MACROINVERTEBRATE MONITORING IN OTTER RUN
1995 - 2014

OR-14 in February 2006

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TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

INTRODUCTION

Normandeau Associates, Inc. has monitored the macroinvertebrate community in Otter Run, located near English Center in northern Lycoming County on behalf of Fisher Mining Company, since May 1998 and continues to do so. Previous to May 1998, Dr. Dean Arnold of The Pennsylvania State University performed this monitoring, beginning in August 1995. This monitoring is associated with re-mining of the Thomas Mine Site by Fisher Mining Company under Surface Mining Permit No. 41940101. The objective of the monitoring is to determine if manganese in the stream water has an effect on the macroinvertebrate community in Otter Run by comparing samples collected in Otter Run, downstream of Fisher's mining operations, to samples collected in nearby Silver Branch. Silver Branch is a tributary to Otter Run and is free of manganese.

This report reviews the history of the Otter Run macroinvertebrate monitoring, with emphasis on the monitoring conducted since August 2000 when a new methodology was put into effect. The results of the macroinvertebrate monitoring are reviewed and water quality measurements of manganese in Otter Run are presented for context.

MONITORING METHODOLOGY

Dr. Dean Arnold, assisted by Penn State graduate students, began monitoring in Otter Run with collection of rock bags placed at multiple locations in August 1995 (see below in this section for a more detailed description of the rock bag sampling methodology). All macroinvertebrates collected were identified and used in data analysis. This sampling and data analysis methodology was followed in sampling conducted monthly until March 1997. Beginning in September 1997, changes were made to reduce the number of sample locations to three and the frequency of sampling to quarterly and to restrict macroinvertebrate identification and data analysis to only mayflies (Ephemeroptera), stoneflies (Plecoptera), and caddisflies (Trichoptera). Sampling followed this methodology, the Protocol for Action Level Determination, Sampling, and Data Analysis for Otter Run at OR-14 (dated 15 September 1997), through May 2000.

A new sampling and data analysis methodology was developed during the summer of 2000 by a work group that included the PA Fish and Boat Commission and Fisher Mining Company's consultants Normandeau Associates, Inc. and Meiser and Earl, Inc. The US Geological Survey mediated the methodology development. This new methodology, the Methodology for Determining a Significant Loss of Biota, Fisher Mining Company, Thomas Mine (Arway *et al.* 2000), was put into effect beginning with macroinvertebrate samples collected in August 2000. Use of this methodology continues today. It is described in greater detail below.

Sampling and Laboratory

Two macroinvertebrate sample stations are employed, one located in Otter Run (Station OR-14) and one located in Silver Branch (SB-01). These stations are approximately 150 yards apart. Both stations

are in close proximity, approximately 150 yards apart. Although Station SB-01 is located in Silver Branch a short distance upstream of the Otter Run confluence, it is sufficiently upgradient to be unaffected by any backwater effect of high flow in Otter Run. Habitat conditions are similar at both stations – shallow riffle and run habitat containing a substrate composed of sand, gravel, cobble, and boulders no larger than approximately 1.5 feet in the largest dimension. No submerged aquatic vegetation was observed at either station throughout the monitoring. Because the surrounding area is eastern hemlock-dominated forest, there is woody debris present at both stations.

Identical macroinvertebrate sample collection methods are employed at both stations. Twelve plastic mesh (0.5-inch openings) bags, 12 inches x 12 inches x 6 inches and filled with cobbles, are submerged on the stream bottom at each station. These rock-filled bags are secured to shoreline tree roots or trunks with lengths of plastic cord in an attempt to prevent their loss during high flow conditions. Remaining in place submerged on the stream bottom for approximately 90 days before collection, the rock-filled bags function as colonization samplers of macroinvertebrates present at the stations.

