# PacifiCorp

# Energy West Mining Company

# Deer Creek Coal Mine

# North Rilda Canyon

# Portal Facilities

**Amendment to 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 Task ID #3613**

# Volume 11A

# 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. Task I.D. #3613**

Five (5) Clean Copies – Volume 11, Appendix Volume A, Soils Tab, Appendix C

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Replace Maps 200-1 and 200-2

C/015/018 Incoming
#3613
R

ENERGY WEST MINING COMPANY
A SUBSIDIARY OF PACIFICORP

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

COPY

November 3, 2010

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

**Subj:** **Clean Copy Submittal for the 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. Task I.D. #3613.**

PacifiCorp, by and through its wholly-owned subsidiary, Energy West Mining Company ("Energy West"), as mine operator, hereby submits the clean copies to the above stated amendment that was conditionally approved on October 5, 2010.

Energy West originally submitted this amendment on June 30, 2010. After the Division's technical analysis of the amendment submittal, the Division found three (3) deficiencies and returned the entire submittal back to the permittee, Energy West.

Energy West corrected the permit submittal to address the Division's concerns and re-submitted for review. On October 5, 2010, the Division conditionally approved this amendment application on the condition that the permittee submit clean copies for incorporation into the Deer Creek MRP.

This clean copy submittal includes six (6) clean copies of the amended information in Volume 11, Volume 11a, and Volume 11b. Also included is the C2 form for aid in incorporating the approved information into the MRP.

As keeping with our original plan, Energy West has completed the first of three parts of this amendment process for the Rilda Facilties. The three parts are as follows:

Part 1 (Current Submittal to Complete) – Update Volume 11, Volume 11 Appendix Volume A, Volume 11 Appendix Volume B – text, maps, and data,

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

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

Energy West will now proceed with Part 2 by recalculating the reclamation bond for the Rilda Facilities. If you have any questions or concerns regarding this submittal, please contact Dennis Oakley at (435) 687-4825.

Sincerely,

Dennis Oakley

for Kenneth Fleck
Geology and Environmental Affairs Manager

File in:
☐ Confidential
☒ Shelf
☐ Expandable
Date Folder 11042010 C/015/0018
See Incoming For additional information

Enclosures C2 Form
Volume 11
Volume 11 Appendix Volume A
Volume 11 Appendix Volume B

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

COPY

**rmittee:** PacifiCorp
**ne:** Deer Creek **Permit Number:** C/015/0018
**Title:** Clean Copy Submittal to Update Volume 11, Rilda Canyon Facilities, PacifiCorp, Deer Creek Mine, C/015/0018, Emery County, Utah, Task ID #3613.

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** |
|---|---|
| | RECEIVED<br>NOV 0 4 2010<br>DIV. OF OIL, GAS & MINING |

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. Task I.D. #3613**

Five (5) Clean Copies – Volume 11, Appendix Volume A, Biology Tab, Appendix D

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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



James F. Karpowitz
Director

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## 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 $\geq 9$ indicates a family is tolerant of pollution and a ranking of $\leq 1$ 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.

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

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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 |

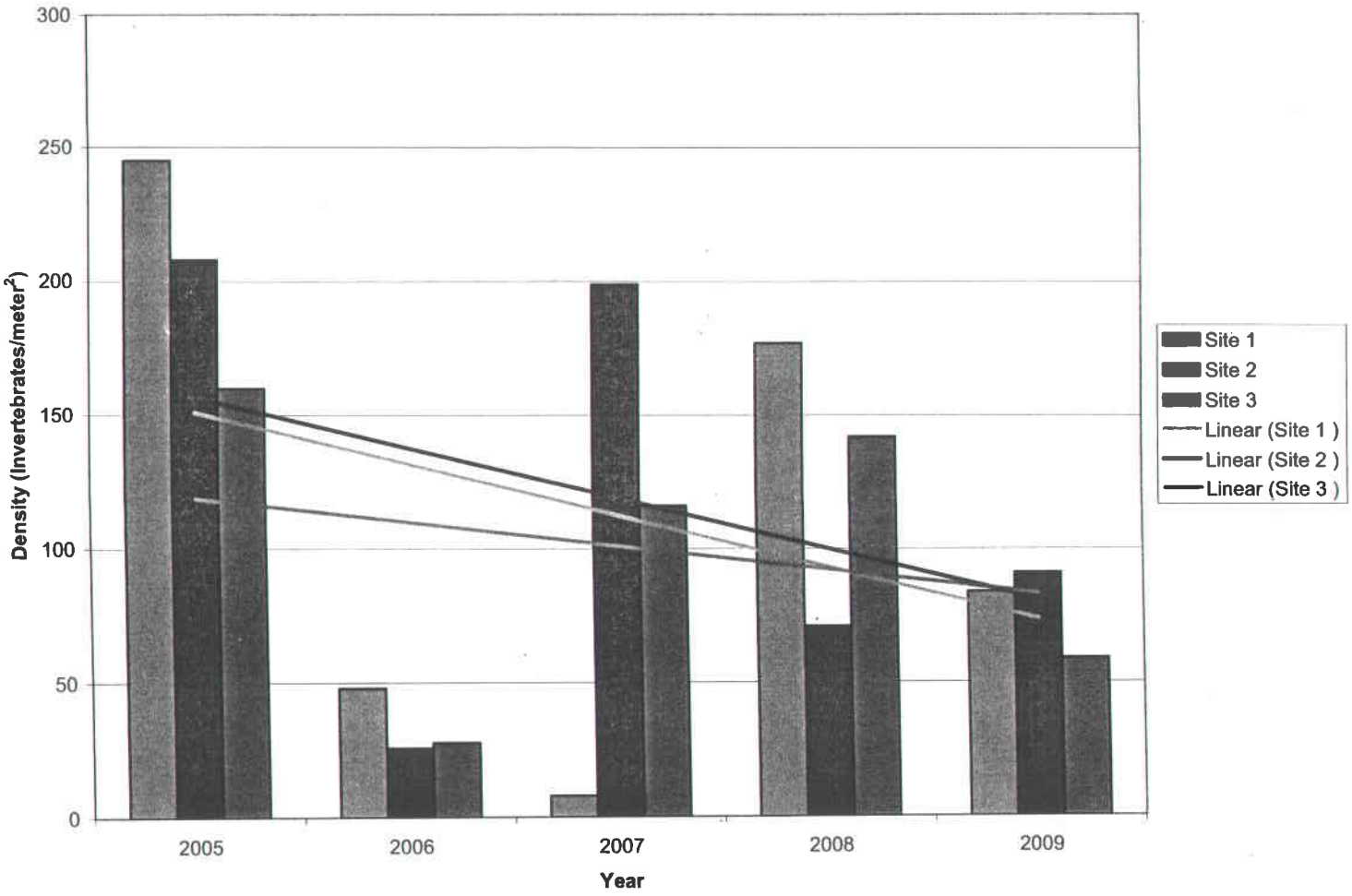


Figure 1. Estimated density of invertebrates per meter$^2$ collected from 3 sites on Rilda Canyon Creek. Site 3 is located upstream of the mine portal and is not expected to be impacted by the mine (Vinson 2005, Vinson 2007, Vinson 2008 and Miller 2009).

