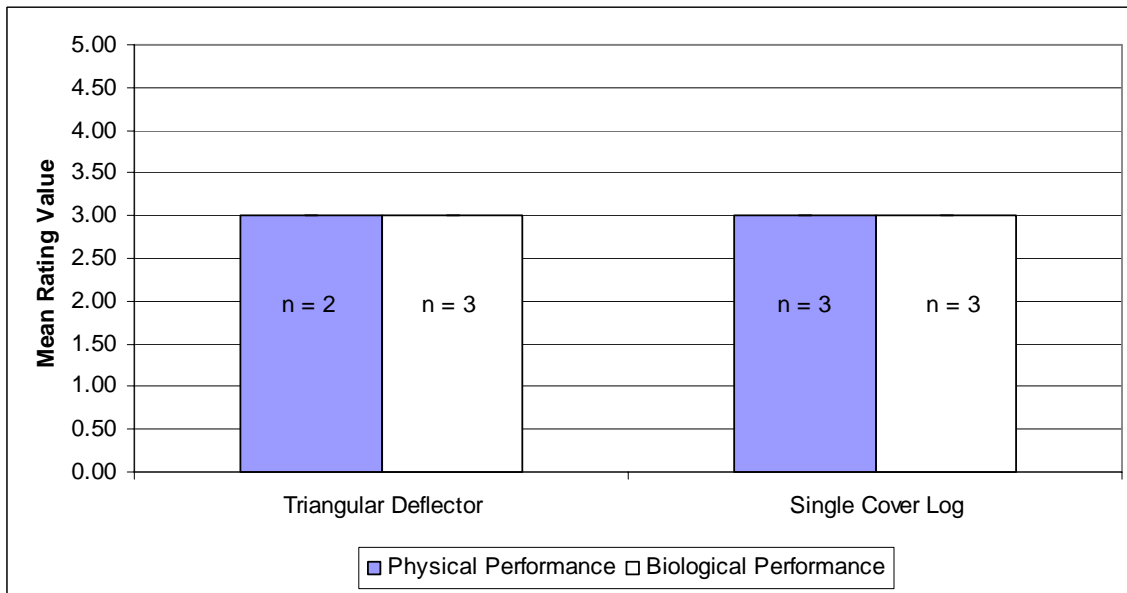


Figure 7. Summary of performance ratings for individual structures on Fish Creek Reach 3 (\pm one standard deviation).

Appendix V

Reach 4 Corkscrew Creek
Summary of performance ratings

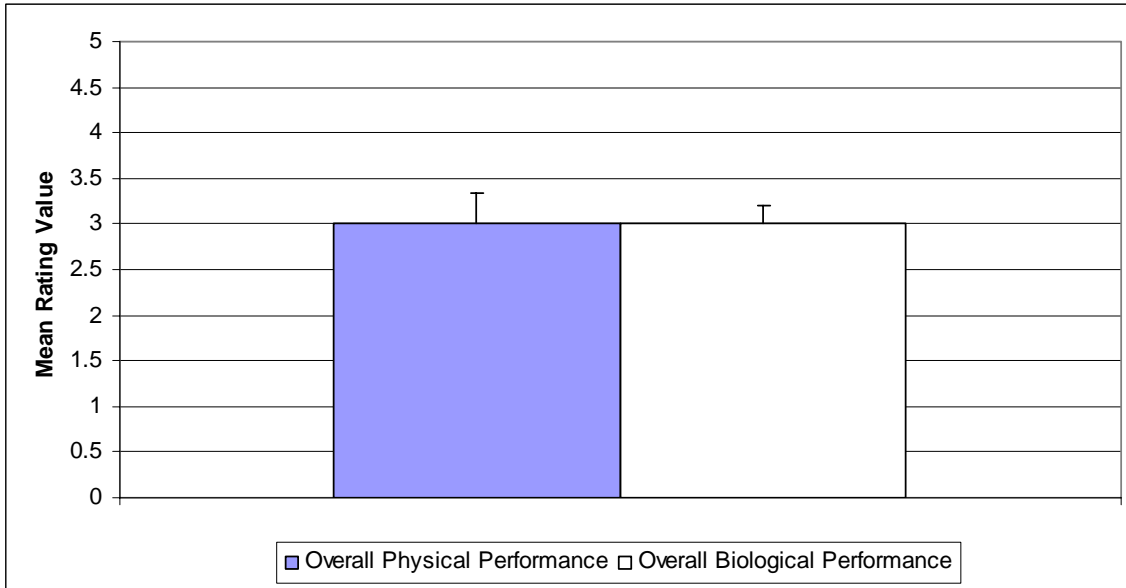


Figure 8. Summary of performance ratings across all structure types on Corkscrew Creek Reach 4 (\pm one standard deviation).

