Canyon Fuel Company, LLC
A Subsidiary of Bowie Resource Holdings, LLC

Task #4557

Skyline Mine
Gregg A. Galecki, Environmental Engineer
HC35, Box 380
Helper, Utah 84526
(435) 448-2636
Fax (435) 448-2632

March 26, 2014

Mr. Daron R. Haddock
Permit Supervisor
Utah Division of Oil, Gas and Mining
1594 West North Temple, Suite 1210
Salt Lake City, Utah 84114-5801

RE: 2013 Annual Report, Canyon Fuel Company, LLC, Skyline Mine, C/007/005,

Dear Mr. Haddock:

Please find enclosed with this letter one copy of a total three (3) separate certified drawings required for submittal in the Annual Report. The drawings include 1) Cumulative Subsidence 1982-2013; 2) Skyline Mine - Mine 3 As Mined 2013; and 3) Skyline Mine - Mine 3 – Level 3 Projected Mining 2014-2018. The remaining portions of the 2013 Annual Report are included on an attached compact disc.

If you have any questions, please call me at (435) 448-2636.

Sincerely,

Gregg A. Galecki

Gregg A. Galecki
Environmental Engineer, Skyline Mine
Canyon Fuel Company, LLC
enclosures

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Annual Report

This Annual Report shows information the Division has for your mine. Submit the completed document and any additional information identified in the Appendices to the Division by the date specified in the cover letter. During a complete inspection an inspector will check and verify the information.

GENERAL INFORMATION

Company Name	Canyon Fuel Company LLC	Mine Name	Skyline Mine
Permit Number	C/007/0005	Permit expiration Date	April 30, 2017
Operator Name	Gregg A. Galecki	Phone Number	+1 (435) 448-2636
Mailing Address	HC 35 Box 380	Email	ggalecki@bowieresources.com
City	Helper		
State	Utah	Zip Code	84526

		DOGM File Location or Annual Report Location
Excess Spoil Piles	☐ Required ☒ Not Required	
Refuse Piles	☒ Required ☐ Not Required	submitted quarterly in electronic format on 7/15/13(1st and 2nd), 10/17/13, and 2/19/14.
Impoundments	☒ Required ☐ Not Required	submitted quarterly in electronic format on 4/29/13, 7/18/13, 10/16/13, and 2/19/14.
Other:		

OPERATOR COMMENTS

REVIEWER COMMENTS ☐ Met Requirements ☐ Did Not meet Requirements

COMMITMENTS AND CONDITIONS

The Permittee is responsible for ensuring annual technical commitments in the Mining and Reclamation Plan and conditions accepted with the permit are completed throughout the year. The Division has identified these commitments below and has provided space for you to report what you have done during the past year for each commitment. If additional written response is required, it should be filed as an attachment to this report.

Title: WASTE ROCK SAMPLING
Objective: To document chemical characteristics and support reclamation plan using less than four feet of cover and to protect surface and groundwater.
Frequency: During periods of deposition at the waste rock site.
Status: Quarterly sampling, one sample per 2000 tons hauled to the disposal site.
Reports: Annual report
Citation: MRP, Volume 3, Section 4.4, page 4-30, 2nd paragraph and 1988 Soils Guidelines Table 6.

Operator Comments

A total of approximately 1,358 tons of material was hauled to the waste rock site in 2013. Since a minimum of 2,000 tons was not deposited, no samples were collected in 2013.

Reviewer Comments ☐ Met Requirements ☐ Did Not Meet Requirements

Title: RAPTOR SURVEYS
Objective: To monitor known nest locations and identify new raptor nests that could be impacted from subsidence or new surface facilities. Damaged nests will be replaced immediately with an artificial structure in consultation with DWR.
Frequency: Annually and according to the Division's Raptor Survey Guidelines
Status: Ongoing
Reports: Annual report
Citation: MRP, Chapter 4, Section 4.18, page 4-103

Operator Comments

A report .pdf file titled, "2013 Wildlife Survey Report_8.9.13_complete has been submitted previously in the North Lease Modification application, but it is attached to this Annual report as well. 2013 subsidence is included in the report.

Reviewer Comments ☐ Met Requirements ☐ Did Not Meet Requirements

Title: MACROINVERTEBRATE SURVEYS
Objective: To determine if mining and mining related activities are impacting the perennial streams located in Woods, Eccles, Burnout and James Canyons.
Frequency: Fall and Spring every three years beginning in 2007.
Status: Spring 2012 report due to Division. next sampling should be fall 2014/spring 2015.
Reports: Annual
Citation: MRP, Appendix A-3, Volume 2, Volume 1A, Section 2.8, pages 2-71, 71A, B,C. Section 2.8, table 2.8-1a

Operator Comments

The Woods-Winter Quarters Creek Fall 2011 report is attached to this Annual report. The .pdf file is title, "Canyon14.WQ11.SepOct. macro.final".

Reviewer Comments ☐ Met Requirements ☐ Did Not Meet Requirements

Title: NORTH LEASE VEGETATION SURVEY
Objective: To determine the effects of longwall mining on riparian vegetation along Winter Quarters and Woods Canyon stream channels.
Frequency: Baseline survey of entire length of channels in 2005. Survey two years prior and during undermining of channel lengths and follow-up surveys two years after undermining.
Status: Ongoing, Please include a discussion of possible impacts from mining on riparian vegetation in report from qualified biologist.
Reports: Annual
Citation: MRP, Volume 1A, Section 2.7, pages 2-61d; A-2 volume 2, and A-3 Volume 2

Operator Comments

The 2013 Riparian Vegetation report is attached to this Annual Report. The .pdf file is titled, "canyon14.WQ13.rip.rpt.final".

Reviewer Comments ☐ Met Requirements ☐ Did Not Meet Requirements

Title: FISH SURVEY
Objective: To determine if mining and mining related activities are impacting the perennial streams located in Eccles, and Winter Quarters. Woods, Burnout and James Canyon Surveys are complete.
Frequency: In the fall every three years beginning in 2007.
Status: 2010 surveys complete. Next survey due in 2013.
Reports: Annual
Citation: MRP, Volume 1A, Section 2.8, page 2-71.

Operator Comments

The Fall 2013 Cutthroat Trout Population Density survey was conducted, but the report is not available from the consultant at the time of this report. It will be submitted when the Operator receives the report.

Reviewer Comments ☐ Met Requirements ☐ Did Not Meet Requirements

FUTURE COMMITMENTS AND CONDITIONS

The following commitments are not required for the current annual report year, but will be required by the permittee in the future as indicated by the "status" field. These commitments are included for information only, and do not currently require action. If you feel that the commitment is no longer relevant or needs to be revised, please contact the Division.

Title: TOPSOIL SAMPLING
Objective: To determine fertilizer application rate.
Frequency: At final reclamation sample redistributed topsoil for N, P, K, Fe, Mg, Mn, Zn, Ca and pH.
Status: At final reclamation
Reports: None specified. Suggest verbal communication with Division and lab analyses to be included in bond release application.
Citation: MRP, Volume 3, Section 4.5, page 4-32, 2nd paragraph.

Title: SUBSOIL SAMPLING AT WASTE ROCK SITE
Objective: To provide chemical characteristics of purchased subsoil.
Frequency: Once. Sample purchased subsoil for parameters in Table 1 of the Utah 1988 Guidelines.
Status: Ongoing with contemporaneous reclamation at the waste rock site.
Reports: None specified. Suggest verbal communication with Division and lab analysis to be included in bond release application.
Citation: MRP, Volume 3, Section 4.6.4.1, page 4-38a, 3rd paragraph, and page 4-38b.

Title: AGE-MONITORING OF WATER
Objective: To understand the possible sources of groundwater inflows.
Frequency: When inflows of 800 gpm are encountered.
Status: No significant inflows in the North Lease.
Reports: Immediately notify Division
Citation: MRP, Volume 1, page 2-35b, paragraph 2.

Title: SAMPLING PRIOR TO SLURRY PLACEMENT IN ABANDONED UNDERGROUND WORKINGS
Objective: Protection of groundwater
Frequency: Every 450 feet of advance
Status: Report if placed slurry in abandoned underground workings.
Reports: Notification if parameters are out of compliance with Guidelines for Topsoil and Overburden.
Citation: MRP, Volume 2, Incorporation of 97K-1 and Section 1.2 (at the end of section 3.2).

Title: SAMPLING OF WASTE ROCK IN TEMPORARY STOCKPILES
Objective: Protection of surface and groundwater
Frequency: one sample per 2000 tons of temporary stockpiled material if remains in temporary location longer than three months.
Status: Ongoing
Reports: Not specified. Assumed to be the same as disposal site sampling (previous paragraph on same page.)
Citation: MRP, Volume 3, page 4-30, 3rd paragraph, and 1988 Soils guidelines, table 6.

OPERATOR COMMENTS (OPTIONAL)

REVIEWER COMMENTS

REPORTING OF OTHER TECHNICAL DATA

Please list other technical data or information that was not included in the form above, but is required under the approved plan, which must be periodically submitted to the Division.

Please list attachments:

Reviewer Comments

MAPS

Copies of mine maps, current and up-to-date, are to be provided to the Division as an attachment to this report in accordance with the requirements of R645-301-525.240. The map copies shall be made in accordance with 30 CFR 75.1200 as required by MSHA. Mine maps are not considered confidential.

Map Name	Map Number	Included		Confidential	
		Yes	No	Yes	No
Cumulative Subsidence 1982-2013	Subsidence 2013 Final	☐	☐	☐	☒
Skyline Mine Mine 3 As Mined 2013	As Mined 2013	☐	☐	☐	☒
Skyline Mine Mine 3 - Level 3 Projected Mining 2014	Projected Mining	☐	☐	☐	☒
		☐	☐	☐	☐
		☐	☐	☐	☐

Reviewer Comments ☐ Met Requirements ☐ Did Not Meet Requirements

Please note that mine maps are not confidential per R645-300-124.300. Confidentiality is limited to the information specified in R645-300-124.310, R645-300-320, and R645-300-124.330.

AN ASSESSMENT OF THE MACROINVERTEBRATES OF WOODS CANYON CREEK & WINTER QUARTERS CREEK CARBON COUNTY, UTAH

in
SEPTEMBER-OCTOBER 2011

Prepared by

MT. NEBO SCIENTIFIC, INC.
330 East 400 South, Suite 6
Springville, Utah 84663
(801) 489-6937

by

Dennis K. Shiozawa, Ph.D.

for

CANYON FUEL COMPANY, LLC.
Skyline Mines
HC 35 Box 380
Helper, Utah 84526

January 2014

TABLE OF CONTENTS

Introduction

This report gives the results of the third series of benthic invertebrate monitoring of the stream systems. These data will establish baseline conditions against which any impacts due to the mining and subsequent subsidence can be compared. The 2011 samples were extended downstream in Woods Canyon because mining has shifted further East (these streams drain to the East).

Methods

Sample placement was determined by examination of the stream systems on USGS 7.5 minute quadrangles. Three reaches were examined on each stream, with each reach being defined by the inflow of a side stream and the general distance from the previous reach. The lowest reach in Winter Quarters Canyon was established on U. S. Forest Service land above the boundary with private grazing lands. The lowest station in Woods Canyon was new, beginning with the 2011 sampling series, and was designated the Base reach to avoid confusion between it and the original Lower Station which was established when sampling was first initiated on Woods Canyon. The location of each reach is given in Table 1. Four riffles were sampled within each reach in the fall of 2002, but this was increased to 8 riffles in the spring of 2004. Two samples were taken at each riffle and were bulked together in the field.

Table 1. Sampling station locations

Canyon	Reach	GPS coordinates	Elevation
Woods	Upper	N 39^{o} 44.340' W 111^{o} 13.471' UTM4398045 12S0480808	2609 m (8560 ft)
Woods	Lower	N 39^{o} 44.071' W 111^{o} 12.592'	2552 m (8374 ft)
Woods	Base	N 39^{o} 44.091' W 111^{o} 12.024'	2486 m (8156 ft)
Winter Quarters	Upper	N 39^{o} 42.763' W 111^{o} 13.907'	2587 m (8488 ft)
Winter Quarters	Middle	N 39^{o} 42.933' W 111^{o} 13.378'	2571 m (8434 ft)
Winter Quarters	Lower	N 39^{o} 43.126' W 111^{o} 12.807'	2519 m (8265 ft)

Physical characteristics for each reach were recorded (Table 2, 3). These included pH, conductivity, in micro-Siemens/cm (uS/cm), alkalinity, and hardness. Alkalinity and hardness were measured with a Hach water chemistry kit. The spring runoff in 2011 was very high and the sampling stations were significantly rearranged by the high flows. Thus the channel morphology, which had remained constant since sampling was initiated, was quite different, becoming shallower in depth in most stations. Those data are provided in Tables 2 and 3. Slope was recorded with an inclinometer, across a 100 meter length of stream, beginning at the first (starting downstream) riffle. The stream channel within each reach was characterized by measuring the width, depth, and velocity of the stream every five meters, beginning with the first riffle. Three depth and velocity measures were taken at each five meter interval, these being at the center and approximately 10% of the width from either shore.

Table 2. Physical Characterization of Woods Canyon Creek

Date	Site	Alkalinity mg/L $CaCO_3$ equivalents	Hardness mg/L $CaCO_3$ equivalents	Conductivity (uS/cm)	slope	depth (cm)	width (m)	velocity (m/s)	pH
10/19/02	1 2	136.8 188.1	273.6 324.9	415 452	4.0^o 3.5^o	3.6 4.333	1.213 1.157	0.268 0.327	8.30 8.23
6/27/03	1 2	119.7 136.8	222.3 239.4	351 393	4.0^o 3.5^o	5.267 6.250	1.645 1.345	0.187 0.276	8.18 8.42
10/13/03	1 2	220 260	320 320	380 440	4.0^o 3.5^o	2.650 3.66	1.048 1.038	0.140 0.118	8.63 7.73
6/28/04	1 2	220 240	240 240	340 405	4.0^o 3.5^o	5.56 4.76	1.919 1.580	0.174 0.244	8.52 8.36
9/25/07	1 2	160 160	180 180	377 446	4.0^o 3.5^o	7.53 5.00	1.296 1.591	0.181 0.175	8.43 8.40
7/17/08	1 2	120 120	200 240	313 396	4.0^o 3.5^o	6.42 8.73	2.304 1.793	0.454 0.493	8.41 8.33
7//11	1 2 3	16 35 35	140 100 110	237 393 399	2.6^o 2.1^o 3.5^o	16.03 15.76 17.20	1.835 1.971 2.218	0.2624 0.7916 0.6211	7.70 7.71 8.10
9/24/11	1 2 3	120 137 154	188 -- --	403 458 458	2.6^o 7.7^o 3.5^o	6.93 6.06 8.77	1.51 5 1.650 1.462	0.1481 0.2053 0.1615	7.69 9.84 10.5

1 - Upper Site 2 - Lower Site 3 – Base Site

Quantitative invertebrate samples were taken with a modified box sampler (Shiozawa 1986) using a capture net with a net mesh of 253 microns. Samples were taken from each of the three reaches in Winter Quarters and Woods Canyon. Samples were concentrated in the field in sieves with 63 micron mesh and were preserved with ethyl alcohol. In the laboratory the samples were sorted in an illuminated pan and organisms were removed. After the visual sorting, the sample was subsampled and the subsamples were examined under magnification. The density estimates from the subsamples were calculated and the projected numbers of organisms missed in the visual sorting were added to the total for the sample. Organisms were identified to the lowest taxonomic unit possible. Small specimens and those of questionable identity were further examined under magnification. Identification was based on the keys of Merritt and Cummins (1996) and Merritt, Cummins, and Berg (2008). The mean values for each taxon were used to determine the density of invertebrates per square meter. Standing crop was estimated from wet weights of total invertebrates collected at the station.

