Deer Creek Coal Mine
North Rilda Canyon
Portal Facilities

PACIFICORP
A MIDAMERICAN ENERGY HOLDINGS COMPANY

ENERGY WEST
MINING COMPANY
A SUBSIDIARY OF PACIFICORP

Ammendment to Update the Deer Creek Mining and Reclamation Permit, Volume 11, North Rilda Canyon Portal Facilities, PacifiCorp, Deer Creek Mine, C/015/0018, Emery County, Utah

Revision June 2010

Volume 11A

C/015/018 Incoming

#3585 K

ENERGY WEST MINING COMPANY
A SUBSIDIARY OF PACIFICORP

P.O. Box 310
15 North Main Street
Huntington, Utah 84528

RECEIVED
JUN 30 2010
DIV. OF OIL, GAS & MINING

COPY

June 30, 2010

HAND DELIVERED

Utah Division of Oil, Gas and Mining
1594 West North Temple, Suite 1210
P.O. Box 145801
Salt Lake City, Utah 84114-5801

Subj: Amendment to Update the Deer Creek Mining and Reclamation Permit, Volume 11, North Rilda Rilda Canyon Portal Facilities, PacifiCorp, Deer Creek Mine, C/015/0018, Emery County, Utah.

PacifiCorp, by and through its wholly-owned subsidiary, Energy West Mining Company ("Energy West"), as mine operator, hereby submits an amendment to update Volume 11, Volume 11 Appendix Volume A, and Volume 11 Appendix Volume B. The amendment includes an update as to the as-built conditions of the site since its completion in 2008.

Energy West is submitting this amendment to update Volume 11 in three parts and requests the each submittal receive a conditional approval by the Division. Submittals will be as follows:

Submittal 1 – Update Volume 11, Volume 11 Appendix Volume A, Volume 11 Appendix Volume B – text, maps, and data,

Submittal 2 – Update bonding calculations for the Rilda facilities (to include Chapter 800 Bonding),

Submittal 3 - Reduce the permit area for the Deer Creek Mine to include only those areas that are currently bonded.

Once the three submittals have been conditionally approved, the Division can give their final approval for this comprehensive amendment.

Updates for this first submittal for **Volume 11** include changes in Chapters 200 Soils through 700 Hydrology. Amended maps are also included in this volume; however, only two copies will have the PE signature. This signature signifies the design has been reviewed by a professional engineer. Once final approval has been granted, signatures for all "Clean Copy" maps will be provided.

Appendix Volume A includes two soil map updates (with PE signatures as stated above) as well as the comprehensive macro-invertebrate surveys in Rilda Creek. These surveys were performed by the Division of Wildlife Resources and a private contractor. Both surveys compliment each other and contain the same findings [construction of the Rilda facilities had no impact on water quality of the Rilda Creek]. The surveys were conducted between 2004 and 2008.

File in:
☐ Confidential
☒ Shelf
☐ Expandable
Date Folder 063010 C/0150018
See: Incoming For additional information

COPY

Appendix Volume B includes an updated hydrological design (Appendix B) for the facilities as built. Maps for the hydrology portion of the permit (with PE signatures as stated above) are included in this appendix. The entire Appendix B was revised, therefore, Energy West requests to remove the existing contents and replace with the updated version of Appendix B.

The required C1/C2 forms are included with this submittal. Seven (7) revised copies of Volume 11, Volume 11 Appendix Volume A, and Volume 11 Appendix Volume B are included. It is Energy West's hopes that by submitting this large permit revision in three parts, the burden of review will be reduced and the revisions will be focused and organized.

If you have any questions or concerns regarding this submittal, please contact Dennis Oakley at (435) 687-4825.

Sincerely,

Kenneth S. Fleck

Kenneth Fleck
Geology and Environmental Affairs Manager

Enclosures C1/C2 Forms
Volume 11
Volume 11 Appendix Volume A
Volume 11 Appendix Volume B

APPLICATION FOR COAL PERMIT PROCESSING

COPY

Permit Change ☒ New Permit ☐ Renewal ☐ Exploration ☐ Bond Release ☐ Transfer ☐

Permittee: PacifiCorp

Mine: Deer Creek Mine **Permit Number:** C/015/0018

Title: Amendment to Update the Deer Creek Mining and Reclamation Permit, Volume 11, North Rilda Canyon Portal Facilities, PacifiCorp, Deer Creek Mine, C/015/0018, Emery County, Utah.

Description, Include reason for application and timing required to implement:

Instructions: If you answer yes to any of the first eight (gray) questions, this application may require Public Notice publication.

☒ Yes ☐ No 1. Change in the size of the Permit Area? Acres: to be decided later ☐ increase ☒ decrease.
☐ Yes ☒ No 2. Is the application submitted as a result of a Division Order? DO# _____
☐ Yes ☒ No 3. Does the application include operations outside a previously identified Cumulative Hydrologic Impact Area?
☐ Yes ☒ No 4. Does the application include operations in hydrologic basins other than as currently approved?
☒ Yes ☐ No 5. Does the application result from cancellation, reduction or increase of insurance or reclamation bond?
☐ Yes ☒ No 6. Does the application require or include public notice publication?
☐ Yes ☒ No 7. Does the application require or include ownership, control, right-of-entry, or compliance information?
☒ Yes ☐ No 8. Is proposed activity within 100 feet of a public road or cemetery or 300 feet of an occupied dwelling?
☐ Yes ☒ No 9. Is the application submitted as a result of a Violation? NOV # _____
☐ Yes ☒ No 10. Is the application submitted as a result of other laws or regulations or policies?
Explain: _____
☐ Yes ☒ No 11. Does the application affect the surface landowner or change the post mining land use?
☐ Yes ☒ No 12. Does the application require or include underground design or mine sequence and timing? (Modification of R2P2)
☐ Yes ☒ No 13. Does the application require or include collection and reporting of any baseline information?
☐ Yes ☒ No 14. Could the application have any effect on wildlife or vegetation outside the current disturbed area?
☐ Yes ☒ No 15. Does the application require or include soil removal, storage or placement?
☐ Yes ☒ No 16. Does the application require or include vegetation monitoring, removal or revegetation activities?
☒ Yes ☐ No 17. Does the application require or include construction, modification, or removal of surface facilities?
☒ Yes ☐ No 18. Does the application require or include water monitoring, sediment or drainage control measures?
☒ Yes ☐ No 19. Does the application require or include certified designs, maps or calculation?
☐ Yes ☒ No 20. Does the application require or include subsidence control or monitoring?
☒ Yes ☐ No 21. Have reclamation costs for bonding been provided?
☒ Yes ☐ No 22. Does the application involve a perennial stream, a stream buffer zone or discharges to a stream?
☐ Yes ☒ No 23. Does the application affect permits issued by other agencies or permits issued to other entities?

Please attach four (4) review copies of the application. If the mine is on or adjacent to Forest Service land please submit five (5) copies, thank you. (These numbers include a copy for the Price Field Office)

I hereby certify that I am a responsible official of the applicant and that the information contained in this application is true and correct to the best of my information and belief in all respects with the laws of Utah in reference to commitments, undertakings, and obligations, herein.

Kenneth Fleck — Kenneth S. Fleck — Manager of Environmental Affairs
Print Name — Sign Name, Position, Date

Subscribed and sworn to before me this 29 day of JUNE, 20 10

Sidney Larsen
Notary Public
My commission Expires: 8-28, 2013
Attest: State of Utah } ss:
County of Emery

NOTARY PUBLIC
Sidney E Larsen
579971
My Commission Expires
August 28, 2013
STATE OF UTAH

For Office Use Only:	Assigned Tracking Number:	Received by Oil, Gas & Mining

Form DOGM- C1 (Revised March 12, 2002)

APPLICATION FOR COAL PERMIT PROCESSING
Detailed Schedule Of Changes to the Mining And Reclamation Plan

COPY

Permittee: PacifiCorp
Mine: Deer Creek **Permit Number:** C/015/0018
Title: Amendment to Update the Deer Creek Mining and Reclamation Permit, Volume 11, North Rilda Canyon Portal Facilities, PacifiCorp, Deer Creek Mine, C/015/0018, Emery County, Utah.

Provide a detailed listing of all changes to the Mining and Reclamation Plan, which is required as a result of this proposed permit application. Individually list all maps and drawings that are added, replaced, or removed from the plan. Include changes to the table of contents, section of the plan, or other information as needed to specifically locate, identify and revise the existing Mining and Reclamation Plan. Include page, section and drawing number as part of the description.

			DESCRIPTION OF MAP, TEXT, OR MATERIAL TO BE CHANGED
☐ Add	☒ Replace	☐ Remove	Volume 11, Introduction Tab, Text Section, Add Red-line text and remove Strikeout text
☐ Add	☒ Replace	☐ Remove	Volume 11, Introduction Tab, Replace Figures A, B, and C
☐ Add	☐ Replace	☒ Remove	Volume 11, General Tab, Remove Tab, and entire contents
☐ Add	☒ Replace	☐ Remove	Volume 11, Soils Tab, Text Section, Add Red-line text and remove Strikeout text
☐ Add	☒ Replace	☐ Remove	Volume 11, Biology Tab, Text Section, Add Red-line text and remove Strikeout text
☐ Add	☒ Replace	☐ Remove	Volume11, R645-301-300 Biology Maps Tab, Replace Maps Table of Contents cover sheet
☐ Add	☒ Replace	☐ Remove	Volume 11, R645-301-300 Biology Maps Tab, Replace Maps 300-1, 300-2, 300-3, 300-4, 300-5 and 300-6
☐ Add	☒ Replace	☐ Remove	Volume 11, Land Use and Air Quality Tab, Text Section, Add Red-line text and remove Strikeout text
☐ Add	☒ Replace	☐ Remove	Volume 11, Land Use and Air Quality Tab, R645-301-400 Maps Tab, Replace Maps Table of Contents coversheet
☐ Add	☒ Replace	☐ Remove	Volume 11, R645-301-400 Land Use and Air Quality Maps Tab, Replace Map 400-1
☐ Add	☒ Replace	☐ Remove	Volume 11, Engineering Tab, Text Section, Add Red-line text and remove Strikeout text
☐ Add	☐ Replace	☒ Remove	Volume 11, Engineering Tab, Remove Appendix A
☐ Add	☒ Replace	☐ Remove	Volume 11, R645-301-500 Engineering Figures Tab, Replace FigureR645-301-500c
☐ Add	☒ Replace	☐ Remove	Volume 11, R645-301-500 Engineering Figures Tab, Replace FigureR645-301-500d
☐ Add	☒ Replace	☐ Remove	Volume 11, R645-301-500 Engineering Maps Tab, Replace Replace Maps Table of Contents cover sheet
☐ Add	☒ Replace	☐ Remove	Volume 11, R645-301-500 Engineering Maps Tab, Replace maps, 500-1 (1of 3 thru 3 of 3), 500-3, 500-4 (1 of 4 thru 4 of 4), 500-5,
☐ Add	☐ Replace	☒ Remove	Volume 11, R645-301-500 Engineering Maps Tab, Remove maps 500-4 (5 of 5)
☒ Add	☐ Replace	☐ Remove	Volume 11, R645-301-500 Engineering Maps Tab, Add Rilda Facility Plans Package
☐ Add	☒ Replace	☐ Remove	Volume 11, Geology Tab, Text Section, Add Red-line text and remove Strikeout text
☐ Add	☒ Replace	☐ Remove	Volume 11, Geology Tab, Geology Maps Tab, Replace Maps Table of Contents cover sheet
☒ Add	☐ Replace	☐ Remove	Volume 11, Hydrology Tab, Add Red-line text and remove Strikeout text
☐ Add	☒ Replace	☐ Remove	Volume 11, Appendix Volume A, Soils, Appendix C, Replace Maps 200-1 and 200-2
☒ Add	☐ Replace	☐ Remove	Volume 11, Appendix Volume A, Biology, Appendix D, Add Macroinvertebrate Comprehensive Report (2004 - 2008)
☒ Add	☐ Replace	☐ Remove	Volume 11, Appendix Volume A, Biology, Appendix D, Add Macroinvertebrate Reports 2009
☐ Add	☒ Replace	☐ Remove	Volume 11, Appendix Volume B, Hydrology, Appendix B, Text Section, replace entire section.
☐ Add	☒ Replace	☐ Remove	Volume 11, Appendix Volume B, Hydrology, Appendix B, Figures Section, replace entire section.
☐ Add	☒ Replace	☐ Remove	Volume 11, Appendix Volume B, Hydrology, Appendix B, Tables Section, replace entire section.
☒ Add	☐ Replace	☐ Remove	Volume 11, Appendix Volume B, Hydrology, Appendix B, Appendicies Section, Add Appendicies 1-6.

☐ Add	☐ Replace	☒ Remove	Volume 11, Appendix Volume B, Hydrology, Appendix B, Remove Appendix 1, Computer Backup.
☐ Add	☒ Replace	☐ Remove	Volume 11, Appendix Volume B, Hydrology, Appendix B, Replace Maps 700-1, 700-2, 700-3, 700-4.
☐ Add	☐ Replace	☒ Remove	Volume 11, Appendix Volume B, Hydrology, Appendix B, Remove Maps 700-5 and 700-6.

Any other specific or special instruction required for insertion of this proposal into the Mining and Reclamation Plan.	**Received by Oil, Gas & Mining**
	COPY

Form DOGM - C2 (Revised March 12, 2002)

PacifiCorp

Energy West Mining Company

Deer Creek Mine

C/015/0018

Amendment Update the Deer Creek Mining and Reclamation Plan, Volume 11, North Rilda Canyon Portal Facilities, PacifiCorp, Deer Creek Mine, C/015/0018, Emery County, Utah.

Seven (7) Redline/Strikeout Copies – Volume 11, Appendix Volume A, Soils Tab, Appendix C

Replace Maps 200-1 and 200-2

RECEIVED
JUN 30 2010
DIV. OF OIL, GAS & MINING

PacifiCorp

Energy West Mining Company

Deer Creek Mine

C/015/0018

Amendment Update the Deer Creek Mining and Reclamation Plan, Volume 11, North Rilda Canyon Portal Facilities, PacifiCorp, Deer Creek Mine, C/015/0018, Emery County, Utah.

Seven (7) Redline/Strikeout Copies – Volume 11, Appendix Volume A, Biology Tab, Appendix D

Add Macro-Invertebrate Report 2009

Macroinvertebrate and Fish Surveys to Determine Effects of Energy Development

Kenneth Breidinger
Aquatic Biologist

December 2009

Prepared for Energy West
By

Utah Department of Natural Resources
Division of Wildlife Resources
1594 West North Temple, Suite 2110
Salt Lake City, UT 84114

An Equal Opportunity Employer

James F. Karpowitz
Director

Table of Contents

Section	Page
List of Tables	ii
List of Figures	iii
Introductions	1
Methods	1
Site description and survey locations	1
Invertebrate sampling	1
Invertebrate sorting and processing	1
Electrofishing	2
Results	2
Macroinvertebrates	2
Electrofishing	4
Discussion	4
Macroinvertebrates	4
Electrofishing	5
Literature sited	6

List of Tables

Table	Page
Table 1. Coordinates for quantitative sample locations collected 8 June 2009 and 9 June 2009 in Rilda Canyon Creek. Coordinates are UTM's and can be referenced to North American Datum 83.	8
Table 2. Coordinates for qualitative sample locations collected 8 June 2009 and 9 June 2009 in Rilda Canyon Creek. Coordinates are UTM's and can be referenced to North American Datum 83. Coordinates for site 3 are not available due to poor GPS coverage.	8
Table 3. Abundance, evenness, and diversity indices of aquatic invertebrates collected 8 June 2009 and 9 June 2009 in Rilda Canyon Creek.	9
Table 4. Taxonomic lists for invertebrates collected in quantitative samples at site 1 in Rilda Canyon Creek on 9 June 2009.	9
Table 5. Taxonomic lists for invertebrates collected in qualitative samples at site 1 in Rilda Canyon Creek on 9 June 2009.	10
Table 6. Taxonomic lists for invertebrates collected in quantitative samples at site 2 in Rilda Canyon Creek on 8 June 2009.	10
Table 7. Taxonomic lists for invertebrates collected in qualitative samples at site 2 in Rilda Canyon Creek on 8 June 2009.	11
Table 8. Taxonomic lists for invertebrates collected in quantitative samples at site 3 in Rilda Canyon Creek on 8 June 2009.	11
Table 9. Taxonomic lists for invertebrates collected in qualitative samples at site 3 in Rilda Canyon Creek on 8 June 2009.	12

List of Figures

Figure	Page
Figure 1. Estimated density of invertebrates per meter^2 collected from 3 sites on Rilda Canyon Creek (Vinson 2005, Vinson 2007, Vinson 2008 and Miller 2009).	13
Figure 2. Mean Hilsenhoff biotic index for quantitative samples collected in Rilda Canyon Creek (Vinson 2005, Vinson 2007, Vinson 2008 and Miller 2009).	14
Figure 3. Mean Hilsenhoff biotic index for quantitative samples collected in Rilda Canyon Creek (Vinson 2005, Vinson 2007, Vinson 2008 and Miller 2009). Invertebrates were not collected from qualitative samples in 2006.	15
Figure 4. Ephemeroptera, Plecoptera and Trichoptera index for quantitative samples collected from Rilda Canyon Creek (Vinson 2005, Vinson 2007, Vinson 2008 and Miller 2009).	16
Figure 5. Ephemeroptera, Plecoptera and Trichoptera index for qualitative samples collected from Rilda Canyon Creek (Vinson 2005, Vinson 2007, Vinson 2008 and Miller 2009). Invertebrates were not collected from qualitative samples in 2006.	17
Figure 6. Evenness index for quantitative samples collected from Rilda Canyon Creek (Vinson 2005, Vinson 2007, Vinson 2008 and Miller 2009). Invertebrate numbers from the 2007 site 1 sample were not sufficient to calculate an evenness value.	18
Figure 7. Evenness index for quantitative samples collected from Rilda Canyon Creek (Vinson 2005, Vinson 2007, Vinson 2008 and Miller 2009). Invertebrates were not collected from qualitative samples in 2006. Invertebrate numbers from the 2008 site 2 and site 3 samples were not sufficient to calculate an evenness value.	19
Figure 8. Genera richness for quantitative samples collected from Rilda Canyon Creek (Vinson 2005, Vinson 2007, Vinson 2008 and Miller 2009).	20
Figure 9. Genera richness for quantitative samples collected from Rilda Canyon Creek (Vinson 2005, Vinson 2007, Vinson 2008 and Miller 2009). Invertebrates were not collected from qualitative samples in 2006.	21

Introduction

Energy development in the Huntington Creek Drainage (Hydrologic Unit #14060009) by Energy West Mining Company has led to safety concerns and a need for increased surface facilities in Rilda Creek Canyon. Portals into the current mine would reduce miner commutes underground and allow for multiple escape and rescue routes. To minimize environmental impacts on Rilda Canyon, Energy West Mining Company began an environmental assessment and the Utah Division of Wildlife Resources was invited to discuss potential biological impacts to the canyon. In subsequent meetings it was decided that the Utah Division of Wildlife Resources would conduct pre and post construction macroinvertebrate and fish surveys to determine construction impacts on the canyon and assist in the development of the environmental assessment. Fish and invertebrate monitoring began in 2005. Construction of surface facilities in Rilda Canyon began in April 2006 and was completed in 2008. This report concludes annual surveys in Rilda Canyon.