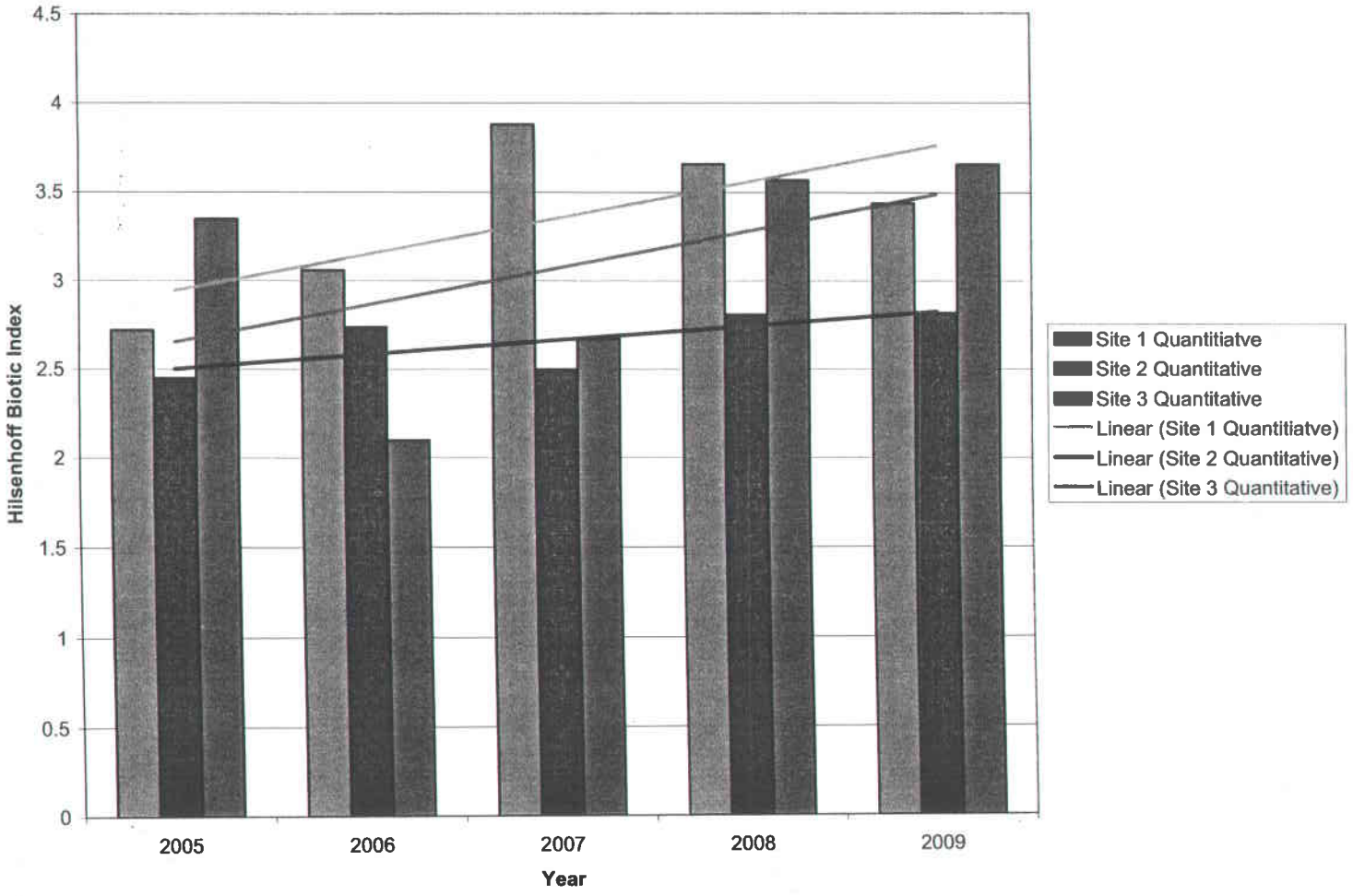


Figure 2. Mean Hilsenhoff biotic index for quantitative samples collected in Rilda Canyon Creek (Vinson 2005, Vinson 2007, Vinson 2008 and Miller 2009).

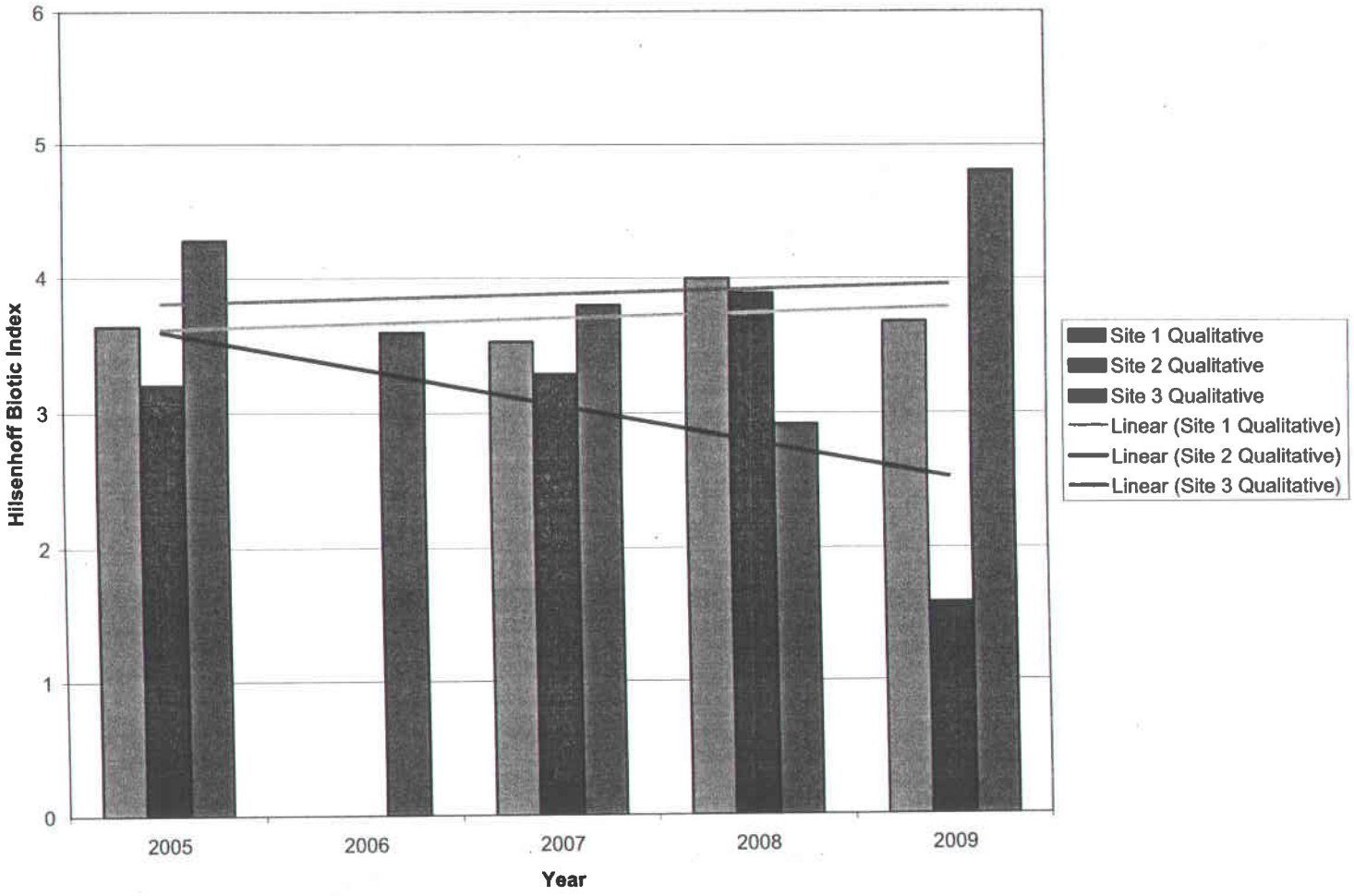


Figure 3. Mean Hilsenhoff biotic index for quantitative samples collected in Rilda Canyon Creek (Vinson 2005, Vinson 2007, Vinson 2008 and Miller 2009). Invertebrates were not collected from qualitative samples in 2006.