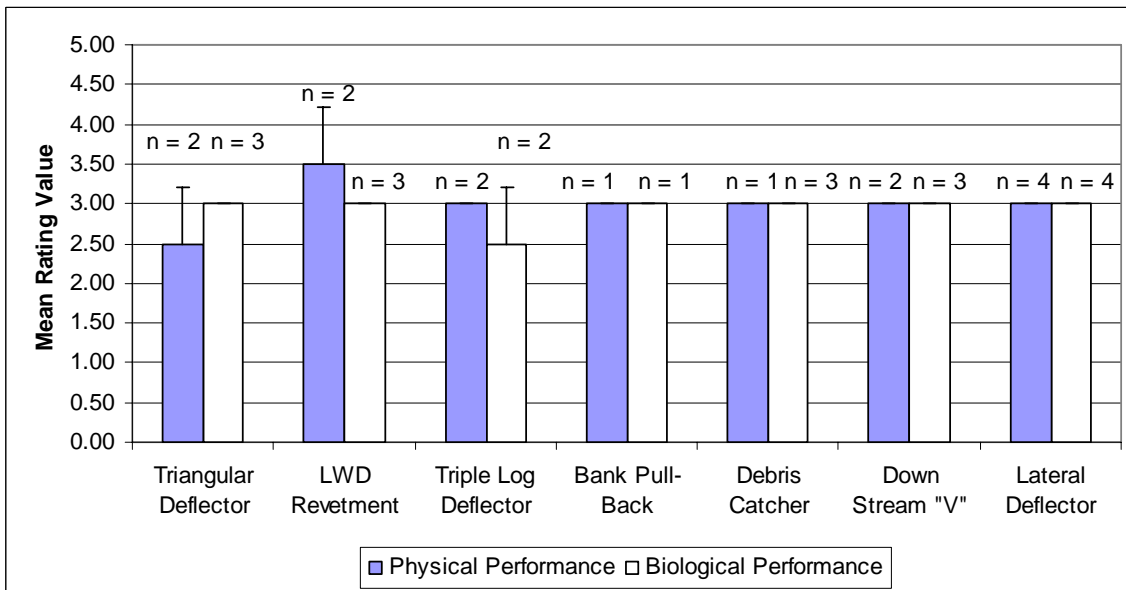


Figure 9. Summary of performance ratings for individual structures on Corkscrew Creek Reach 4 (\pm one standard deviation).