Methods

Site Description and Survey Locations

Rilda Canyon Creek is a first order tributary to Huntington Creek in the San Rafael drainage (Hydrologic Unit #14060009). At the start of this project three macroinvertebrate sample sites were assigned to gauge construction effects. Site three is located upstream of the construction project and acts as the control site. Sites one and two are located downstream and will exhibit effects of the development.

Specific sites were not designated for fish sampling. Single pass electrofishing surveys were conducted at numerous sites between the confluences with Huntington Creek to approximately 3.5 km upstream.

Invertebrate sampling

Macroinvertebrate samples were collected from Rilda Creek on 8 June 2009 and 9 June 2009. A .09 meter^2 500-micron mesh Surber sampler was used to collect quantitative samples from the three sample sites. Two samples were collected from the first four swift water habitats occurring upstream from the sample stations. Collected samples were placed into a bottle and the mesh net was thoroughly rinsed to ensure that all material and invertebrates were collected. A ten-minute qualitative sample was taken in each habitat type (riffle, run, and pool) at each site using a 500-micron mesh D-frame kick net. Each habitat type was sampled in proportion to its occurrence. Collected samples were placed into a bottle and the mesh net was thoroughly rinsed to ensure that all material and invertebrates were collected. Sample bottles were labeled and fixed with 95% ethanol.

Invertebrate sorting and processing

In the lab invertebrates were sorted from the sample and preserved in 95% ethanol. Quantitative samples from each site were combined to produce one .72 meter^2 sample. Samples were then sent to Utah State University's National Aquatics Monitoring Center for identification and analysis.

National Aquatics Monitoring Center (NAMC) personnel followed processing procedures adapted from Cuffney et al. (1993). Procedures can be found outlined in

Vinson and Hawkins (1996). Identified samples were preserved in 70% ethanol and placed in NAMC's permanent collection. NAMC then calculated a number of metrics to evaluate invertebrate communities at Rilda Creek (Miller 2009). Population metrics were calculated as follows.

Total Taxa Richness: The number of unique genera or families at each station (Miller 2009).

Total Sample Abundance: The number of individuals per unit area for quantitative samples and the number of individuals collected for qualitative samples (Miller 2009).

EPT Taxa Richness: The number of unique genera within the orders Ephemeroptera, Plecoptera and Trichoptera (Karr and Chu 1998).

EPT Abundance: The number of individuals within the orders Ephemeroptera, Plecoptera and Trichoptera (Karr and Chu 1998).

Percent Taxon: An assemblage largely dominated (>50%) by a single taxon or several taxa from the same family suggests environmental stress. Habitat conditions likely limit the number of taxa that can occur at the site (Miller 2009).

Evenness: The distribution of taxa within a sample represented by a range of zero to one. A score of zero indicates one dominant taxonomic group exists at the site (Ludwig and Reynolds, 1998).

Shannon's diversity index: Describes the community structure based on the number of unique taxa and their relative abundances (Ludwig and Reynolds, 1998).

HBI: The Hilsenhoff biotic index assigns a number between zero and ten to each invertebrate family to rank their tolerance of organic pollution. A ranking of ≥ 9 indicates a family is tolerant of pollution and a ranking of ≤ 1 indicates the family is intolerant to pollution and only found in pristine environments (Hilsenhoff 1987, Hilsenhoff 1988). A mean HBI was calculated for each sample.

Feeding, habitat, and life stage: Invertebrate groups were classified by their functional feeding groups, habitat requirements, and lifecycle length. Functional feeding groups were identified as shredders, scrapers, collector-filterers, collector-gatherers, predators, long-lived taxa, and clinger taxa. Taxa richness and abundances was then calculated for each group (Miller 2009). Functional groups are as follows:

-**Shredders** consume vascular hydrophytes and decomposing vascular tissue and are sensitive to changes in riparian vegetation (Miller 2009).

-**Scrapers** feed on periphyton and their abundances tend to increase as sedimentation and organic pollution decreases (Miller 2009).

-**Collector-filterers** feed on fine suspended organic matter and are sensitive to pollutants in water and sediment (Miller 2009).

-**Collector-gatherers** feed on fine organics deposited in the sediment and are sensitive to deposited pollutants (Miller 2009).

-**Predators** feed on aquatic prey and are sensitive to changes in invertebrate abundances (Miller 2009).

-**Long-lived taxa** are present in the system for 2-3 years and are sensitive to habitat changes, disturbances, diminished water and water quality (Karr and Chu 1998).

- **Clinger taxa** cling to rocks and are sensitive to increased sedimentation, algal growth, and human disturbance (Karr and Chu 1998).

Electrofishing

Single pass electrofishing surveys were conducted using a battery powered backpack electrofisher between the mouth of Rilda Creek and the flow gauge located approximately 400 meters upstream on 9 June 2009. Encountered fish were captured, enumerated, measured for total length, and released. Surveys were not performed upstream of the flow gauge in 2009 due to equipment failure.

Results

Macro invertebrates

Site 1, Quantitative

Sixty two invertebrates were captured in .72 meters^2 at this site. The sample was comprised of five families and eight genera. Shannon's diversity and evenness were estimated to be 1.15 and .55 respectively. The Hilsenhoff biotic index was 3.44 and no taxa were considered tolerant or intolerant to pollution. Three functional feeding groups were present in this sample. The sample was comprised of 13% shredders, 13% scrapers, and 75% collector-gatherers.

Site 1, Qualitative

The total number of macroinvertebrates collected in a ten minute kick net sample was 40 individuals. The sample consisted of five families and seven genera. Shannon's diversity and evenness were estimated to be .910 and .570 respectively. The Hilsenhoff biotic index was 3.68 and no taxa were considered tolerant or intolerant to organic pollution. Three functional feeding groups were present in this sample. The sample was comprised of 20% scrapers, 60% collector-gatherers and 20% predators.

Site 2, Quantitative

Sixty seven invertebrates were captured in .72 meters^2 at this site. The sample was comprised of eight families and nine genera. Shannon's diversity and evenness were estimated to be 1.930 and .840 respectively. The Hilsenhoff biotic index was 2.82 and species intolerant to organic pollution made up 20% of the sample. The sample contained five functional feeding groups and was comprised of 10% shredders, 30% scrapers, 30% collector gatherers, 20 % predators and 10% unknowns.

Site 2, Qualitative

The total number of macroinvertebrates collected in a ten minute kick net sample was 56 individuals. The sample consisted of seven families and eight genera. Shannon's diversity and evenness were estimated to be 1.99 and .866 respectively. The Hilsenhoff biotic index was 1.59 and species intolerant to organic pollution made up 46% of this sample. The sample contained five functional feeding groups and was comprised of 30%

scrapers, 10% collector filterers, 30% collector gatherers, 20 % predators and 10% unknowns.

Site 3, Quantitative
Forty four invertebrates were captured in .72 meters^2 at this site. The sample was comprised of four families and four genera. Shannon's diversity and evenness were estimated to be .950 and .590 respectively. The Hilsenhoff biotic index was 3.66 and species intolerant to pollution made up 5% of the sample. The sample contained two functional feeding groups and was comprised of 60% scrapers and 40% collector gatherers.

Site 3, Qualitative
The total number of macroinvertebrates collected in a ten minute kick net sample was 139 and consisted of seven families and nine genera. Shannon's diversity and evenness were estimated to be 1.450 and .660 respectively. The Hilsenhoff biotic index was 4.81 and species intolerant to pollution made up 3% of the sample. The sample contained five functional feeding groups and was comprised of 11% shredders, 33% scrapers, 11% collector filterers, 33% collector gatherers and 11% predators.

Electrofishing
Ten Cutthroat trout were captured from Rilda Canyon Creek during 2009. Lengths ranged from 111 mm to 267 mm with a mean length of 174 mm. All fish were captured below the barrier created by the gauging station.

Discussion
Macroinvertebrates
Construction of the Rilda Canyon mine portal began in April 2006 and was completed in 2008. Pre construction surveys conducted in 2004 and 2005 indicate that study sites below and above the construction site remain similar enough to detect impacts to the downstream section of stream (Vinson 2004 and Vinson 2005). Therefore only changes that are observed at sites one and two and not observed at site three can be attributed to portal construction.

Invertebrate densities have trended down at all three sites since the start of surveys in Rilda Canyon (Figure 1). This is a result of the high densities encountered during the initial surveys. Beginning in 2006 densities began trending upward. Although declining densities were not as severe at site 3 the densities did trend down suggesting a drainage wide impact that is not associated with the mine portal construction.

The Hilsenhoff biotic index ranges from zero to ten and assesses a family's tolerance to organic pollution. As the index increases the family's pollution tolerance increases (Hilsenhoff 1987, Hilsenhoff 1988). Quantitative samples at all three sites have showed an increasing HBI suggesting that organic pollutants are increasing throughout the drainage (Figure 2). Qualitative samples also show an increasing HBI at sites one and three however site two demonstrates a declining index (Figure 3). The increasing HBIs at sites one and three suggest that factors other than mine portal construction are contributing to organic pollutants in Rilda Canyon.

The Ephemeroptera, Plecoptera and Trichoptera index shows conflicting results between the qualitative and quantitative samples (Figure 4 and 5). In both samples, sites one or two trended in the same direction as site three suggesting that changes occurring over the study period are drainage wide and not a result of portal construction.

Evenness varied greatly between qualitative and quantitative samples (Figure 6 and 7). This is likely do to the D-frame kick nets ability to sample multiple habitat types allowing a greater diversity of invertebrates to be collected. As with the other indices evenness trends do not indicate impacts to the invertebrate populations caused by the portal construction.

The number of unique genera present in each sample has declined throughout the study (Figure 8 and 9). This decline has occurred at each site and is likely not a result of the portal construction.

Macroinvertebrate indices and abundances have fluctuated throughout the course of this study (Breidinger 2008, Breidinger 2007, and Walker 2005), however no trends appear that can be related to construction or operation of the Rilda Canyon Mine Portal. Additionally many of these fluctuations appear at all three sites.

Electrofishing

All fish captured since 2005 in Rilda Canyon Creek were captured below the barrier created by the gauging station. The fish encountered upstream of the barrier in 2004 have not been encountered since and it is likely that this population has been extirpated.

The number of fish encountered each year in Rilda Canyon has fluctuated significantly through out this study. No trends have been identified that can be directly related to the mine portal construction or operation.

Literature sited

Breidinger, K.T. 2007. Macroinvertebrate and Fish Surveys to Determine Effects of Energy Development in Rilda Canyon. Utah Division of Wildlife Resources, Salt Lake City, UT

Breidinger, K.T. 2008. Macroinvertebrate and Fish Surveys to Determine Effects of Energy Development in Rilda Canyon during 2007. Utah Division of Wildlife Resources, Salt Lake City, UT

Cuffney, T.G., M.E. Gurtz, and M.R. Meador. 1993. Guidelines for processing and quality assurance of benthic invertebrate samples collected as part of the National Water Quality Assessment Program. U.S. Geological Survey Open File Report 93-407.

Hilsenhoff, W.L. 1987. An improved index of organic stream pollution. The Great Lakes Entomologist. 20:31-39.

Hillsenhoff, W.L. 1988. Rapid field assessment of organic pollution with a family level biotic index. The Journal of the North American Benthological Society. 7:65(68).

Karr, J.R. and E.W. Chu. 1998. Restoring life in running waters; better biological monitoring. Island Press, Washington, D.C.

Ludwig, J.A. and J.F. Reynolds. 1988. Statistical Ecology: a primer on methods and computing. John Wiley and Sons, New York

Miller, S. 2009. Aquatic invertebrate report for samples collected by Utah Division of Wildlife Resources. Report of US Department of Interior Bureau of Land Management National Aquatic Monitoring Center to Utah Division of Wildlife Resources, Southeast Region, Logan, Utah

Vinson, M.R. and C.P. Hawkins. 1996. Effects of sampling area and subsampling procedure on comparisons of taxa richness among streams. Journal of the North American Benthological Society 15(3): 392-399

Vinson, M.R. 2004. Aquatic invertebrate report for samples collected in Rilda Creek, Emery County, Utah on 28 May 2004. Report of US Department of Interior Bureau of Land Management National Aquatic Monitoring Center to Utah Division of Wildlife Resources, Southeast Region, Logan, Utah

Vinson, M.R. 2005. Aquatic invertebrate report for samples collected in Rilda Creek, Emery County, Utah on 16 June 2005. Report of US Department of Interior Bureau of Land Management National Aquatic Monitoring Center to Utah Division of Wildlife Resources, Southeast Region, Logan, Utah

Vinson, M.R. 2007 Aquatic invertebrate report for samples collected in Rilda Creek, Emery County, Utah on 21 May 2007 and 5 June 2007. Report of US Department of

Interior Bureau of Land Management National Aquatic Monitoring Center to Utah Division of Wildlife Resources, Southeast Region, Logan, Utah

Vinson, M.R. 2008. Aquatic invertebrate report for samples collected in Rilda Creek, Emery County, Utah on 23 June 2008 and 24 June 2008. Report of US Department of Interior Bureau of Land Management National Aquatic Monitoring Center to Utah Division of Wildlife Resources, Southeast Region, Logan, Utah

Walker, C.A. 2005. Surveys conducted to determine pre-disturbance conditions prior to surface facility development in Rilda Canyon during 2004 – 2005. Utah Division of Wildlife Resources, Salt Lake City, UT

Table 1. Coordinates for quantitative sample locations collected 8 June 2009 and 9 June 2009 in Rilda Canyon Creek. Coordinates are UTM's and can be referenced to North American Datum 83.

Site	Sample	X Coordinate	Y Coordinate
1	1a, 1b	489711	4362808
	1c, 1d	489715	4362809
	1e, 1f	489712	4362803
	1g, 1h	489703	4362799
2	2a, 2b,	487649	4361557
	2c, 2d	487637	4361547
	2e, 2f	487628	4361534
	2g, 2h	487627	4361527
3	3a, 3b	485869	4361811
	3c, 3d	485869	4361817
	3e, 3f	485871	4361823
	3g, 3h	485868	4361825

Table 2. Coordinates for qualitative sample locations collected 8 June 2009 and 9 June 2009 in Rilda Canyon Creek. Coordinates are UTM's and can be referenced to North American Datum 83. Coordinates for site 3 are not available due to poor GPS coverage.

Site	X Coordinate	Y Coordinate
1	489717	4362792
2	487622	4361519
3	-	-

Table 3. Abundance, evenness, and diversity indices of aquatic invertebrates collected 8 June 2009 and 9 June 2009 in Rilda Canyon Creek.

Site	Sample Type	Total Abundance	EPT Abundance	Most Abundant Taxon	Abundance (Most Abundant Taxon)	Evenness	Shannon's Diversity
1	Quantitative	62	61	Baetidae *Baetis*	57	0.55	1.14
	Qualitative	40	27	Baetidae *Baetis*	26	0.56	0.91
2	Quantitative	67	84	Baetidae *Baetis*	26		
				Heptageniidae *Cinygmula*	26	0.83	1.92
	Qualitative	56	48	Baetidae *Baetis*	16	0.86	1.9
3	Quantitative	44	57	Baetidae *Baetis*	38	0.59	0.95
	Qualitative	139	75	Simuliidae *Prosimuliini*			
				Baetidae *Baetis*	53	0.66	1.45

Table 4. Taxonomic lists for invertebrates collected in quantitative samples at site 1 in Rilda Canyon Creek on 9 June 2009.

Phylum	Class	Sub Class	Order	Family	Subfamily/ Genus/species	Life stage	Number observed
Annelida	Clitellata	Oligochaeta				Adult	9
Arthropod	Insecta	Pterygota	Diptera	Chironomidae	Chironominae	Larvae	1
					Orthocladiinae	Larvae	1
				Stratiomyidae	*Euparyphus*	Larvae	1
				Tipulidae	*Antocha monticola*	Larvae	8
					Tipula	Larvae	1
			Ephemeroptera	Baetidae	*Baetis*	Larvae	57
				Heptageniidae	*Cinygmula*	Larvae	4

Table 5. Taxonomic lists for invertebrates collected in qualitative samples at site 1 in Rilda Canyon Creek on 9 June 2009.

Phylum	Class	Sub Class	Order	Family	Subfamily/ Genus/species	Life stage	Number observed
Arthropod	Arachnida	Acari	Trombidiformes	Lebertiidae	Lebertia	Adult	1
	Insecta	Pterygota	Diptera	Chironomidae	Orthocladiinae	Larvae	1
				Tipulidae	Antocha *monticola*	Larvae	11
			Ephemeroptera	Baetidae	*Baetis*	Larvae	26
				Heptageniidae	*Cinygmula*	Larvae	1

Table 6. Taxonomic lists for invertebrates collected in quantitative samples at site 2 in Rilda Canyon Creek on 8 June 2009.

Phylum	Class	Sub Class	Order	Family	Subfamily/ Genus/species	Life stage	Number observed
Annelida	Clitellata	Oligochaeta				Adult	5
Arthropod	Insecta	Pterygota	Diptera	Tipulidae	*Tipulinae*	Larvae	3
			Ephemeroptera	Ameletidae	*Ameletus*	Larvae	11
				Baetidae	*Baetis*	Larvae	26
				Ephemerellidae	*Drunella coloradensis*	Larvae	4
				Heptageniidae	*Cinygmula*	Larvae	26
				Heptageniidae	*Epeorus*	Larvae	4
			Plecoptera	Nemouridae	*Malenka*	Larvae	7
				Perlodidae	*Isoperlinae Isoperla*	Larvae	4
			Trichoptera	Rhyacophilidae	Rhyacophila *vofixa*	Larvae	3

Table 7. Taxonomic lists for invertebrates collected in qualitative samples at site 2 in Rilda Canyon Creek on 8 June 2009.

Phylum	Class	Sub Class	Order	Family	Subfamily/ Genus/species	Life stage	Number observed
Annelida	Clitellata	Oligochaeta				Adult	3
Arthropoda	Insecta	Pterygota	Diptera	Simuliidae		Larvae	1
			Ephemeroptera	Ameletidae	*Ameletus*	Larvae	16
				Baetidae	*Baetis*	Larvae	12
				Ephemerellidae	*Drunella coloadensis*	Larvae	3
				Heptageniidae	*Cinygmula*	Larvae	6
			Plecoptera	Nemouridae	*Malenka*	Larvae	3
				Perlodidae	Isoperlinae *Isoperla*	Larvae	1
			Trichoptera	Rhyacophilidae	*Rhyacophila vofixa*	Larvae	7
Platyhelminthes	Turbellaria					Adult	4

Table 8. Taxonomic lists for invertebrates collected in quantitative samples at site 3 in Rilda Canyon Creek on 8 June 2009.

Phylum	Class	Sub Class	Order	Family	Subfamily/ genus	Life stage	Number observed
Annelida	Clitellata	Oligochaeta				Adult	3
Arthropoda	Insecta	Pterygota	Ephemeroptera	Ameletidae	*Ameletus*	Larvae	1
				Baetidae	*Baetis*	Larvae	38
				Ephemerellidae	*Drunella coloradensis*	Larvae	1
				Heptageniidae	*Cinygmula*	Larvae	16

Table 9. Taxonomic lists for invertebrates collected in qualitative samples at site 3 in Rilda Canyon Creek on 8 June 2009.