The macroinvertebrate samples are collected at each station once per quarter in late February (Winter Quarter), May (Spring Quarter), August (Summer Quarter), and November (Fall Quarter). On each sample date, a target number of 10 submerged rock-filled bags are removed from the stream bottom at each station. However, occasionally fewer than 10 bags are found to be submerged at one or both stations. The others are found above the waterline or lost due to high flow. Each submerged bag collected is placed into a bucket immediately after it is lifted from the water in order to minimize loss of macroinvertebrates through the mesh. The bag is opened and the contents (rocks, sand, organic matter, and macroinvertebrates) dumped/washed into the bucket. The rocks and larger organic materials (twigs, leaves, etc.) are washed free of macroinvertebrates and set aside (rocks) or discarded (larger organic materials). The water in the bucket (including sand, smaller organic materials, and macroinvertebrates) is poured over a 0.200 mm mesh sieve in order to reduce the amount of water in the sample. Everything retained on the sieve is placed into a ziplock plastic bag, labelled, and preserved with isopropanol for transport to the laboratory.

The sampling process is completed by placing the rocks back into the plastic mesh bags and returning the bags to the stream bottom. In this way, the bags can be colonized by macroinvertebrates before the next sample collection effort scheduled approximately 90 days later.

In the laboratory, the entire contents of each sample are placed into a white enameled pan and all macroinvertebrates are sorted from the sand and smaller organic materials in the sample. All of the macroinvertebrates sorted from each sample are identified using dissection microscopes. Identification is performed to genus level in most cases. The exceptions are midges (Chironomidae), worms (Oligochaeta, Nematoda, etc.), and mites (Hydracarina), which are left at these taxonomic levels.

Data Analysis

Ten macroinvertebrate samples are collected at each station on most dates. On dates when fewer and unequal numbers of samples are collected, the number of samples are made equal for both stations by randomly selecting samples to be excluded from data analysis for the station where more samples are collected.

The data obtained from the macroinvertebrate samples collected at each station are entered into a spreadsheet for computation of five metrics:

- Mean Density (the average number of individual macroinvertebrates per rock bag)
- Taxa Richness (the total number of taxa identified in all of the rock bags)
- Mean EPT Density (the average number of mayfly, stonefly, and caddisfly individuals per rock bag)
- EPT Taxa (the total number of mayfly, stonefly, and caddisfly taxa identified in all of the rock bags)
- Community Loss Index (the difference in the number of taxa between Stations SB-01 and OR-14). This index is described in Courtemanch and Davies (1987).

These metrics are computed for each station's samples and then scored, based on Biological Condition Scoring Criteria adapted from the US Environmental Protection Agency's Rapid Bioassessment Protocols for Use in Streams and Rivers: Benthic Macroinvertebrates and Fish (Plafkin, *et al.* 1989). Percent of Reference is computed and compared to 50% of the appropriate Seasonal Biological Condition Score. The Seasonal Biological Condition Scores were determined in methodology development using the data obtained from macroinvertebrate samples collected at Stations OR-14 and SB-01 in July 1996 through May 1998, a period considered to represent baseline conditions for benthic community stability. Values for 50% of the Seasonal Biological Condition Scores are: winter – 28%, spring – 27%, summer – 34%, and fall – 30%. Percent of Reference below 50% of the Seasonal Biological Condition Score in two consecutive quarters constitutes "a significant loss of biota" at Station OR-14.

MONITORING RESULTS

The complete record of monitoring results compiled from macroinvertebrate samples collected at Otter Run Station OR-14 and Silver Branch Reference Station SB-01 from August 1995 through September 2014 is shown in Figures 1-a through 1-d. Station OR-14 was determined to be impaired, compared to Station SB-01, on 6 of 9 sample dates between August 1995 and June 1996 (Figure 1-a). This period corresponds exactly to the period during which the Fisher Mine's alkaline discharge did not flow to Buckeye Run. Mining on the Fisher operation ceased in August 1995 and pumpage of alkaline pit water to Buckeye Run stopped at that time (Ed Meiser, January 2015, personal comm.). Water quality monitoring at Station OR-14 in September 1995 indicated that absence of the alkaline Fisher Mine pumped discharge in Buckeye Run resulted in increased acidity in Otter Run downstream of the Buckeye Run confluence. When the backfilled Fisher Mine filled with water in Spring 1996, the M-1 discharge began to flow in May 1996, discharging alkaline mine water to Buckeye and Otter Runs. This resumption