Appendix VI

Reach 5 Corkscrew Creek
Summary of performance ratings

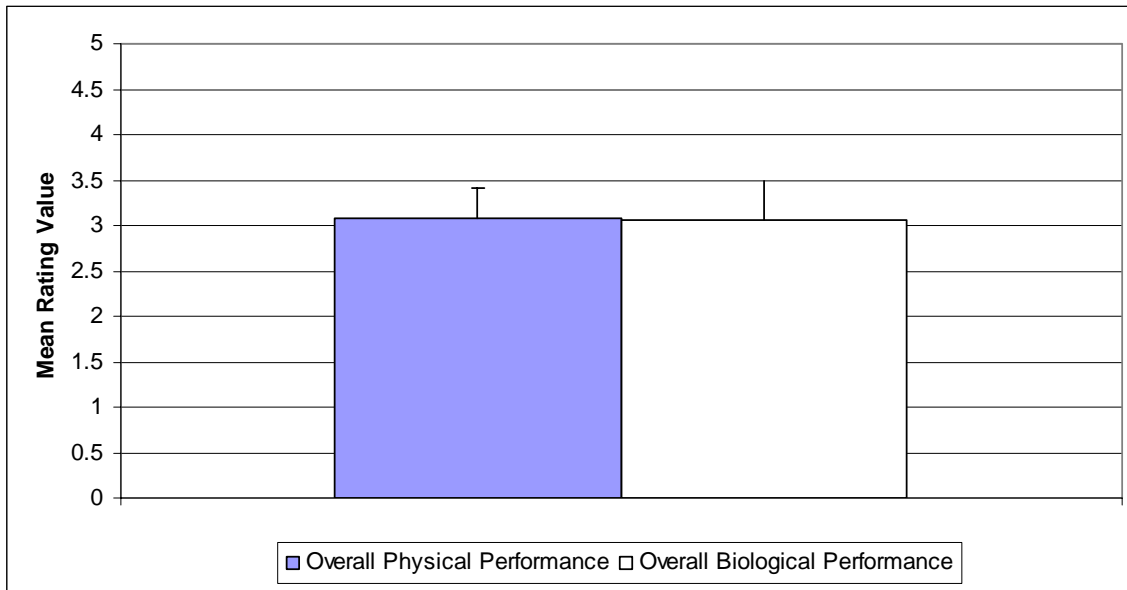


Figure 10. Summary of performance ratings across all structure types on Corkscrew Creek Reach 5 (\pm one standard deviation).

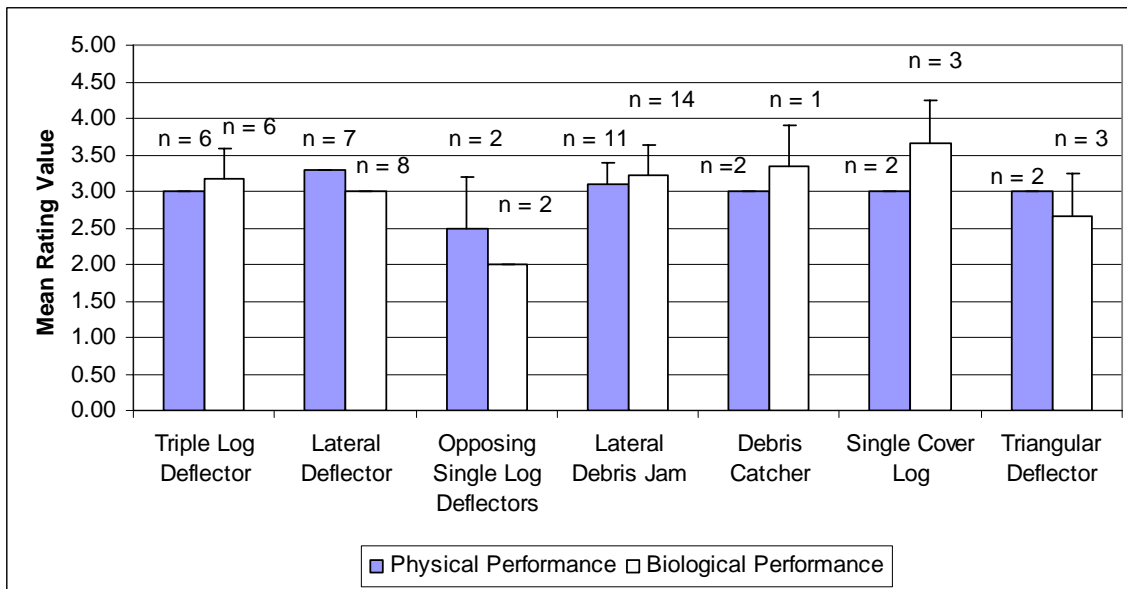


Figure 11. Summary of performance ratings for individual structures on Corkscrew Creek Reach 5 (\pm one standard deviation).