Table 3. Physical Characterization of Winter Quarters Creek

Date	Site	Alkalinity mg/L $CaCO_3$ equivalents	Hardness mg/L $CaCO_3$ equivalents	Conductivity (uS/cm)	slope	depth (cm)	width (m)	velocity (m/s)	pH
10/18/02	1 2 3	119.7 136.8 136.8	188.1 273.6 256.5	343 371 390	4.0° 3.0° 2.5°	5.8 6.367 6.983	1.028 1.252 2.129	0.199 0.240 0.222	8.26 8.34 8.32
6/20/03	1 2 3	51.3 85.5 119.7	136.8 153.9 205.2	239 275 352	4.0° 3.0° 2.5°	8.633 8.3 11.433	1.215 1.799 2.07	0.224 0.333 0.399	8.39 8.60 8.62
10/15/03	1 2 3	140 200 180	240 260 260	280 310 280	4.0° 3.0° 2.5°	4.817 6.433 5.266	0.978 1.945 1.680	0.210 0.275 0.240	8.57 8.55 8.58
6/30/04	1 2 3	160 180 180	160 200 240	260 294 353	4.0° 3.0° 2.5°	6.066 7.133 8.833	1.10 1.45 1.83	0.254 0.348 0.345	8.60 8.48 8.52
10/4/07	1 2 3	140 140 140	200 200 220	317 363 390	4.0° 3.0° 2.5°	5.917 7.233 9.600	1.059 1.853 2.183	0.168 0.242 0.2999	8.49 8.54 8.66
7/19/08	1 2 3	160 140 140	100 220 200	247 308 355	4.0° 3.0° 2.5°	8.700 10.47 13.867	1.398 2.19 2.631	0.4638 0.5086 0.6348	8.43 8.56 8.68
7/17/11	1 2 3	20 20 20	140 140 120	232 329 357	3.2° 2.5° 2.6°	11.833 14.000 16.333	2.597 2.048 2.682	0.3148 0.5282 0.4560	8.60 8.78 9.10
10/1/11	1 2 3	102.6 120 120	154 154 240	362 427 442	3.2° 2.5° 2.6°	7.833 9.767 14.200	1.291 2.087 2.394	0.1881 0.2930 0.2338	10.37 10.8 10.96

1 - Upper site 2 - Middle site 3 - Lower Site

The USFS Biotic Condition Index (Winget and Mangum 1979) was calculated with the actual community tolerance quotient (CTQa). The predicted community tolerance quotient (CTQp), based on water chemistry data provided in Winget (1972) for the Huntington Creek drainage, has been consistently 80. But in the spring 2011 samples water hardness and alkalinity dropped considerably, likely associate with a higher proportion of shallow surface runoff rather than groundwater input and as note above slope also changed. Since we did not have a measure of sulfate concentration, we assume it also fell with the high flows as is typical for chemical

concentrations under such situations (Hem 1971). By the fall 2011sample set, the hardness and alkalinity readings of both streams appeared to be returning to more normal conditions for fall readings, although in Woods Canyon the stream appeared to be, on average, slightly wider and shallower. The flows were significantly less than were recorded in the spring of 2011. It appears that the pH meter was damaged on the first sampling site on Woods Canyon as the readings taken from that point on become quite high and we consider them to be unreliable.
Diversity was calculated for each reach using the Shannon-Weiner index (Pielou 1977). Diversity indices take the number of taxa and their individual densities into account, generating a single value for each station. The greater the number of species or taxa and generally the more even the distribution of densities between taxa, the higher the diversity index value.

Cluster analysis was run with NTSYS-pc (Rolf 2000), using the Bray-Curtis dissimilarity index with the UPGM clustering algorithm. Data from all reaches for the previous sampling periods from both Woods Canyon Creek and Winter Quarters Canyon Creek were included in the cluster analysis.

Principle Components Analysis (PCA) was run on the data set as well, using the program CANOCO (Braak and Smilauer 2002) to generate a graphical view of the relationships among the stations sampled in Woods and Winter Quarters Canyons. Only the first two orthogonal axes were plotted because these two axes carry sufficient information to establish the general seasonal and annual patterns in the communities being examined.

Since these samples are to be used to establish pre-mining base-line information, the most important information for future assessment will be the actual densities and taxa lists and the PCA. The CTQa, diversity indices, and cluster analysis will serve to help understand relative associations between the two streams, seasonality effects, and within stream trends. As with all field collected data, annual variations in weather patterns (e.g. drought, high runoff) will need to be taken into account in interpreting the data.

Results and Discussion

Physical Characterization

The pre 2011 stream channel slopes became shallower as the streams proceeded down the canyons, a typical geomorphological profile for stream systems draining mountainous areas (Horton 1945). However following the high runoff in 2011, the Upper and Lower Woods Canyon stations were shallower than in previous sampling periods. This is likely a transitional phase which should gradually return towards an equilibrium profile over time. However since equilibrium dynamics are a function of watershed –level processes, not site specific changes, this may not happen if the site specific channel rearrangements included movement of large woody debris and boulders to new locations. Channel depth increased downstream for Winter Quarters Canyon and channel width increased downstream in Woods Canyon, but the width in Winter Quarters and depth in Woods Canyon varied. Velocity generally increased downstream.

The chemical characteristics of the streams changed in the July 2011 samples. During this sampling period stream flow was high and this diluted the impact of ground waters. Usually the water chemistry appears typical for high desert systems draining exposed sedimentary bedrock. As a general rule, alkalinity, hardness, and conductivity increase in the downstream reaches as the water in the channel accumulates salts from streams, springs, and seeps that enter the main channel. In the fall of 2011 the stream chemistry returned to conditions similar to previous fall sampling periods, indicating that the changes seen in the July sampling series were related to the high water and were not reflecting a permanent change in stream chemistry. Unfortunately the data indicate that the pH meter may have been damaged during the sampling on the first Fall field day. I therefore am not able to comment on pH changes.

Biological Characterization

Number of Taxa

The Upper Woods Canyon sample site for the fall of 2011 had 39 taxa, just below the running mean of 39.3 for the six sampling periods (Table 4). Lower Woods had 35 taxa, the lowest number collected since sampling began. The running mean for this station is 39.5. However this change in number of taxa alone is likely not significant, despite the recorded changes in the physical environment. The base station had 40 taxa collected, six more than in the July 2011 samples.

The Upper Winter Quarters Canyon sample site for October 2011 had 32 taxa identified, below the running mean of 36.8 and, most notable, the lowest estimate for that station. Middle Winter Quarters recorded 34 different taxa in October 2011, below the average of 37.5 taxa from that site, but within the range of previous samples from that location. The Lower Winter Quarters Canyon sample sites for the October 2011 collection recorded 34 different taxa, short of the running average of 38.2 from Lower Winter Quarters Canyon (Table 4). This is the lowest number of taxa collected at that site.

Total Densities

For July 2011, all repeated stations on both streams showed a dramatic decline in density from previous years (Table 5). The densities averaged about 10% of the previously measured sample densities. These densities ranged from 6% in Woods Canyon to a maximum of about 20% in Winter Quarters Canyon. This decrease is extreme, but corresponds to the high runoff which occurred in the spring of 2011. As noted above, the spring channel was significantly rearranged by the high flows associate with the winter of 2010-2011 and that in turn would have both scoured in-stream invertebrates as well as reduced the availability of detritus in the stream bed. Woods Canyon, in July 2011, averaged 9689 organisms per square meter, while in previous years the average was 97,231. Winter Quarters Canyon in July 2011 averaged 14,330 while in previous years the average density in this stream was 91,629.

Table 4. Number of Taxa collected from Woods and Winter Quarter Canyons

	Shiozawa 2006	Shiozawa 2006	Shiozawa and Fordham 2010	Shiozawa and Fordham 2010	Shiozawa 2013	This Report
Sampling date	October 2003	June 2004	Sept/Oct 2007	July 2008	July 2011	Sept/Oct 2011
Upper Woods Canyon	42	37	37	40	41	39
Lower Woods Canyon	42	39	42	41	38	35
Base Woods Canyon	-	-	-	-	34	40
Upper Winter Quarters Canyon	35	42	39	34	39	32
Middle Winter Quarters Canyon	34	45	39	33	40	34
Lower Winter Quarters Canyon	37	44	41	35	38	34

By the fall 2011 sampling period total numbers had rebounded substantially. Upper Woods Canyon had about a 15 fold increase in densities, Middle Woods a thirteen fold increase and the Base Station on Woods Canyon had almost a five-fold increase. These increases placed the Upper and Lower Woods Canyon stations well within the range of earlier total density estimates. Winter Quarters Canyon also showed an increase but not at the same proportions as detected in Woods Canyon. Upper Winter Quarters Canyon increased about 3.5 fold from the Spring 2011 total density estimate while Middle Winter Quarters Canyon increased by 4.5 fold and Lower Winter Quarters Canyon increased by 3 fold. These increases brought the three stations within the low range of pre-2011 station density estimates.

Taxa Specific Densities

In Upper Woods Canyon, only five taxa comprise 5% or more of the total September, 2011 density (Table 6). These were Ephemeroptera: *Baetis* (5.4%; 4108/m^2), Ephemeroptera: *Cinygmula* (5.2%, 3979/m^2), early instar ephemeroptera (20.2%; 15358/m^2), early instar plecoptera (6.0%, 4564/m^2) and Diptera: Chironomidae (45.5%; 34549/m^2). In Contrast, eight taxa for the July 2011 samples comprised 5% or more of the total density. These were Diptera: Chironomidae (20.4%; 1053/m^2), Ephemeroptera: *Baetis* (9.3%; 480/m^2), *Cinygmula* (5.2%; 271/m^2), early instar Ephemeroptera (12.8%; 660/m^2), Coleoptera: *Heterolimnus* (9.0%; 467/m^2), Crustacea: *Ostracoda* (5.6%; 292/m^2), Hydracariina (7.4%; 383/m^2), and Oligochaeta (6.2%; 319/m^2).

Table 5. Total invertebrate densities per square meter for Woods and Winter Quarter Canyons

	Shiozawa 2006	Shiozawa 2006	Shiozawa & Fordham 2010	Shiozawa & Fordham 2010	Shiozawa 2013	This Report
Sampling date	Oct 2003	June 2004	Sept/Oct 2007	July 2008	July 2011	Sept/Oct 2011
Upper Woods Canyon	58804	32949	181813	59267	5131	75962
Lower Woods Canyon	62655	41852	212752	127756	7916	104542
Base Woods Canyon	-	-	-	-	16021	76590
Upper Winter Quarters Canyon	60471	42464	119136	99763	12085	41763
Middle Winter Quarters Canyon	49713	40272	217796	107936	13205	58934
Lower Winter Quarters Canyon	46179	54894	136740	124181	17881	52416

In Lower Woods Canyon only three taxa made up more than 5% of the total density (Table 6). These were early instar ephemeroptera (26.0%; 27189/m^2), Ephemeroptera: *Drunella doddsi* (7.9%; 8303/m^2), and Diptera: Chironomidae (47.0%; 49178/m^2). In July 2011, six taxa comprised 5% or more of the total density. These were Diptera: Chironomidae (43.2%; 3415/m^2), Ephemeroptera: Baetis (11.2%; 887/m^2), early instar Ephemeroptera (8.9%; 703/m^2), Coleoptera: Heterolimnus (8.8%; 696/m^2), Hydracariina (6.6%; 519/m^2), and Oligochaeta (5.1%; 400/m^2) .

In Base Woods Canyon three taxa were in abundance over 5%(Table 6). These were Ephemeroptera: *Baetis* (9.9%; 7589/m^2), early instar Ephemeroptera (16.8%; 12875/m^2), and Chironomidae (58.4%; 44716/m^2). In July 2011 four taxa comprised 5% or more of the total density. These were Diptera: Chironomidae (50.9%; 7933/m^2), Ephemeroptera: Baetis (17.5%; 2727/m^2), early instar Ephemeroptera (7.6%; 1186/m^2), and Oligochaeta (7.4%; 1148/m^2) .

In Upper Winter Quarters Canyon, six taxa comprised over 5% of the total density (Table 6). These were Diptera: Chironomidae (16.5%; 6883/m^2), Ephemeroptera: Baetis (13.4%; 5608/m^2), Cinygmula (7.1%; 2964/m^2), early instar Ephemeroptera (21.3%; 8911/m^2), Crustacea: Ostracoda (14.5%; 6068/m^2), and Collembola (5.2%; 2178/m^2). In the July 2011 seven taxa comprised 5% or more of the total density. These were Diptera: Chironomidae (16.5%; 1898/m^2), Ephemeroptera: Baetis (10.8%; 1247/m^2), Cinygmula (5.5%; 633/m^2), early instar Ephemeroptera (28.3%; 3250/m^2), Coleoptera - Heterolimnus (9.2%; 1055/m^2), Crustacea: Ostracoda (12.1%; 1389/m^2), and Hydracarina (5.0%; 578/m^2).

Table 6. Individual invertebrate densities per square meter for Woods and Winter Quarter Canyons.