of the M-1 discharge in May 1996 increased alkalinity and reduced acidity in Otter Run, simultaneous with observed improvement in macroinvertebrate community structure at Station OR-14. This relationship between the M-1 discharge and downstream water quality in Otter Run was described in the 2000 Methodology for Determining a Significant Loss of Biota.

The M-1 discharge has continued to flow to Buckeye Run to the present day and Station OR-14 was determined to be not impaired on every sample date after June 1996 (Figures 1-a through 1-d). Although Station OR-14 Percent of Reference exceeded 50% of the appropriate Seasonal Biological Condition Score (27-34%, depending on season) by only a few percentage points on several sample dates (e.g., Station OR-14 Percent of Reference between 30 and 40 percent), most of the time the difference was much greater (e.g., Station OR-14 Percent of Reference ≥60%), especially after mid-2006.

The in-stream limit for manganese below a regulated mine discharge under a PA Department of Environmental Resources surface mining permit is 1.0 mg/l, out of concern that manganese in excess of this value is a threat to macroinvertebrate community structure. However, measurements of manganese made monthly at OR-14, also shown in Figures 1-a through 1-d, frequently exceeded 1.0 mg/l after June 1996, a period of over 18 years in which Station OR-14 was determined not to be impaired. Therefore, manganese at the levels measured does not impair the macroinvertebrate community at Station OR-14.

The samples collected at Station OR-14 describe a resident macroinvertebrate community containing several dozen taxa comprised almost entirely of insects. These insect taxa include various kinds of flies (Diptera), including chironomids, blackflies, and craneflies, as well as the mayflies (Ephemeroptera), stoneflies (Plecoptera), and caddisflies (Trichoptera) that are indicators of good water quality. In addition, crayfish (Decapoda), water mites (Hydracarina), and worms (Oligochaeta) are collected occasionally in small numbers at Station OR-14. A sample dataset collected at Station OR-14 in September 2014 is shown as Table 1. For comparison purposes, a sample dataset collected at Station SB-01 on the same date is shown as Table 2.

REFERENCES

Arway, J., S. Kepler, E. Meiser, B. Cameron, W. Ettinger, and M. Bilger. 2000. Methodology for Determining a Significant Loss of Biota, Fisher Mining Company, Thomas Mine. Pennsylvania Fish and Boat Commission.

Courtemanch, D.L. and S.P. Davies. 1987. A coefficient of community loss to assess detrimental change in aquatic communities. Wat. Res. 21(2): 217-222.

Plafkin, J.L., M.T. Barbour, K.D. Porter, K.D. Gross, and R.M. Hughes. 1989. Rapid Bioassessment Protocols for Use in Streams and Rivers: Benthic Macroinvertebrates and Fish. EPA/444/4-89-001. U.S. Environmental Protection Agency, Assessment and Watershed Division, Washington, DC.

Figure 1-a.
Fisher Mining Company - Otter Run Station OR-14 compared to Silver Branch Reference Station SB-01
Results of Macroinvertebrate Monitoring Using the August 2000 Protocol and Monthly Manganese Measurements
August 1995 through December 1999