Phylum	Class	Sub Class	Order	Family	Subfamily/ genus	Life stage	Number observed
Arthropoda	Insecta	Pterygota	Diptera	Chironomidae	*Chironominae*	Larvae	1
					Orthocladiinae	Larvae	9
				Simuliidae	*Simuliinae*	Larvae	53
				Tipulidae		Larvae	1
			Ephemeroptera	Baetidae	*Baetis*	Larvae	53
				Ephemerellidae	*Drunella coloradensis*	Larvae	3
				Heptageniidae		Larvae	7
					Cinygmula	Larvae	11
			Trichoptera	Rhyacophilidae	*Rhyacophila*	Larvae	1

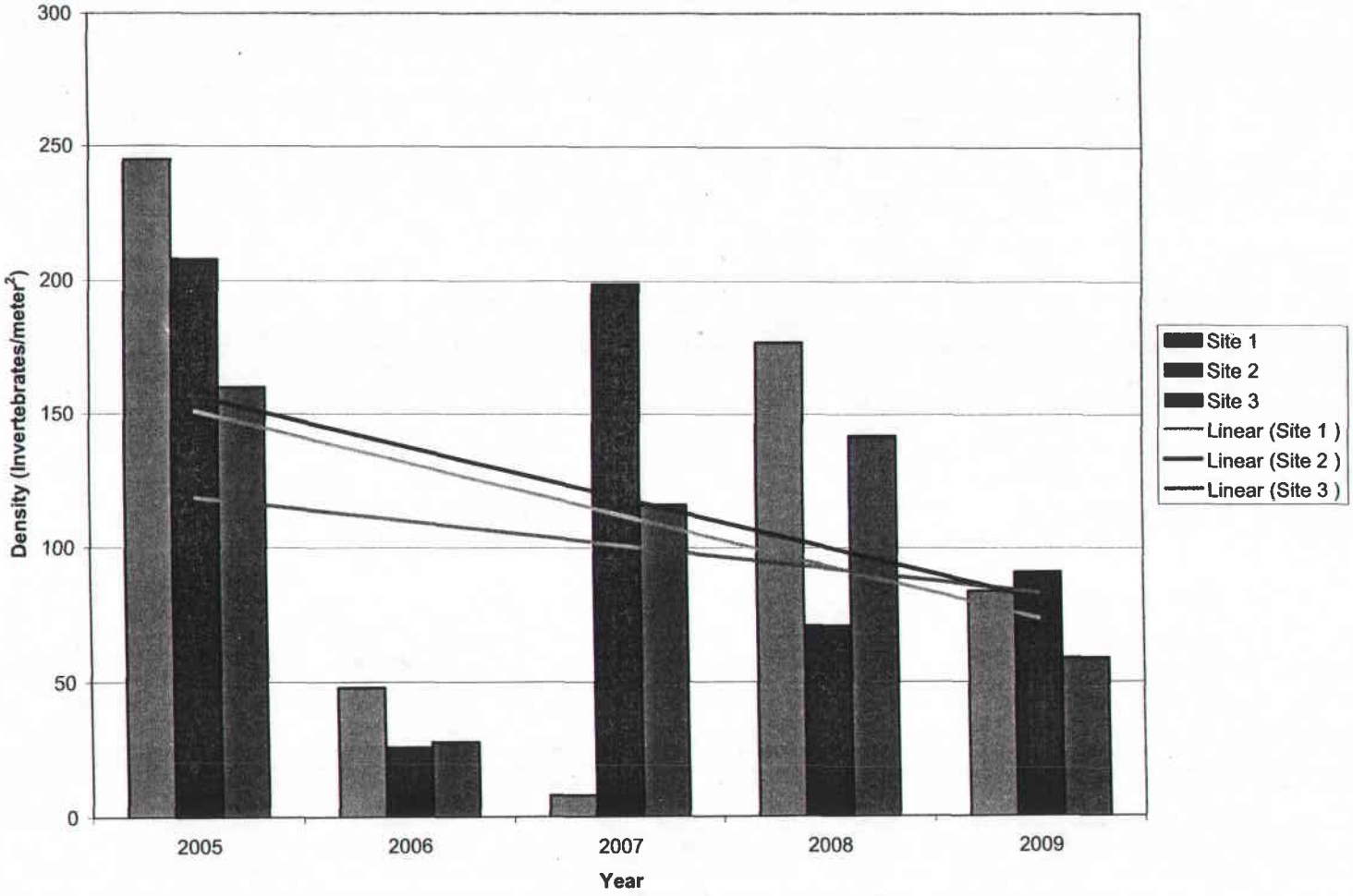

Figure 1. Estimated density of invertebrates per meter^2 collected from 3 sites on Rilda Canyon Creek. Site 3 is located upstream of the mine portal and is not expected to be impacted by the mine (Vinson 2005, Vinson 2007, Vinson 2008 and Miller 2009).

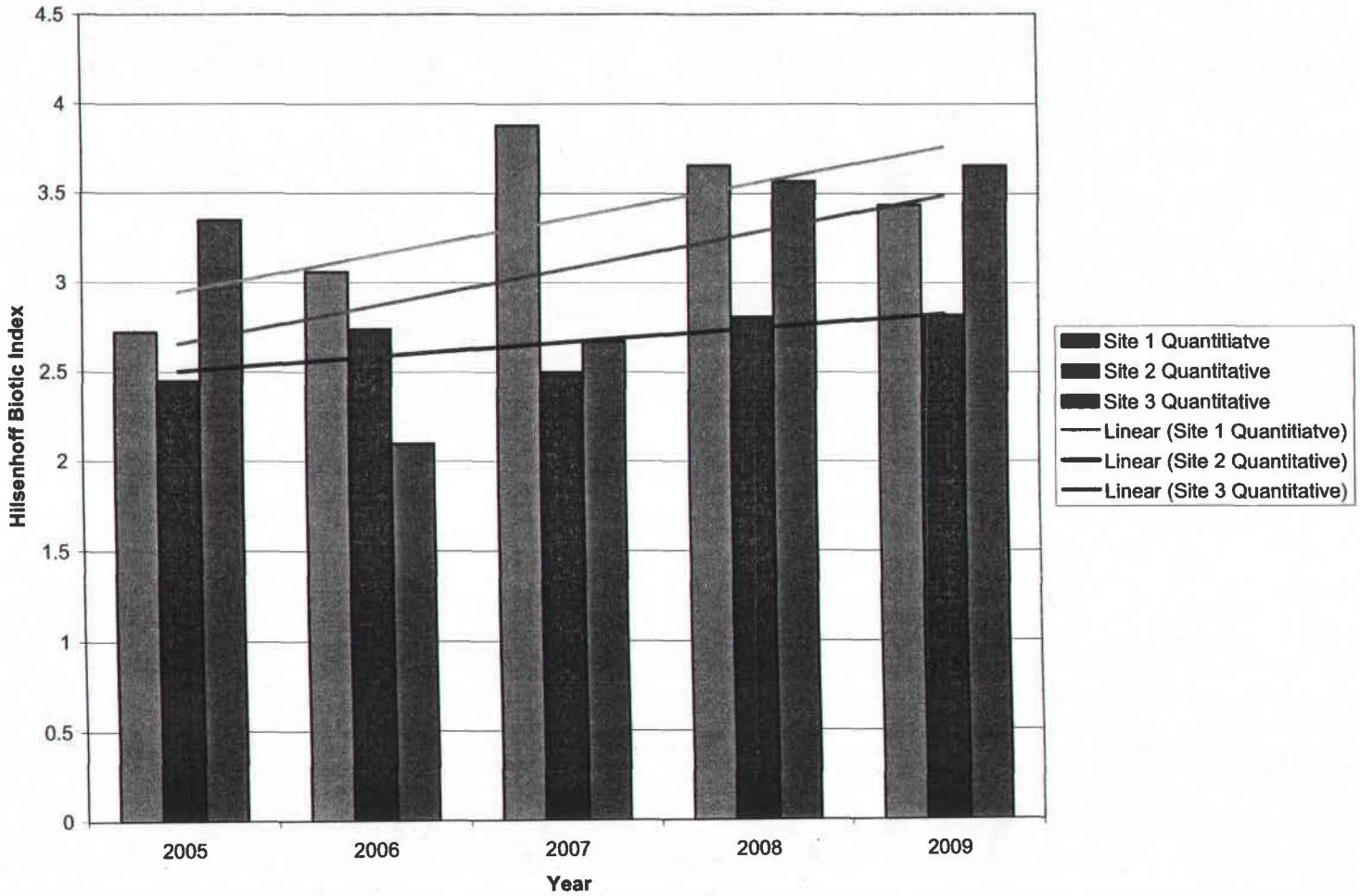

Figure 2. Mean Hilsenhoff biotic index for quantitative samples collected in Rilda Canyon Creek (Vinson 2005, Vinson 2007, Vinson 2008 and Miller 2009).

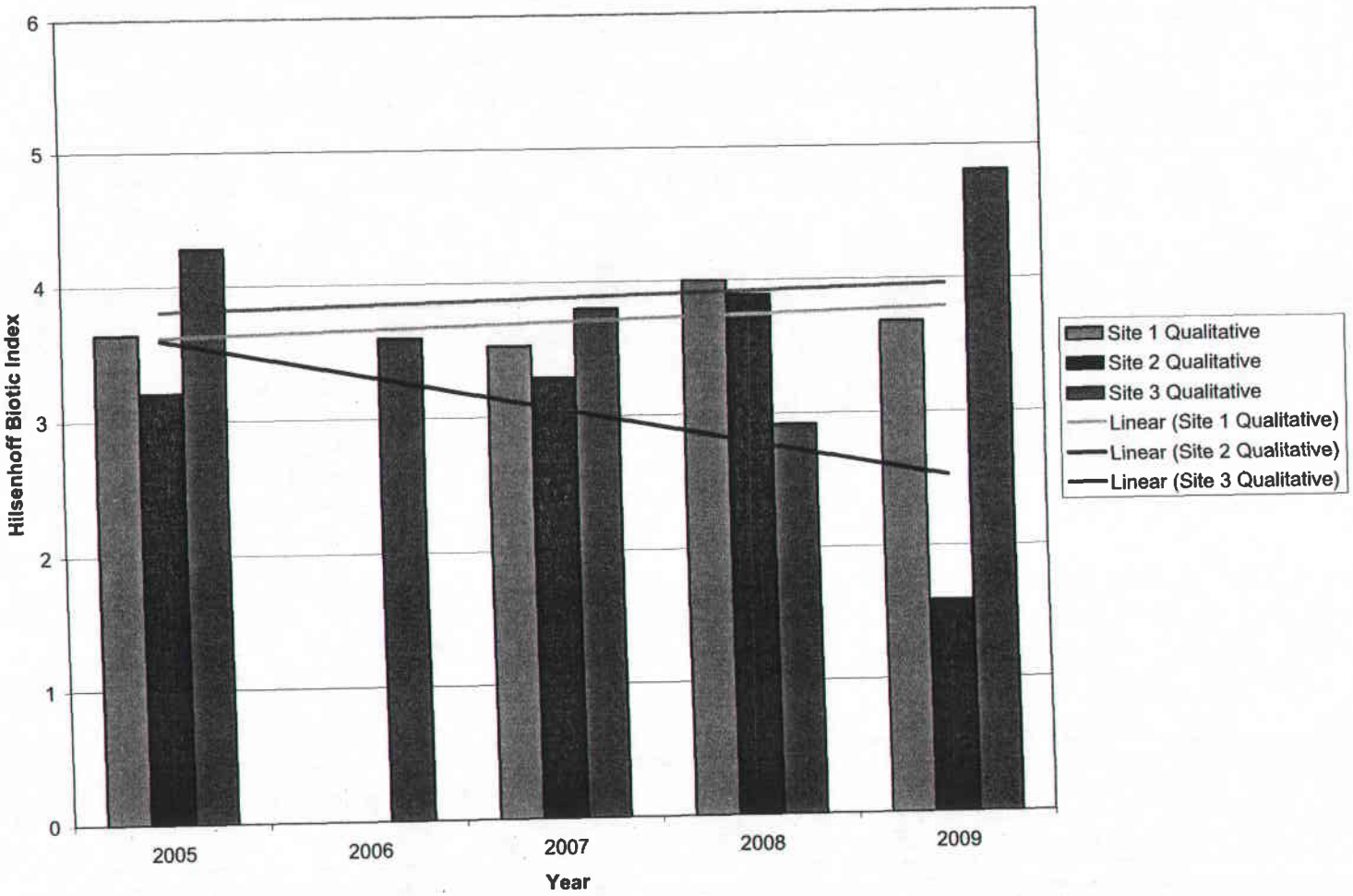

Figure 3. Mean Hilsenhoff biotic index for quantitative samples collected in Rilda Canyon Creek (Vinson 2005, Vinson 2007, Vinson 2008 and Miller 2009). Invertebrates were not collected from qualitative samples in 2006.

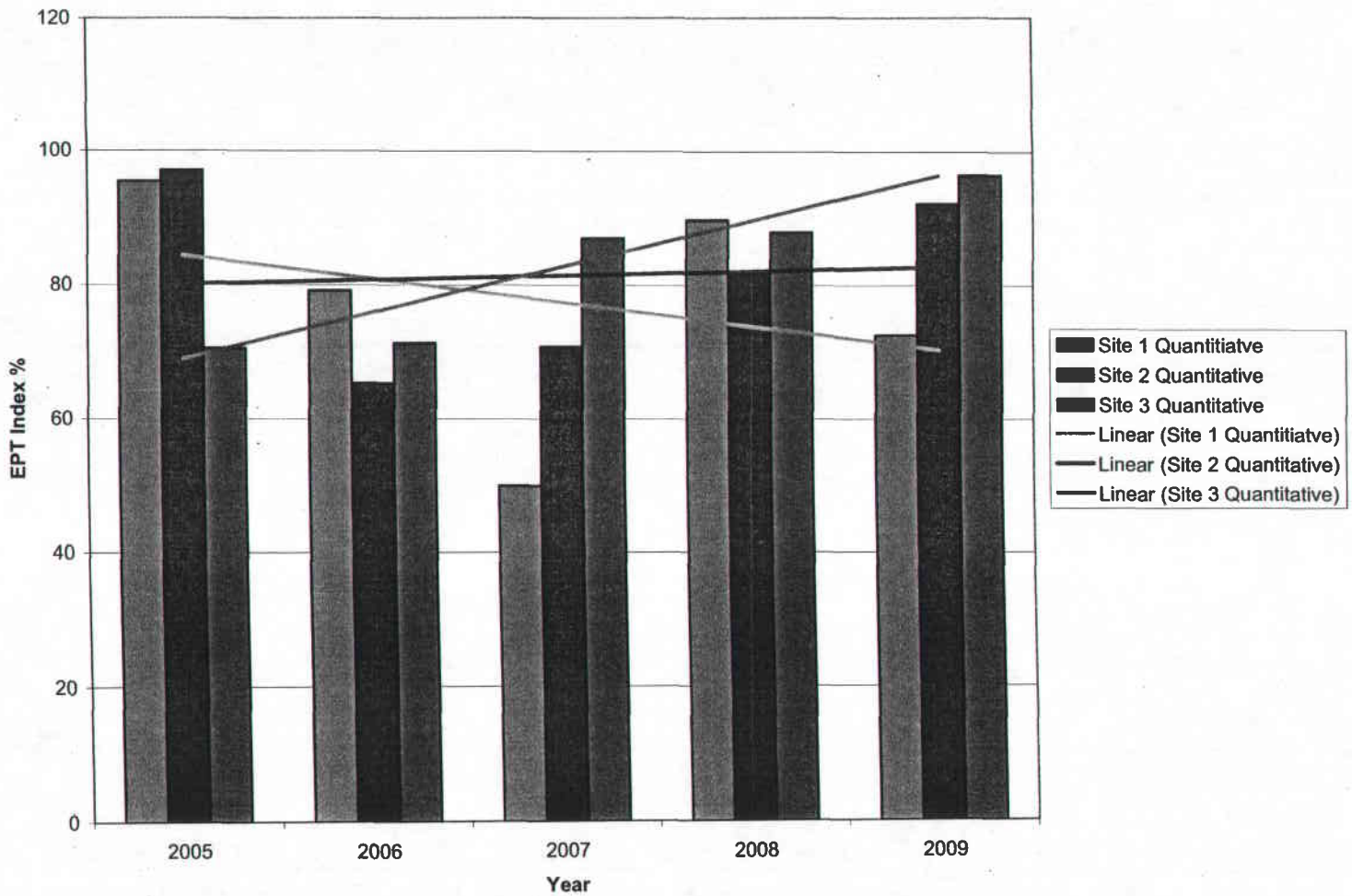

Figure 4. Ephemeroptera, Plecoptera and Trichoptera index for quantitative samples collected from Rilda Canyon Creek (Vinson 2005, Vinson 2007, Vinson 2008 and Miller 2009).

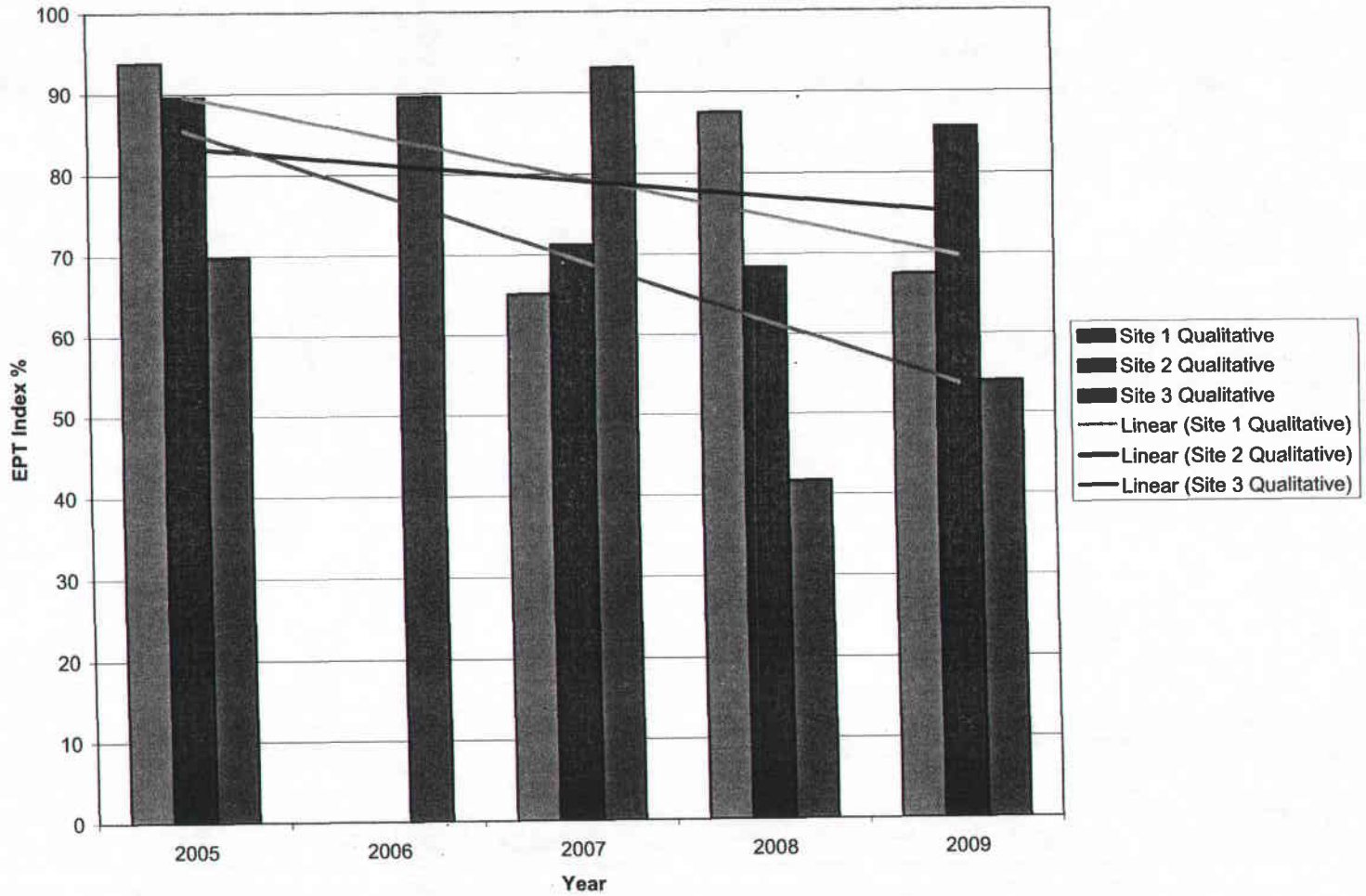

Figure 5. Ephemeroptera, Plecoptera and Trichoptera index for qualitative samples collected from Rilda Canyon Creek (Vinson 2005, Vinson 2007, Vinson 2008 and Miller 2009). Invertebrates were not collected from qualitative samples in 2006.