Appendix VII

Reach 6 Corkscrew Creek
Summary of performance ratings

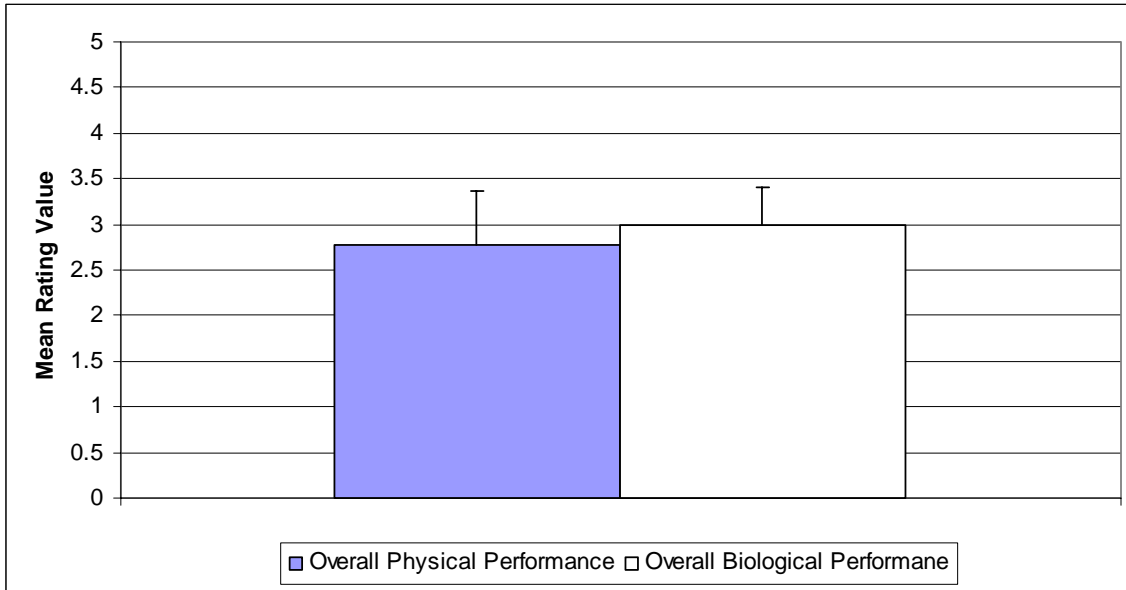


Figure 12. Summary of performance ratings across all structure types on Corkscrew Creek Reach 6 (\pm one standard deviation).