Taxa	Upper Woods Sept. 2011	Lower Woods Sept. 2011	Base Woods Sept. 2011	Upper WQ Oct. 2011	Middle WQ Oct. 2011	Lower WQ Oct. 2011
Ephemeroptera: Ameletus	32	4	63	74	55	15
Ephemeroptera: Baetidae: Baetis sp.	4108	3710	7589	5608	11473	14807
Ephemeroptera: early instar *	15358	27189	12875	8911	11343	13246
Ephemeroptera: Ephemerellidae: Drunella coloradensis			4	8		72
Ephemeroptera: Ephemerellidae: Drunella doddsi	742	8303	426	494	845	261
Ephemeroptera: Ephemerellidae: Drunella grandis	1634					
Ephemeroptera: Ephemerellidae: Ephemerella					2	
Ephemeroptera: Ephemerellidae: Seratella tibialis				580	15	45
Ephemeroptera: Heptageniidae: Cinygmula	3979	919	653	2964	1604	2305
Ephemeroptera: Heptageniidae: Epeorus iron		21				
Ephemeroptera: Heptageniidae: Heptagenia	657	68	8			
Ephemeroptera: Heptageniidae: Nixe criddlei						
Ephemeroptera: Heptageniidae: Rithrogena		259				
Ephemeroptera: Leptophlebiidae: Paraleptophlebia	21	21	25	19	6	9
Plecoptera: Capniidae: Isocapina						
Plecoptera: Chloroperlidae: Alloperla severa						
Plecoptera: Chloroperlidae: Paraperla frontalis						
Plecoptera: Paragnetina						
Plecoptera: Chloroperlidae: Suwallia	4	2				
Plecoptera: Chloroperlidae: Sweltza	2	11	13	314	123	157
Plecoptera: early instar *	4564	2242	958	1027	6383	2669
Plecoptera: Nemouridae: Malenka californica						
Plecoptera: Nemouridae: Zapada	646	256	1015	189	377	66
Plecoptera: Perlidae: Classenia sabulosa						
Plecoptera: Perlidae: Hesperoperla pacifica	112	129	57	38	42	8
Plecoptera: Perlodidae: Diura knowltoni						2
Plecoptera: Perlodidae: Isogenoides						
Plecoptera: Perlodidae: Isoperla						
Plecoptera: Perlodidae: Megarcys signata	80	9	17	125	131	91
Plecoptera: Perlodidae: Skwalla parallela	2	2				
Plecoptera: Pteronarcyidae: Pteronarcella badia			4			
Trichoptera: pupae *		28				
Trichoptera: Amphicomoecus						
Trichoptera: Brachycentridae: Brachycentrus	72		6	4		
Trichoptera: Brachycentridae: Micrasema						
Trichoptera: Hydroptilidae: Hydroptila			4			
Trichoptera: Hydroptilidae: Ochrotrichia						
Trichoptera: Hydropsychidae: Arctopsyche grandis						
Trichoptera: Hydropsychidae: Hydropsyche	193	19	2	30	2	
Trichoptera: Hydropsychidae: Parapsyche elsis	13	6		6	2	
Trichoptera: Lepidostomatidae: Lepidostoma	40	38		4		
Trichoptera: Leptoceridae: Ocetis						
Trichoptera: Limnephilidae: Asynarchus						
Trichoptera: Limnephilidae: Chyranda						
Trichoptera: Limnephilidae: Dicosmoecus	21	104	15	21	42	9
Trichoptera: Limnephilidae: Hesperophylax						
Trichoptera: Limnephilidae: Limnephilus						
Trichoptera: Philopotamidae: Dolophilodes gabriella						
Trichoptera: Psychomyidae: Tinodes						
Trichoptera: Rhyacophilidae: Rhyacophila	153	932	191	32	616	375
Trichoptera: Uenoidae: Neothremma Alicia				8	8	
Trichoptera: Uenoidae: Oligophlebodes			24	24	24	24

Coleoptera: Dryopidae: Helichus						
Coleoptera: Dytiscidae						
Coleoptera: Dytiscidae: Agabus	2	2				
Coleoptera: Elmidae: Ampumixis						
Coleoptera: Elmidae: Cleptelmis						
Coleoptera: Elmidae: Heterlimnius	885	1555	942	1108	714	1089
Coleoptera: Elmidae: Microcylleopus						
Coleoptera: Elmidae: Narpus		2	2			
Coleoptera: Elmidae: Optioservus	17	125	57	24	8	50
Coleoptera: Haliplidae: Peltodytes callosus						
Coleoptera: Hydrophilidae: Hydrobius					4	
Coleoptera: Hydrophilidae: Tropisternis						
Coleoptera: Staphylinidae		44				
Diptera: pupae *						
Diptera: Athericidae: Atherix			8			
Diptera: Canacidae: Canace macateei						
Diptera: Ceratopogonidae	74	491	127	725	161	491
Diptera: Chironomidae	34549	49178	44716	6883	15918	12249
Diptera: Dixidae: Dixa					2	2
Diptera: Dolichopodidae						
Diptera: Empididae: Chelifera	15	6	8	8	9	9
Diptera: Empididae: Clinocrea						
Diptera: Empididae: Hemerodromia						
Diptera: Empididae: Neoplasta						
Diptera: Empididae: Oreogeton	11	13	8		6	2
Diptera: Muscidae: Limnophora		2			8	
Diptera: Pedica						
Diptera: Psychodidae: Pericoma	163	1727	589	212	2021	445
Diptera: Ptychopteridae: Ptychoptera					4	
Diptera: Simuliidae: Simulium	833	129	481	191	1210	36
Diptera: Stratomyidae: Allognasta						
Diptera: Stratiomyidae: Caloparyphus	2	4	9	2	13	4
Diptera: Stratiomyidae: Euparyphus	2		11		2	4
Diptera: Syrphidae		8				
Diptera: Tabanidae: Chyrsops						
Diptera: Tipulidae: Antocha	28					
Diptera: Tipulidae: Dicranota	127	136	25	64	44	28
Diptera: Tipulidae: Hexatoma	9	2	9	9	4	
Diptera: Tipulidae: Limnophila						
Diptera: Tipulidae:Scleroprocta tetonica						
Diptera: Tipulidae: Tipula	25	4	11	288	4	2
Diptera: Limoniidae: Nr. Rhabdomastix						
Crustacea: Cladocera						
Crustacea: Copepoda	78	114	4	6	297	114
Crustacea: Isopoda						
Crustacea: Ostracoda	2491	1218	2646	6068	2644	831
Arachnida: Hydracarina	2949	2254	1511	1805	1723	1822
Mollusca: Lymnaidae: Lymai			2			
Mollusca: Planoribidae: Gyraulus						
Mollusca: Sphaeriidae: Sphaerium	32	176	66	23	2	95
Annelida: Oligochaeta	468	1203	934	563	271	189
Annelida: Hirudinea						
Tricladida: Planariidae	127	125	288	98	23	8
Collembola	617	125	57	2178	178	95
Hemiptera: Corixidae						
Lepidoptera				6		
Nematoda *	2	814	23		9	133
Total	75962	104542	76590	41763	58934	52416
N	39	35	40	32	34	34

For October 2011 in Middle Winter Quarters Canyon four taxa, Diptera: Chironomidae (27.0%; 15918/m^2), Ephemeroptera: Baetis (28.2%; 11473/m^2), early instar Ephemeroptera (19.2%; 11343/m^{2,} and early instar Plecoptera (10.8%; 6383/m^2), made up the taxa with over 5% abundance (Table 6). In Middle Winter Quarters Canyon, for the July 2011 samples, just two taxa comprised 5% or more of the total density. These were Diptera: Chironomidae (42.2%; 5485/m^2) and early instar Ephemeroptera (34.2%; 4438/m^2).

In Lower Winter Quarters Canyon, four taxa (Table 6), Diptera: Chironomidae (23.4%; 12249/m^2), Ephemeroptera: Baetis (19.5%; 14807/m^2), early instar Ephemeroptera (25.3%; 13246/m^2) and early instar Plecoptera (5.1%; 2669/m^2). Three taxa for the July 2011 samples comprised 5% or more of the total density. These were Diptera: Chironomidae (58.6%; 10371/m^2), Ephemeroptera: Baetis (6.7%; 1194/m^2), and early instar Ephemeroptera (20.1%; 3551/m^2

Biomass

Because of the drastic decrease in density of invertebrates in the two streams in July 2011, the biomass estimates also decreased significantly for that sampling period (Table 7). By the fall 2011 sampling period most stations had recovered their biomass to within their previous range. The Upper Woods Canyon and the Lower Winter Quarters stations were the exception. Both the density and number of taxa in Upper Woods Canyon in were in the range of previous samples. Lower Winter Quarters site had slightly fewer taxa but the densities were well within the range of previous years. This suggests that different species or perhaps earlier instars of usual common taxa resulted in the lower than average biomass readings.

Table 7. Biomass in grams for Woods and Winter Quarters Canyons

	Woods Canyon			Winter Quarters Canyon		
Sample period	Upper	Lower	Base	Upper	Middle	Lower
Oct-03	31.64 g/m^2	49.43 g/m2	---	51.82 g/m^2	67.18 g/m^2	37.72 g/m^2
Jun-04	30.78 g/m^2	57.19 g/m^2	---	47.07 g/m^2	52.43 g/m^2	86.60 g/m^2
Sep-07	32.98 g/m2	22.52 g/m2	---	17.56 g/m2	22.75 g/m2	30.88 g/m2
Jul-08	35.49 g/m2	31.45 g/m2	---	42.03 g/m2	67.06 g/m2	42.31 g/m2
Jul-11	5.88 g/m2	10.72 g/m2	11.48 g/m2	13.21 g/m2	14.38 g/m2	19.04 g/m2
Sep-Oct-11	21.53 g/m2	31.27 g/m2	18.00 g/m2	16.79 g/m2	25.77 g/m2	15.87 g/m2

The Biotic Condition Index

The actual Community Tolerance Quotient (CTQa; Winget and Mangum 1979) was determined from the taxa present at each station (Table 8). These represent an overall average generated from a list provided by Winget and Mangum (1979) and are based on the presence-absence of taxa. Relative abundance is not considered in this index. Thus a single individual per square meter is equal in weight to another taxa represented by thousands of individuals in the same area. The fall, 2011 CTQa values, for the six stations, ranged from 59.9 to 67.7. Since lower values represent higher habitat quality, these scores indicate that the two streams are in better condition than in the July 2011 sample series, where CTQa values ranged from 62.1 to 74.5. Under this index the stations have recovered from the high flows experienced in the spring. The upper stations in both Winter Quarters and Woods Canyon have the lowest CTQa values, suggesting that, under these metrics, the upstream reaches are in better condition than the downstream reaches.

Community Tolerance Quotient and Biotic Condition Indices

The CTQp values are estimated from a combination of gradient, substrate, and water chemistry in accordance with a key provided by Winget and Mangum (1979). By September 2011, the water chemistry had shifted back to conditions standard prior to July 2011. However, the gradient of some sites had changed, so the CTQp had to be adjusted appropriately. The Biotic Condition Index, the ratio of CTQp/CTQa, is expressed as a percent. This ratio effectively reverses the reading of the relationships so that instead of low values being indicative of higher quality waters (as with the CTQa measure), high BCI values indicate better water quality. The ideal is a BCI of 100 or higher, meaning that the station meets or exceeds the predicted level.

In the spring 2011 samples Woods Canyon recorded CTQa values in the range of 70 to 75 for all three sites. This is classified as high to moderate habitat quality which, according to Winget and Mangum (1979), may require habitat improvement. Previously Woods Canyon has tended to have high habitat quality with this index, so it is likely that the high spring runoff in 2011was the causal factor in this shift. By the fall samples, the readings were back to the 62-67 range. In contrast, Winter Quarters Canyon ranged from 62 to 65 in the spring samples, which indicates high habitat quality and no stream improvement is recommended beyond maintaining the habitat. By the fall sampling period Winter Quarters Canyon readings ranged from 60 to 68. This is a continuation of the trend noted in previous years (Table 9).

The BCI values for the stations also showed the streams’ recovery from the high runoff conditions. Prior to the spring 2011 samples they had all been characterized by BCIs well over 100, indicating better than expected condition. The July 2011 BCI values fell to between 66.6 to 80.6 percent of ideal. This change was induced in part by water chemistry, which is a component of calculating the BCI. If water chemistry changes quickly but the stream community does not have time for equilibrating with the system, the result will be a community that is being evaluated on physical-chemical parameters that only recently developed. In this case the change was short-term because of the unique local weather conditions in the spring of 2011. In the fall 2011 sampling period, the chemical conditions had trended back to previous conditions. The BCI values for Woods Canyon in the fall of 2011 ranged from 119 to 129 and those for Winter Quarters Canyon ranged from 118 to 133. According to Winget and Magnum (1979), all stream sites in both streams should have either a high (CTQa<65 and BCI>80) or a low habitat quality rating (65<CTQa <80 and BCI >70). In this assessment I disagree with their ratings, since the scales are not properly bounded, and I would classify all sites as having a high to high-moderate habitat quality rating.

Table 8. Tolerance quotients for Woods and Winter Quarter Canyons

Taxa	Upper Woods July 2011	Lower Woods July 2011	Base Woods July 2011	Upper WQ July 2011	Middle WQ July 2011	Lower WQ July 2011	Ideal stream
Ephemeroptera: Ameletus	48	48	48	48	48	48	48
Ephemeroptera: Baetidae: Baetis sp.	72	72	72	72	72	72	72
Ephemeroptera: early instar *	72	72	72	72	72	72	72
Ephemeroptera: Ephemerellidae: Drunella coloradensis			18	18		18	18
Ephemeroptera: Ephemerellidae: Drunella doddsi	4	4	4	4	4	4	4
Ephemeroptera: Ephemerellidae: Drunella grandis	24						24
Ephemeroptera: Ephemerellidae: Ephemerella					48		48
Ephemeroptera: Ephemerellidae: Seratella tibialis				24	24	24	24
Ephemeroptera: Heptageniidae: Cinygmula	21	21	21	21	21	21	21
Ephemeroptera: Heptageniidae: Epeorus iron		21					21
Ephemeroptera: Heptageniidae: Heptagenia	48	48	48				48
Ephemeroptera: Heptageniidae: Nixe criddlei							48
Ephemeroptera: Heptageniidae: Rithrogena		21					21
Ephemeroptera: Leptophlebiidae: Paraleptophlebia	24	24	24	24	24	24	24
Plecoptera: Capniidae: Isocapina							24
Plecoptera: Chloroperlidae: Alloperla severa							24
Plecoptera: Chloroperlidae: Paraperla frontalis							24
Plecoptera: Paragnetina							24
Plecoptera: Chloroperlidae: Suwallia	24	24					24
Plecoptera: Chloroperlidae: Sweltza	24	24	24	24	24	24	24
Plecoptera: early instar *	36	36	36	36	36	36	36
Plecoptera: Nemouridae: Malenka californica							36
Plecoptera: Nemouridae: Zapada	16	16	16	16	16	16	16
Plecoptera: Perlidae: Classenia sabulosa							6
Plecoptera: Perlidae: Hesperoperla pacifica	18	18	18	18	18	18	18
Plecoptera: Perlodidae: Diura knowltoni						24	24
Plecoptera: Perlodidae: Isogenoides							24
Plecoptera: Perlodidae: Isoperla							48
Plecoptera: Perlodidae: Megarcys signata	24	24	24	24	24	24	24
Plecoptera: Perlodidae: Skwalla parallela	18	18					18
Plecoptera: Pteronarcyidae: Pteronarcella badia			24				24
Trichoptera: pupae *		108					108
Trichoptera: Amphicomoecus							18
Trichoptera: Brachycentridae: Brachycentrus	24		24	24			24
Trichoptera: Brachycentridae: Micrasema							24
Trichoptera: Hydroptilidae: Hydroptila			108				108
Trichoptera: Hydroptilidae: Ochrotrichia							108
Trichoptera: Hydropsychidae: Arctopsyche grandis							18
Trichoptera: Hydropsychidae: Hydropsyche	108	108	108	108	108		108
Trichoptera: Hydropsychidae: Parapsyche elsis	6	6		6	6		6
Trichoptera: Lepidostomatidae: Lepidostoma	18	18		18			18
Trichoptera: Leptoceridae: Ocetis							54
Trichoptera: Limnephilidae: Asynarchus							108
Trichoptera: Limnephilidae: Chyranda							18
Trichoptera: Limnephilidae: Dicosmoecus	24	24	24	24	24	24	24
Trichoptera: Limnephilidae: Hesperophylax							108
Trichoptera: Limnephilidae: Limnephilus							108
Trichoptera: Philopotamidae: Dolophilodes gabriella							24
Trichoptera: Psychomyidae: Tinodes							108
Trichoptera: Rhyacophilidae: Rhyacophila	18	18	18	18	18	18	18
Trichoptera: Uenoidae: Neothremma Alicia				8	8		8
Trichoptera: Uenoidae: Oligophlebodes			24	24	24	24	24
Coleoptera: Dryopidae: Helichus							54
Coleoptera: Dytiscidae							72
Coleoptera: Dytiscidae: Agabus	72	72					72