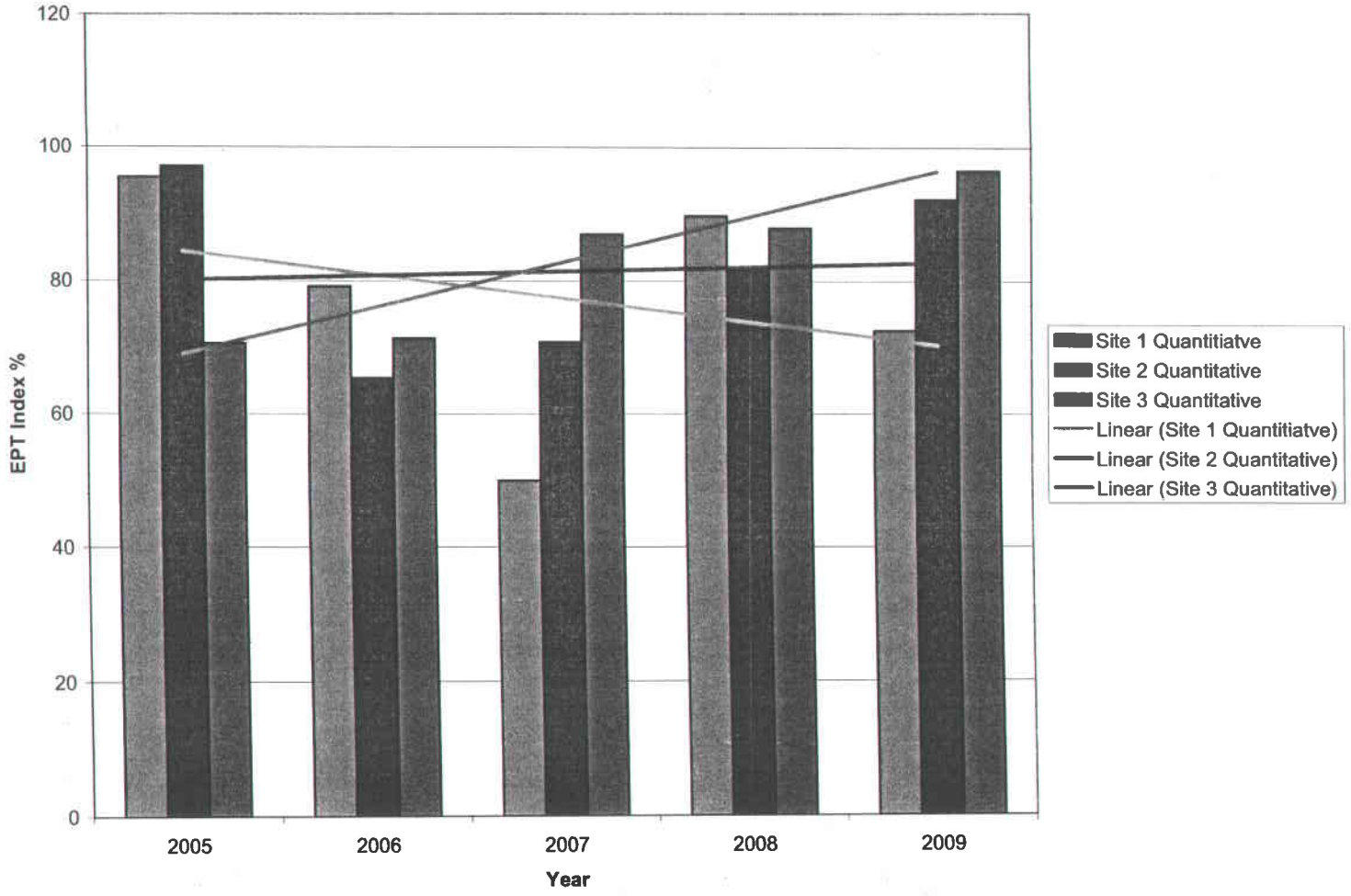


Figure 4. Ephemeroptera, Plecoptera and Trichoptera index for quantitative samples collected from Rilda Canyon Creek (Vinson 2005, Vinson 2007, Vinson 2008 and Miller 2009).

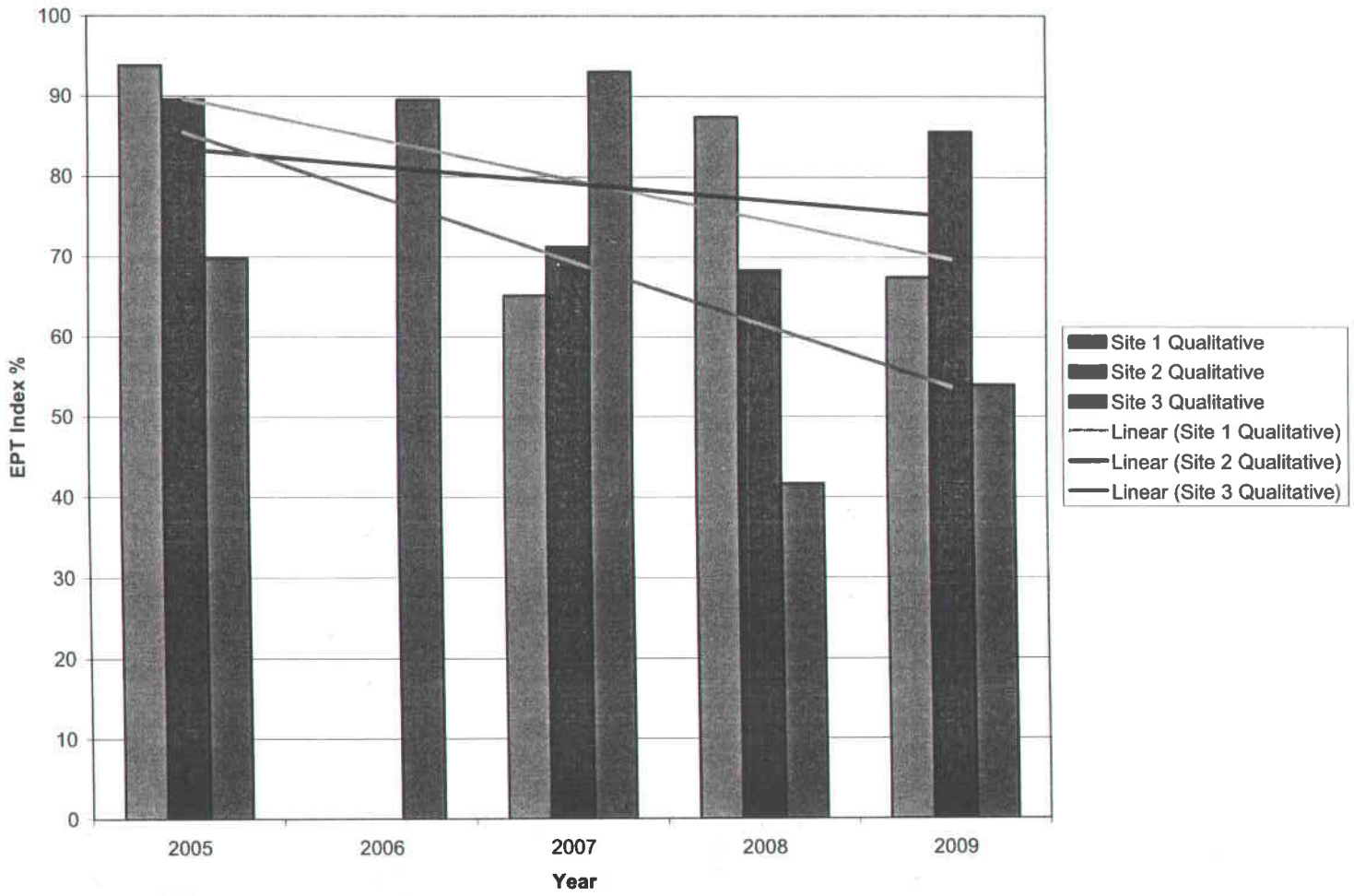


Figure 5. Ephemeroptera, Plecoptera and Trichoptera index for qualitative samples collected from Rilda Canyon Creek (Vinson 2005, Vinson 2007, Vinson 2008 and Miller 2009). Invertebrates were not collected from qualitative samples in 2006.