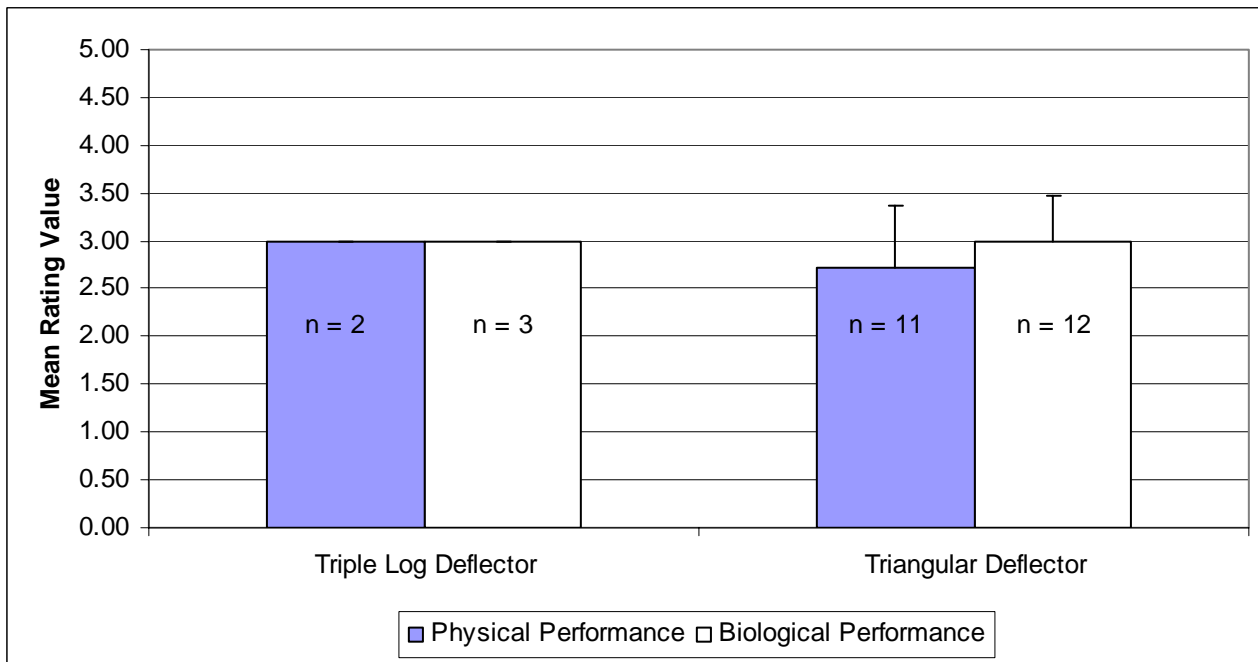


Figure 13. Summary of performance ratings for individual structures on Corkscrew Creek Reach 6 (\pm one standard deviation).

Appendix VIII

Reach 2 Stony Creek
Summary of performance ratings

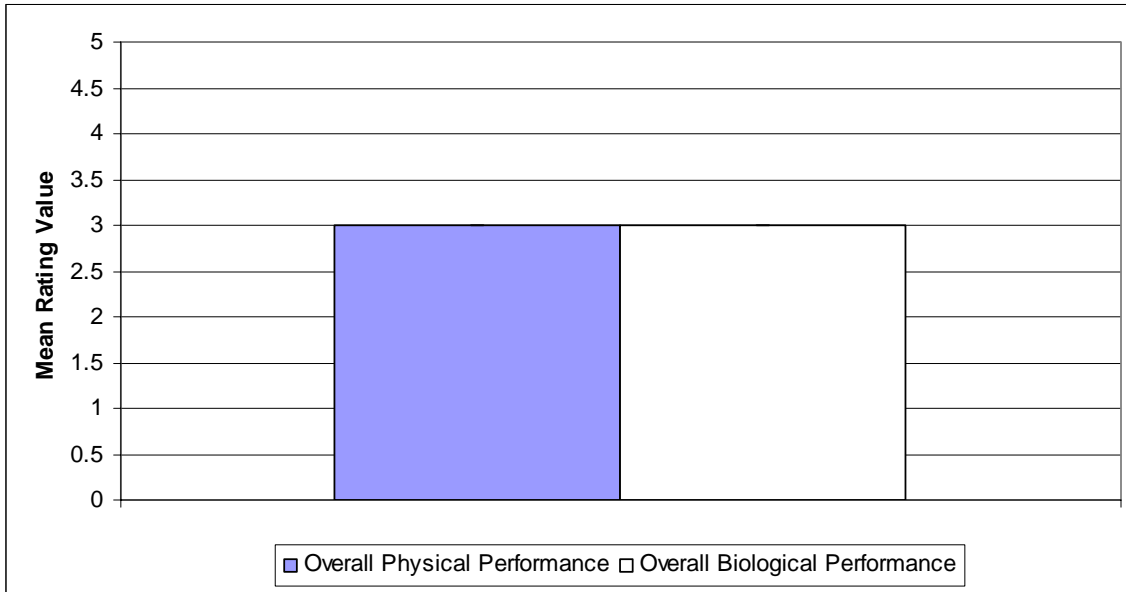


Figure 14. Summary of performance ratings across all structure types on Stony Creek Reach 2 (\pm one standard deviation).