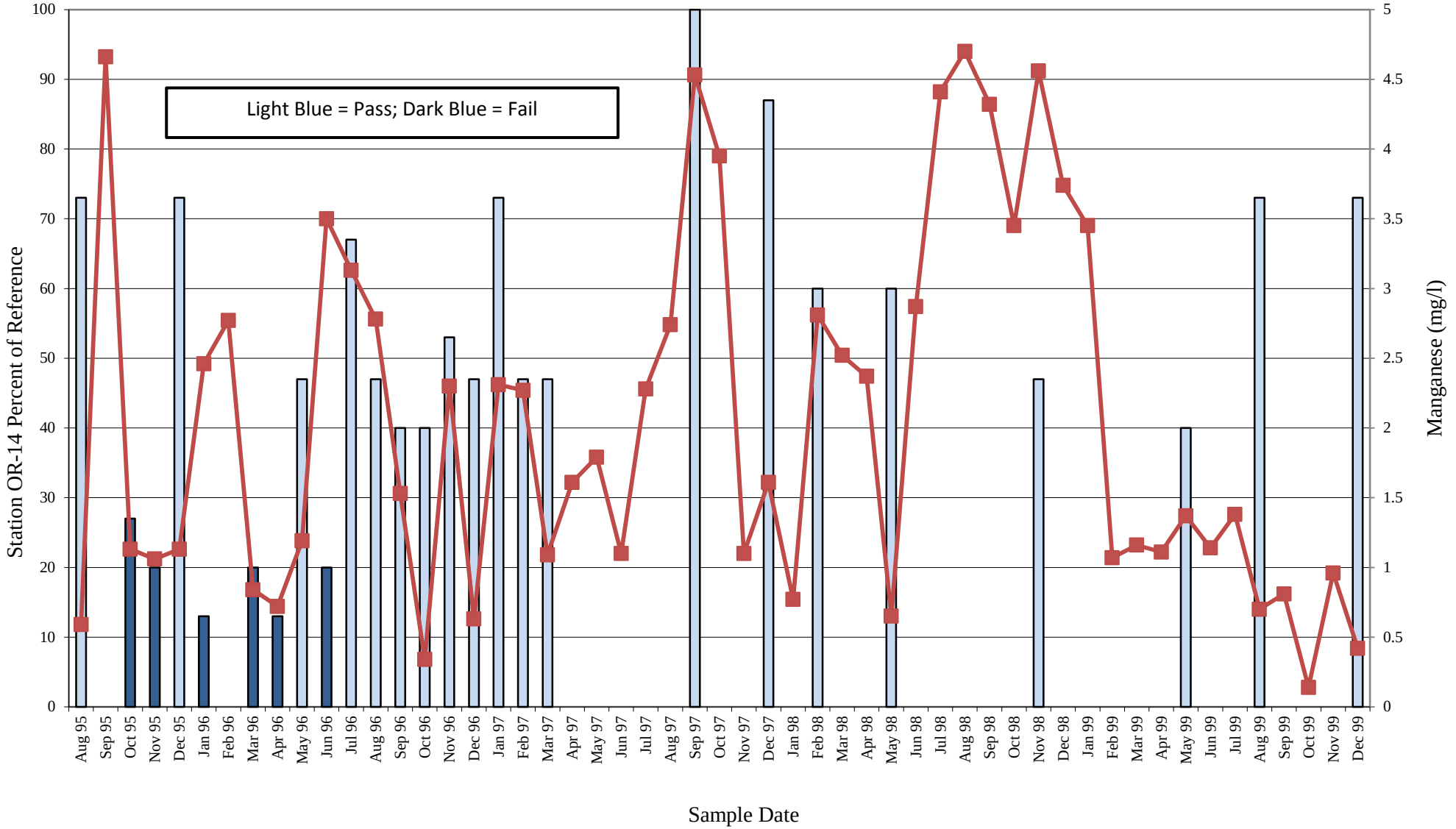

Figure 1-b.
Fisher Mining Company - Otter Run Station OR-14 compared to Silver Branch Reference Station SB-01
Results of Macroinvertebrate Monitoring Using the August 2000 Protocol and Monthly Manganese Measurements
January 2000 through December 2004