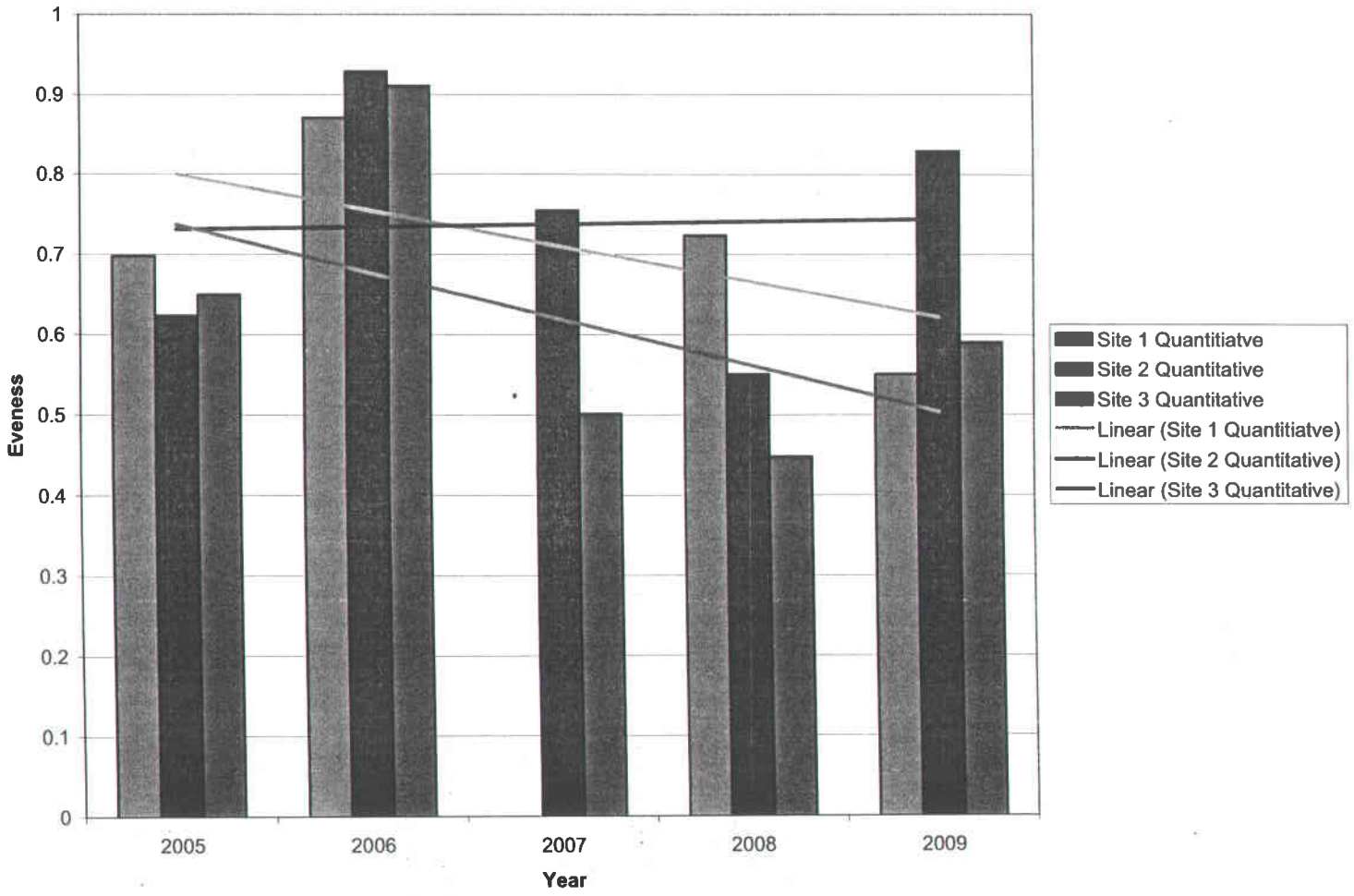


Figure 6. Evenness index for quantitative samples collected from Rilda Canyon Creek (Vinson 2005, Vinson 2007, Vinson 2008 and Miller 2009). Invertebrate numbers from the 2007 site 1 sample were not sufficient to calculate an evenness value.

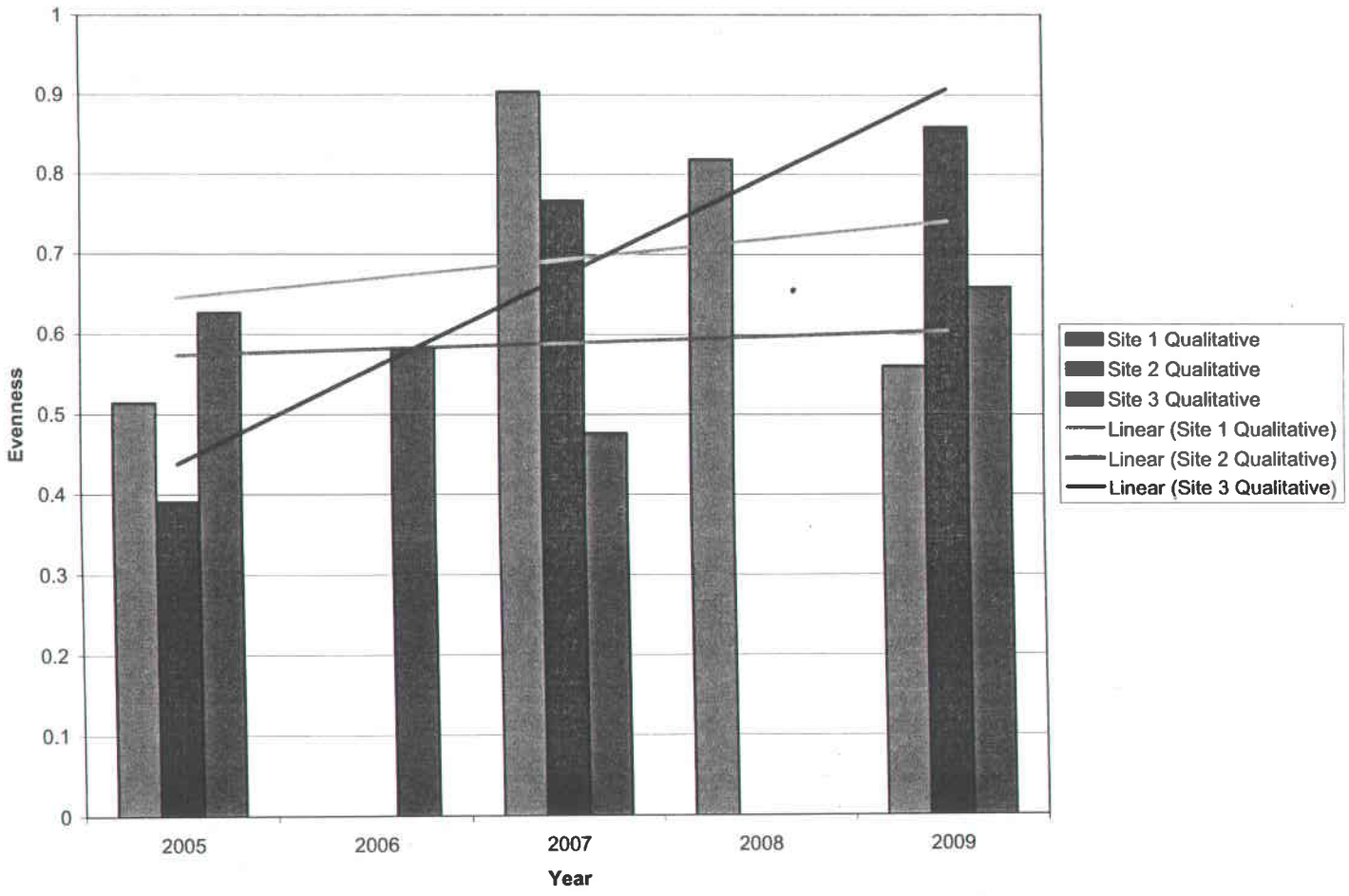


Figure 7. Evenness index for quantitative samples collected from Rilda Canyon Creek (Vinson 2005, Vinson 2007, Vinson 2008 and Miller 2009). Invertebrates were not collected from qualitative samples in 2006. Invertebrate numbers from the 2008 site 2 and site 3 samples were not sufficient to calculate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