Coleoptera: Elmidae: Ampumixis							108
Coleoptera: Elmidae: Cleptelmis							108
Coleoptera: Elmidae: Heterlimnius	108	108	108	108	108	108	108
Coleoptera: Elmidae: Microcylleopus							108
Coleoptera: Elmidae: Narpus		108	108				108
Coleoptera: Elmidae: Optioservus	108	108	108	108	108	108	108
Coleoptera: Haliplidae: Peltodytes callosus							54
Coleoptera: Hydrophilidae: Hydrobius				72			72
Coleoptera: Hydrophilidae: Tropisternis							72
Coleoptera: Staphylinidae		108					108
Diptera: pupae *							108
Diptera: Athericidae: Atherix			24				24
Diptera: Canacidae: Canace macateei							108
Diptera: Ceratopogonidae	108	108	108	108	108	108	108
Diptera: Chironomidae	108	108	108	108	108	108	108
Diptera: Dixidae: Dixa					108	108	108
Diptera: Dolichopodie							108
Diptera: Empididae: Chelifera	108	108	108	108	108	108	108
Diptera: Empididae: Clinocrea							108
Diptera: Empididae: Hemerodromia							108
Diptera: Empididae: Neoplasta							108
Diptera: Empididae: Oreogeton	108	108	108		108	108	108
Diptera: Muscidae: Limnophora		108			108		108
Diptera: Pedica							24
Diptera: Psychodidae: Pericoma	36	36	36	36	36	36	36
Diptera: Ptychopteridae: Ptychoptera					108		108
Diptera: Simuliidae: Simulium	108	108	108	108	108	108	108
Diptera: Stratomyidae: Allognasta							108
Diptera: Stratiomyidae: Caloparyphus	108	108	108	108	108	108	108
Diptera: Stratiomyidae: Euparyphus	108		108		108	108	108
Diptera: Syrphidae		108					108
Diptera: Tabanidae: Chyrsops							108
Diptera: Tipulidae: Antocha	24						24
Diptera: Tipulidae: Dicranota	24	24	24	24	24	24	24
Diptera: Tipulidae: Hexatoma	36	36	36	36	36		36
Diptera: Tipulidae: Limnophila							72
Diptera: Tipulidae:Scleroprocta tetonica							72
Diptera: Tipulidae: Tipula	36	36	36	36	36	36	36
Diptera: Limoniidae: Nr. Rhabdomastix							108
Crustacea: Cladocera							108
Crustacea: Copepoda	108	108	108	108	108	108	108
Crustacea: Isopoda							108
Crustacea: Ostracoda	108	108	108	108	108	108	108
Arachnida: Hydracarina	108	108	108	108	108	108	108
Mollusca: Lymnaidae: Lymai			108				108
Mollusca: Planoribidae: Gyraulus							108
Mollusca: Sphaeriidae: Sphaerium	108	108	108	108	108	108	108
Annelida: Oligochaeta	108	108	108	108	108	108	108
Annelida: Hirudinea							108
Tricladida: Planariidae	108	108	108	108	108	108	108
Collembola	108	108	108	108	108	108	108
Hemiptera: Corixidae				108			108
Lepidoptera							72
Nematoda *	108	108	108		108	108	108
Total	2735	3137	2963	2455	2911	2531	
N	44	47	44	41	43	38	
CTQa	62.16	66.74	67.34	59.88	67.70	66.61	

Table 9. CTQa and BCI values for Woods and Winter Quarter Canyons

	Shiozawa 2004	Shiozawa 2004	Shiozawa and Fordham 2010	Shiozawa and Fordham 2010	Shiozawa 2013	This report
Sampling date	Oct 2003	June 2004	Sept/Oct 2007	June July 2008	July 2011	Sept/Oct 2011
	CTQa / BCI	CTQa / BCI	CTQa / BCI	CTQa / BCI	CTQa / BCI	CTQa / BCI
Upper Woods Canyon	61/131	68/ 117	64/125	60/ 117	70/ 71.4	62/129
Lower Woods Canyon	60/134	73/ 110	67/119	66/ 110	74/ 67.6	67/119
Base Woods Canyon	---	---	---	---	75/ 66.6	67/119
Upper Winter Quarters Canyon	58/ 139	67/ 121	59/ 137	60/ 121	62/ 80.6	60/133
Middle Winter Quarters Canyon	58/139	66/ 122	61/130	69/ 116	65/ 76.9	68/118
Lower Winter Quarters Canyon	55/ 145	61/ 133	68/118	65/ 133	63/ 79.4	67/119
Average	58/ 138	67/ 121	64/ 126	64/ 121	68/ 73.3	65/123

Diversity Indices

Diversity indices combine both number of taxa and relative densities into a single measurement. High diversity index values indicate more taxa and an even number of individuals per taxon. Low diversity values generally reflect a depauperate fauna in species and a very skewed distribution in numbers per taxon. Usually a low diversity community will be dominated by just a few taxa with other taxa being rare and in low density.

The fall 2011 Upper Woods Canyon sample diversity index was 1.9212, considerably lower than the value of 2.716 for the spring of 2011 (Table 10), but closer to earlier estimates of diversity. This suggests that the spring floods reduced the abundant taxa more than some of the rarer ones. the September 2011 Lower Woods Canyon diversity index was 1.7507, again lower than the July 2011 value of 2.054for the same station. The fall Lower Woods diversity value was slightly higher than the July 2008 value of 1.648 and appears to be about the mean for that station. Since sampling at the base station of Woods Canyon was initiated in 2011 no comparisons can be made other than to note that it continued to have a much lower diversity that the two upstream stations

The Upper Winter Quarters diversity value was 2.4392, higher than the July 2011 diversity index of 2.234, and the July 2008 value of 1.718. It was much more similar to the values obtained in the early 2000's. The Middle Winter Quarters October 2011 diversity index of 2.2008 was also higher than previous estimates for July, and more similar to estimates for the early 2000's as well. Lower Winter Quarters October 2011 diversity index was 1.9523 was higher than the 1.4640 for July 2011 and the 1.208 recorded for July 2008. It was close to, but lower than, the diversity values recorded for earlier samples at that station.

Table 10. Diversity indices, based on natural logs, for Woods and Winter Quarter Canyons

	Shiozawa 2004	Shiozawa 2004	Shiozawa and Fordham 2010	Shiozawa and Fordham2010	Shiozawa 2013	This report
Sampling date	Oct 2003	June 2004	Sept/Oct 2007	July 2008	July 2011	Sept/Oct 2011
Upper Woods Canyon	2.041	2.327	2.153	1.957	2.7161	1.9219
Lower Woods Canyon	1.930	2.153	1.532	1.648	2.0541	1.7507
Base Woods Canyon	----	----	----	----	1.7564	1.5202
Upper Winter Quarters Canyon	2.518	2.447	2.135	1.718	2.2337	2.4392
Middle Winter Quarters Canyon	2.250	2.240	1.983	1.703	1.6658	2.2008
Lower Winter Quarters Canyon	2.125	2.139	2.057	1.208	1.4640	1.9528

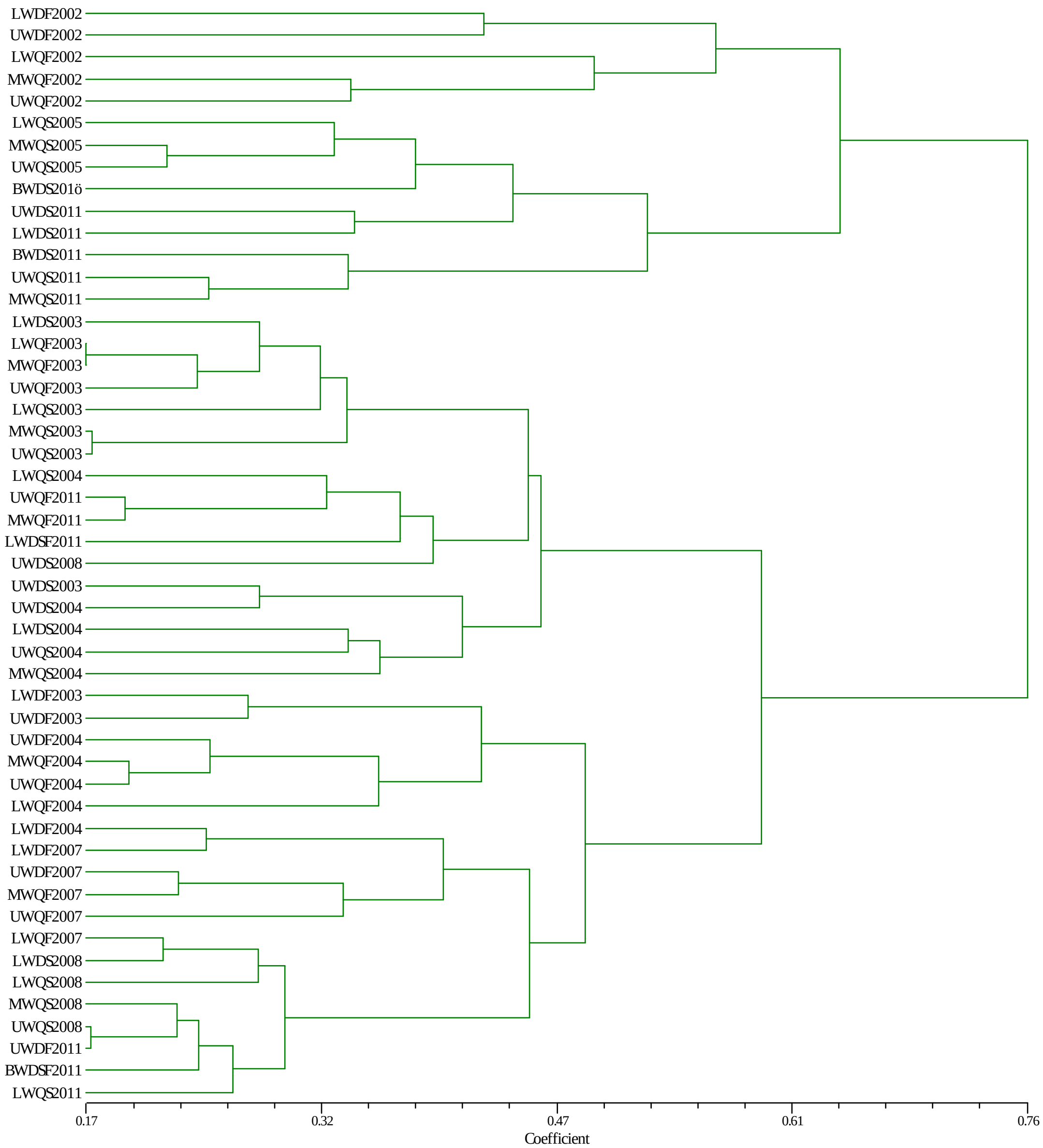
These diversity values seem somewhat counterintuitive given the impact of the spring floods on both biomass and densities (Tables 6 and 7). However, the total number of taxa remained about the same (Table 5) and that is the key factor. Since densities were reduced but the number of taxa remained about the same, the difference between the high densities and the low densities were not as great (see the Taxa Specific Densities section above). The computation of diversity indices weighs these differences and when the magnitude of the differences is lower, the diversity index is higher.

Cluster Analysis

The species density data were examined with cluster analysis using the Bray-Curtis dissimilarity index (Poole 1974, Krebs 1989) with the unweighted pairs group mean averaging algorithm (UPGMA) (NTSYS; Rolf 2000). The analysis (Figure 1) resulted in two principle clusters separating at a dissimilarity value of 0.76. The top cluster, cluster 1 for reference, has two subclusters which split at a dissimilarity of about 0.64. Subcluster 1a contained all of the fall 2002 sites for both Woods Canyon Creek and Winter Quarters Creek. The second subcluster, subcluster 1b, included all of the July 2011 samples from both streams and the three Winter Quarters Canyon sample stations from the spring of 2005.

The lower cluster, cluster 2, also has two subclusters, separating at a dissimilarity value of about 0.60. The upper subcluster, subcluster 2a is mostly comprised of fall 2003 and spring 2004 samples

Figure 1. UPGMA Cluster dendrogram of relationships among communities from Woods and Winter Quarters Canyons.



but also has two fall 2011 Winter Quarters stations and the lower Woods Canyon fall 2011 station. The second subcluster, subcluster 2b, includes the fall 2004 and the majority of both fall 2007 and spring 2008 samples. The remaining fall 2011 stations are also in this cluster. The sites show a tendency to be grouped by site and sampling date. But these trends do not suggest a strong seasonal signal. They likely reflect a combination of annual variations in weather conditions (e.g. wet years and dry years) and seasonal changes and in the community structure as modified by the simplifying effects of both the Bray-Curtis index and the UPGMA algorithm. While these data develop a complex picture of the range of variation in the two streams systems, other techniques may give a more easily interpreted view of station associations.

Principal Components Analysis

The final procedure use in this analysis was principal components analysis. This procedure rotates the multi-dimensional data set (in this case 128 dimensions representing the taxa) in such a way to maximize variance along orthogonal axes. These axes are linear functions of the data (species) variables. The axes, or principal components, are ranked with the first principal component axis explaining the maximum variance, the second axis explaining the next greatest amount of remaining variance in the data set and so on. Generally the majority of the variation is described in the first four or five dimensions. We will examine the first two in this report because they will give adequate separation to illustrate the procedure and to illustrate its helpfulness in describing the complex data set.