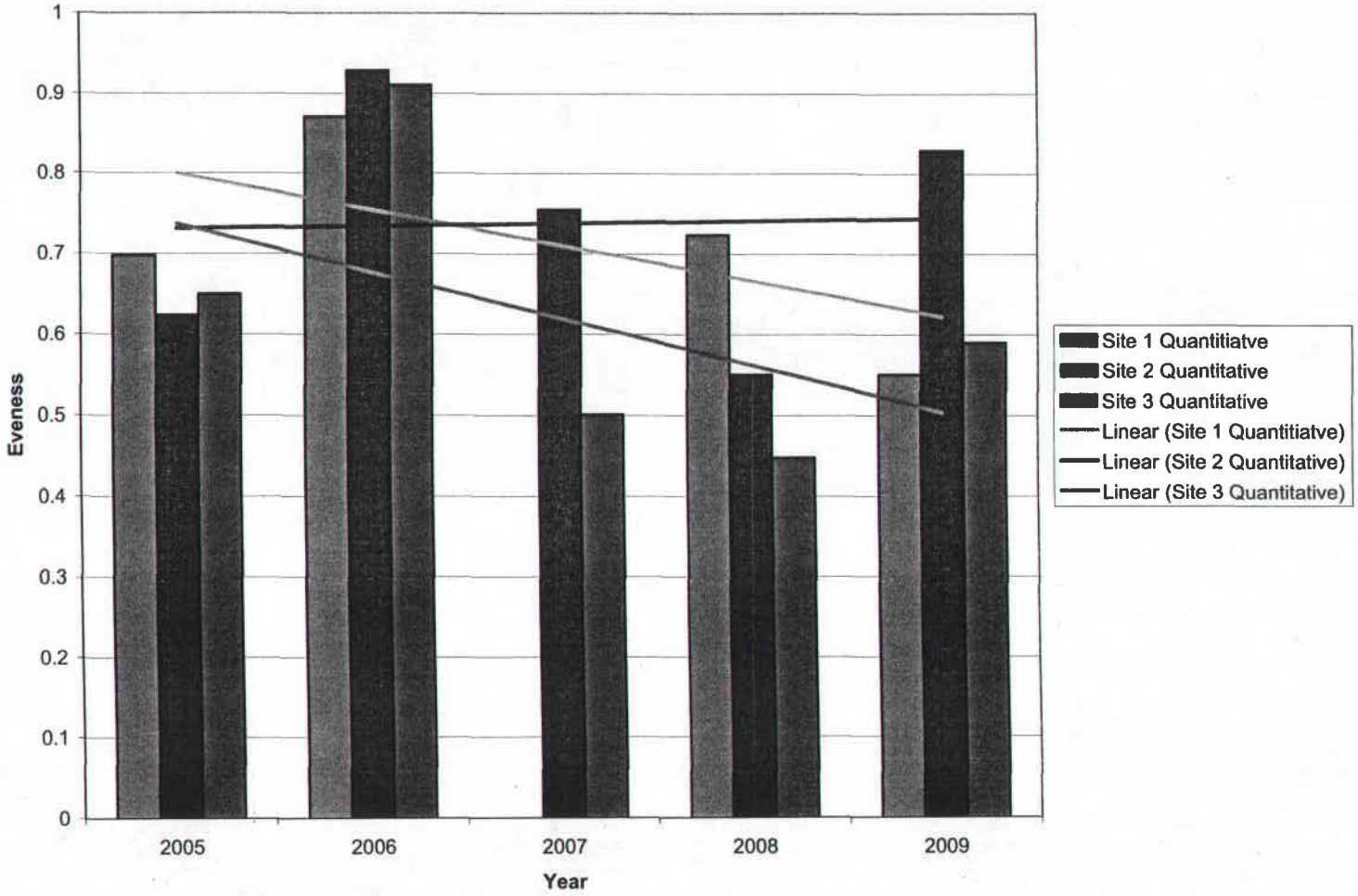

Figure 6. Evenness index for quantitative samples collected from Rilda Canyon Creek (Vinson 2005, Vinson 2007, Vinson 2008 and Miller 2009). Invertebrate numbers from the 2007 site 1 sample were not sufficient to calculate an evenness value.

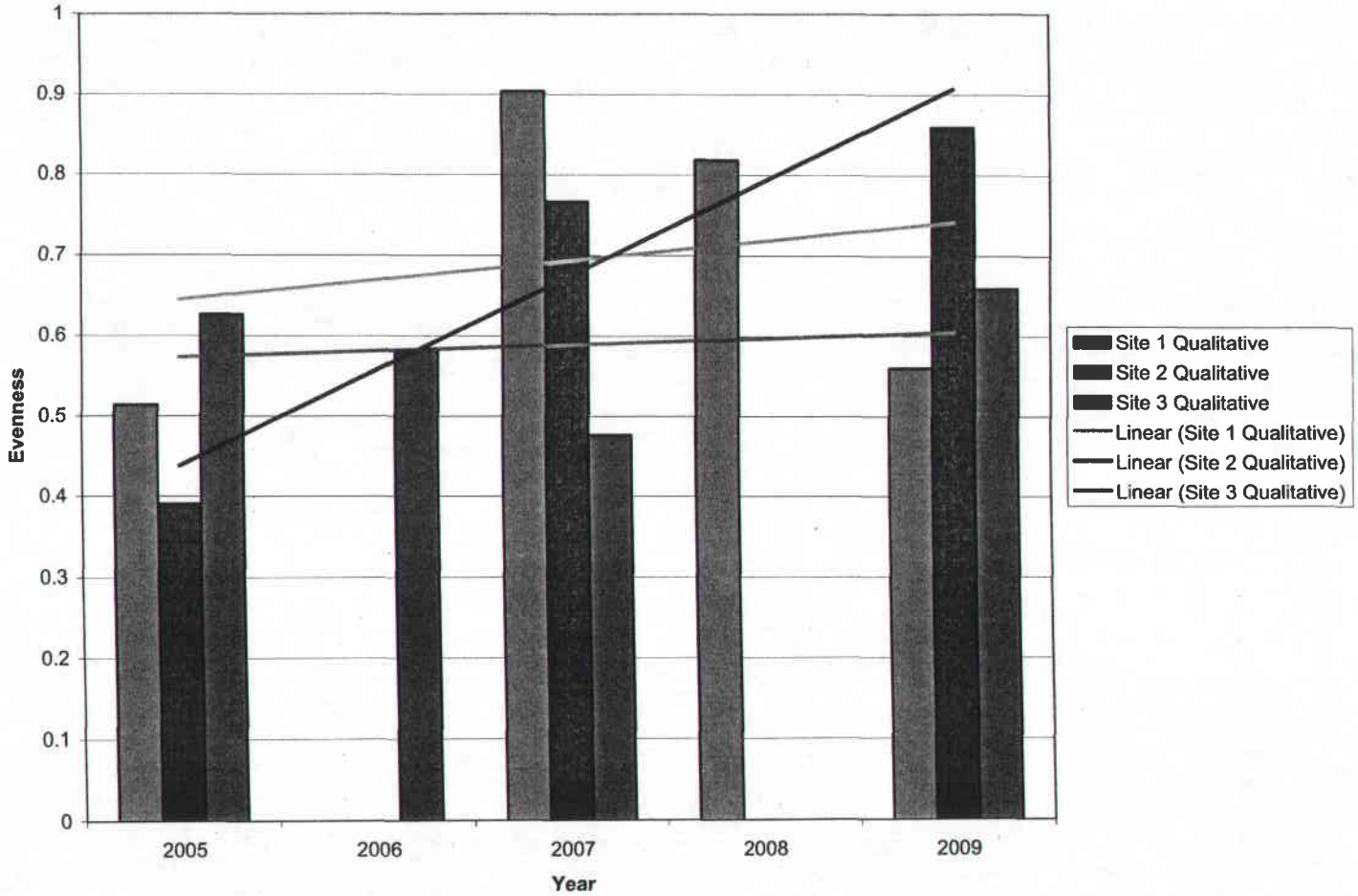

Figure 7. Evenness index for quantitative samples collected from Rilda Canyon Creek (Vinson 2005, Vinson 2007, Vinson 2008 and Miller 2009). Invertebrates were not collected from qualitative samples in 2006. Invertebrate numbers from the 2008 site 2 and site 3 samples were not sufficient to calculate an evenness value.

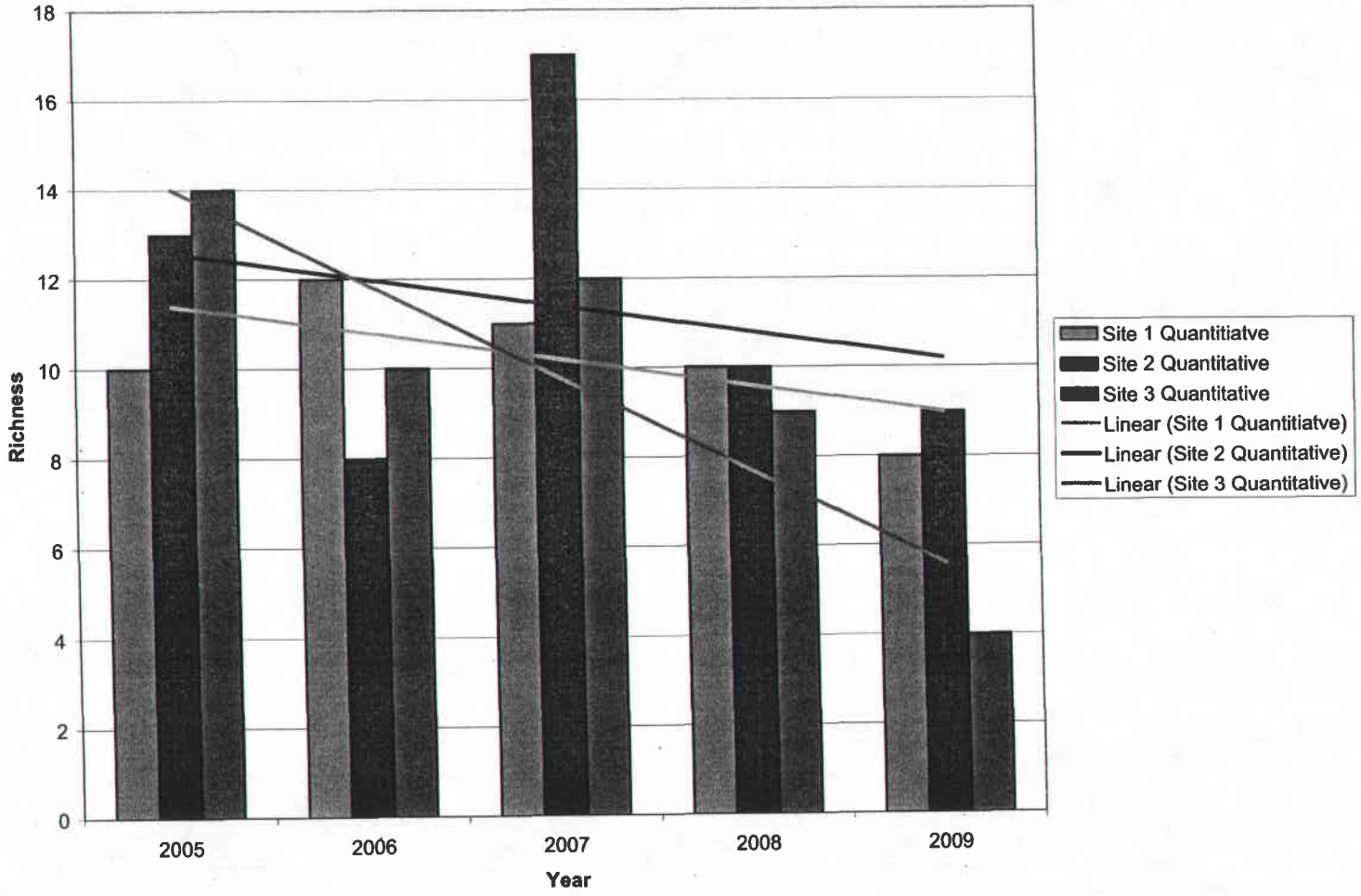

Figure 8. Genera richness for quantitative samples collected from Rilda Canyon Creek (Vinson 2005, Vinson 2007, Vinson 2008 and Miller 2009).

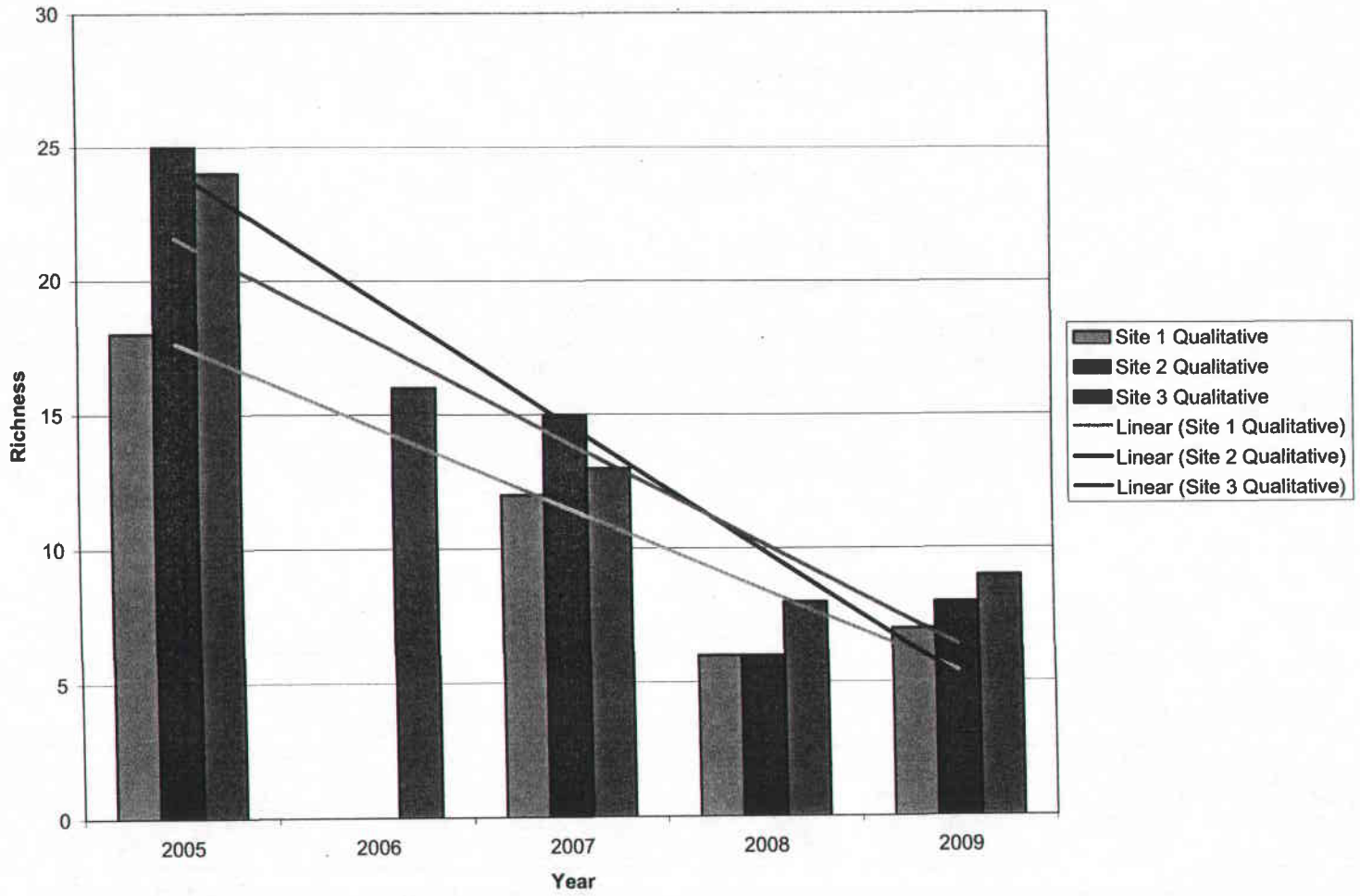

Figure 9. Genera richness for quantitative samples collected from Rilda Canyon Creek (Vinson 2005, Vinson 2007, Vinson 2008 and Miller 2009). Invertebrates were not collected from qualitative samples in 2006.

PacifiCorp

Energy West Mining Company

Deer Creek Mine

C/015/0018

Amendment Update the Deer Creek Mining and Reclamation Plan, Volume 11, North Rilda Canyon Portal Facilities, PacifiCorp, Deer Creek Mine, C/015/0018, Emery County, Utah.

Seven (7) Redline/Strikeout Copies – Volume 11, Appendix Volume A, Biology Tab, Appendix D

Add Macro-Invertebrate Comprehensive Report (2004-2008)

ASSESSMENT OF PRE- AND POST-DISTURBANCE CONDITION OF MACROINVERTEBRATES AND FISH AT RILDA CREEK, EMERY, UTAH.