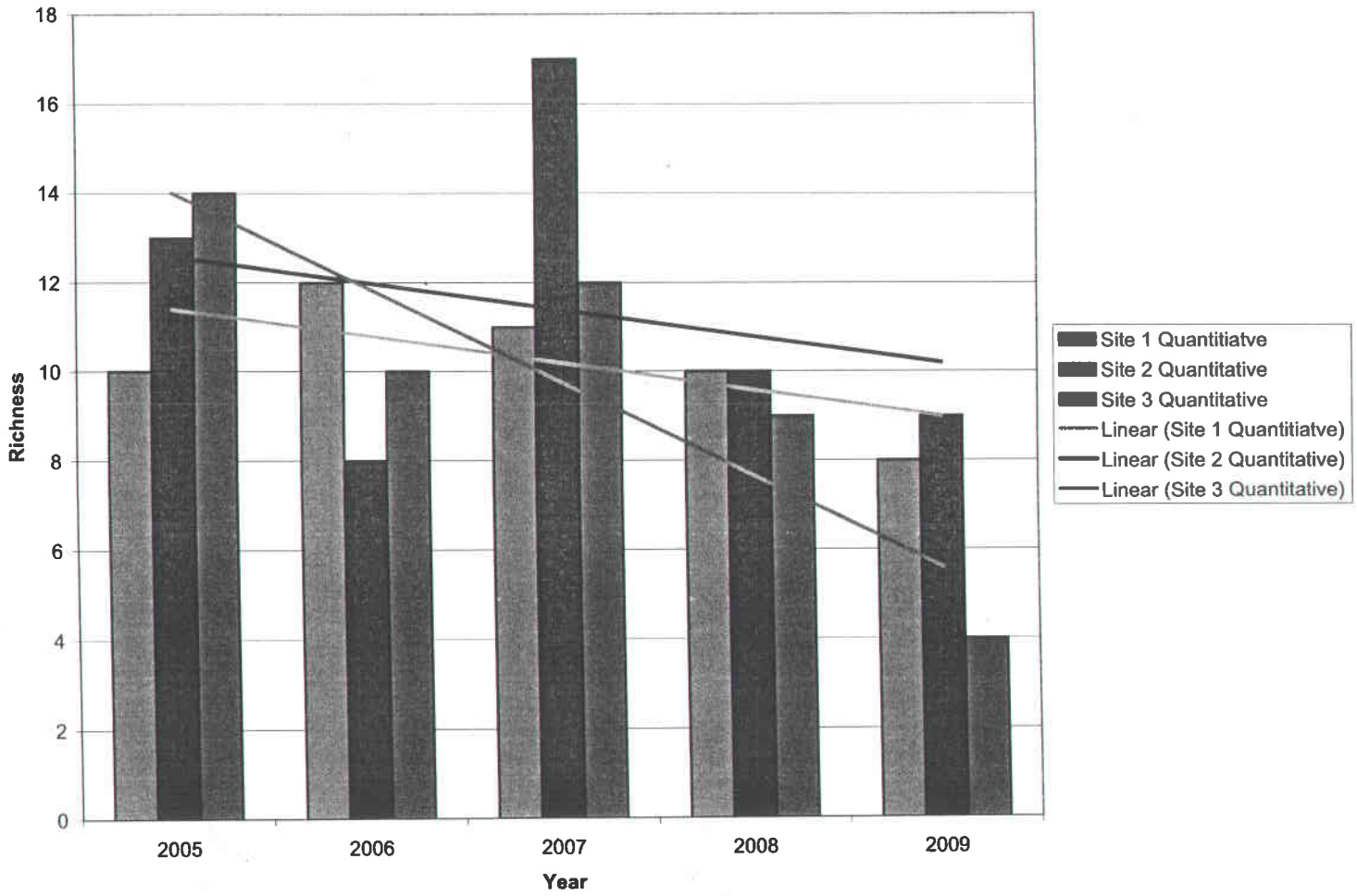


Figure 8. Genera richness for quantitative samples collected from Rilda Canyon Creek (Vinson 2005, Vinson 2007, Vinson 2008 and Miller 2009).

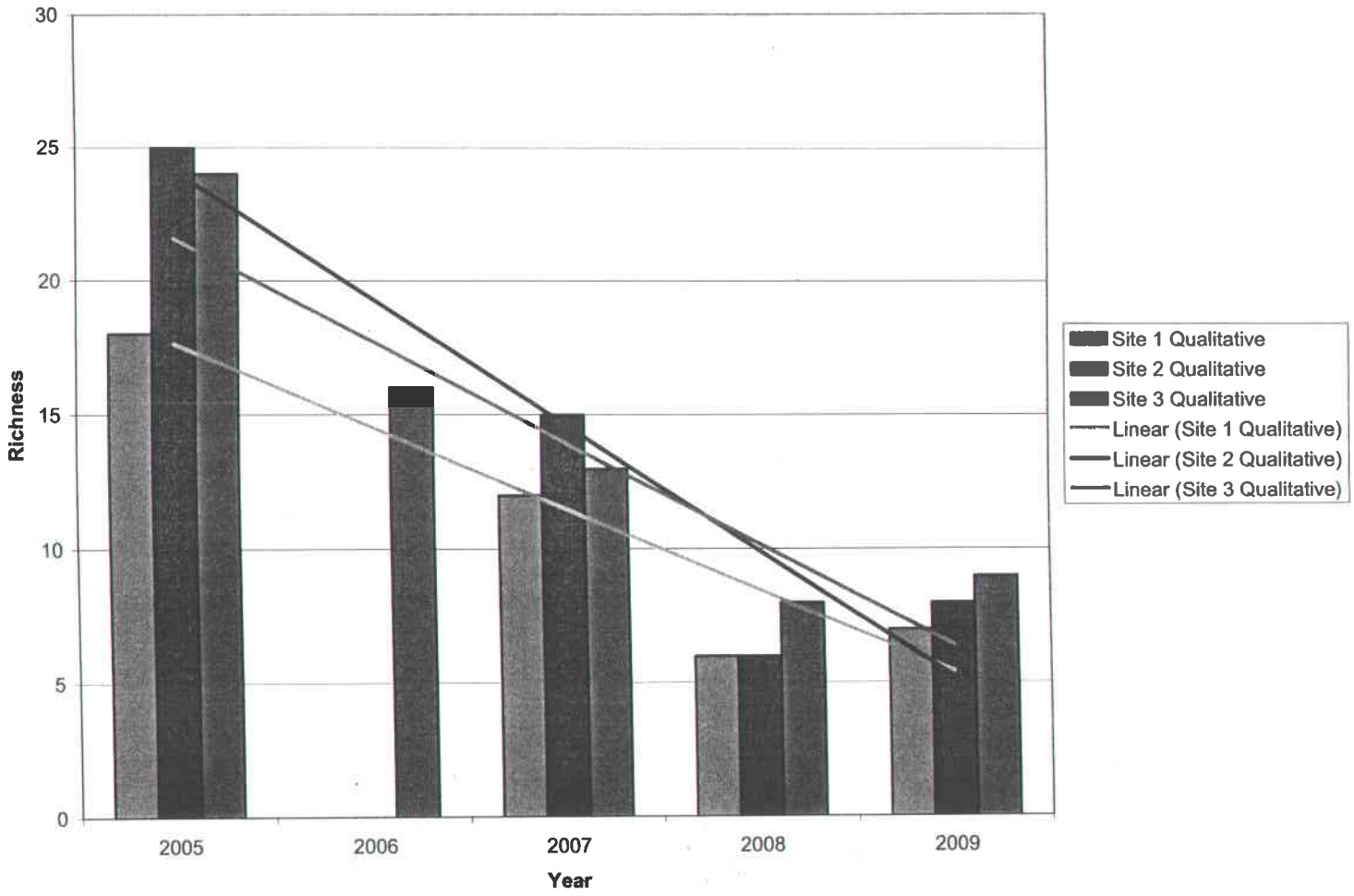


Figure 9. Genera richness for quantitative samples collected from Rilda Canyon Creek (Vinson 2005, Vinson 2007, Vinson 2008 and Miller 2009). Invertebrates were not collected from qualitative samples in 2006.

# 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. Task I.D. #3613**

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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:

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May 20, 2009

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# 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).

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**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 County, Utah (2004-2008): Site comparison.**

| Site | Site 1-Test | | | | | Site 2- Test | | | | | Site 3-Control | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 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-May-07 | 23-Jun-08 | 28-May-04 | 16-Jun-05 | 22-Jun-06 | 21-May-07 | 23-Jun-08 |
| Total abundance [a] | 118 | 48 | 245 | 116 | 177 | 99 | 26 | 208 | 199 | 71 | 73 | 28 | 160 | 8 | 142 |
| EPT abundance [a] | 78 | 38 | 234 | 101 | 159 | 67 | 17 | 202 | 141 | 58 | 43 | 20 | 113 | 4 | 125 |
| Total taxa richness | 14 | 12 | 10 | 12 | 10 | 13 | 8 | 13 | 17 | 10 | 11 | 10 | 14 | 4 | 9 |
| Number of families [b] | 9(10) | 7(NA) | 8(10) | 9(9) | 8 (6) | 10(10) | 6(NA) | 12(14) | 12(10) | 7 (6) | 8(8) | 5(12) | 10(15) | 4(6) | 8 (7) |
| Shannon diversity | 1.97 | 2.112 | 1.37 | 1.597 | 1.425 | 1.96 | 1.835 | 1.722 | 2.249 | 1.65 | 1.68 | 2.016 | 1.736 | 1.242 | 0.96 |
| Simpson diversity | 0.19 | 0.136 | 0.328 | 0.336 | 0.304 | 0.19 | 0.17 | 0.259 | 0.135 | 0.302 | 0.28 | 0.144 | 0.247 | 0.239 | 0.582 |
| Evenness | 0.68 | 0.871 | 0.698 | 0.501 | 0.724 | 0.71 | 0.929 | 0.624 | 0.755 | 0.55 | 0.596 | 0.911 | 0.65 | NA | 0.448 |
| Hilsenhoff HBI [c] | 2.72 | 3.06 | 3.55 | 3.88 | 3.66 | 2.45 | 2.74 | 3.26 | 2.5 | 2.81 | 3.35 | 2.1 | 4.21 | 2.67 | 3.57 |
| Intolerant taxa abundance | 3 | 5 | 36 | 12 | 24 | 17 | 5 | 54 | 54 | 19 | 1 | 3 | 7 | 4 | 5 |
| Tolerant taxa abundance | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 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) | Heptageniidae 21% (Baetidae) | Baetidae 54% (Chironomidae) | Baetidae 48% (Baetidae) | Heptageniidae 32% (Ephemereliidae) | Baetidae 41% (Baetidae) | Baetidae 50% (Baetidae) | Baetidae 76% (Baetidae) |

[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 dominant taxa in qualitative samples.