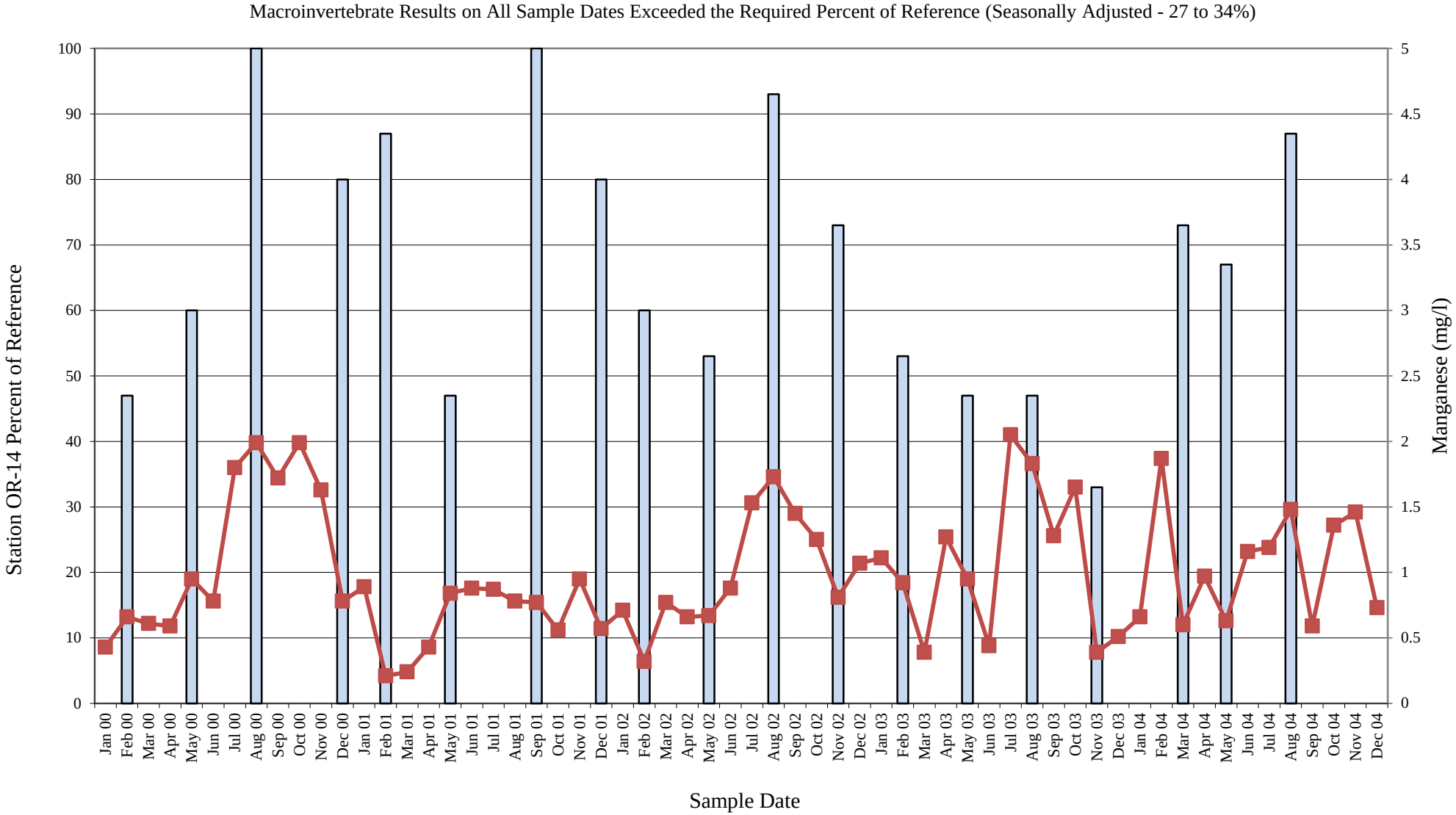

Figure 1-c.
Fisher Mining Company - Otter Run Station OR-14 compared to Silver Branch Reference Station SB-01
Results of Macroinvertebrate Monitoring Using the August 2000 Protocol and Monthly Manganese Measurements
January 2005 through December 2009