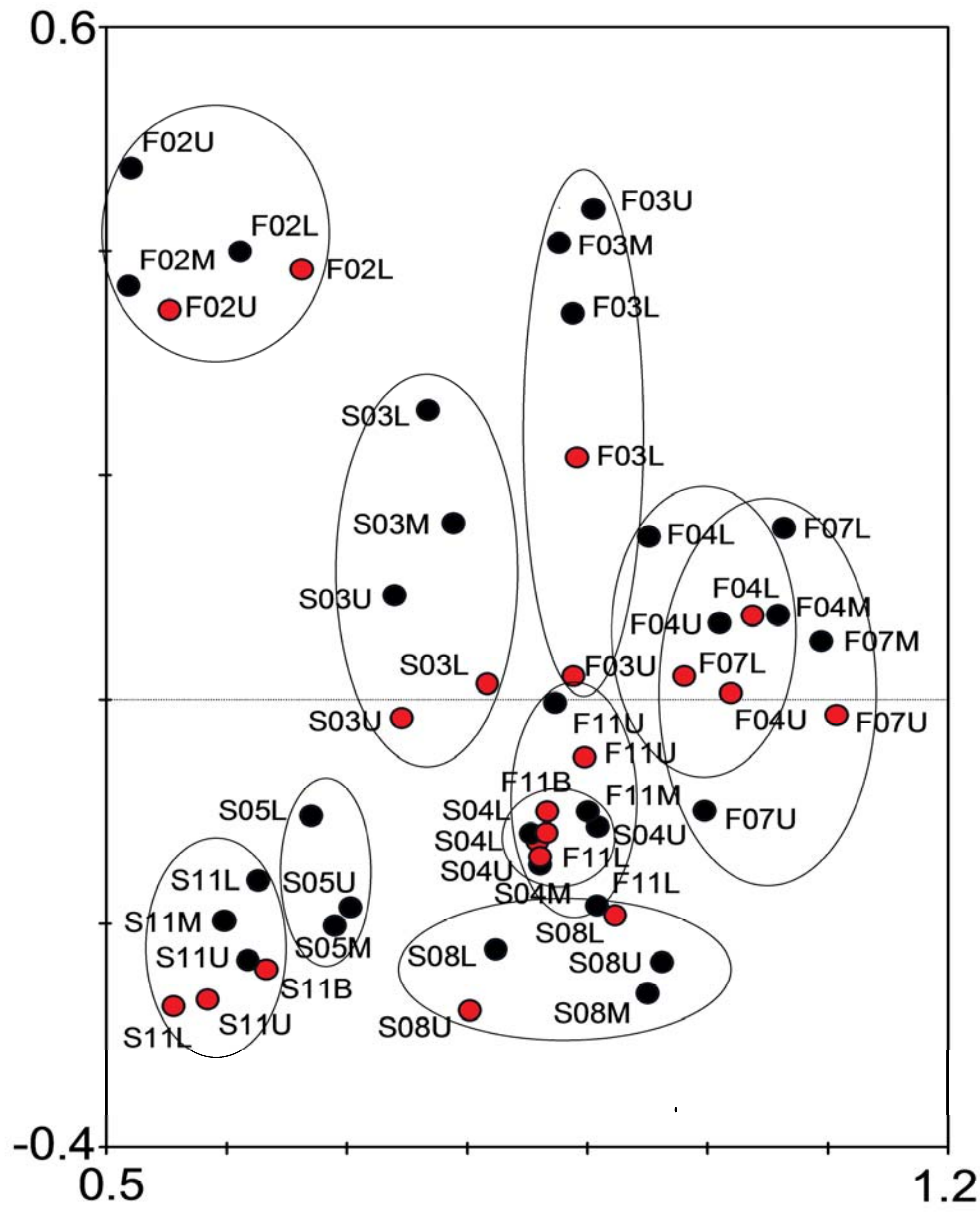
In this analysis data from stations sampled since 2002 were included so that relationships between stations and sampling periods could be visualized. The data were treated with a log (X+1) transformation because of the large range of differences among the taxa. This step linearized the data. The analysis and plots (Figure 2) were completed with the program CANOCO (Braak and Smilauer 2002). The first axis, Principal Component Axis 1 (PC1), explained about 71% of the variation in the data set, and adding the second axis, Principal Compoent axis 2 (PC2), increased that to a total of 75%. The plot of the first two axes generate a distinct pattern which is much more revealing than the cluster analysis. This likely comes about because the transformed data are linearized and the fact that the analysis takes into account the total data set variance simultaneously rather than in a stepwise approach as is done in the cluster algorithm.

The main factors separating the stations in the first two principal components axes are associated with season. This results in the stations being separated roughly diagonally into an upper right half which is fall sample periods (noted with lead letter of S on the station codes; Figure 2), and the lower left half which predomiantly consists of spring sample periods (noted with lead letter of S on the station codes; Figure 2).

Two other points are of note. First, stations for each sampling date only cover a limited area of the principal component space (circled in Figure 2). The ovals tend to have minimal overlap, and this indicates that the communities in both streams are more similar to each other for a given year and season than tey are to communities sampled on other years or seasons.

Second, the size of the ellipses tend to be smaller in the spring than in the fall. This suggests that the communities in a given year are more similar to one another in the spring than in the fall. This type of shift would be expected as biotic factors begin to structure the community over time. Life history adaptations, predation, competition, disease, and parasitism may be important processes that operate in streams where a strong seasonal temperature and discharge signal exists. Once the

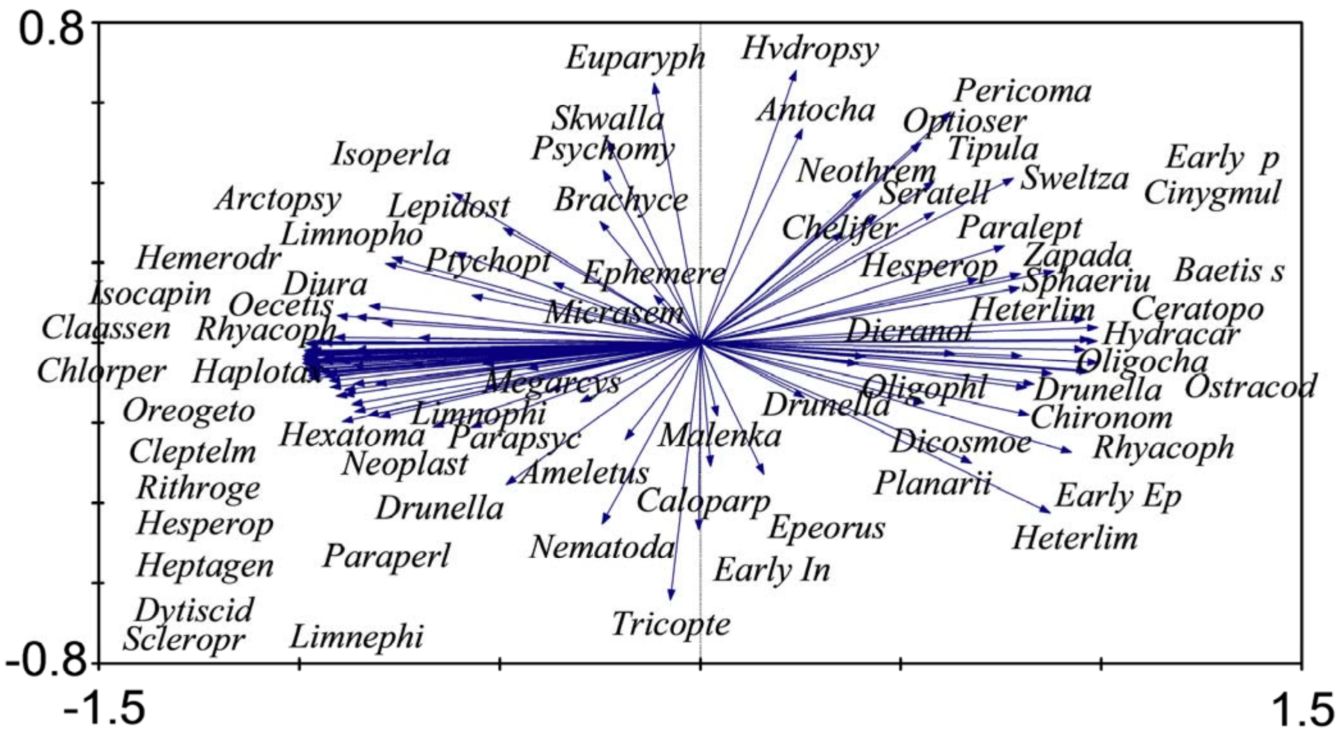
Figure 2. Principal Components (PC) plot of the first two principal component axes. Red = Woods Canyon station, Black = Winter Quarters Canyon stations. Labels: the first letter dentotes Spring (S) of Fall (F) seasons and the following two digits indicate the year of sampling. The last letter denotes Upper (U), Middle (M), Lower (L), and Base (B) stations. Ovals circumscribe each sampling period. The X axis is the PC1 axis and the Y axis is the PC2 axis.



taxa comprising the communities begin to interact, time is required for their interactions to result in detectible changes in densities. This implies a more determinant early season structure, potentially dominated by physical conditions, and then, as the season progresses, biotic factors take the communities on a broadening (and diverging) set of trajectories.

The taxa-based loadings were also plotted (Figure 3) so that the important taxa in the Principle Components Analysis could be visualized. The taxa most important for fall samples are in the upper right half of the plot and those important in the spring are in the lower left half of the plot. These correspond directly with the station plots in Figure 2. Thus in the case of the fall 2002 samples *Antocha*, *Optioservus*, *Isoperla*, and *Hydropsyche* (Figure 3) were some of the important taxa determining the placement of the fall 2002 samples in the principal components plot (Figure 2).

Figure 3. Loading for taxa important in the spread of the stations in the Principal Components Analysis. Arrows show direction of increasing importance of individual taxa. Some taxa have been removed for clarity and taxa listerdon the left were moved below their associated left-directed medium vectors.



The fall taxa include the ephemeropterans *Seratella*, *Cyngmula*, *Paraleptophlebia*, and *Baetis*; the plecopterans *Sweltza* and *Zapada*; the trichopterans *Hydropsyche*, *Neotheremma*, and *Brachcentrus*; the coleopteran *Optioservus*; the dipterans *Pericoma*, *Tipula*, *Antocha*, *Chelifera*, and

Certopogonidae. The spring taxa include the ephemeropterns *Ameletus, Drunella grandis, Heptagenia,* and *Rithrogenia*; the plecopterans *Megarcys, Isocapnia*, and *Classenia*; the trichopterans *Parapsyche*, *Linnephilus*, and *Rhyacophila*; the coleopterans Dytiscidae and *Cleptelmis*; and the dipterans *Limnophora*, *Hexatoma*, *Limnophila*, and *Hemerodromia* .

Conclusions

The July 2011samples were strongly influenced by the flooding that took place in the spring of that year. Invertebrate densities in the five established stations were significantly down from previous sampling periods as was the standing crop of invertebrates. However, these numbers had rebounded by the September-October sampling period (Table 5). While the numbers and most of the biomass estimates have returned to the general range detected in previous years, the year to year densities show significant variation, so this alone does not necessarily indicate recovery from the spring 2011 floods. Several noteworthy observations can be made about the densities of individual taxa in these stations in September-October, 2011. First chironomids were much more abundant in Woods Canyon than in Winter Quarters. As in the July 2011 samples, the stonefly, *Hesperoperla pacifica* appears to be best established in Woods Canyon Creek, and in Winter Quarters Canyon the chloroperlid stonefly, *Sweltza* and the perlodid stonefly, *Megarcys* are abundant. *Zapada*, a nemourid stonefly, is most abundant in Woods Canyon Creek. Hesperoperla and Megarcys are important predators in aquatic invertebrate communities.

Completely reviewing all taxa is tedious and quickly becomes difficult to comprehend. For that reason a number of indices and data exploration techniques have been developed (e.g. CTQa, BCI, diversity indices, cluster analysis, and principal components analysis). The July 2011 changes were not detected with the CTQa in the Winter Quarters stations and only slightly so with the Woods Canyon stations (Table 9). By the fall 2011 sample period the CTQa had recovered in both stream systems. The BCI did change in the July 2011sampling period because the CTQp value was shifted in response to the changes in water chemistry. That in turn was a transient effect of the high runoff. By the Fall 2011 samples, the BCI values had recovered to their previous high levels. Again this was related to the two streams' water chemistry returning towards normal background levels.

The fall Woods Canyon station diversity indices (Table 10) decreased from the July Woods Canyon estimates. This suggests a loss of taxa or an increase in unevenness of the taxa present in the stream. The number of taxa decreased in the Fall 2011 upper Woods Canyon station (Table 4), but numbers increased in the other two stations. Thus in the latter two stations it is likely that the unevenness of the distribution of taxa was important in the decline in the diversity index. This change in Woods Canyon diversity index values for fall 2011 is likely due to the increase in chironomids in the September samples. Their increase, two-fold in Upper Woods and by at least 10% in the other two stations would reduce evenness in the data sets.

In Winter Quarters Canyon the number of taxa decreased by 10 to 15 percent at the three Fall 2011 stations relative to the July 2011 sample period. But the diversity index values actually increased indicating a more even distribution of organism densities in the fall samples. This is related to the decrease in chironomid densities in the fall Winter Quarters Canyon stations.

The cluster analysis, based on dissimilarity of taxon densities placed the Fall 2011 samples into the same main cluster but then placed the six stations into two subclusters (Figure 1). The stations are not separated by stream, yet within each subcluster the fall 2011 stations clump together, indicating that they share unique community compositions. Unfortunately while this technique can classify groupings, it is difficult to determine from this alone, which variables decide cluster membership. If the Principal Component Graph is examined it can be seen that the difficult station overlap in their placement on the first two Principal Components axes.

Principal Components Analysis resolves many of the problems associated with the above indices and techniques. This analysis shows that stations taken on a given date tend to be more similar to one another and that on a broader scale a distinct seasonal pattern exist in the sample stations. By including the corresponding variables (invertebrates) in a second plot it is possible to identify the taxa that are most important in the placement of the stations in principal component space. With this analysis it becomes clear that a different community structure separates fall from spring samples and that year to year variation also reflects shifts in dominant taxa. The Fall 2011 stations are much more similar to the Spring 2004 samples than they are to other fall season samples. The Spring 2011stations are the most distinct sample series taken in the Spring sampling season. This placement was likely associated with the intense spring flooding in 2011, and this natural perturbation pushed the spring samples far enough away from a ‘normal’ spring community structure, that it is likely the fall 2011 stations had still not recovered to the ‘normal’ fall position in Principal Component space.