**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. |

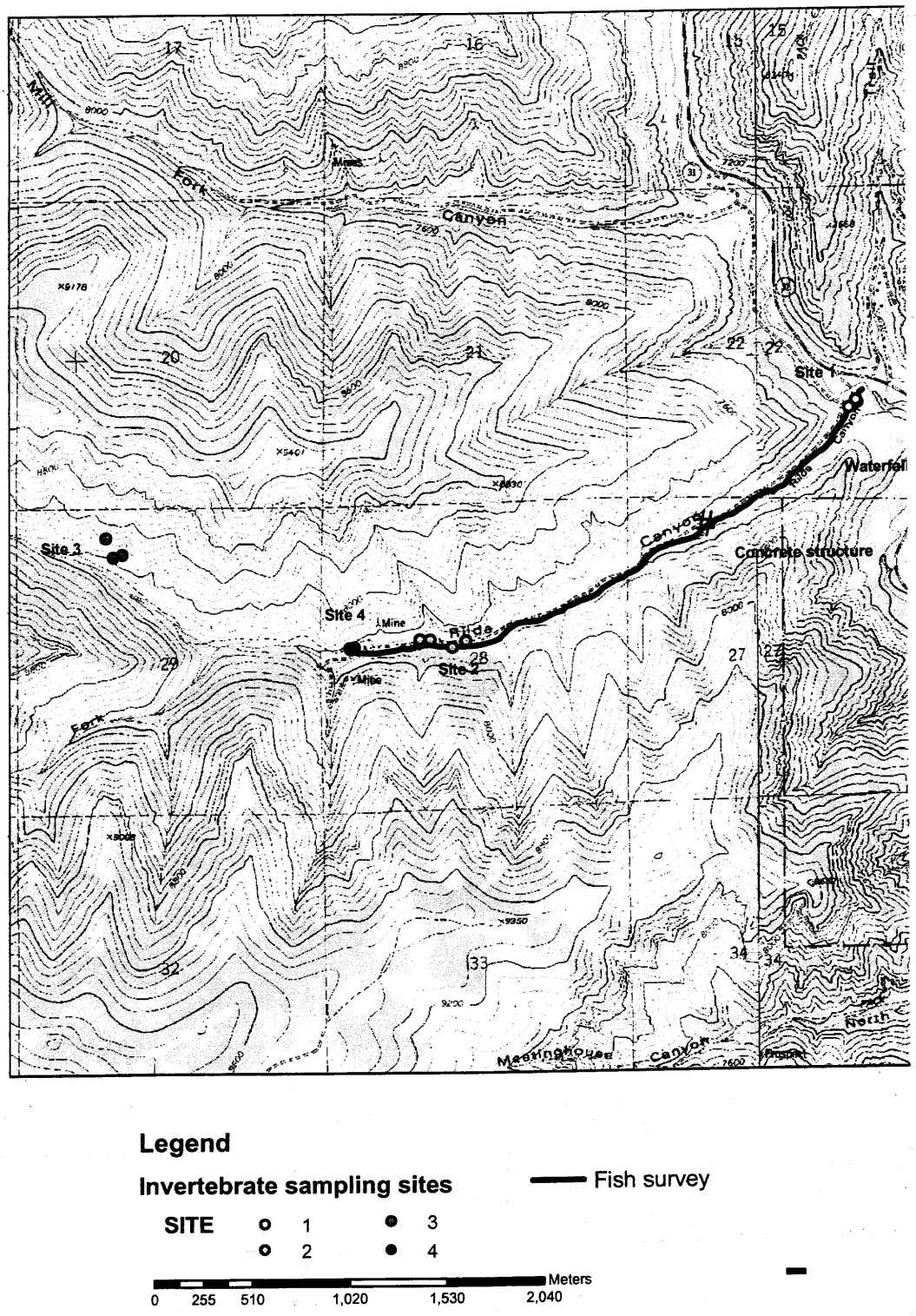


Figure 1. Map of Rilda Creek Canyon, Emery, Utah. Location of macroinvertebrate sampling sites and fish survey sampling section.

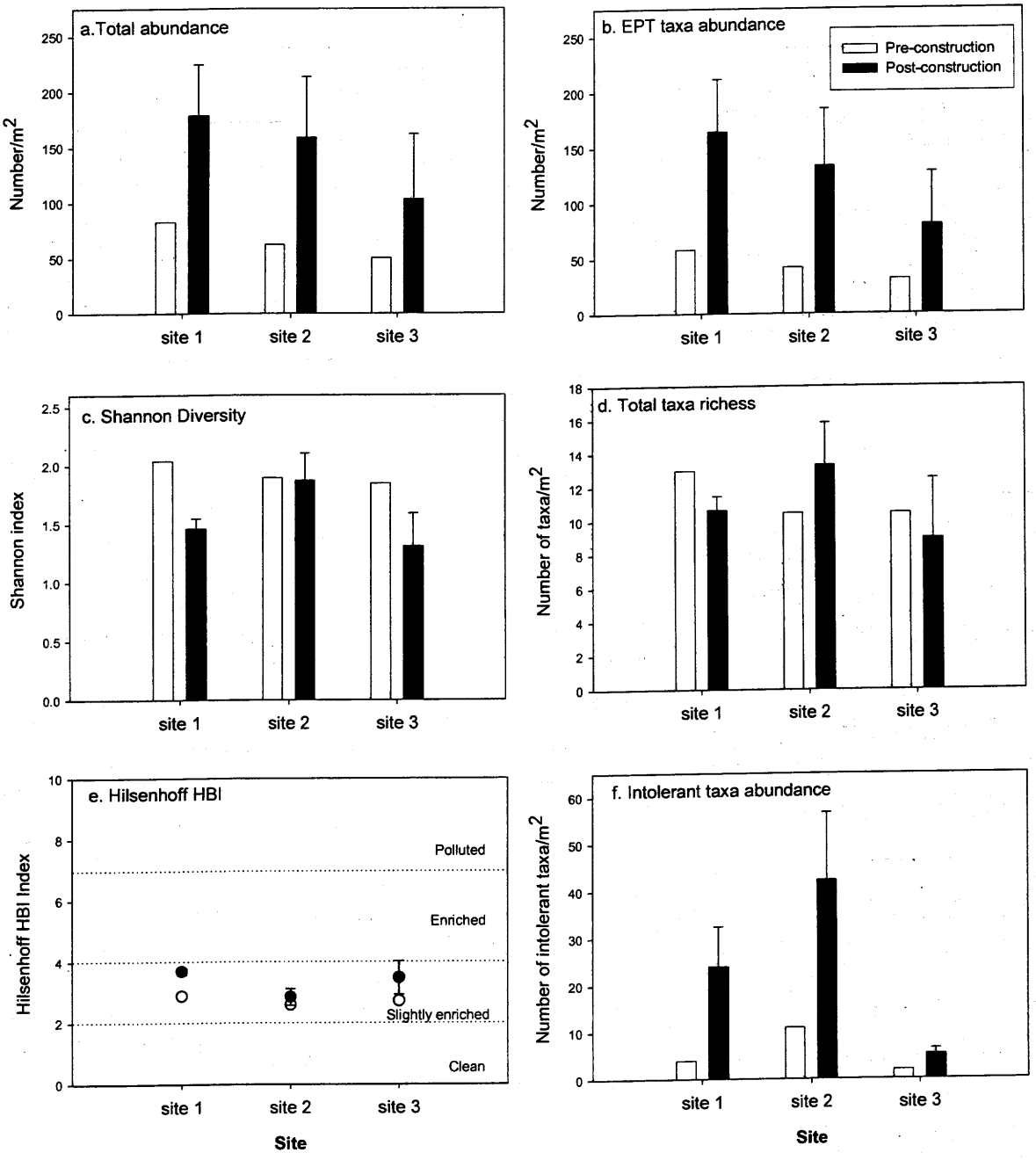


Figure 2. Total abundance (a), EPT taxa abundance (b), Shannon diversity (c), and Total taxa richness (d), Hilsenhoff HBI, and Intolerant taxa abundance for spring macroinvertebrate surveys at Rilda Creek, Emery County, Utah, conducted during pre- (white) and post- (black) construction. Bars or circles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