COMPREHENSIVE REPORT (2004-2008)

Prepared for:

Energy West Mining Company
P.O. Box 310
Huntington, Utah 84528

Prepared by:

Ernesto de la Hoz, MS.
S.E.C
1109 Lamplighter Dr.
River Heights, Utah 84321

May 20, 2009

TABLE OF CONTENTS

Table of Contents i
List of Tables i
List of Figures i
Appendices ..... **Error! Bookmark not defined.**
1. Introduction 1
2. Methods 1
2.1 Study Area 1
2.2 Macroinvertebrate Sampling 2
2.2.1 Data summarization ..... **Error! Bookmark not defined.**
2.3 Fish Survey 2
2.4 Data analysis 3
3. Results and Discussion 3
3.1 Macroinvertebrate Survey 3
3.1.1 Test and control site comparison 3
3.1.2 Seasonal comparison 4
3.1.3 Year-to-year comparison 5
3.2 Fish Survey 6
References Cited 6

LIST OF TABLES

Table 1. Summary of sampling events and locations in Rilda Creek, Emery, UT. (2004-2008) ... 8
Table 2. UTM coordinates for macroinvertebrate sampling locations in Rilda Creek, Emery, UT. 8
Table 3. Summary of macroinvertebrate surveys conducted in spring at Rilda Creek, Emery County, Utah (2004-2008): Site comparison. 9
Table 4. Summary statistics for macroinvertebrate surveys at Rilda Creek, Emery County, Utah: Seasonal comparison[a]. 11
Table 5. Summary statistics for spring macroinvertebrate surveys (2004-2008) 12
Table 6. Summary statistics for fall macroinvertebrate surveys (2004-2008) 12
Table 7. Summary of selected water quality data collected at invertebrate sampling sites along Rilda Creek during spring and fall surveys conduced from 2004 to 2008 13
Table 8. Summary of fish surveys in Rilda Creek, Emery County, Utah. 2004-2008 14

LIST OF FIGURES

Figure 1. Map of Rilda Creek Canyon, Emery, Utah. Location of macroinvertebrate sampling sites and fish survey sampling section. 15
Figure 2. Total abundance (a), EPT taxa abundance (b), Shannon diversity (c), and Total taxa richness (d), Hilsenhoff HBI, and Intolerant taxa abundance for spring macroinvertebrate surveys at Rilda Creek, Emery County, Utah, conducted during pre- (white) and post- (black) construction. 16

Figure 3. Total abundance (a,b), EPT abundance (c,d), Total richness (e,f), and EPT richness (g,h) for sping (left figures) and fall (right figures) macroinvertebrate surveys at Rilda Creek, Emery County, Utah, conducted during pre- (white circles) and post- (black circles) construction..... 17
Figure 4. Evenness (a,b), Shannon diversity (c,d), and Simpson indexes (e,f) in Rilda Creek for spring (left figures) and fall (right figures) macroinvertebrate surveys at Rilda Creek, Emery County, Utah, conducted during pre- (white circles) and post- (black circles) disturbance conditions. 18
Figure 5. Abundance of intolerant taxa (a,b), number of families (c,d), and Hilsenhoff HBI (e,f) in Rilda Creek for spring (left figures) and fall (right figures) macroinvertebrate surveys at Rilda Creek, Emery County, Utah, conducted during pre- (white circles) and post- (black circles) disturbance conditions. 19
Figure 6. Spring and fall macroinvertebrate taxa abundance by functional feeding group in Rilda Creek (2004-2008)..... 20

APPENDIX

Taxa list for individual samples..... 20

ASSESSMENT OF PRE- AND POST-DISTURBANCE CONDITION OF MACROINVERTEBRATES AND FISH AT RILDA CREEK, EMERY, UTAH (2004-2008)

1. INTRODUCTION

Increases in the cost of surface mining operations, as well as the increased risk for miners caused by long commuting distances and lack of access points for rescue activities, has lead Energy West Mining Company to propose an additional surface development in Rilda Canyon. Such development would involve the construction of a new portal in Rilda Canyon to provide an additional entry into the mine, reduce the commute time and risk for the miners, and provide a more accessible rescue site in case of accidents.

The construction of the Rilda Canyon portal facility could potentially disturb aquatic macroinvertebrate communities and fish that occur in Rilda Creek. Energy West in cooperation with the Division of Oil, Gas and Mining prepared environmental assessment (EA) to identify potential negative effects and minimize potential impacts of the Rilda Canyon development on the biota of Rilda Canyon. The Utah Division of Wildlife Resources (UDWR), the Utah Division of Oil, Gas, and Mining, the Forest Service, and the Bureau of Land Management contributed to the development of a comprehensive EA.

The main objective of this study is to assess potential effects of surface development disturbance associated with mining activities on fish and the aquatic invertebrate community in Rilda Creek. This study addresses differences between control and experimental sites, between seasons (spring and fall), and years (pre- and post-construction). To address this objective, the UDWR Southeast Region and contracted environmental consulting firms have conducted pre-and-post disturbance surveys of macroinvertebrate and fish communities in Rilda Creek. Fish surveys will be used to qualitatively assess potential changes on fish species. Pre-disturbance surveys took place during spring and fall of 2004 and 2005. Construction of surface facilities began in April of 2006. Post-disturbance surveys were conducted in spring and fall of 2006, 2007 and 2008.

This report includes a description of the study area, the methodology used, and results and discussion of fish and invertebrate surveys that have been completed to date by both the UDWR and private consultants (2004-2008). The results and discussion section of this report addresses differences across sites, seasons, and years (pre-and-post construction).

2. METHODS

2.1 STUDY AREA

Rilda Creek is a small first-order stream tributary to Huntington Creek. This stream is located in the San Rafael River Drainage (Hydrologic Unit #14060009) within the Manti La-Sal National Forest. Historically, mining has been a major management activity in this area. The current Forest Plan identifies this area as appropriate for mineral development.

Three sampling sites were selected during a preliminary assessment at Rilda Canyon (Walker 2004). Site 1 is located near the confluence with Huntington Creek, Sites 2 and 3 are located approximately 1.4 miles (2.3 Km) and 2.7 miles (4.3 Km), respectively, above the mouth of Rilda Creek (Figure 1). Elevation ranges from 6,942 feet (2,116 m) at Site 1 to 7,881 feet (2,402 m) at Site 3. Site 3 (Test Site) was located upstream from the area potentially impacted by the new surface development and was used as a control for the spring sampling surveys. The collection of invertebrate samples was possible at these sites during the spring surveys. However, Site 3 did not present flow during fall surveys. An alternative sampling site was selected (Site 4) and the third sample was collected in an area adjacent to the federally restricted zone for culinary water use (Figure 1). This alternative site was used to compare pre- and post-construction conditions but was not used as a control site because it is located downstream of the construction area.

This report focuses on the pre- and post-construction sampling efforts completed to date. Spring pre-disturbance surveys were conducted on May 28, 2004 and June 16, 2005. Fall pre-disturbance surveys were conducted on October 22, 2004 and October 19, 2005. Spring post-disturbance surveys were completed on June 22, 2006, May 21, 2007, and 23 June, 2008. Fall post-disturbance surveys were completed on October 21, 2006, October 12, 2007, and October 8, 2008. The same standard procedures for the collection and processing of samples were used for all surveys. A summary of sampling events conducted to date is shown in Table 1.

2.2 MACROINVERTEBRATE SAMPLING

Two types of macroinvertebrate samples were collected. A quantitative sample was collected using a 500 um Surber sampler (surface area=0.09 m^2). Two samples were collected at the first four fast-water habitat units encountered. All samples were combined at each site (i.e., eight samples per site). Sampling locations were not randomly selected due to the small size of the sampling units and low flow conditions during fall surveys. The location of the habitat units sampled is shown in Table 2. In addition, a 10-minute (fixed-time) qualitative sample was collected using a 500 um kick net. This sample was collected within the same reach boundaries as sampled for the quantitative sample. All habitats within the reach were sampled in proportion to their occurrence. Samples were processed in the field following the protocol recommended by the National Aquatic Monitoring Center (NAMC). The material collected in each sample was preserved using 10 percent buffered formalin. Sample processing was completed at the NAMC. Selected habitat data was recorded at each sampling site (e.g., water temperature, pH, conductivity). The NAMC also calculated a number of metrics (e.g., abundance, richness, and diversity) based on taxa found in each sampling station. A description of these metrics can be found in Cirrus (2007). This report compiles metrics calculated for all fish and aquatic invertebrate surveys conducted along Rilda Creek from 2004 to 2008.

2.3 FISH SURVEY

As described by Walker (2005), sites were not assigned for fish sampling. A single pass electrofishing survey was conducted from the mouth of Rilda Creek to an area approximately 3.5 km upstream. A single backpack electrofisher (Smith-Roth LR-24) was used (electrofisher settings: 30Hz, 150 volts, 400-watt power limit). Stream conditions (i.e., flow and clarity) were typically adequate for effective sampling. Fish collected were identified, enumerated, and classified according to their size as young of the year (YOY), juveniles, or adults. Fish were allowed to recover in buckets filled with stream water and subsequently released. Electrofishing surveys were conducted prior to aquatic invertebrate sample collection.

2.4 DATA ANALYSIS

Summaries of the metrics calculated for quantitative invertebrate samples collected in Rilda Creek were presented in tabular and/or graphic form. The comparison between sites, seasons, and pre-/post-construction years was based on these tabular and graphic presentations of the data.

Metrics from sites 1, 2, and 3 collected in spring sampling events were used to compare test and control sites. The seasonal comparison was based on metrics calculated for sites 1 and 2. This seasonal comparison did not include data from Site 3 because this site was desiccated during fall sampling events. Due to the observed differences in invertebrate abundance and diversity between seasons, data from spring and fall sampling events were treated independently to assess differences across years (i.e., pre- and post-construction). Data from sites 1, 2, and 3 were used to compare spring sampling events across years, while data from sites 1, 2, and 4 were used to compare fall sampling events. Table 1 shows sampling events completed to date and the surveys used to compare sites, seasons, and years.

3. RESULTS AND DISCUSSION

3.1 MACROINVERTEBRATE SURVEY

3.1.1 TEST AND CONTROL SITE COMPARISON

Consistent with Cirrus (2006, 2007), the metrics calculated for qualitative and quantitative samples were similar for all sites. A compilation of the metrics calculated for test and controls sites during spring sampling events is shown in Table 3. The following discussion is based on quantitative results.

As noted in previous surveys (e.g.,Cirrus 2007), the total and EPT invertebrate abundance tends to increase from the uppermost site (i.e., Site 3) to the lowermost site (i.e., Site 1; Figure 2a and 2b). While this pattern appeared to be consistent for both pre and post-construction sampling events, average total and EPT taxa abundance was higher in post-construction samples from Sites 1, 2, and 3. Higher total and EPT abundances at the middle and lower sampling sites (i.e., test sites) suggests that there is more invertebrate habitat available in the lower stream reaches. As noted by Breidinger (2007), the lower EPT abundance at the uppermost site may be caused by higher water velocities at this site. It is also possible that reduced base flows limit invertebrate habitat and the recruitment of invertebrates at this site.

A trend in species diversity (based on Shannon diversity index) and total taxa richness was not observed across sites. However, the average Shannon index at Sites 1, 2 and 3 appeared to be lower for post-construction samples than for pre-construction samples (Figure 2c). Average total taxa richness was also lower for post-construction samples at site 1 and site 2 (Figure 2d). Overall, the lack of noticeable differences in invertebrate diversity and taxa richness across sites indicated that water quality conditions are similar between control and test sites.

The predominant taxa across sites, Baetidae and Heptageniidae, are both members of the Ephemeroptera order which is generally considered sensitive to pollution. Baetidae continues to be the predominant family at Sited 1, 2, and 3. However, an award trend in the community dominance by this taxa was observed in post-construction samples (Table 3). Consistent with

Cirrus (2007), results from recent surveys show that average intolerant taxa abundance is higher at Sites 1 and 2 than at Site 3 (Figure 2e). Average intolerant taxa abundance was higher in post-construction samples from all sites.

The Hilsenhoff Biotic Index (HBI), which summarizes the overall pollution tolerances of the taxa collected, suggested that slight enrichment is prevalent at all sites (Figure 2f). This index has been used to detect nutrient enrichment, high sediment loads, low dissolved oxygen, and thermal impacts. A consistent pattern of increasing or decreasing HBI values across sites was not observed but it was noted that average index values were slightly higher for post-construction samples than for pre-construction samples.

Overall, the low Hilsenhoff biotic index (HBI) values (i.e., typically below 4), the absence of tolerant taxa in the samples collected, and the relatively higher abundance of taxa belonging to the ephemeroptera order suggested that pollution levels in Rilda Creek were low across all test and control sites. The macroinvertebrate assessment also indicated that stream condition during spring surveys appear to increase slightly from upstream to downstream sites. However, the observed increase invertebrate abundance, coupled with lower species diversity, taxa richness, and the increasing dominance of the community by a single taxa across test and control sites (Sites 1,2, and 3), suggest that lower water quality conditions occurred during post-construction sampling events. Given that the control site (Site 3) is located upstream of the disturbed area where construction activities took place, it cannot be concluded that construction activities have lead to the observed changes in the aquatic invertebrate community. Differences in the aquatic invertebrate community during pre and post-construction sampling events are explored and discussed further below under the year to year comparison.

3.1.2 SEASONAL COMPARISON

Survey data from spring and fall of 2007 and 2008 support earlier findings of considerable seasonal differences in the aquatic invertebrate fauna in Rilda Creek (Cirrus 2007). Seasonal differences are observed in metrics calculated for spring and fall surveys conducted from 2004 to 2008. These seasonal differences are consistent across sites and years. A seasonal comparison of summary statistics for the metrics calculated is shown in Table 4. These seasonal differences also became apparent when comparing metrics across years (see Figures 3, 4, and 5).

Consistent with earlier reports, total and EPT abundance in samples collected during fall surveys were typically several orders of magnitude higher than in those collected during spring. Total abundance in spring surveys was typically below 250 invertebrates/m^2, while in fall surveys abundance exceeded 950 invertebrates/m^2. Similar differences were observed in EPT abundance across seasons. Further, the total taxa richness and the number of families are consistently higher in fall that in spring. From 5 to 9 more families were typically observed in fall surveys than in spring surveys. The extent of change between spring and fall measured by these metrics remains consistent across years (Table 4).

While a consistent pattern of increasing or decreasing diversity across seasons was not observed, the number of families found in fall samples was higher than in samples collected in spring (Table 4; Figure 5c and 5d). As noted in Cirrus (2006), the distribution of taxa within the invertebrate community, as measured by the evenness index, typically decreased in the fall as the abundance of individual taxa increased. Taxa within the Ephemeroptera order (e.g., Baetidae and Heptageniidae) were the dominant taxa during both seasons but their abundance was substantially higher in the fall than in spring. The availability of more suitable invertebrate habitat could

explain the increase in the number of families, total richness, EPT richness, and the increase in both tolerant and intolerant taxa abundance during fall.

It is likely that observed seasonal differences in the aquatic invertebrate community is related to natural disturbances to the stream ecosystem. In general, variation in flow (floods to desiccation) is the major cause of natural disturbance in streams and leads to large, often temporary reductions in insect abundance and diversity (Thorp and Covish 2001). The observed cycles of increased and decreased abundance and richness across seasons in Rilda Creek may reflect natural history strategies of aquatic invertebrates that are adapted to large variations in stream flow conditions.

Substantial differences in organic enrichment across seasons were not observed. The Hilsenhoff biotic index (HBI) was typically between 2 and 4, indicating that Rilda Creek could be considered slightly enriched. The number of tolerant taxa in fall surveys indicated that while there may be more habitat available during this time of the year, water quality conditions likely decrease.

As Cirrus (2006) pointed out, the observed differences in invertebrate community composition between spring and fall may not be linked to differences in water quality but rather to stream flow and habitat conditions. Invertebrate community differences observed across sites may be associated with seasonal changes in flow. These changes in flow conditions could also be associated with the differences in invertebrate communities observed across seasons. High spring runoff flows may function as discrete events that disrupt aquatic invertebrate populations leading to the observed seasonal oscillations in invertebrate abundance and richness. As flow conditions decrease and stabilize through summer and fall, some invertebrate taxa may re-colonize the stream while the abundance of other taxa (e.g., Baetidae) increases.

3.1.3 YEAR-TO-YEAR COMPARISON

Bi-annual surveys conducted from 2004 to 2008 suggested that while noticeable changes in the aquatic invertebrate community were not observed post-construction, there are some differences in metrics based on pre and post-construction aquatic invertebrate samples that should be noted. Summary statistics for annual spring and fall surveys are shown in Table 6 and Table 7, respectively. Graphic presentations of these metrics are shown in Figures 3, 4, and 5.

As noted above, given the differences in the aquatic invertebrate community across seasons, differences across years were assessed separately for spring and fall surveys. Average total abundance in spring surveys were substantially higher in 2006 and 2008 than in pre-construction surveys (Figure 3a). Conversely, mean total abundance in fall samples were lower in 2007 and 2008 than in pre-construction surveys (Figure 3b). Similar differences were also observed in EPT abundance for both spring and fall surveys (Figures 3c and 3d). Changes between pre and post-construction total taxa richness were not observed (Figure 3e and 3f). However, while no differences were observed in EPT richness in fall pre and post-construction samples (Figure 3g), a downward trend in average EPT richness in post-construction samples was observed with the lowest mean EPT richness values occurring in 2008 (Figure 3h).

In terms of species diversity, pre-and-post construction differences in the taxa evenness index were not observed in spring (Figure 4a) or fall samples (Figure 4b). However, as noted above under the Test and Control site comparison, the percentage of dominant taxa was typically higher in post-construction than in pre-construction samples. The cause of this increase in dominance by a single taxa is not known given that it was observed in both test and control sites (Table 3).

Further, while no obvious annual differences in diversity metrics (i.e., Shannon index- Figure 4c-4d and Simpson index- Figure 4e-4f) were noted, Shannon index values appeared lower in post-construction spring samples, particularly in 2008 (Figure 4c).

Substantial differences were not observed in the mean abundance of intolerant taxa, number of families, and Hilsenhoff HBI across pre-and-post construction surveys (Figure 5). Overall, differences in the aquatic invertebrate community that could reveal a decline in water quality resulting from construction activities in Rilda Canyon were not evident. In addition, while there was variability in the composition of the aquatic invertebrate community across years, the lack of noticeable changes in the proportions of functional feeding groups across pre-and-post construction surveys also suggested that comparable conditions of invertebrate habitat and water quality occurred before and after construction (Figure 6).

Overall, results of spring and fall surveys conducted to date suggest that the aquatic invertebrate community has not changed drastically following construction activities in Rilda Canyon and suggests that water quality conditions have remained stable after construction began. Observed differences cannot be associated to construction activities given that they occurred at all sites, including the control site located upstream of the construction area. This is also consistent with findings reported by Breidinger (2008).

3.2 FISH SURVEY

A summary of the qualitative fish surveys conducted to date is shown in Table 8. As noted in previous reports, the only two fish species that have been observed along Rilda Creek are brown trout (*Salmo trutta*) and cutthroat trout (*Oncorhynchus clarki*). Fish sampling efforts in fall of 2008 resulted in the capture of 50 cutthroat trout and 2 brown trout. The qualitative survey conducted in fall of 2008 suggests that cutthroat trout continues to be the dominant species. Most of the cutthroat trout observed over 100 mm in total length; 14 were less than 100 mm, and a total of 8 young of the year were observed. The presence of these young fish suggests that natural reproduction continues to occur along low to middle reaches of Rilda Creek. This also suggests that water quality and fish habitat conditions have not declined substantially since construction activities began. The observed variability in numbers of fish captured could be the result of variations in sampling effort and/or due to natural variability annual fish recruitment. Overall, and as noted in previous reports, no fish were observed above the concrete structure located downstream of the road crossing in Rilda Canyon during the 2008 fall surveys (Figure 1).