While these samples are still documenting the before mining-subsidence conditions of the two streams, a fuller interpretation of background variation is developing as the data base accumulates. This should establish a good baseline for assessing any potential impacts from subsidence-related issues.

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Wildlife Survey Report
Power Line, Ventilation Hole, Access Road Analysis Area, Subsidence Area, and Spring Survey
2013

Northern Goshawk, other Raptors, Western Toad, and
General Wildlife Surveys

Prepared for:

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Environmental Engineer
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08.09.2013

Table of Contents

Contents

Appendices

1.0 Introduction

The following narrative is submitted pursuant to requirements regulating potential impacts to threatened, endangered, candidate and sensitive species and their associated habitats. The following report details the results of the northern goshawk (*accipiter gentilis*) protocol surveys, raptor surveys, general wildlife surveys, and a western (boreal) toad (*bufo boreas*) survey. The areas surveyed are displayed on Figure 1, attached hereto in Appendix A.

Pre-field research was completed by Alpine wildlife biologists who utilized GIS data from the Utah Division of Wildlife Resources' (UDWR) Utah Threatened, Endangered, and Sensitive Species Occurrences (TES Shapefile 20130510); coordinated with wildlife biologists from the US Forest Service (USFS), and the Utah Division of Oil, Gas, and Mining (UDOGM); and researched species ecology, life history, known distributions, and habitat requirements. Previous surveys conducted near the area were also reviewed prior to conducting inventories.

2.0 Project Description

The 2013 wildlife survey included the following areas: a potential power line route, ventilation hole, and access roads (Figure 2); a subsidence survey (Figure 3); and a spring survey (Figure 4). Each survey area is displayed on a map attached hereto in Appendix A as Figure 1. Northern goshawk protocol surveys, general raptor surveys, and general wildlife surveys were conducted in and around the areas displayed on Figure 2 and Figure 3.

3.0 General Habitat Overview

The vegetation across the survey area is very diverse and is somewhat consistent throughout the survey area. Vegetation is dependent on elevation, slope, and available water resources. Riparian areas are dominated by typical high elevation riparian species. The bottoms of the valleys that are drier are dominated by mountain big sagebrush and silver sagebrush communities. South and East facing slopes, at higher elevations are dominated by quaking aspen communities. However, there are some areas that are open on South and East facing slopes. These open areas are typically grass and tall forb communities. However, a significant number of the open areas are dominated by false hellebore. The North and West facing slopes are dominated by conifer communities. The tree species within the conifer community are mostly dead or dying, and most areas have an abundance of deadfall due to beetle infestations. Because of the deadfall and dead trees the forbs and grasses within the conifer communities are very diverse and most areas have a solid understory. The tops of the ridges in the survey area vary with some being dominated by shrub communities such as mountain big sagebrush, elderberry or chokecherry while others are dominated by grass and tall forb communities. Some of the ridge tops are dominated by cluster tarweed.

4.0 Methodology

Northern Goshawk broadcast acoustical surveys were conducted following U.S. Department of Agriculture (USDA) Forest Service, 2006, Northern Goshawk Inventory and Monitoring Technical Guide pp.3.13-15. Using GIS, survey transects were established 250 meters apart throughout the survey area which extended 0.5 miles beyond the project footprint. Broadcast calling stations were then established every 200 meters along each transect. Upon arrival at each broadcast calling station, the surveyor looked and listened before broadcasting the pre-recorded alarm calls. Utilizing FoxPro game calls, pre-recorded northern goshawk alarm calls were broadcast for approximately 10 seconds followed by 30 seconds of looking and listening. After turning 120 degrees the sequence was then repeated. Once the sequence of 10 seconds of calling and 30 seconds of looking and listening was completed 3 times and no response was elicited the surveyor then repeated the sequence before moving to the next calling station. Surveys were timed in accordance to the survey requirements outlined in the 2006 Technical Guide and were based on local knowledge of nesting chronologies in the area and coordination with the US Forest Service. Additionally, surveyors searched for foraging raptors between calling stations when vantage points were available. Consultation with the USFS and UDOGM was conducted concerning survey timing and was within the seasonal guidelines as defined in the 2006 Technical Guide. Prior to conducting the survey, the Upper Huntington Territory was monitored for nesting activity. The nest was located and documented as blown out and therefore inactive and unoccupied.

According to the UNHP 2003 progress report there are western toad records of occurrence in the area of Skyline Mine prior to 1983. The mapping scale within the report makes it difficult to determine exact locations. The Utah Conservation Database Center (UCDC) cites the last observation within the Scofield map quadrant was on 6/18/1950. This is the same quadrant as Skyline Mine. However, as required, western toad surveys were conducted around five springs within suitable habitat; areas surveyed are displayed on Figure 4. Surveys were conducted by walking meandering transects around each of the springheads and extended into areas of surface flow.

5.0 Survey Results

Species observed during the course of the inventories included golden eagle (*Aquila chysaetos*), northern goshawk, red-tailed hawk (*Buteo jamaicensis*), common raven (*Corvus corax*), dark-eyed junco (*Junco hyemalis*), brown creeper (*Certhia americana)*, black-capped chickadee (*Poecile atricapillus*), lazuli bunting (*Passerina amoena*), Stellar's jay (*Cyanocitta stelleri*), red-naped sapsucker (*Sphyrapicus nuchalis*), Clark's nutcracker (*Nucifraga columbiana*), American robin (*Turdus migratorius*), dusky blue grouse (*Dendragapus obscurus*), mountain chickadee (*Poecile gambeli*), Rocky Mountain elk (*Cervus elaphus*), mule deer (*Odocoileus hemionus*), and black bear (*Urus americanus*). Information such as species, call station observed, and type of observation (e.g., audio (A) or visual (V)) were documented for species of concern such as northern goshawk, red-tailed hawk, and golden eagle. Other species are listed for reference only. A single response from a northern goshawk was elicited during the first survey at call station 56. Both audio and visual responses were documented. The adult responded between the second and third call on the last call sequence. The call station is located on the southernmost transect in the head of Burnout Canyon. Forest Service Wildlife Biologist Jeff Jewkes indicated the Burnout Canyon northern goshawk territory was occupied. After the discussion with Jeff, it is likely the response came from the adult occupying that territory. No other responses from northern goshawk were documented during the course of these surveys.

Table 1 summarizes the results of the survey by raptor species, call station, and type of observation.

Station#	Survey	Auditory	Visual	Species	Notes
52	1	Yes	Yes	NOGO	2 Adults responded to the call; 2nd call sequence; between 2nd and 3rd call. They flew south out of the project area towards Burnout Canyon.
150	1	No	Yes	GOEA	1 GOEA observed flying over call station
152	1	No	Yes	REHA	1 REHA observed soaring above station
134	1	Yes	Yes	REHA	REHA-territorial behavior
103	1	Yes	No	REHA	N/A
211	1	Yes	No	REHA	Heard between 210 and 211.
12	1	Yes	No	REHA	Heard calling stations
30	1	No	Yes	REHA	Observed REHA flying. No response to call.
75	1	Yes	No	REHA	Heard REHA call. No response to call.
179	1	Yes	Yes	REHA	Before I approached 179 a saw a REHA soaring in a circle. Responded to call intermittently.
113	1	Yes	No	REHA	Heard REHA call one time.
215	2	Yes	Yes	REHA	REHA flying and calling above station.
224	2	Yes	Yes	REHA	REHA flying and calling above station.
237	2	Yes	Yes	REHA	REHA calling from the east.
179	2	No	Yes	REHA	REHA soaring to the east.
251	2	Yes	Yes	REHA	REHA calling and soaring from the east.
36	2	Yes	No	REHA	Heard REHA call.

The vegetative communities within the Project Area are classified by the Utah Division of Wildlife Resources as crucial summer mule deer fawning habitat and crucial summer elk calving habitat. This was confirmed by biologists throughout each project area as individual mule deer fawns and elk calves were observed on numerous occasions throughout the project areas during both surveys.

There were no observations of western toad during the course of the spring inventories.

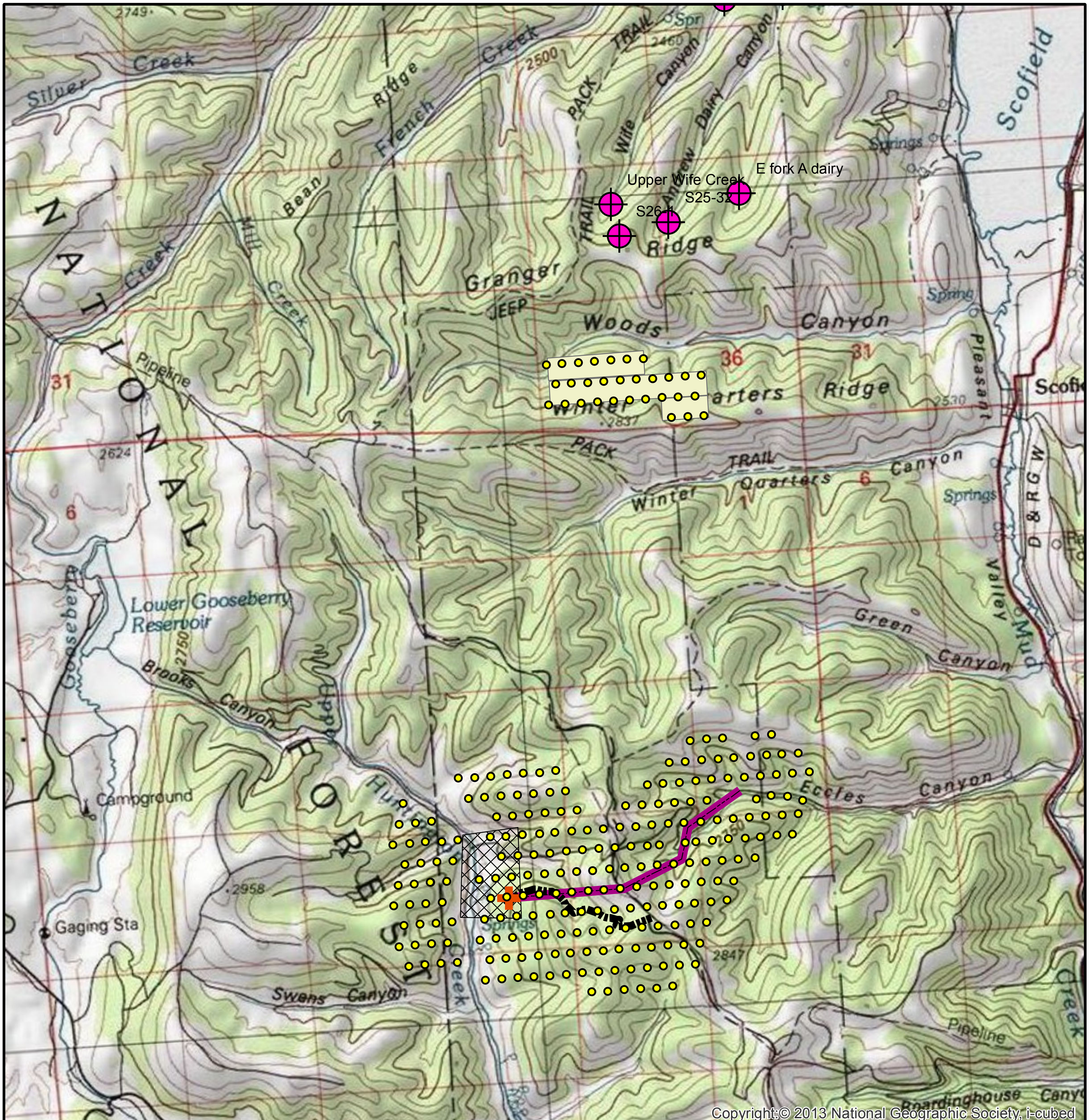
6.0 Conclusions and Recommendations

During the 2013 wildlife inventory biologists documented audible and visual detections of northern goshawks on one occasion, at call station 52. Data collected during the observation suggests that the pair were likely the adults from the Burnout Canyon Territory. There were no northern goshawk responses elicited in this area during the second inventory. Other raptors were documented on 16 occasions; 1 golden eagle and 15 red-tailed hawks. Nest searches were conducted west of the highway in areas of high activity. No nests were found during those searches.

There were no observations of western toad during the spring surveys.

We recommend in subsequent years coordination with the UNHP, UDOGM and the USFS continues to be conducted prior to inventory initiation in order to refine the survey area requirements, ensure nesting data is transferred, and up to date protocols are followed.

Appendix A-Project Maps



- Call Stations Export
- Spring Survey Area
- Vent Shaft
- East Access Road
- Powerline
- Access Road Analysis Area
- Subsidence Areas