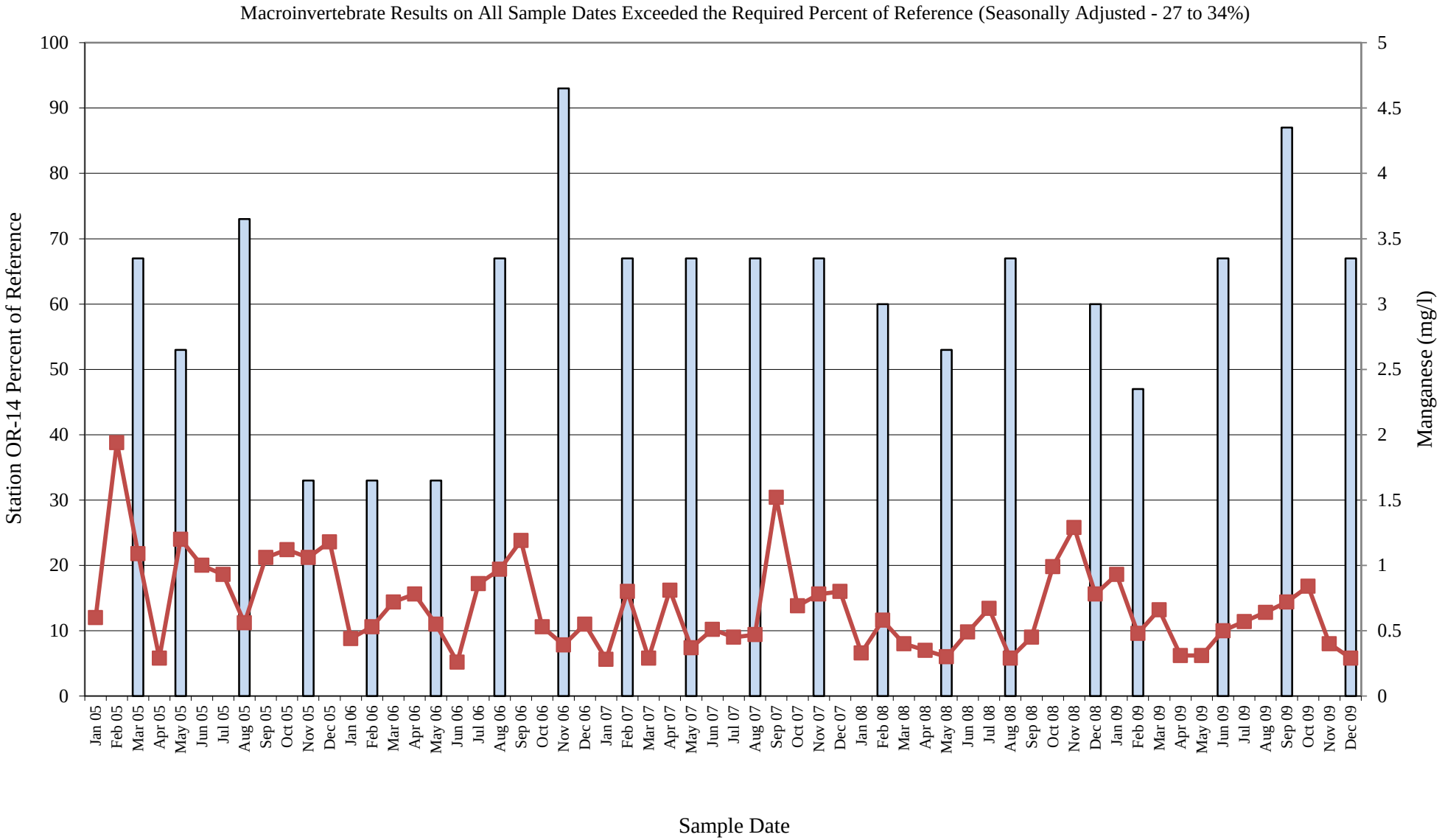

Figure 1-d.
Fisher Mining Company - Otter Run Station OR-14 compared to Silver Branch Reference Station SB-01
Results of Macroinvertebrate Monitoring Using the August 2000 Protocol and Monthly Manganese Measurements
January 2010 through December 2014