REFERENCES CITED

Breidinger, K. 2007. Macroinvertebrate and fish surveys to determine effects of energy development in Rilda Canyon. Utah Department of Natural Resources, Division of Wildlife Resources. Salt Lake City, UT. 13pp.

Breidinger, K. 2008. Macroinvertebrate and fish surveys to determine effects of energy development in Rilda Canyon during 2008. Utah Department of Natural Resources, Division of Wildlife Resources. Salt Lake City, UT. 11pp.

Cirrus, 2006. Assessment of pre-disturbance condition macroinvertebrates and fish at Rilda Creek, Emery, Utah. Cirrus Ecological Solutions. 21pp.

Cirrus, 2007. Assessment of pre-and post- disturbance condition macroinvertebrates and fish at Rilda Creek, Emery, Utah (2004-2006). Cirrus Ecological Solutions. 41pp.

Thorp, J.H., and A.P. Covich. 2001. Ecology and classification of North American freshwater invertebrates. 2nd edition. Academic Press. San Diego, CA. 1056pp.

Walker, A.W. 2004. Preliminary report on surveys conducted to determine potential impacts of Rilda Creek surface facility development in Rilda Canyon during 2004. Utah Department of Natural Resources, Division of Wildlife Resources. Salt Lake City, UT. 9pp.

Walker, A.W. 2005. Surveys conducted to determine pre-disturbance conditions prior to surface facility development in Rilda Canyon during 2004-2005. Utah Department of Natural Resources, Division of Wildlife Resources. Salt Lake City, UT. 24pp.

Table 1. Summary of sampling events and locations in Rilda Creek, Emery, UT. (2004-2008)

	Pre-disturbance				Post-disturbance					
	2004		2005		2006		2007		2008	
Site	28-May	22-Oct	16-Jun	19-Oct	22-Jun	21-Oct	21-May	12-Oct	23-Jun	8-Oct
Site 1	X [a, b, c]	X [b, c]	X [a, b, c]	X [b, c]	X [a, b, c]	X [b, c]	X [a, b, c]	X [b, c]	X [a, b, c]	X [b, c]
Site 2	X [a, b, c]	X [b, c]	X [a, b, c]	X [b, c]	X [a, b, c]	X [b, c]	X [a, b, c]	X [b, c]	X [a, b, c]	X [b, c]
Site 3	X [a, c]		X [a, c]		X [a, c]		X [a, c]		X [a, c]	
Site 4[d]		X [c]		X [c]		X [c]		X [c]		X [c]

[a] Data used to assess differences between control and test sites.

[b] Data used to assess differences between seasons (i.e., spring and fall).

[c] Data used to assess differences between years (i.e., pre-disturbance: 2004- 2005, and post-disturbance: 2006-2008).

[d] Site 4 was selected as an additional sampling site for the fall surveys given that no flow conditions were present at Site 3 during this time.

Table 2. UTM coordinates for macroinvertebrate sampling locations in Rilda Creek, Emery, UT.

Site	Samples	UTM X[a]	UTM Y[a]
1	1a, 1b	489769	4362610
	1c,1d	489771	4362548
	1e,1f	489764	4362562
	1g, 1h	489727	4362522
2	2a,2b	487709	4361324
	2c,2d	487637	4361290
	2e,2f	487520	4361329
	2g,2h	487467	4361330
3	3a,3b	485904	4361789
	3c,3d	485856	4361774
	3f,3g	485818	4361876
	3g,3h	485818	4361876
4[b]	4a,4b	487093	4361288
	4c,4d	487122	4361293
	4f,4g	487113	4361280
	4g,4h	487096	4361279

[a] NAD 27

[b] Site 4 was selected as an additional sampling site for the fall surveys given that no flow conditions were present at Site 3 during this time.

Table 3. Summary of macroinvertebrate surveys conducted in spring at Rilda Creek, Emery Cou

Site	Site 1-Test					Site 2- Tes			
Date	**28-May-04**	**16-Jun-05**	**22-Jun-06**	**21-May-07**	**23-Jun-08**	**28-May-04**	**16-Jun-05**	**22-Jun-06**	**21**
Total abundance [a]	118	48	245	116	177	99	26	208	
EPT abundance [a]	78	38	234	101	159	67	17	202	
Total taxa richness	14	12	10	12	10	13	8	13	
Number of families [b]	9(10)	7(NA)	8(10)	9(9)	8 (6)	10(10)	6(NA)	12(14)	
Shannon diversity	1.97	2.112	1.37	1.597	1.425	1.96	1.835	1.722	
Simpson diversity	0.19	0.136	0.328	0.336	0.304	0.19	0.17	0.259	
Evenness	0.68	0.871	0.698	0.501	0.724	0.71	0.929	0.624	
Hilsenhoff HBI [c]	2.72	3.06	3.55	3.88	3.66	2.45	2.74	3.26	
Intolerant taxa abundance	3	5	36	12	24	17	5	54	
Tolerant taxa abundance	0	0	0	0	0	0	0	0	
Dominant family [d]	Baetidae 30% (Baetidae)	Heptageniidae 23% (NA)	Heptageniidae 44% (Baetidae)	Ephemerellidae 50% (Chironomi)	Baetidae 40% (Heptageniidae)	Baetidae 34% (Baetidae)	Baetidae 35% (NA)	Baetidae 45% (Baetidae)	Hep (B

[a] Total and EPT invertebrate abundance for quantitative samples is given as the estimated number of individuals per square meter.
[b] Numbers in parenthesis are the number of families observed in qualitative samples.
[c] Hilsenhoff Biotic Index (HBI) values of 0-2 are considered clean, 2-4 slightly enriched, 4-7 enriched, and 7-10 polluted.
[d] Dominant taxa in quantitative samples. Number in parenthesis indicates the percent dominance of the dominant taxa. Taxa in parenthesis indicate the domi

Table 4. Summary statistics for macroinvertebrate surveys at Rilda Creek, Emery County, Utah: Seasonal comparison[a].

Year	2004		2005		2006		2007		2008	
Season	Spring	Fall	Spring	Fall	Spring	Fall	Spring	Fall	Spring	Fall
Total abundance (number/m2)										
Mean	109	1700	37	2607	227	2965	158	1118	124	991
SD	13	179	16	1036	26	332	59	765	75	759
EPT abundance (number/m2)										
Mean	67	1243	28	2347	218	2628	121	1014	109	878
SD	1	263	15	1042	23	205	28	671	71	682
Total taxa richness										
Mean	14	32	10	26	12	29	15	24	10	24
SD	1	3	3	2	2	1	4	6	0	5
Number of families										
Mean	10	18	7	16	10	16	11	16	8	17
SD	1	2	1	2	2	1	2	4	1	4
Shannon diversity										
Mean	1.97	2.06	1.97	1.3	1.55	1.86	1.92	1.59	1.54	1.6
SD	0.01	0.04	0.2	0	0.25	0.06	0.46	0.15	0.16	0.54
Simpson diversity										
Mean	0.19	0.24	0.15	0.52	0.29	0.31	0.24	0.36	0.3	0.36
SD	0	0.02	0.02	0.07	0.05	0.01	0.14	0.11	0	0.13
Evenness										
Mean	0.7	0.49	0.9	0.35	0.66	0.4	0.63	0.48	0.64	0.5
SD	0.02	0.04	0.04	0.07	0.05	0	0.18	0.15	0.12	0.14
Hilsenhoff HBI[b]										
Mean	2.59	4	2.9	3.82	3.41	3.38	3.19	3.48	3.24	3
SD	0.19	0.5	0.23	0.23	0.21	0.23	0.98	0.37	0.6	0
Intolerant taxa abundance (number/m2)										
Mean	10	260	5	240	45	732	33	188	22	235
SD	10	227	0	228	13	247	30	28	4	207
Tolerant taxa abundance (number/m2)										
Mean	0	2	0	1.5	0	34	0	22	0	2
SD	0	2.8	0	2.1	0	17	0	30	0	3

[a] Based on spring and fall data collected from 2004 to 2008.

[b] Hilsenhoff Biotic Index (HBI) values of 0-2 are considered clean, 2-4 slightly enriched, 4-7 enriched, and 7-10 polluted.

Table 5. Summary statistics for spring macroinvertebrate surveys (2004-2008)

Year	Mean Values (Spring surveys)										
	Total Abundance	EPT Abundance	Total Richness	EPT Richness	Abundance of Intolerant Taxa	Abundance of Tolerant Taxa	No. of Families	Shannon Diversity	Simpson Diversity	Evenness	Hilsenhoff HBI
2004 Avg	97	59	13	7	7	0	9	1.87	0.22	0.66	2.84
SE	15.97	9.60	1.08	2.04	6.16	0	0.71	0.12	0.04	0.04	0.33
2005 Avg	34	25	10	6	4	0	6	1.99	0.15	0.90	2.63
SE	8.60	8.03	1.41	1.08	0.82	0	0.71	0.10	0.01	0.02	0.35
2006 Avg	204	183	12	7	32	0	10	1.61	0.28	0.66	3.67
SE	30.14	44.33	1.47	0.41	16.77	0	1.41	0.15	0.03	0.03	0.34
2007 Avg	104	73	11	5	29	0	8	1.75	0.19	0.76	2.59
SE	95.50	68.50	4.64	4.00	25.00	0	4.00	0.50	0.05	0.13	0.09
2008 Avg	177	159	10	4	24	0	8	1.43	0.30	0.72	3.66
SE	38.19	36.34	0.41	0.71	6.96	0	0.41	0.25	0.11	0.10	0.33

Table 6. Summary statistics for fall macroinvertebrate surveys (2004-2008)

Year	Mean Values (Fall surveys)										
	Total Abundance	EPT Abundance	Total Richness	EPT Richness	Abundance of Intolerant Taxa	Abundance of Tolerant Taxa	No. of Families	Shannon Diversity	Simpson Diversity	Evenness	Hilsenhoff HBI
2004 Avg	2076	1588	33	17	740	2.67	17	2.02	0.26	0.44	3.45
SE	470	443	2.16	1.63	600	1.63	1.22	0.04	0.03	0.05	0.71
2005 Avg	2725	2316	25	14	312	2.33	15	1.47	0.45	0.39	3.85
SE	538	522	1.08	0.82	145	1.47	1.08	0.21	0.1	0.06	0.12
2006 Avg	2292	1977	29	16	613	27	16	2.08	0.26	0.45	3.19
SE	841	804	0.82	0.41	190	12	1.08	0.26	0.07	0.06	0.26
2007Avg	1181	988	28	13	185	20	17	1.8	0.32	0.45	3.37
SE	390	337	6.01	1.22	14	15	2.68	0.27	0.08	0.08	0.23
2008 Avg	1116	967	26	11	275	3	17	1.75	0.31	0.54	0.39
SE	409	358	3.63	2.16	115	2.16	2.04	0.34	0.09	0.08	0.10

Table 7. Summary of selected water quality data collected at invertebrate sampling sites along Rilda Creek during spring and fall surveys conducted from 2004 to 2008.

Site	Date	Temperature (°C)	Conductivity (µS/sec)	Dissolved oxygen (%)	pH
1	28-May-04	7.9	39	92.7	8.51
1	22-Oct-04	8.7	512	85.8	8.7
1	16-Jun-05	9.7	37	90.8	8.58
1	19-Oct-05	5.5	507	83.3	8.52
1	14-Jun-06	8.6	38	NA	7.68
1	21-Oct-06	4.7	726	98	8.08
1	21-May-07	8.3	39	80.6	9.34
1	12-Oct-07	4	702	NA	8.9
1	23-Jun-08	NA	NA	NA	NA
1	8-Oct-08	5.5	1048	82.5	9
2	28-May-04	7.1	39	89.6	8.51
2	22-Oct-04	8.6	582	84.5	8.58
2	16-Jun-05	8.4	38	87	8.85
2	19-Oct-05	7.3	571	85.2	8.48
2	14-Jun-06	9.6	38	86	9.12
2	21-Oct-06	4.4	657	NA	8.07
2	21-May-07	6.7	38	80.2	9.22
2	12-Oct-07	8	734	91	8.8
2	23-Jun-08	NA	NA	NA	NA
2	8-Oct-08	8	739	78.6	8.7
3	28-May-04	5	41	89.4	8.55
3	16-Jun-05	9.3	37	86.3	8.64
3	14-Jun-06	11.5	37	78.3	9.38
3	17-May-07	4.6	42	NA	13.14
3	23-Jun-08	NA	NA	NA	NA
4	22-Oct-04	7.4	580	81.2	7.86
4	19-Oct-05	7.5	585	83.5	8.09
4	21-Oct-06	5.8	603	81.3	7.63
4	12-Oct-07	7	606	85	8.4
4	8-Oct-08	9	669	86.7	8.2

Table 8. Summary of fish surveys in Rilda Creek, Emery County, Utah. 2004-2008.

Date	Species	Number observed	Comments
4-Jun-04	Cutthroat trout	20	UDWR survey. Larger fish (100-250 mm) captured in lower reaches. YOY (<100mm) captured throughout the section. No fish observed above road crossing.
	Brown trout	1	
22-Oct-04	Cutthroat trout	56	Cirrus Survey. Larger fish (40: 100-250 mm) captured mainly in lower and middle reaches of the sections surveyed. 26 fish less than 100 mm (including 9 YOY) were captured throughout the section. No fish observed above the road crossing.
	Brown trout	1	
16-Jun-05	Cutthroat trout	1	UDWR survey. No fish observed due to high flow conditions.
	Brown trout	0	
19-Oct-05	Cutthroat trout	37	Cirrus survey. Larger fish (15: 100-250 mm) captured mainly in lower and middle reaches of the sections surveyed. 22 fish less than 100 mm (including 16 YOY) were captured throughout the section. No fish observed above the concrete structure.
	Brown trout	0	
14-Jun-06	Cutthroat trout	10	UDWR survey. Seven fish with lengths from 100 to 250 mm and 3 fish with less than 100 mm were captured. Three fish were longer than 200mm. All fish were captured below the concrete structure.
	Brown trout	0	
20-Oct-06	Cutthroat trout	27	Cirrus survey. Larger fish (12: 100-250 mm) captured mainly in lower and middle reaches of the sections surveyed. 15 fish less than 100 mm (including 7 YOY) were captured throughout the section. No fish observed above the concrete structure.
	Brown trout	0	
22-May-07	Cutthroat trout	6	UDWR survey. Six cutthroat trout and one brown trout Salmo trutta were captured during electrofishing surveys. All fish measured over 100mm and four exceeded 200mm. No young of year were captured during this sampling.
	Brown trout	1	
13-Oct-07	Cutthroat trout	88	S.E.C. survey. Larger fish (22: 100-250) were captured in lower to middle reaches of the section surveyed. 13 fish with total length less than 100mm were captured throughout the section surveyed. 53 YOY were also captured throughout this section. No fish were observed above the concrete structure.
	Brown trout	7	S.E.C. survey. 5 brown trout with total length less than 100mm and 2 with length greater than 250mm were observed in lower to middle reaches of the section surveyed. No fish were observed above the concrete structure.
23-Jun-08	Cutthroat trout	0	UDWR Survey.
	Brown trout	1	UDWR survey. One fish with 132 mm in total length. This fish was captured below the concrete structure.
8-Oct-08	Cutthroat trout	50	S.E.C. survey. Larger fish (33: 100-250mm) were observed in lower to middle reaches of the section surveyed. 14 fish with total length less than 100mm were captured throughout the section surveyed. 3 YOY were also captured throughout this section, and 5 YOY were observed. No fish were observed above the concrete structure.
	Brown trout	2	S.E.C. survey. 2 brown trout with total length greater than 250mm were observed in lower to middle reaches of the section surveyed. No fish were observed above the concrete structure.

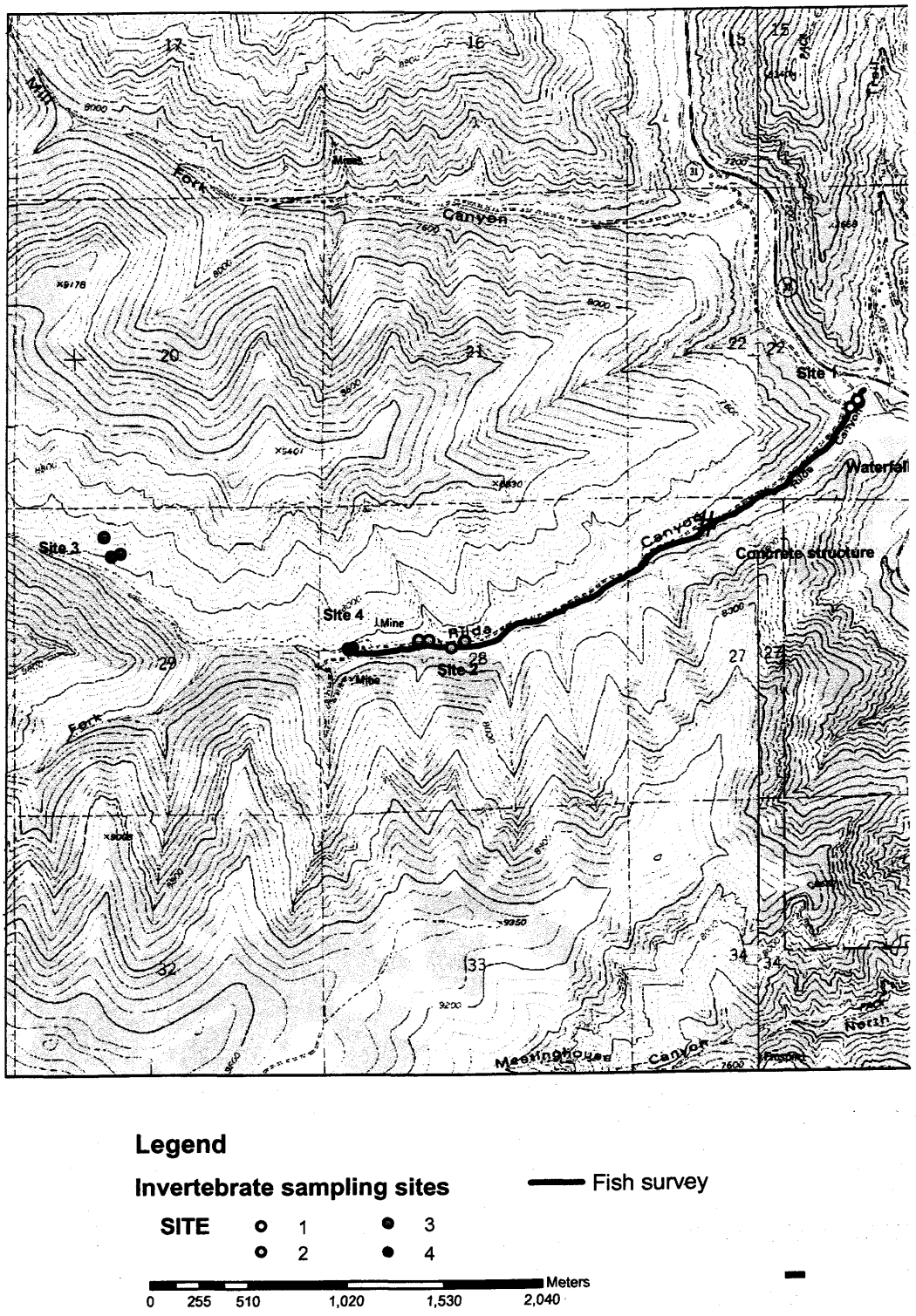

Figure 1. Map of Rilda Creek Canyon, Emery, Utah. Location of macroinvertebrate sampling sites and fish survey sampling section.