N

Skyline Mine
2013 Wildlife Surveys

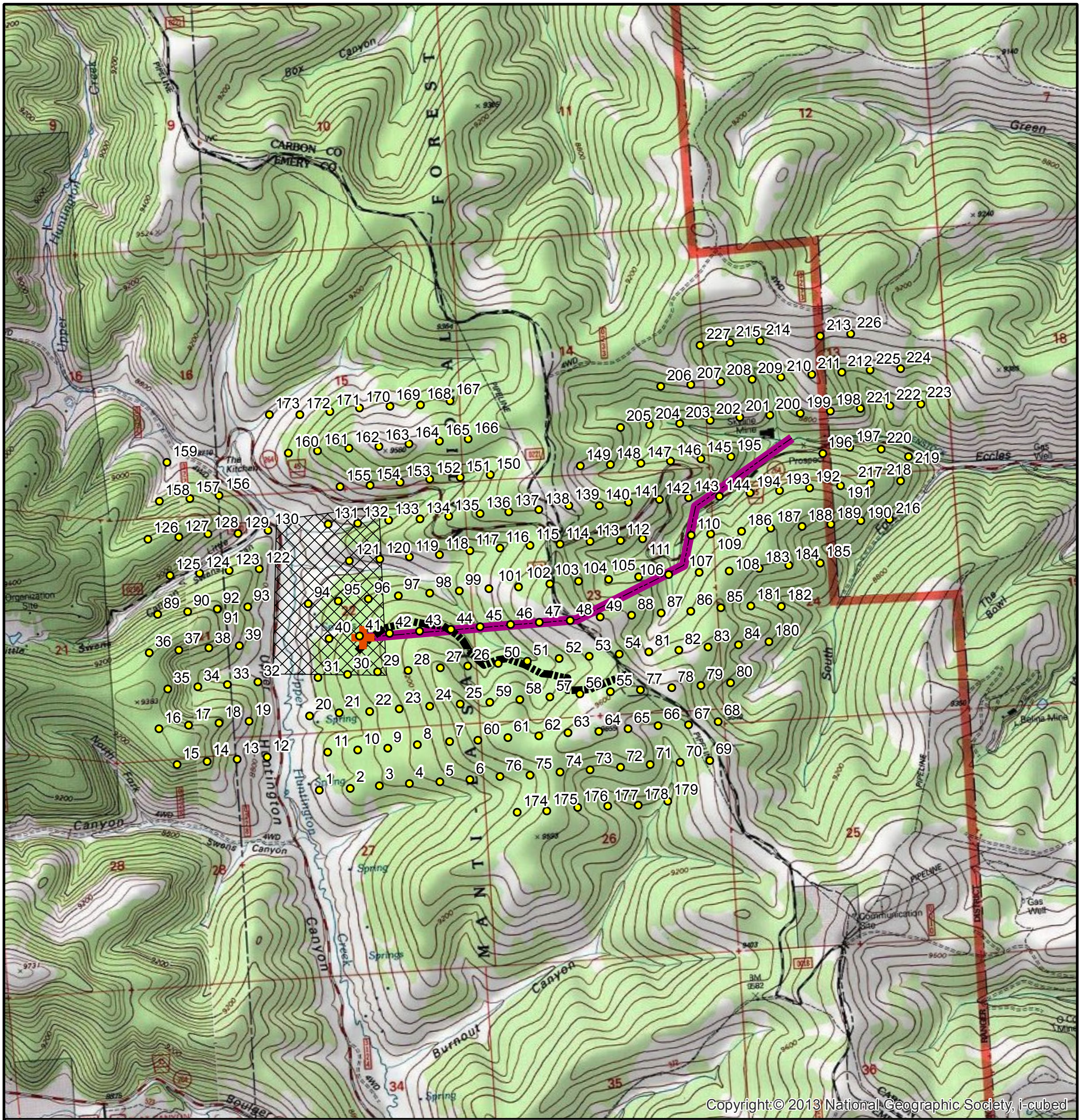
FIGURE 1
PROJECT LOCATION

DATE DRAWN

7/31/13

SCALE

0.5 0.25 0 0.5 Miles



Call Stations Export

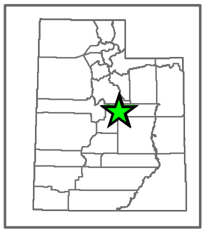
Vent Shaft

East Access Road

Powerline

Access Road Analysis Area

Subsidence Areas



N

Skyline Mine
2013 Wildlife Surveys

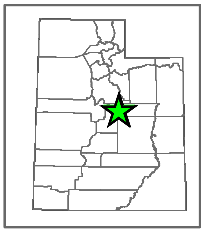
FIGURE 2
Power line, Access Roads, and Ventilation Shaft

DATE DRAWN
7/31/13

SCALE
0.25 0.125 0 0.25
Miles

Call Stations Export

Subsidence Areas



N

Skyline Mine
2013 Wildlife Surveys

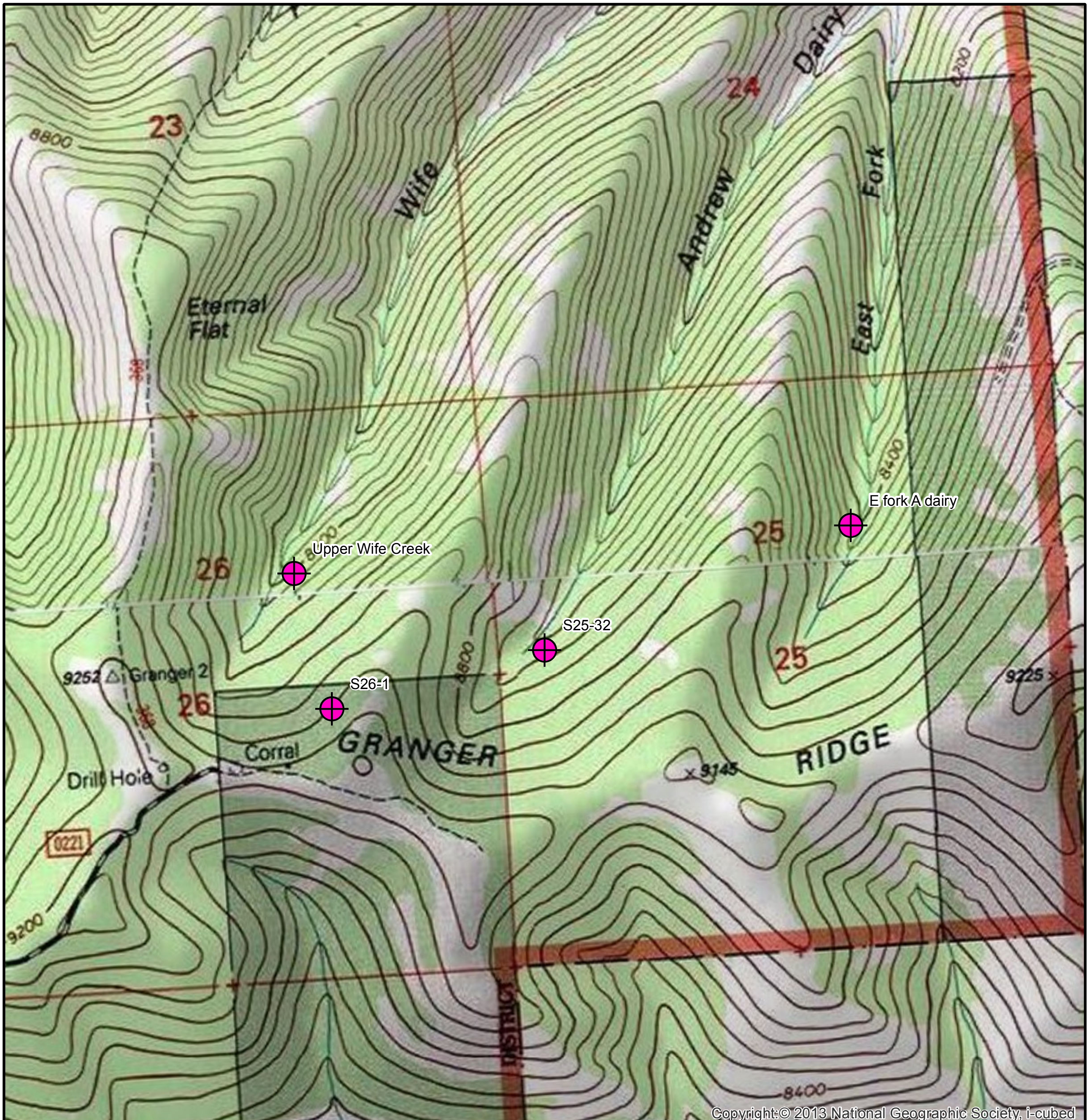
FIGURE 3
Potential Subsidence
Survey Area

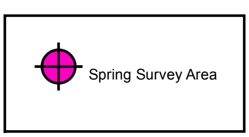
DATE DRAWN

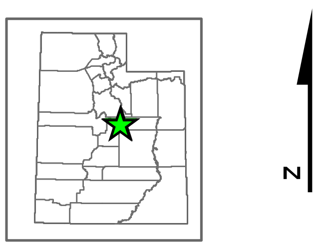
7/31/13

SCALE

0.15 0.075 0 0.15
Miles





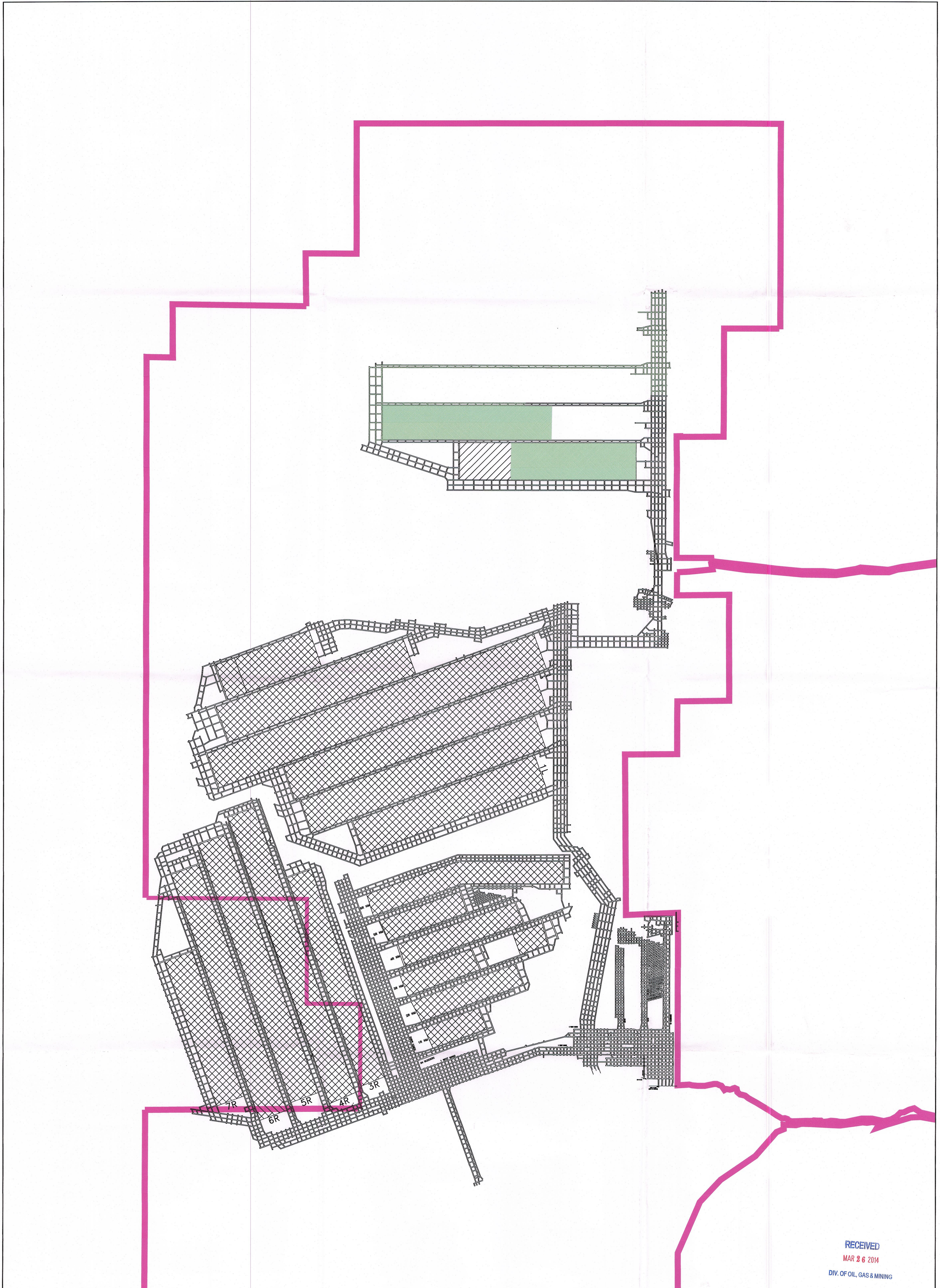


Skyline Mine
2013 Wildlife Surveys

FIGURE 4
Spring Survey Area

DATE DRAWN
7/31/13

SCALE
0.1 0.05 0 0.1 Miles



LEGEND

- Area Approved for Mining Activities
- 2013 As Mined (Longwall)
- 2013 As Mined (Development)

REGISTERED PROFESSIONAL ENGINEER
CARL W WINTERS
NO 22 157953-2202
STATE OF UTAH

1000' 0' 500' 1000'

Skyline Mine
Mine 3
As Mined 2013

Canyon Fuel Company, LLC
Skyline Mines

HCR 35 BOX380, HELPER, UT, 84526 435-448-2632	DATE: 03/21/14	CK.BY: GAG	REVISION: 0 03/21/14
CAD FILE: P:\permits\sky\reports\Annual	SCALE: 1"=1000'	DR.BY: GAG	
DWG. NO.: As Mined 2013			

LEGEND

- 1st QUARTER 2014
- 2nd QUARTER 2014
- 3rd QUARTER 2014
- 4th QUARTER 2014
- 2015
- 2016
- 2017
- 2018
- AS MINED

SEE PLATE 1.6-3 FOR PERMIT AND ADJACENT AREAS

NOTES:

1. COORDINATE BASE ON MINE GRID DATA.
2. MAP DIGITIZED FROM 1:24000 USGS QUADRANGLE MAPS, SCOFIELD, UTAH AND FAIRVIEW LAKES, UTAH.
3. MINE FACILITY, CONVEYOR, AND NEW ECCLES CANYON ROAD LOCATIONS FROM EXISTING RECORD DATA AND INCORPORATED TO MAP IN BEST FIT LOCATIONS.
4. UTM GRID TICK VALUES SHOWN ARE IN METERS.

BASE PREPARED BY INTERMOUNTAIN AERIAL SURVEYS, SALT LAKE CITY, UTAH – M96147

REGISTERED PROFESSIONAL ENGINEER
CARL W WINTERS
NO 22 157958-2202
STATE OF UTAH
3-21-14

0 500 1000 2000 Feet

RECEIVED
MAR 26 2014
DIV. OF OIL, GAS & MINING

Skyline Mine
Mine 3 – Level 3
Projected Mining 2014 – 2018

Canyon Fuel Company, LLC
Skyline Mines

HCR 35 BOX380, HELPER, UT, 84526 435-448-2632	DATE: 3/21/2014	CK.BY: GAG	REVISION: 0
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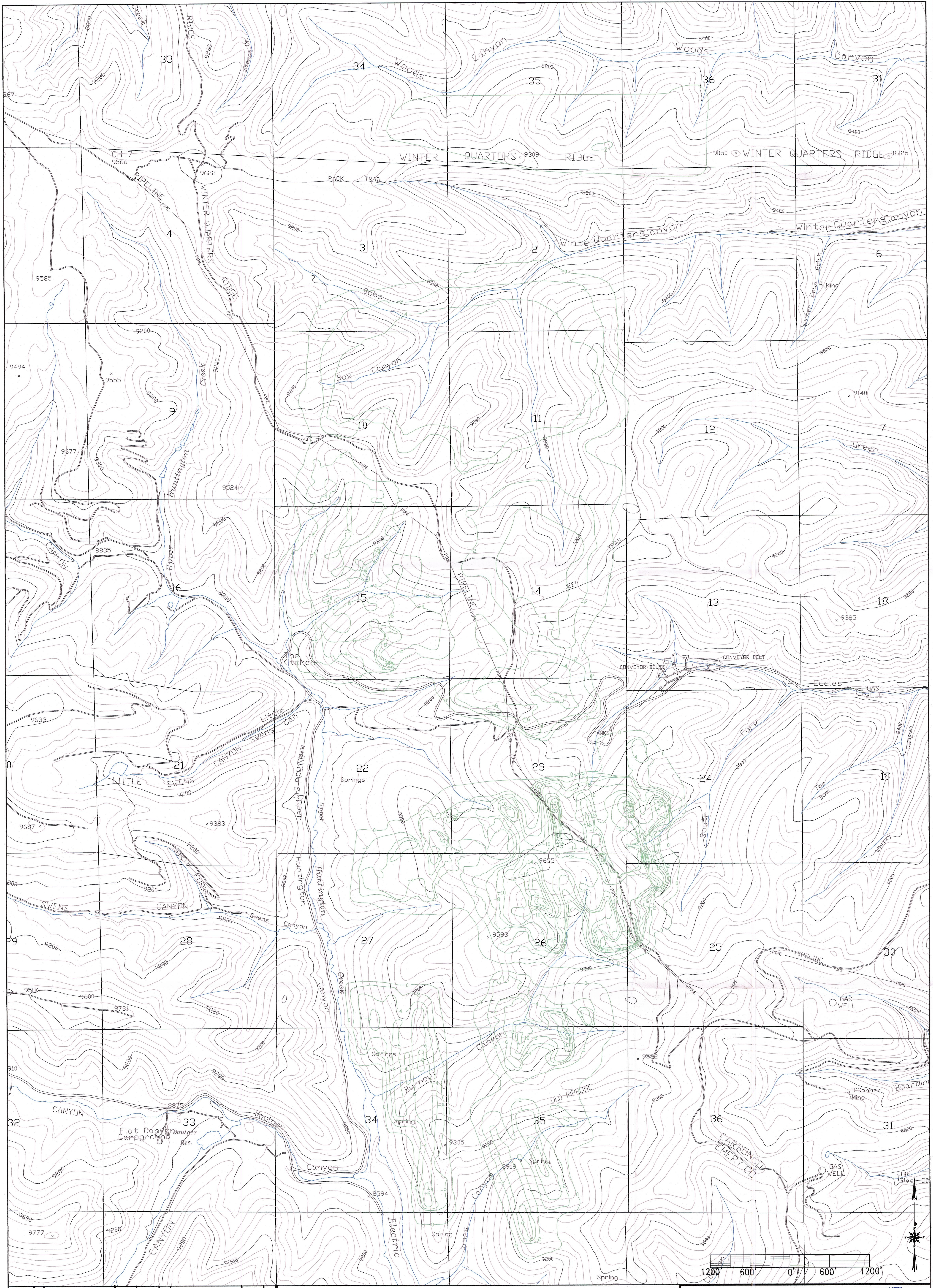