Macroinvertebrate Results on All Sample Dates Exceeded the Required Percent of Reference (Seasonally Adjusted - 27 to 34%)

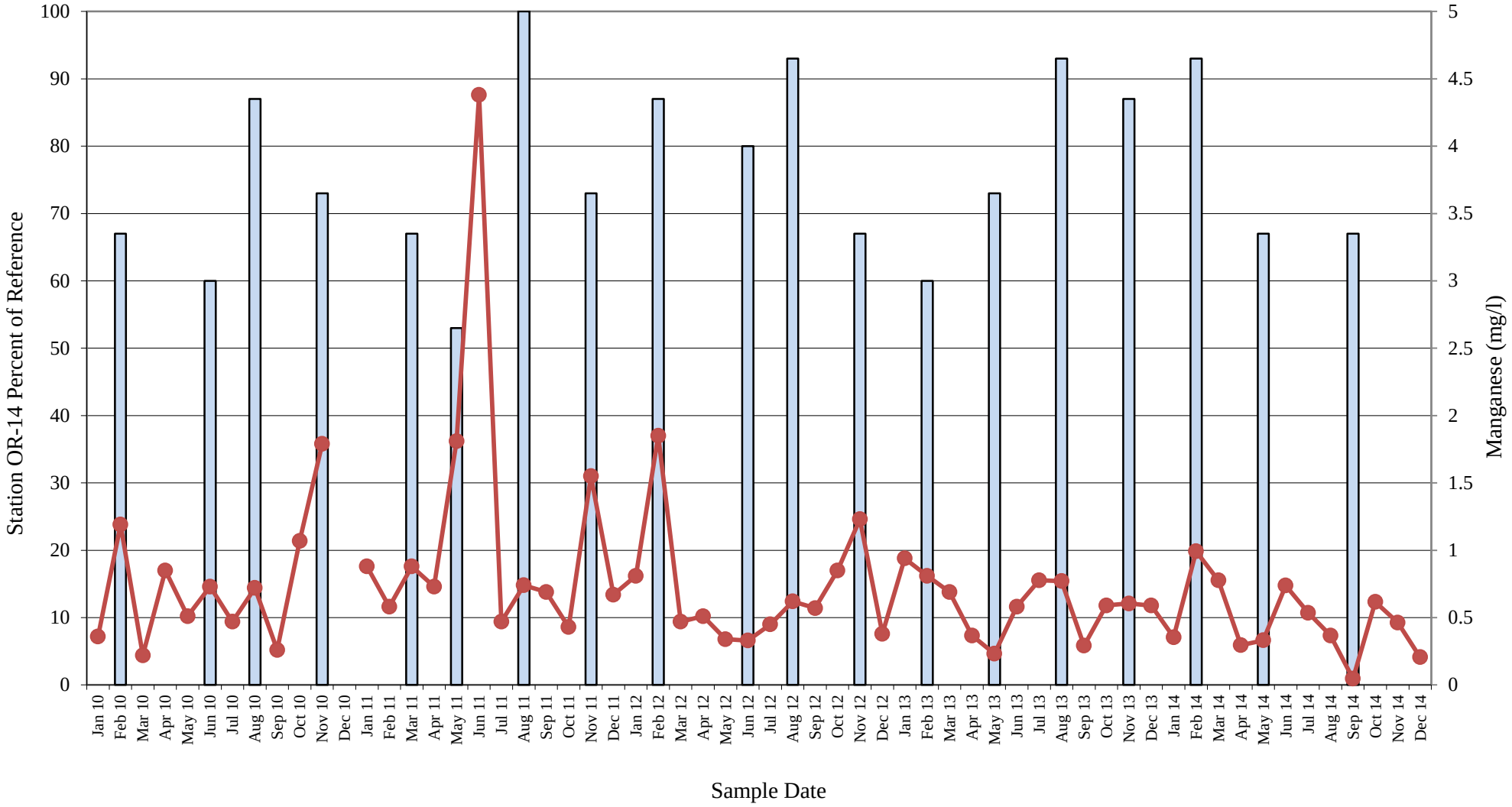

Table 1. Benthic macroinvertebrate individuals collected at Station OR-14 in Otter Run on 2 September 2014.