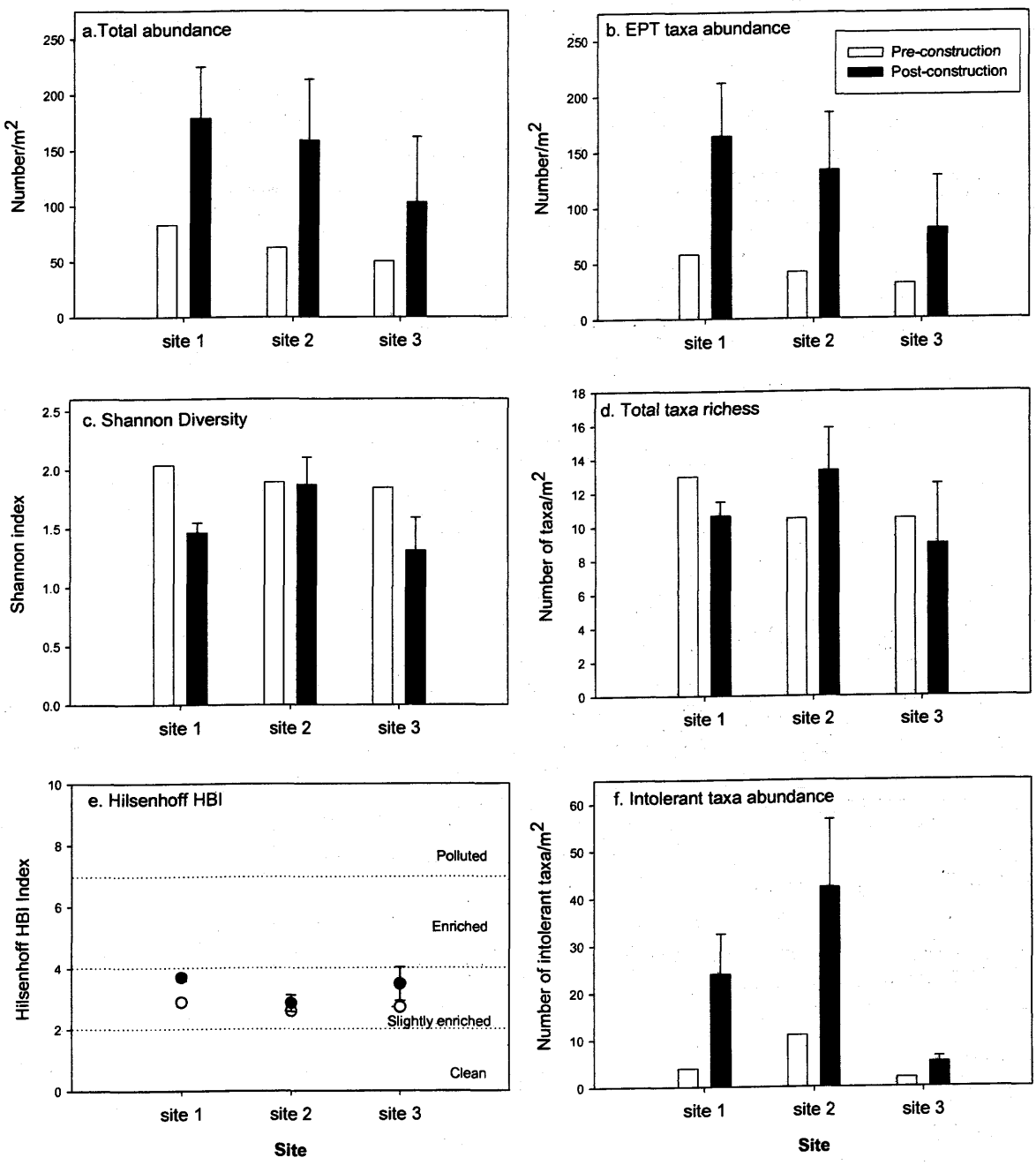

Figure 2. Total abundance (a), EPT taxa abundance (b), Shannon diversity (c), and Total taxa richness (d), Hilsenhoff HBI, and Intolerant taxa abundance for spring macroinvertebrate surveys at Rilda Creek, Emery County, Utah, conducted during pre- (white) and post- (black) construction. Bars or circles represent the mean. Lines show standard errors.

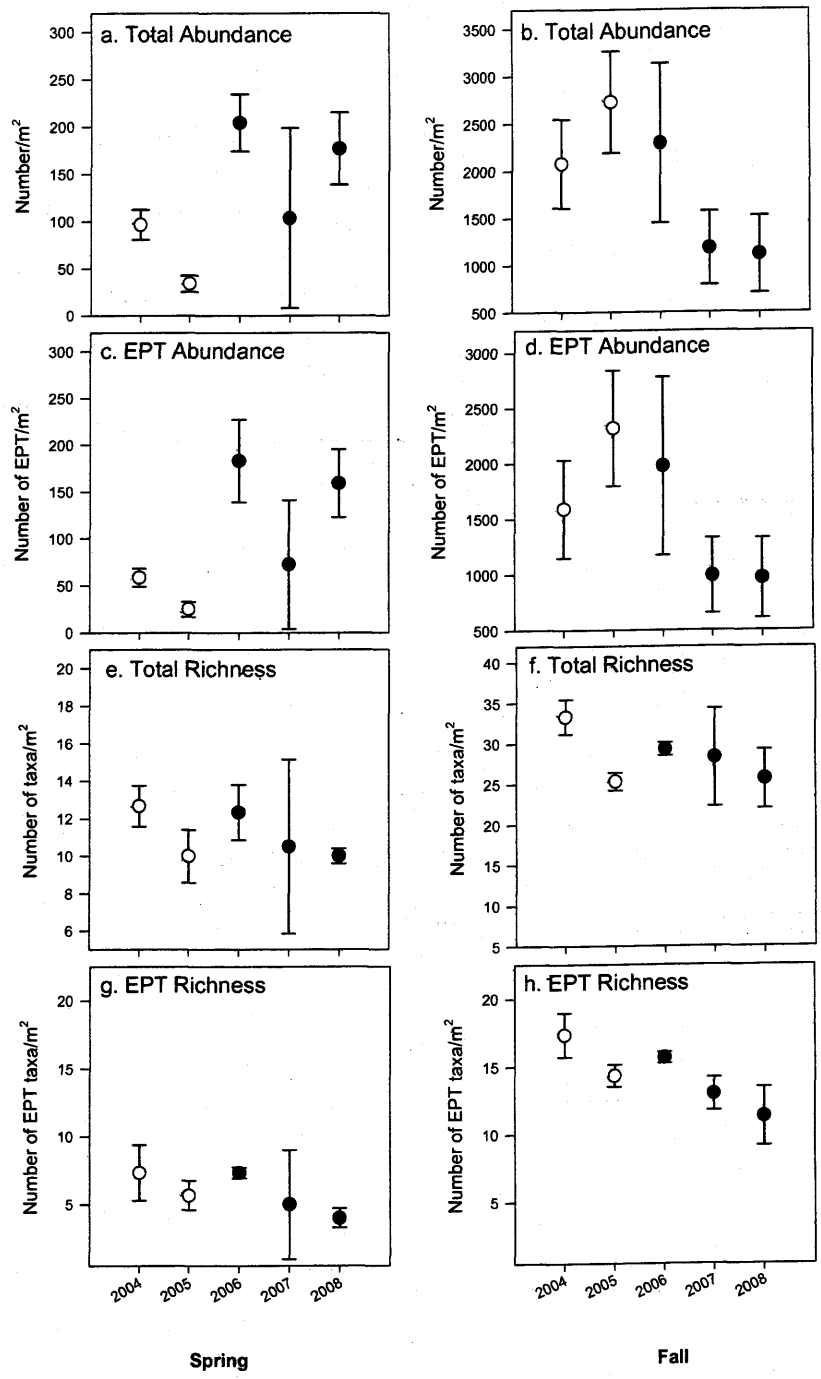

Figure 3. Total abundance (a,b), EPT abundance (c,d), Total richness (e,f), and EPT richness (g,h) for spring (left figures) and fall (right figures) macroinvertebrate surveys at Rilda Creek, Emery County, Utah, conducted during pre- (white circles) and post- (black circles) construction. Circles represent the mean. Lines show standard errors.

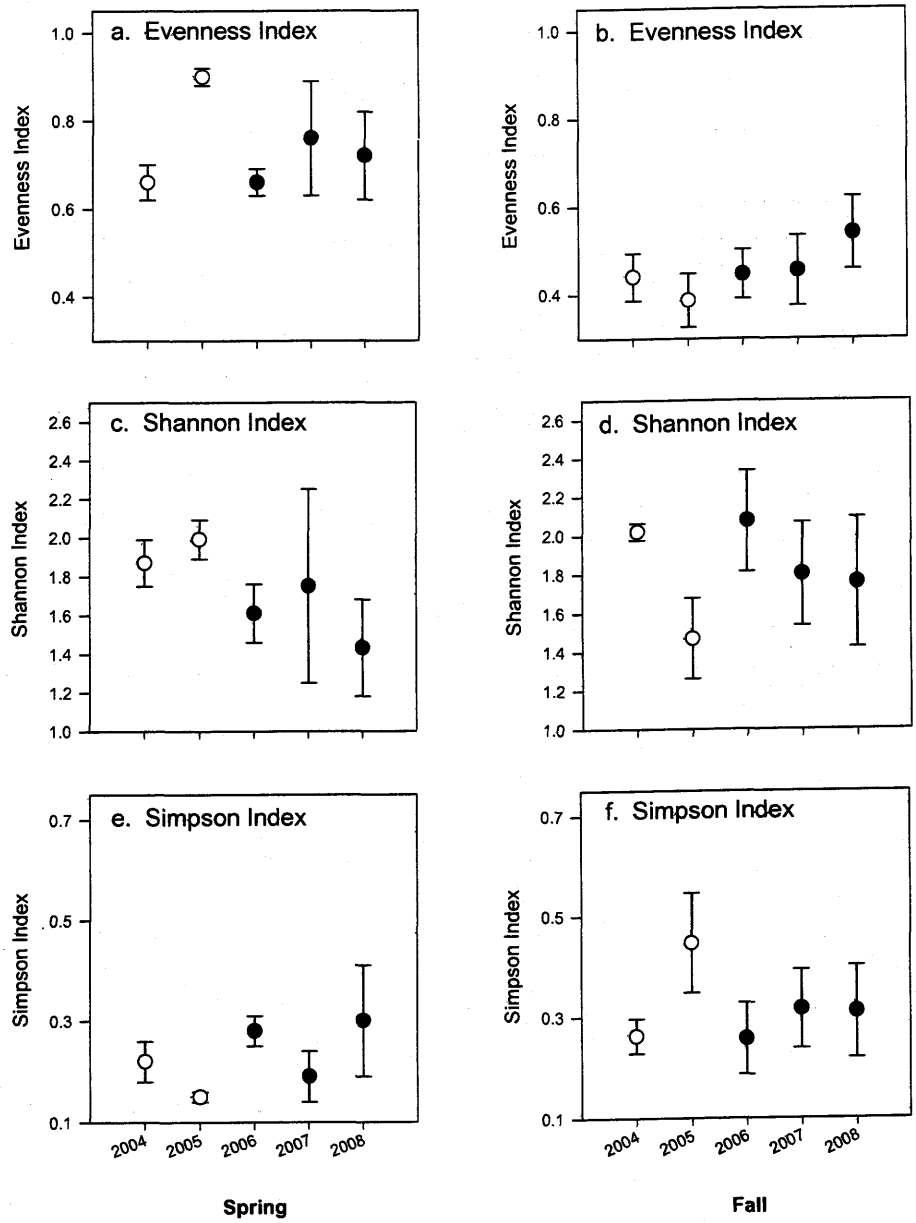

Figure 4. Evenness (a,b), Shannon diversity (c,d), and Simpson indexes (e,f) in Rilda Creek for spring (left figures) and fall (right figures) macroinvertebrate surveys at Rilda Creek, Emery County, Utah, conducted during pre- (white circles) and post- (black circles) disturbance conditions. Circles represent the mean. Lines show standard errors.

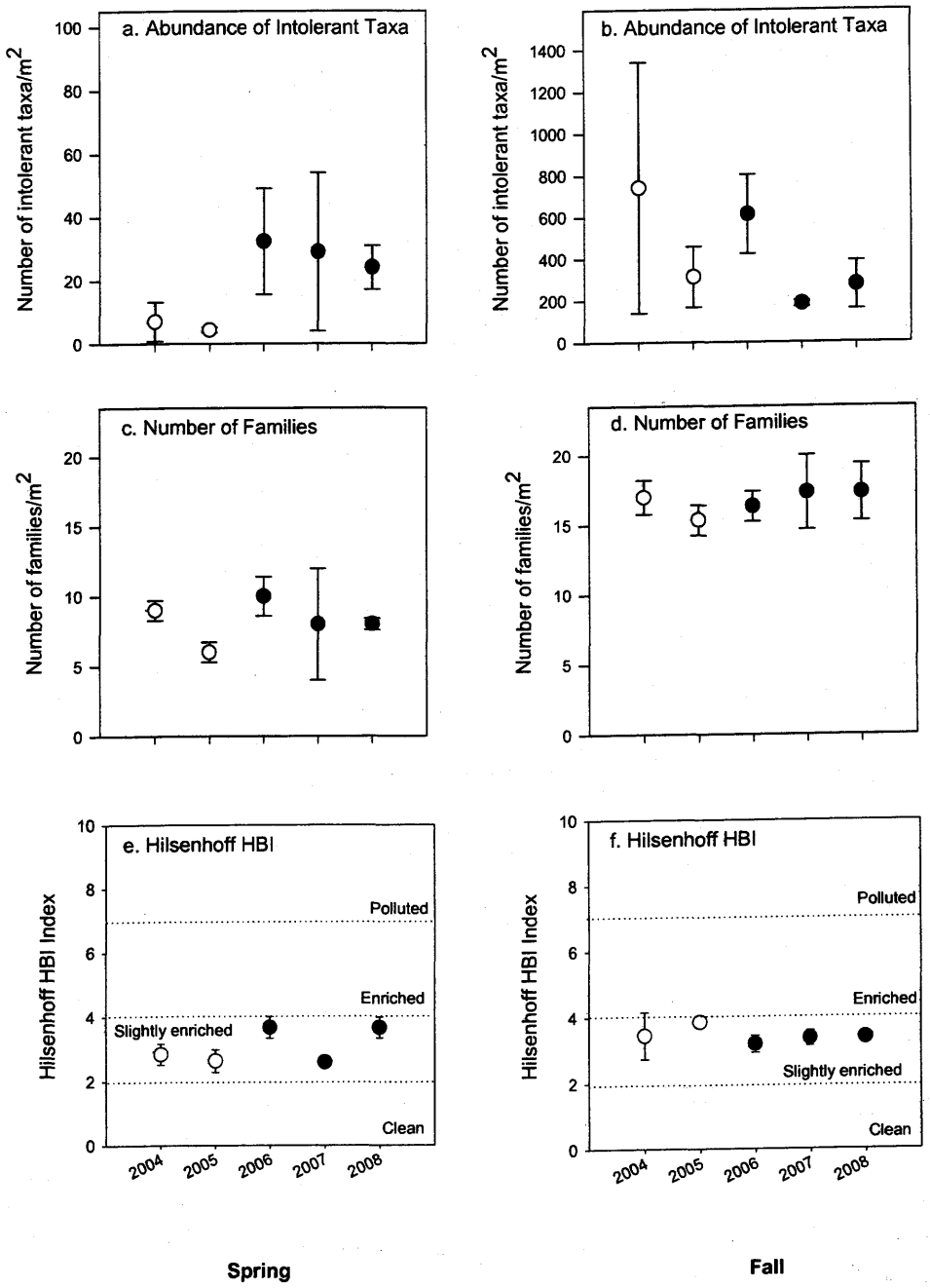

Figure 5. Abundance of intolerant taxa (a,b), number of families (c,d), and Hilsenhoff HBI (e,f) in Rilda Creek for spring (left figures) and fall (right figures) macroinvertebrate surveys at Rilda Creek, Emery County, Utah, conducted during pre- (white circles) and post- (black circles) disturbance conditions. Circles represent the mean. Lines show standard errors.

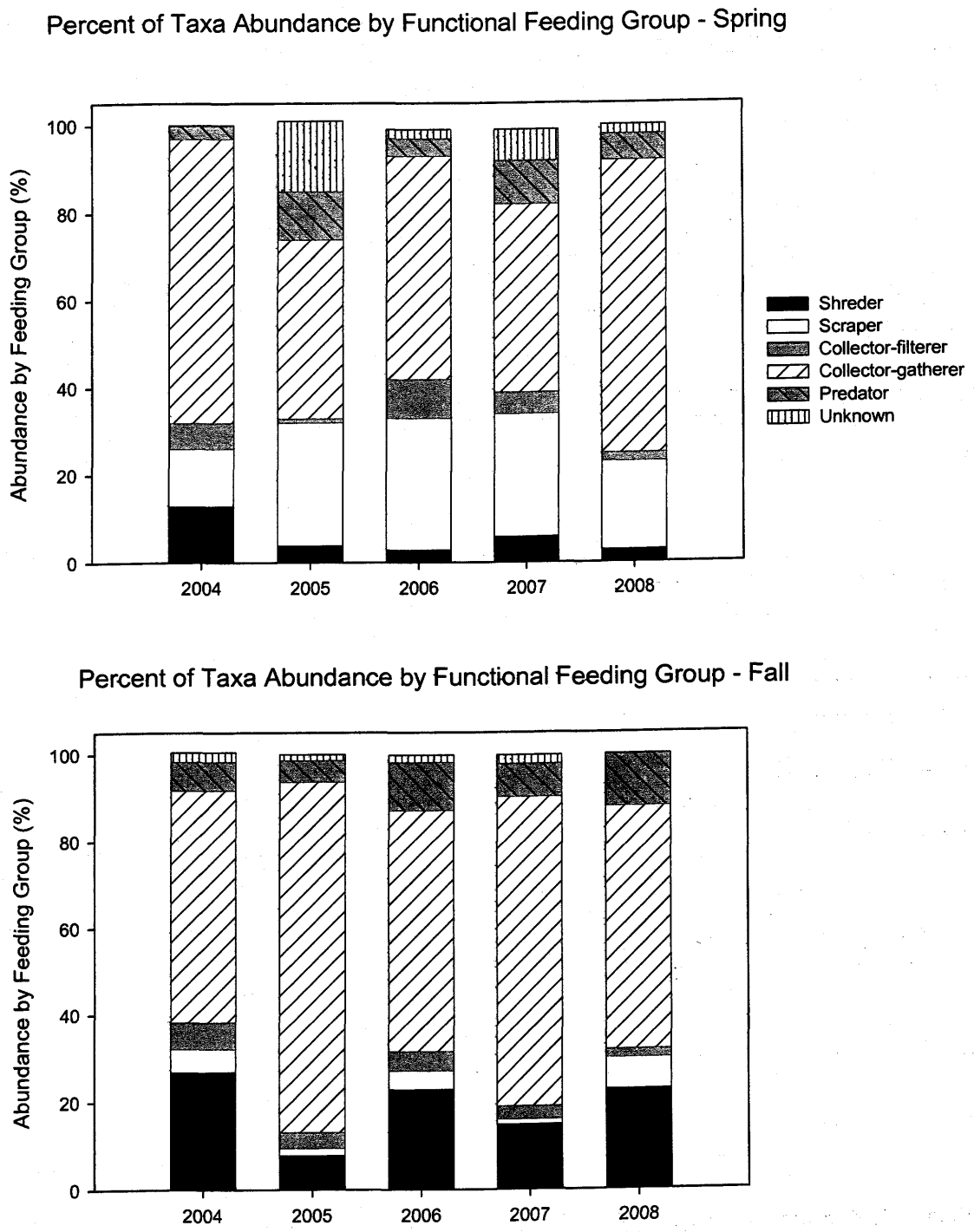

Figure 6. Spring and fall macroinvertebrate taxa abundance by functional feeding group in Rilda Creek (2004-2008).