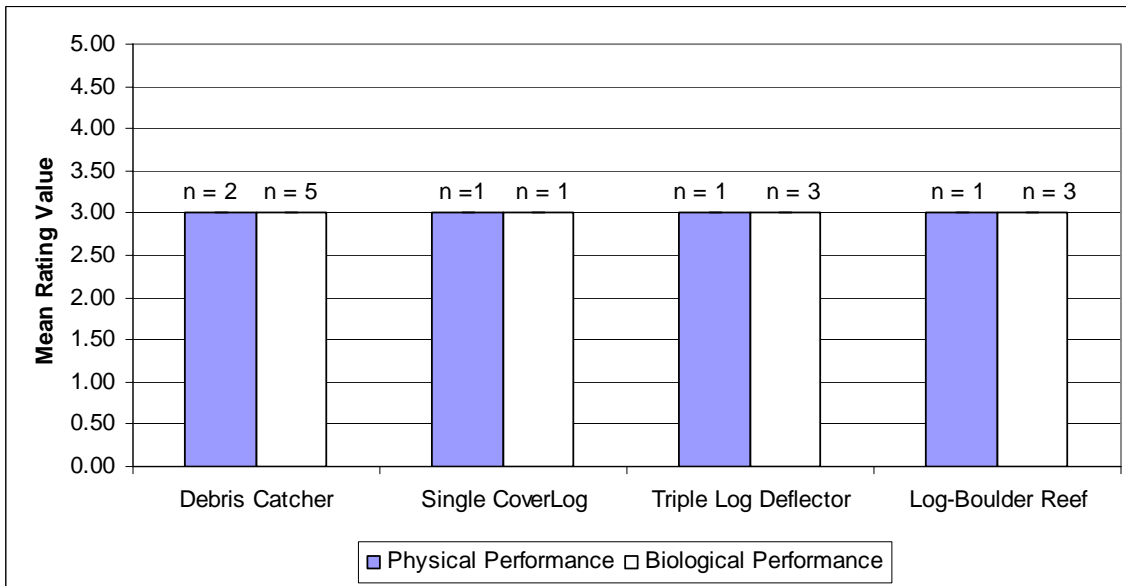


Figure 15. Summary of performance ratings for individual structures on Stony Creek Reach 2 (\pm one standard deviation).

Appendix IX

Fork length frequency histograms
for electrofisher and minnow trap
sampling methods

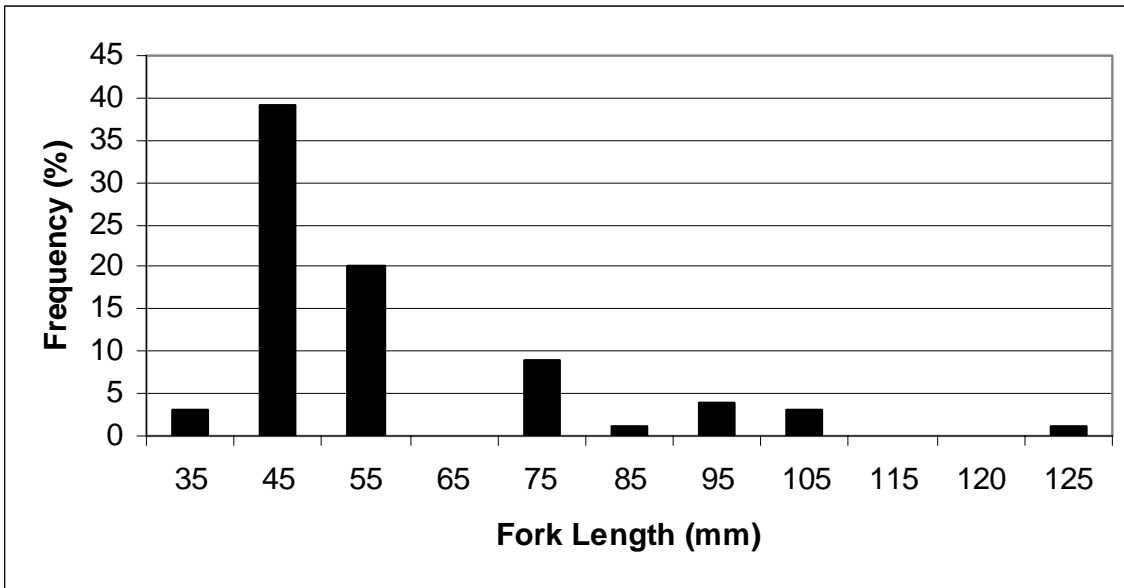


Figure 16. Fork length frequency of total fish captured by electrofishing (N = 81).