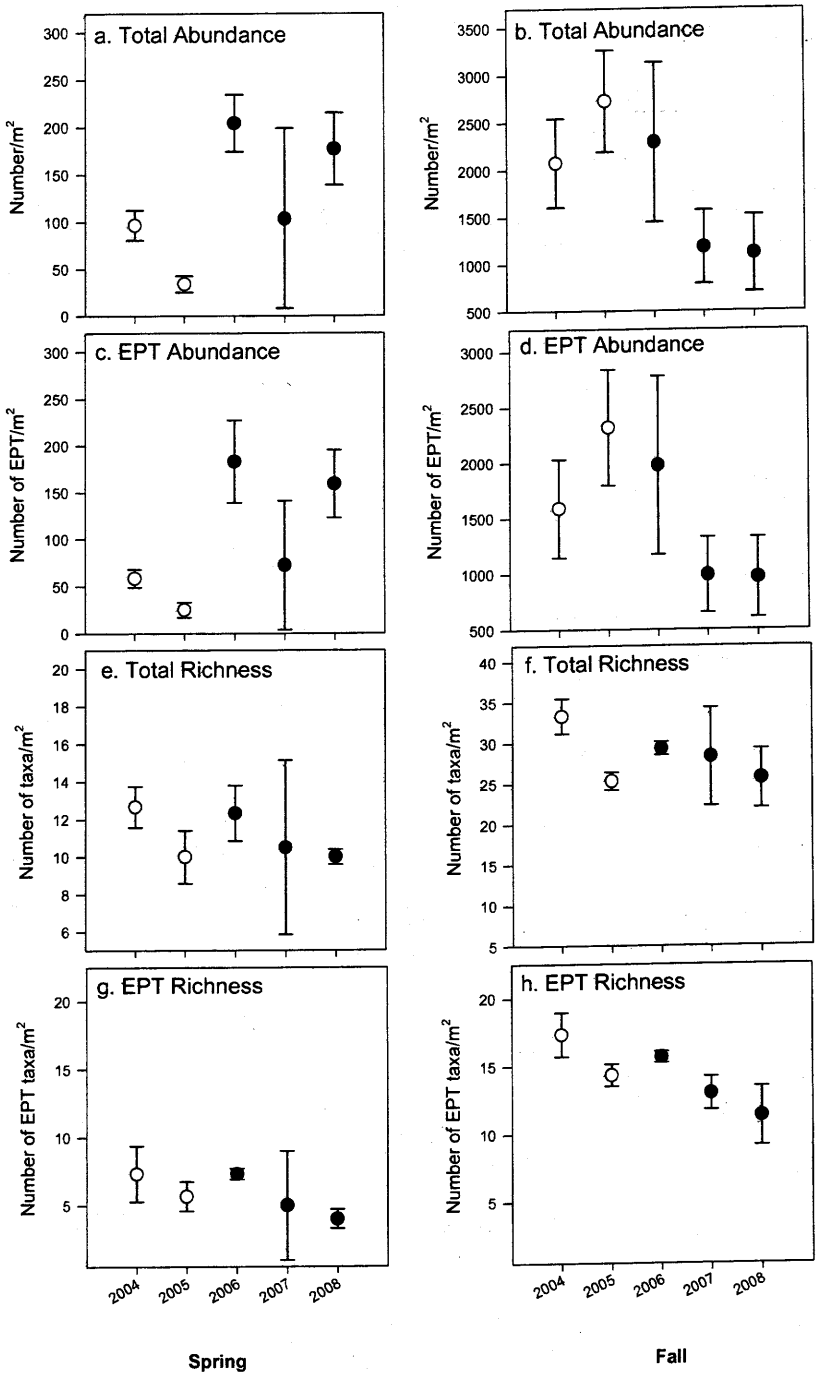


Figure 3. Total abundance (a,b), EPT abundance (c,d), Total richness (e,f), and EPT richness (g,h) for spring (left figures) and fall (right figures) macroinvertebrate surveys at Rilda Creek, Emery County, Utah, conducted during pre- (white circles) and post- (black circles) construction. Circles represent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

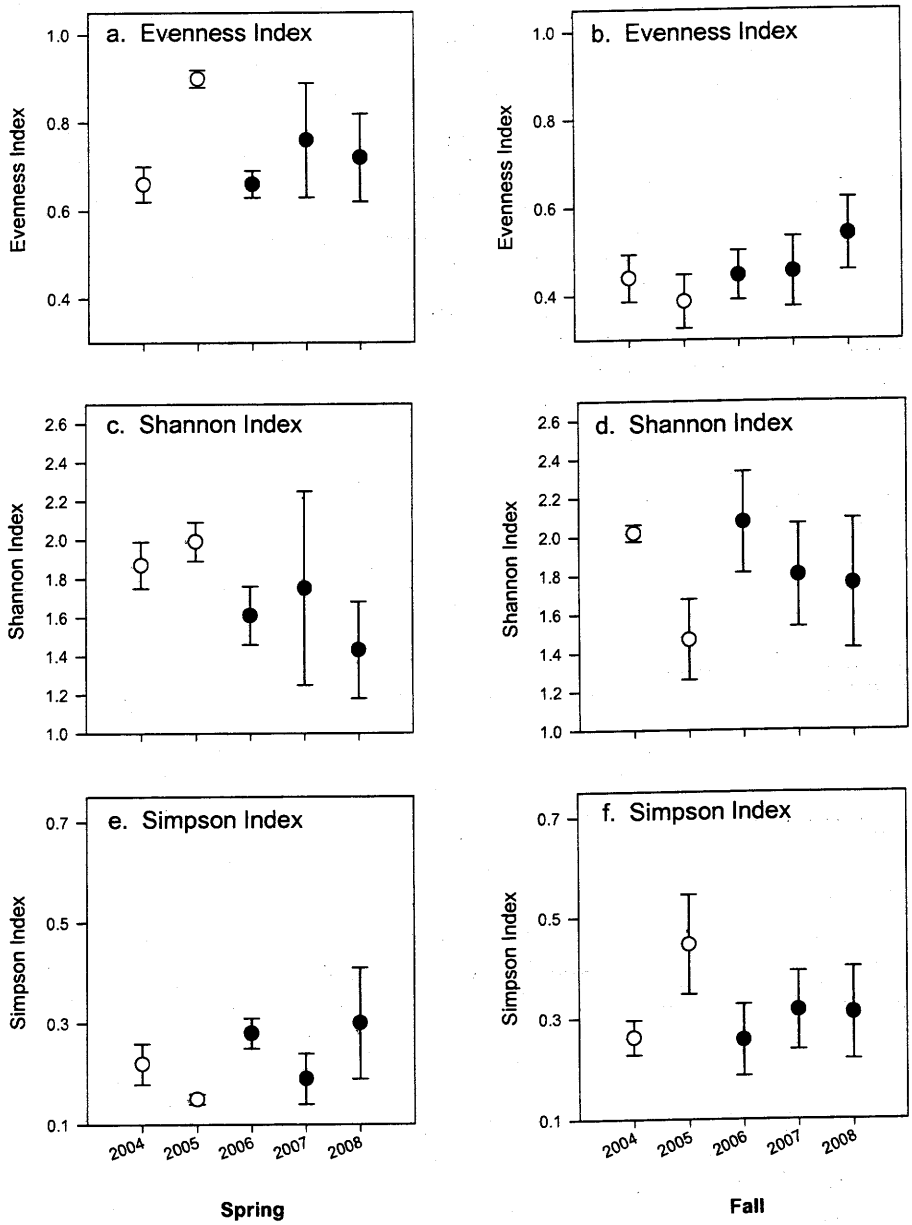


Figure 4. Evenness (a,b), Shannon diversity (c,d), and Simpson indexes (e,f) in Rilda Creek for spring (left figures) and fall (right figures) macroinvertebrate surveys at Rilda Creek, Emery County, Utah, conducted during pre- (white circles) and post- (black circles) disturbance conditions. Circles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