Taxon	Individual Rock Bag Number										Total
	1	2	3	4	5	6	7	8	9	10	
Coleoptera											
Hydrobius			1								1
Diptera											
Alluaudomyia			1								1
Chelifera			2		2						4
Chironomidae	140	44	150	21	232		48	78			713
Clinocera					1						1
Dicranota			1	1				1			3
Dixa			4								4
Palpomyia gr.								1			1
Probezzia	2		1								3
Ephemeroptera											
Baetis		2	1		1						4
Ephemerella	1	3			2						6
Oligochaeta	2		15								17
Plecoptera											
Amphinemura		30	9		360		4	192			595
Isoperla	3	2	1		32						38
Leuctra	23	5	37	5	16		17	32			135
Paracapnia	3	1	4	2				10			20
Pteronarcys								2			2
Sweltsa			2	4	16		2	4			28
Tallaperla					8						8
Yugus								8			8
Trichoptera											
Cheumatopsyche							1	13			14
Dolophilodes				1			3	13			17
Hydropsyche		5		1	91			10			107
Nyctiophylax	3										3
Polycentropus			3								3
Rhyacophila	3				19			14			36
Total Taxa	9	8	15	7	12	0	6	13	0	0	26
Total Individuals	180	92	232	35	780	0	75	378	0	0	1772

Table 2. Benthic macroinvertebrate individuals collected at Station SB-01 in Silver Branch on 2 September 2014.

Taxon	Individual Rock Bag Number										Total
	1	2	3	4	5	6	7	8	9	10	
Coleoptera											
Optioservus					1						1
Oulimnius	3	4	3	7	5	4	2				28
Decapoda											
Cambarus				1							1
Diptera											
Antocha					2						2
Cecidomyidae						2					2
Chelifera		2					2				4
Chironomidae	111	188	77	172	472	592	216				1828
Dicranota		1			4		1				6
Hexatoma					2						2
Probezzia				2	6	1					9
Simulium			2		13		8				23
Ephemeroptera											
Acentrella					3						3
Acerpenna	3	8	7								18
Baetis			1	1	10		36				48
Diphetor					2						2
Ephemerella			2				24				26
Eurylophella	24	14		13	1	9					61
Heptagenia	1	2	4		6		26				39
Maccaffertium		4		1		1	1				7
Paraleptophlebia	3			8	1	3					15
Hydracarina		1									1
Oligochaeta	1	15	6	8	116	7	4				157
Plecoptera											
Acroneuria			1								1
Amphinemura		5					12				17
Isoperla		3	2		4		16				25
Leuctra	2	6	6	26	96	33	16				185
Paracapnia	2		1	6	28	1					38
Pteronarcys			1		4		16				21
Sweltsa					8	2					10
Tallaperla		1			8		32				41
Trichoptera											
Cheumatopsyche				1			14				15
Cyrnellus			1		2						3
Diplectrona					2		2				4
Dolophilodes					9						9
Glossosoma					1		1				2
Hydropsyche		2	4	1	51		2				60

Table 2. Continued.

Taxon	Individual Rock Bag Number										Total
	1	2	3	4	5	6	7	8	9	10	
Trichoptera (continued)											
Lepidostoma							1				1
Polycentropus	1	1		7	3	2	1				15
Pycnopsyche	1			1			1				3
Rhyacophila	5	29	14	2	24	1	31				106
Wormaldia							1				1
Total Taxa	12	17	16	16	28	13	24	0	0	0	41
Total Individuals	157	286	132	257	884	658	466	0	0	0	2840