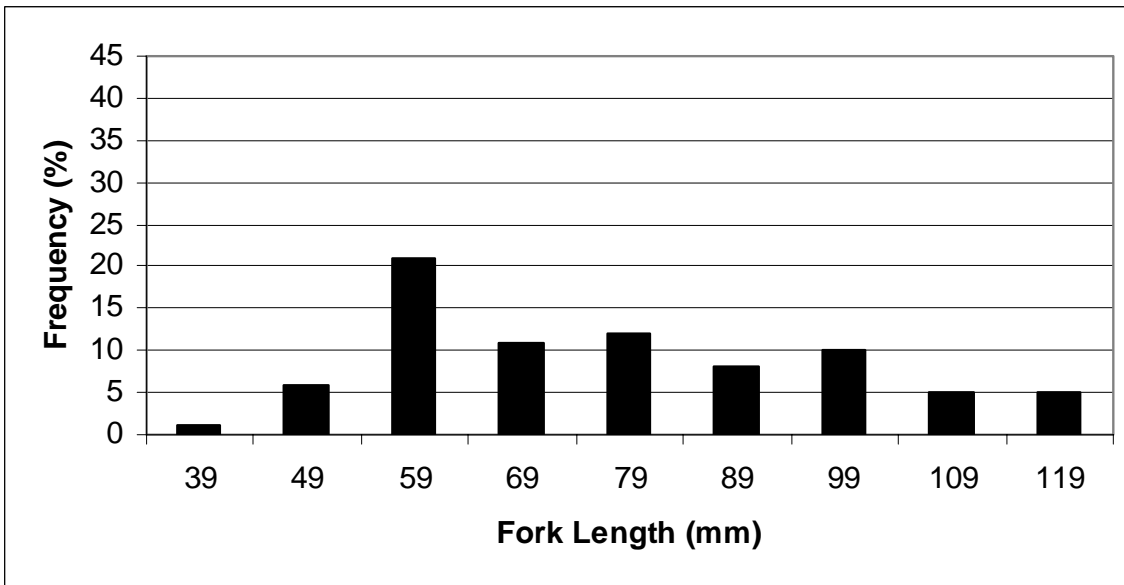


Figure 17. Fork length frequency of total fish captured by minnow trap (N = 81).

Appendix X

Length versus weight of all rainbow trout sampled.

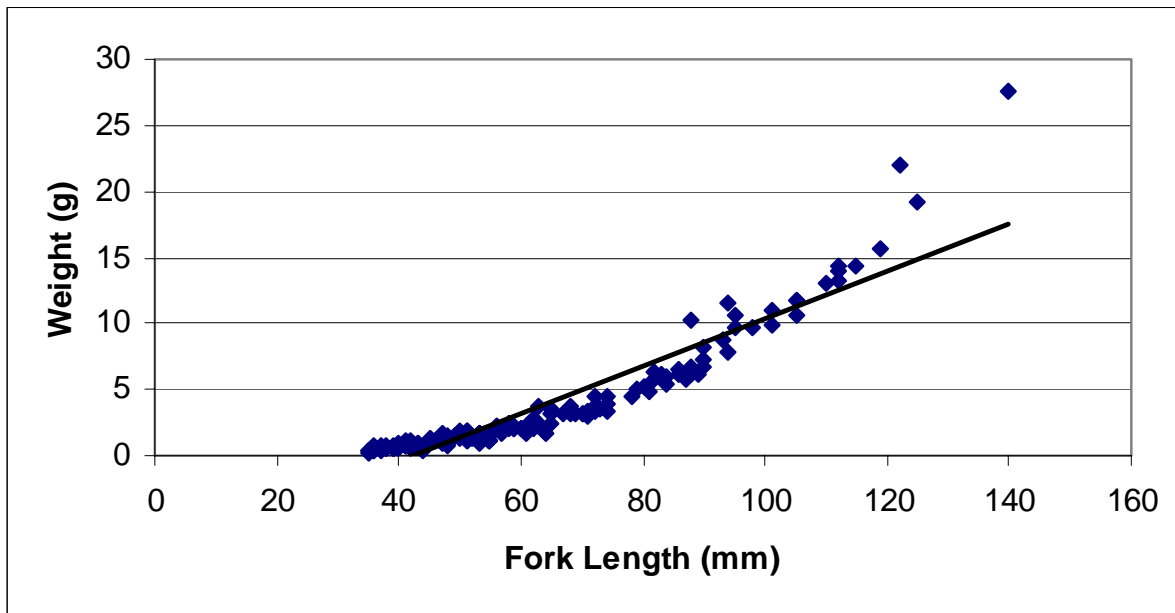


Figure 18. Fork length versus weight of all rainbow trout sampled (N = 162).

Appendix XI

Site photos