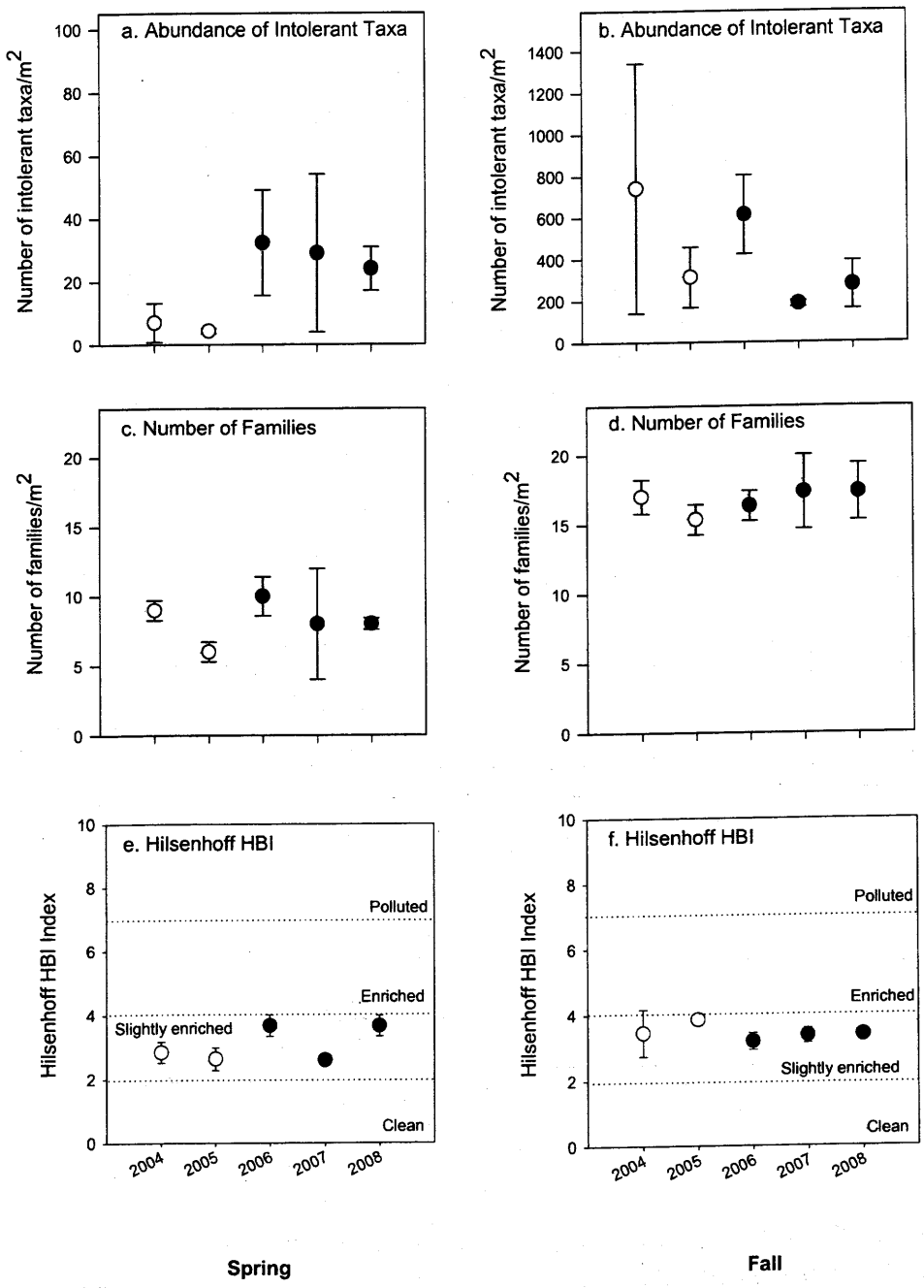


Figure 5. Abundance of intolerant taxa (a,b), number of families (c,d), and Hilsenhoff HBI (e,f) in Rilda Creek for spring (left figures) and fall (right figures) macroinvertebrate surveys at Rilda Creek, Emery County, Utah, conducted during pre- (white circles) and post- (black circles) disturbance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

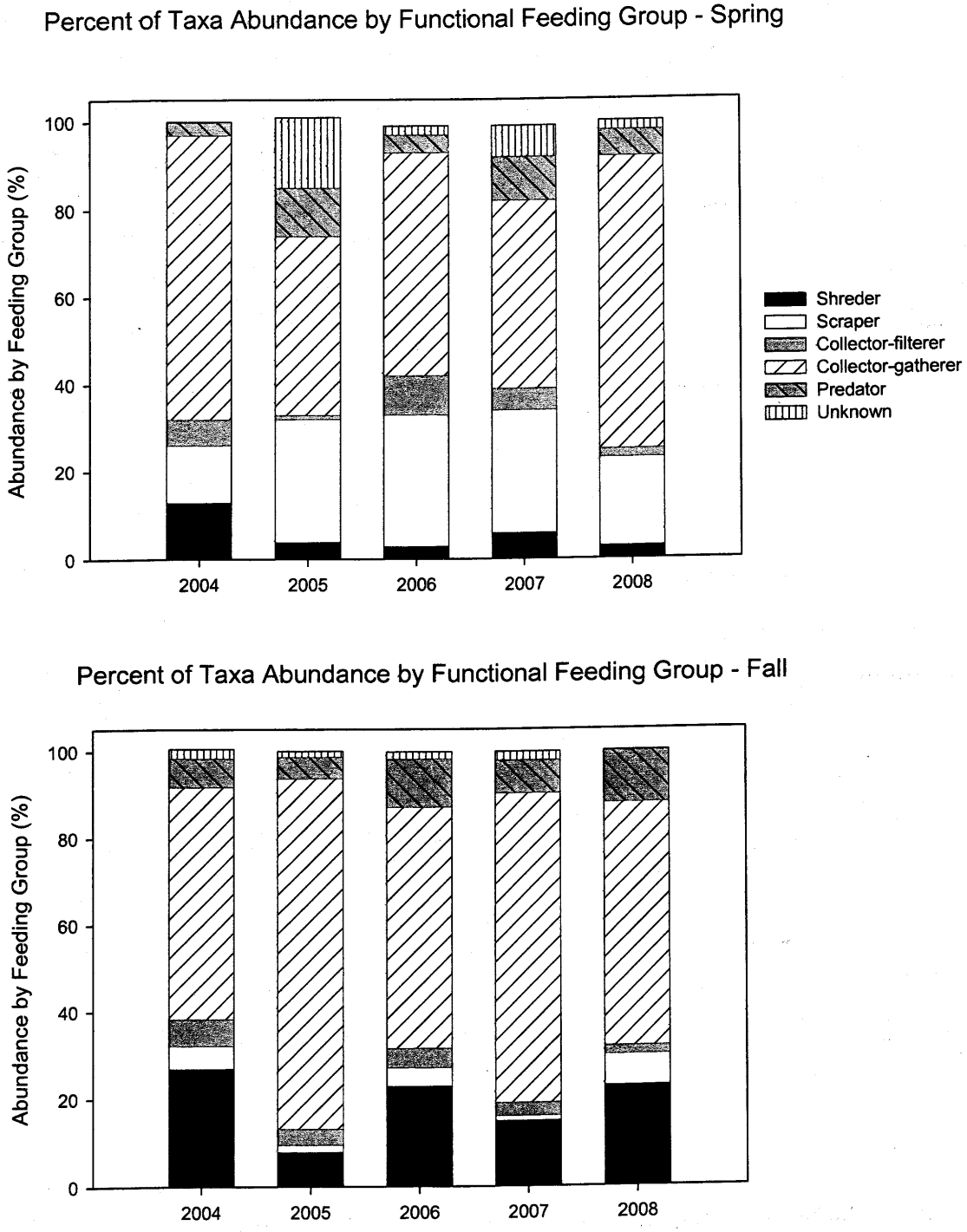


Figure 6. Spring and fall macroinvertebrate taxa abundance by functional feeding group in Rilda Creek (2004-2008).

# APPENDIX

## Taxa Lists for Individual Samples

Taxonomic list and densities of aquatic invertebrates identified and retained from a sample collected October 8, 2008 t 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 t 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 at 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 | |
| Phylum: 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 | |