APPENDIX

Taxa Lists for Individual Samples

Taxonomic list and densities of aquatic invertebrates identified and retained from a sample collected October 8, 2008 at station RC1, Rilda Creek, Emery county, Utah. The sample was collected from riffle habitat using a surber net. The total area sampled was 0.093 square meters. The percentage of the sample that was identified and retained was 75% of the collected sample. A total of 857 individuals were removed, identified and retained. The sample identification number is 135006. OTU=operational taxonomic unit. Notes - identification to genus or species was not supported because: I - immature organisms, D- damaged organisms, M - poor slide mount, G - gender, U - indistinct characters or distribution, R - retained in our reference collection.

Order	Family	Subfamily/Genus/Species	Life Stage	Density	Notes
Phylum: Annelida					
Class: Clitellata	SubClass: Oligochaeta				
			adult	57.41	
Phylum: Arthropoda					
Class: Arachnida	SubClass:				
Acariformes Prostigmata	Sperchonidae	Sperchon	adult	71.76	
Class: Insecta	SubClass:				
Coleoptera	Curculionidae		adult	14.35	
Coleoptera	Elmidae	Optioservus quadrimaculatus	adult	14.35	
Diptera	Chironomidae		pupae	43.05	
Diptera	Chironomidae	Chironominae	larvae	86.11	
Diptera Nematocera	Chironomidae	Orthocladiinae	larvae	373.14	
Diptera	Empididae	Chelifera	larvae	14.35	
Diptera	Simuliidae	*Simulium*	larvae	423.37	
Diptera	Tipulidae	Antocha monticola	larvae	14.35	
Diptera	Tipulidae	Tipula	larvae	168.63	
Ephemeroptera	Baetidae	Baetis	larvae	7502.31	
Ephemeroptera	Heptageniidae	Cinygmula	larvae	71.76	
Plecoptera	Capniidae		larvae	3006.66	I,D,U
Plecoptera	Nemouridae	Zapada cinctipes	larvae	10.76	
Plecoptera	Perlodidae	Isoperla	larvae	100.46	
Trichoptera	Limnephilidae		larvae	71.76	I
Trichoptera	Limnephilidae	Limnephilinae Limnephilini Hesperophylax	larvae	39.47	
Trichoptera	Rhyacophilidae	Rhyacophila vofixa group	larvae	28.70	
Phylum: Platyhelminthes					
Class: Turbellaria	SubClass:				
			adult	57.41	
Total: OTU Taxa : **20**	Genera : **12**	Families : **15**		12170.17	

Taxonomic list and densities of aquatic invertebrates identified and retained from a sample collected October 8, 2008 at station RC1, Rilda Creek, Emery county, Utah. The sample was collected from multiple habitat using a kick net. The total area sampled was 1.000 square meters. The percentage of the sample that was identified and retained was 56% of the collected sample. A total of 622 individuals were removed, identified and retained. The sample identification number is 135007. OTU=operational taxonomic unit. Notes - identification to genus or species was not supported because: I - immature organisms, D- damaged organisms, M - poor slide mount, G - gender, U - indistinct characters or distribution, R - retained in our reference collection.

Order	Family	Subfamily/Genus/Species	Life Stage	Density	Notes
Phylum: Arthropoda					
Class: Arachnida	SubClass:				
Acariformes Prostigmata	Lebertiidae	Lebertia	adult	6.00	
Acariformes Prostigmata	Sperchonidae	Sperchon	adult	7.00	
Class: Insecta	SubClass:				
Coleoptera	Dytiscidae	Oreodytes	adult	1.00	
Coleoptera	Elmidae	Optioservus divergens/pecosensis	adult	1.00	
Coleoptera	Hydrophilidae	Ametor	adult	1.00	
Diptera	Ceratopogonidae		larvae	1.00	U
Diptera	Chironomidae		pupae	3.00	
Diptera	Chironomidae	Chironominae	larvae	4.00	
Diptera Nematocera	Chironomidae	Orthocladiinae	larvae	19.00	
Diptera	Chironomidae	Tanypodinae	larvae	4.00	
Diptera	Empididae	Chelifera	larvae	4.00	
Diptera	Simuliidae	Simulium	larvae	4.00	
Diptera	Tipulidae	Antocha monticola	larvae	16.00	
Diptera	Tipulidae	Dicranota	larvae	1.00	
Diptera Nematocera	Tipulidae	Limoniinae Hexatomini Limnophila	larvae	2.00	
Diptera	Tipulidae	Ormosia	larvae	1.00	
Diptera	Tipulidae	Tipula	larvae	22.00	
Ephemeroptera	Ameletidae	Ameletus	larvae	2.00	
Ephemeroptera	Baetidae	Baetis	larvae	267.00	
Ephemeroptera	Baetidae	Diphetor hageni	larvae	6.00	
Ephemeroptera	Heptageniidae		larvae	5.00	I,D
Ephemeroptera	Heptageniidae	Cinygmula	larvae	4.00	
Plecoptera	Capniidae		larvae	191.00	I,U,D
Plecoptera	Perlodidae		larvae	13.00	I
Plecoptera	Perlodidae	Isoperla	larvae	14.00	
Plecoptera	Taeniopterygidae	Taenionema	larvae	1.00	
Trichoptera	Hydropsychidae		larvae	3.00	I
Trichoptera	Hydropsychidae	Hydropsyche	larvae	1.00	
Trichoptera	Limnephilidae		larvae	9.00	I
Trichoptera	Rhyacophilidae	Rhyacophila vofixa group	larvae	5.00	
Phylum: Platyhelminthes					
Class: Turbellaria	SubClass:				
			adult	4.00	
Total: OTU Taxa : 31	Genera : 20	Families : 20		622.00	

Taxonomic list and densities of aquatic invertebrates identified and retained from a sample collected October 8, 2008 at station RC2, Rilda Creek, Emery county, Utah. The sample was collected from riffle habitat using a surber net. The total area sampled was 0.093 square meters. The percentage of the sample that was identified and retained was 100% of the collected sample. A total of 336 individuals were removed, identified and retained. The sample identification number is 135008. OTU=operational taxonomic unit. Notes - identification to genus or species was not spported because: I - immature organisms, D- damaged organisms, M - poor slide mount, G - gender, U - indistint characters or distribution, R - retained in our reference collection.

Order	Family	Subfamily/Genus/Species	Life Stage	Density	Notes
Phylum: Arthropoda					
Class: Arachnida	SubClass:				
Acariformes Prostigmata	Lebertiidae	Lebertia	adult	43.05	
Acariformes Prostigmata	Sperchonidae	Sperchon	adult	21.53	
Class: Insecta	SubClass:				
Coleoptera	Elmidae	Optioservus	larvae	10.76	
Coleoptera	Elmidae	Optioservus quadrimaculatus	adult	10.76	
Coleoptera	Hydrophilidae	Ametor	adult	10.76	
Diptera	Chironomidae	Chironominae	larvae	10.76	
Diptera Nematocera	Chironomidae	Orthocladiinae	larvae	32.29	
Diptera	Chironomidae	Tanypodinae	larvae	10.76	
Diptera	Empididae	Chelifera	larvae	10.76	
Diptera	Empididae	Clinocera	larvae	10.76	
Diptera	Psychodidae	Pericoma	larvae	32.29	
Diptera	Simuliidae	Simulium	larvae	21.53	
Diptera	Tipulidae	Antocha monticola	larvae	21.53	
Diptera Nematocera	Tipulidae	Limoniinae Hexatomini Limnophila	larvae	32.29	
Diptera	Tipulidae	Tipula	larvae	193.75	
Ephemeroptera	Ameletidae	Ameletus	larvae	21.53	
Ephemeroptera	Baetidae	Baetis	larvae	1786.78	
Ephemeroptera	Ephemerellidae		larvae	21.53	I
Ephemeroptera	Heptageniidae		larvae	129.16	I
Ephemeroptera	Leptophlebiidae		larvae	10.76	I
Plecoptera	Capniidae		larvae	333.68	I,U
Plecoptera	Nemouridae	Zapada	larvae	21.53	I,D
Plecoptera	Perlodidae		larvae	161.46	I
Plecoptera	Perlodidae	Isoperla	larvae	247.57	
Trichoptera	Limnephilidae		larvae	75.35	I
Trichoptera	Limnephilidae	Limnephilinae Limnephilini Hesperophylax	larvae	10.76	
Trichoptera	Rhyacophilidae	Rhyacophila vofixa group	larvae	322.91	
Total: OTU Taxa : **27**	Genera : **18**	Families : **19**		3616.61	

Taxonomic list and densities of aquatic invertebrates identified and retained from a sample collected October 8, 2008 t station RC2, Rilda Creek, Emery county, Utah. The sample was collected from multiple habitat using a kick net. The total area sampled was 1.000 square meters. The percentage of the sample that was identified and retained was 50% of the collected sample. A total of 731 individuals were removed, identified and retained. The sample identification number is 135009. OTU=operational taxonomic unit. Notes - identification to genus or species was not spported because: I - immature organisms, D- damaged organisms, M - poor slide mount, G - gender, U - indistint characters or distribution, R - retained in our reference collection.

Order	Family	Subfamily/Genus/Species	Life Stage	Density	Notes
Phylum: Annelida					
Class: Clitellata	SubClass: Oligochaeta				
			adult	1.00	
Phylum: Arthropoda					
Class: Arachnida	SubClass:				
Acariformes Prostigmata			adult	3.00	U
Acariformes Prostigmata	Lebertiidae	Lebertia	adult	1.00	
Acariformes Prostigmata	Sperchonidae	Sperchon	adult	1.00	
Class: Entognatha	SubClass:				
Collembola			adult	1.00	
Class: Insecta	SubClass:				
Coleoptera	Elmidae		larvae	2.00	I
Diptera	Chironomidae	Chironominae	larvae	13.00	
Diptera Nematocera	Chironomidae	Orthocladiinae	larvae	4.00	
Diptera	Chironomidae	Tanypodinae	larvae	47.00	
Diptera	Empididae	Chelifera	larvae	9.00	
Diptera	Psychodidae	Pericoma	larvae	4.00	
Diptera	Simuliidae	Simulium	larvae	1.00	
Diptera	Tipulidae		larvae	1.00	I
Diptera	Tipulidae	Antocha monticola	larvae	1.00	
Diptera	Tipulidae	Dicranota	larvae	1.00	
Diptera Nematocera	Tipulidae	Limoniinae Hexatomini Limnophila	larvae	6.00	
Diptera	Tipulidae	Tipula	larvae	6.00	
Ephemeroptera	Ameletidae	Ameletus	larvae	2.00	
Ephemeroptera	Baetidae	Baetis	larvae	222.00	
Ephemeroptera	Baetidae	Diphetor hageni	larvae	16.00	
Ephemeroptera	Ephemerellidae		larvae	13.00	I
Ephemeroptera	Heptageniidae		larvae	3.00	I
Ephemeroptera	Heptageniidae	Cinygmula	larvae	44.00	
Ephemeroptera	Leptophlebiidae	Paraleptophlebia	larvae	2.00	
Plecoptera	Capniidae		larvae	96.00	I
Plecoptera	Chloroperlidae		larvae	2.00	I
Plecoptera	Nemouridae	Zapada	larvae	13.00	I
Plecoptera	Perlodidae		larvae	8.00	I
Plecoptera	Perlodidae	Isoperla	larvae	22.00	
Trichoptera	Limnephilidae		larvae	3.00	
Trichoptera	Rhyacophilidae	Rhyacophila	larvae	4.00	I
Trichoptera	Rhyacophilidae	Rhyacophila vofixa group	larvae	21.00	
Class: Ostracoda	SubClass:				
			adult	100.00	
Phylum: Nemata					
Class:	SubClass:				
			adult	2.00	
hylum: Platyhelminthes					
Class: Turbellaria	SubClass:				

					adult	56.00
Total:	OTU Taxa : **35**	Genera : **18**	Families : **20**			731.00

Taxonomic list and densities of aquatic invertebrates identified and retained from a sample collected October 8, 2008 at station RC3, Rilda Creek, Emery county, Utah. The sample was collected from riffle habitat using a surber net. The total area sampled was 0.093 square meters. The percentage of the sample that was identified and retained was 63% of the collected sample. A total of 635 individuals were removed, identified and retained. The sample identification number is 135010. OTU=operational taxonomic unit. Notes - identification to genus or species was not spported because: I - immature organisms, D- damaged organisms, M - poor slide mount, G - gender, U - indistint characters or distribution, R - retained in our reference collection.

Order	Family	Subfamily/Genus/Species	Life Stage	Density	Notes
Phylum: Arthropoda					
Class: Arachnida	SubClass:				
Acariformes Prostigmata	Lebertiidae	Lebertia	adult	34.44	
Acariformes Prostigmata	Sperchonidae	Sperchon	adult	17.22	
Class: Insecta	SubClass:				
Coleoptera	Elmidae	Narpus concolor	larvae	17.22	
Coleoptera	Elmidae	Optioservus	larvae	17.22	
Coleoptera	Elmidae	Optioservus divergens/pecosensis	adult	17.22	
Coleoptera	Elmidae	Optioservus quadrimaculatus	adult	258.33	
Coleoptera	Scirtidae	Elodes	larvae	17.22	
Diptera	Chironomidae	Chironominae	larvae	17.22	
Diptera Nematocera	Chironomidae	Orthocladiinae	larvae	723.32	
Diptera	Chironomidae	Tanypodinae	larvae	258.33	
Diptera	Empididae	Chelifera	larvae	34.44	
Diptera	Psychodidae	Pericoma	larvae	51.67	
Diptera	Tipulidae	Dicranota	larvae	51.67	
Diptera Nematocera	Tipulidae	Limoniinae Hexatomini Limnophila	larvae	17.22	
Diptera	Tipulidae	Ormosia	larvae	34.44	
Diptera	Tipulidae	Tipula	larvae	182.98	
Ephemeroptera	Ameletidae	Ameletus	larvae	86.11	
Ephemeroptera	Baetidae	Baetis	larvae	4075.14	
Ephemeroptera	Ephemerellidae		larvae	34.44	I
Ephemeroptera	Heptageniidae	Cinygmula	larvae	1567.20	
Plecoptera	Capniidae		larvae	2014.97	I,U
Plecoptera	Leuctridae		larvae	17.22	I
Plecoptera	Nemouridae	Zapada cinctipes	larvae	68.89	
Plecoptera	Perlodidae	Isoperla	larvae	103.33	
Plecoptera	Perlodidae	Megarcys signata	larvae	34.44	
Trichoptera	Hydropsychidae		larvae	103.33	I
Trichoptera	Hydropsychidae	Parapsyche elsis	larvae	165.76	
Trichoptera	Limnephilidae		larvae	182.98	I
Trichoptera	Rhyacophilidae	Rhyacophila	larvae	51.67	
Trichoptera	Rhyacophilidae	Rhyacophila vofixa group	larvae	628.60	
Total: OTU Taxa : **30**	Genera : **22**	Families : **19**		10884.26	

Taxonomic list and densities of aquatic invertebrates identified and retained from a sample collected October 8, 2008 at station RC3, Rilda Creek, Emery county, Utah. The sample was collected from multiple habitat using a kick net. The total area sampled was 1.000 square meters. The percentage of the sample that was identified and retained was 38% of the collected sample. A total of 675 individuals were removed, identified and retained. The sample identification number is 135011. OTU=operational taxonomic unit. Notes - identification to genus or species was not spported because: I - immature organisms, D- damaged organisms, M - poor slide mount, G - gender, U - indistint characters or distribution, R - retained in our reference collection.

Order	Family	Subfamily/Genus/Species	Life_Stage	Density	Notes
Phylum: Arthropoda					
Class: Arachnida	SubClass:				
Acariformes Prostigmata	Lebertiidae	Lebertia	adult	2.00	
Class: Insecta	SubClass:				
Coleoptera	Elmidae	Optioservus quadrimaculatus	adult	2.00	
Coleoptera	Scirtidae	Elodes	larvae	1.00	
Diptera	Chironomidae	Chironominae	larvae	8.00	
Diptera Nematocera	Chironomidae	Orthocladiinae	larvae	111.00	
Diptera	Chironomidae	Tanypodinae	larvae	68.00	
Diptera	Empididae	Chelifera	larvae	2.00	
Diptera	Psychodidae	Pericoma	larvae	5.00	
Diptera Nematocera	Tipulidae	Limoniinae Hexatomini Limnophila	larvae	1.00	
Diptera	Tipulidae	Ormosia	larvae	2.00	
Diptera	Tipulidae	Tipula	larvae	9.00	
Ephemeroptera	Ameletidae	Ameletus	larvae	2.00	
Ephemeroptera	Baetidae	Baetis	larvae	206.00	
Ephemeroptera	Baetidae	Diphetor hageni	larvae	11.00	
Ephemeroptera	Ephemerellidae		larvae	15.00	I
Ephemeroptera	Heptageniidae	Cinygmula	larvae	98.00	
Ephemeroptera	Leptophlebiidae	Paraleptophlebia	larvae	1.00	
Plecoptera	Capniidae		larvae	104.00	I
Plecoptera	Nemouridae	Zapada	larvae	6.00	I
Trichoptera	Hydropsychidae	Parapsyche elsis	larvae	7.00	
Trichoptera	Limnephilidae		larvae	1.00	I
Trichoptera	Limnephilidae	Limnephilinae Limnephilini Hesperophylax	larvae	1.00	
Trichoptera	Rhyacophilidae	Rhyacophila vofixa group	larvae	9.00	
Phylum: Platyhelminthes					
Class: Turbellaria	SubClass:				
			adult	3.00	
Total: OTU Taxa : 24	Genera : 17	Families : 18		675.00	