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MARCH 07	2	2006 SUBSIDENCE	GAG/GAG	MARCH 14	9	2013 SUBSIDENCE	JCA/GAG
JUNE 08	3	2007 SUBSIDENCE	KMC/GAG		10		/
MAY 09	4	2008 SUBSIDENCE	ARB/GAG		11		/
MARCH 10	5	2009 SUBSIDENCE	ARB/GAG		12		/
MARCH 11	6	2010 SUBSIDENCE	GAG/GAG		13		/
MARCH 12	7	2011 SUBSIDENCE	GAG/GAG				

–2 SUBSIDENCE CONTOUR

NOTES:
1. COORDINATE BASE ON MINE GRID DATA.
2. MAP DIGITIZED FROM 1:24000 USGS QUADRANGLE MAPS, SCOFIELD, UTAH AND FAIRVIEW LAKES, UTAH.
3. MINE FACILITY, CONVEYOR, AND NEW ECCLES CANYON ROAD LOCATIONS FROM EXISTING RECORD DATA AND INCORPORATED TO MAP IN BEST FIT LOCATIONS.
4. UTM GRID TICK VALUES SHOWN ARE IN METERS.
5. SUBSIDENCE SURVEY CONDUCTED IN SEPTEMBER 2003

BASE PREPARED BY INTERMOUNTAIN AERIAL SURVEYS, SALT LAKE CITY, UTAH – M96147

LICENSED PROFESSIONAL GEOLOGIST
GREGG GALECKI
5248584
3-21-14
STATE OF UTAH

Cumulative Subsidence 1982 – 2013

RECEIVED
MAR 26 2014
DIV. OF OIL, GAS & MINING

Canyon Fuel Company, LLC
Skyline Mines

HCR 35 BOX380, HELPER, UT, 84526
435-448-2632

DATE: 3/20/2014
CK.BY:GAG
REVISION: 9
3/20/2014

CAD FILE: P\...\Reports\2013 Sub...Working
SCALE: 1" = 1200'
DR.BY:JCA

DWG. NO.: Subsidence 2013 Final

C/007/0005
Received 7/21/2014
Task ID #4557
Annual Report

ESTIMATES OF THE FALL, 2013, CUTTHROAT TROUT POPULATION DENSITIES IN WINTER QUARTERS CANYON CREEK AND WOODS CANYON CREEK, TRIBUTARIES TO SCOFIELD RESERVOIR

CARBON COUNTY, UTAH

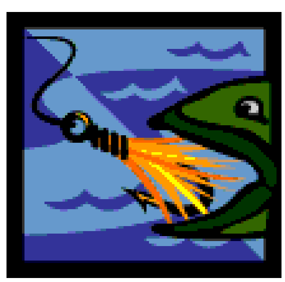

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TABLE OF CONTENTS

INTRODUCTION

The northward extension of Skyline Mine, of Eccles Canyon mine is now under both Winter Quarters Canyon and Woods Canyon. The invertebrate communities in both canyons have been monitored since 2002 (Shiozawa 2004) and fish populations were assessed in the upper reaches of both streams at that time (Shiozawa 2005). Young-of-the-year trout were found in the upper reaches of Winter Quarters Canyon on U. S. Forest Service lands but the majority of the Winter Quarters Canyon trout populations occurred downstream on private land. That population was not sampled. Trout were not detected in Woods Canyon. In 2009 Skyline Mine began installation of a ventilator shaft in lower Winter Quarters Canyon and in 2010 was mining under lower Woods Canyon. These activities had the potential to impact the lower reaches of the two streams so the trout population in Winter Quarters Canyon Creek was monitored in the vicinity of the ventilator shaft and lower Woods Canyon Creek was surveyed for the presence of cutthroat trout.

Monitoring began in the fall of 2010 at one station in Woods Canyon and two in Winter Quarters Canyon. All sections were 150 meters in length. In Winter Quarters Canyon Creek one station was above the new ventilation shaft pad and one just below the pad. In 2013 the second series of population sampling was completed.

METHODS

The upper-most Winter Quarters Canyon Creek station begins just above the ventilation shaft pad (Table 1: Above Pad - Winter Quarters Canyon Station). The lower station begins at the bridge crossing the stream below the pad (Table 1: Below Pad - Winter Quarters Canyon Station). The Woods Canyon site begins at a trail crossing approximately in the center of section 36, just above a side canyon entering from the south. All three sites were sampled in September of 2010 and September to October, 2013. All field equipment, including boots, holding pens, buckets, nets, and the electrofisher, were sterilized with a quaternary ammonium-based compound prior to entering each stream section and again immediately after leaving each stream section to prevent inadvertent transfer of invasive aquatic taxa either into or out of the streams.

Fish population estimates were based on removal-summation sampling (Moran 1951; Zippen 1956, 1958; Van Deventer and Platts 1985) applied to the designated sections of stream. The fish were captured with a Smith-Root Model 12 battery-powered backpack electrofisher. All fish captured on the first run were transferred to buckets and held in flow-through holding pens placed in large pools. The fish captured on the second run were held in buckets until the electrofishing crew reached an appropriate location for measuring and releasing the fish. Fish were released approximately 5 meters below the active electrofishing location to avoid recaptures. Processing of second run fish shortly after capture minimized stress on the fish. The holding pens were temporarily removed from the stream when the second electrofishing run was approximately 5 meters below the pen. Depending on the complexity of the location, either the fish in the pen were temporarily held out of the stream until the electrofisher was approximately 5 meters above the pen's original location, or the pen was moved downstream approximately 10 meters. On the second run, when an appropriate temporary stopping location was reached by the electrofishing crew, the first run fish in the adjacent holding pen were measured and released. Measurements consisted of total lengths.

Table 1. Sampling Stations on Eccles Creek

Station	GPS Coordinates Start Location	GPS Coordinates End Location
Below pad - Winter Quarters Canyon	N 39^{0} 43' 12.5" W 111^{0} 11' 57.9"	N 39^{0} 43' 12.5" W 111^{0} 12' 2.7"
Above pad Winter Quarters Canyon	N 39^{0} 43' 17.6" W 111^{0} 10' 57.8"	N 39^{0} 43' 54.48" W 111^{0} 10' 16.6"
Woods Canyon	N 39^{0} 44' 6.4" W 111^{0} 11' 58.5"	N 39^{0} 44' 5.9" W 111^{0} 12' 3.8"

RESULTS AND DISCUSSION

Both Winter Quarters Canyon and Woods Canyon creeks are relatively small and this resulted in high fish capture probabilities. All fish collected from both streams were cutthroat trout with no obvious signs of introgression with rainbow trout. However, it is likely that the trout are introgressed Colorado River cutthroat trout and Yellowstone cutthroat trout.

Trout have been in Winter Quarters Canyon throughout the period of benthic invertebrate monitoring. Adult trout can be found in low density into the lower part of the U. S. Forest Service lands. An occasional trout has been noted while sampling at the Lower Winter Quarters Invertebrate Monitoring Station (Shiozawa personal observations). Woods Canyon Creek did not have trout when surveyed in 2002 (Shiozawa 2005). At that time the conclusion was that the shallow stream had very little habitat suitable for overwintering trout. Yet in the fall 2010 electrofishing survey cutthroat trout were collected at low density, with a population estimate of eight fish (Table 2). The fish were similar in size to age 2+ trout in Winter Quarters Canyon. Thus it appears that the trout may have resulted from reproduction two years previous to the sampling survey. That suggests a downstream connection between Woods Canyon Creek and Mud Creek allowed spawning trout to enter the stream in 2008 (Shiozawa 2010), thus establishing the small population.

In 2013 densities in both Winter Quarters and Woods Canyon showed a significant decline from estimates made in 2010. No fish were collected in Woods Canyon in 2013. A single fish was seen, but it was in a deeply undercut bank and was not captured and thus could not be positively verified as a fish. It appeared to be small, which could indicate successful reproduction the previous year. Because that suspected fish was not captured, we were unable to make an estimate for the 2013 population in Woods Canyon. The absence or near absence of trout in Woods Canyon Creek in 2013 may be a result of fish not being able to survive summer drought or harsh winter conditions because of the shallow nature of the stream. Sustained populations of trout in Woods Canyon may require active connections with Mud Creek, and even then, Wood Canyon Creek would likely serve mostly as a nursery area for fluvial or adfluvial populations, with small fish out-migrating in the fall. Generally the stream appears to not be suitable for maintaining a closed fish populations over long time periods.

Table 2. Population estimates and confidence intervals for Winter Quarters Canyon and Woods Canyon creeks, September, 2010

Station	Year	Capture probability	Population Estimate	Lower 95% Confidence Interval	Upper 95% Confidence Interval
Below Pad - Winter Quarters Canyon	2010	0.820	51	50.0	54.7
	2013	0.800	12	9.6	14.3
Above Pad Winter Quarters Canyon	2010	0.914	64	62.3	65.6
	2013	0.728	19	14.3	23.7
Woods Canyon	2010	0.889	8	7.07	8.93
	2013	----	----	----	----

The populations in the two Winter Quarters Canyon stations were down considerably (Table 2). The 2013 population estimate for the Below Pad site was 12 fish in the 150 m reach while in 2010 the estimate was 51 fish. The Above Pad site had a population estimated to be 19 fish compared to an estimated 64 fish in 2010. These declines in numbers are also reflected in the density estimates (Table 3) for the fish. Overall the population in Winter Quarters Canyon Creek declines to between one third to one fourth of the 2010 densities.

The length frequencies for the Below Pad - Winter Quarters Canyon Station in 2013 (Figure 1) ranged from 12 to 15.5 cm in total length. This range is significantly more narrow than the 4.3 to 21 cm length range in 2010 (Shiozawa 2010). The trout collected in 2013 were in the size range of the 2+ fish in 2010. None of the 2013 trout were young-of-the-year (age 0+) nor age 1+. Older age classes were also absent. Some fish in this age class could possibly reproduce in

2014 (age class 3+), although in high elevation populations, constrained by short growing seasons, reproduction may be delayed even longer (Belk et al 2009).

Table 3. Densities per linear meter for Winter Quarters Canyon and Woods Canyon creeks, September 2010.

Station	Density per Linear Meter of Stream	
	2010	2013
Below pad - Winter Quarters Canyon	0.34	0.08
Above pad Winter Quarters Canyon	0.427	0.127
Woods Canyon	0.053	----

The Above Pad - Winter Quarters Canyon Station fish ranged in length from 7.0 to 19.5 cm (Figure 2). Only one age 0+ trout was present in the Above Pad - Winter Quarters Canyon Station, indicating either low reproduction or low fry survival in this section. Assuming age 2+ fish in Winter Quarters Canyon are between 12.5 and 16 cm in length, a few fish collected were probably age 3+ or older.

The changes in fish density and population estimates from 2010 to 2013 could be attributed to a number of factors. Weather could play a significant role, since both severe winters and prolonged below normal annual precipitation has impacted the area. Winter Quarters Canyon has higher discharge than Woods Canyon so either of these two factors would have less impact in Winter Quarters Canyon than they would have in Woods Canyon. Likewise both the Above and Below pad stations showed similar declines although the Below Pad station had only one narrow trout size range present.

Fishing may also play a role. Typically fishermen remove larger fish, leaving smaller ones to grow. However this selective harvest, especially in small populations, can readily eliminate the reproductive age classes, and without those, recruitment into the population can fail. The landowners do fish Winter Quarters Canyon Creek, but it is less likely that they fish in Woods Canyon. If fishing pressure was the primary cause one would expect Woods Canyon Creek to have maintained a measurable population at the study site.

Finally the mine ventilation shaft may have impacted the stream. In that case one would expect the Woods Canyon population to have persisted and the Below Pad site to have lost most of its fish. The Below Pad site did lose most of its fish, showing about a 75% decline, more than seen in the Above Pad station, which lost about 70% of its fish. However as noted above the Woods

Canyon population also disappeared. In addition, trout were present in the stream several hundred meters below the Ventilation pad, and the land owners did not notice any decline in the trout in that area.

At this time it appears that the main factor impacting the fish population is associated with changes in weather conditions, but one cannot rule out the potential impact of fishing mortality, nor of siltation in the Below Pad station. The downstream reaches of Winter Quarters Canyon Creek, below the study stations, flows more slowly, has deeper pools, and more woody vegetative cover in the riparian. It also has a more sandy-silt substrate. Yet it had what appeared to have a higher density of fish than either of the study reaches. The study reaches were selected because of their similarity to each other, not for similarity with the this downstream reach because habitat similar to the downstream reach is uncommon upstream of the pad site.

Figure 1. Length Distribution of Cutthroat Trout in the Below Pad Station on Winter Quarters Canyon Creek, 2013

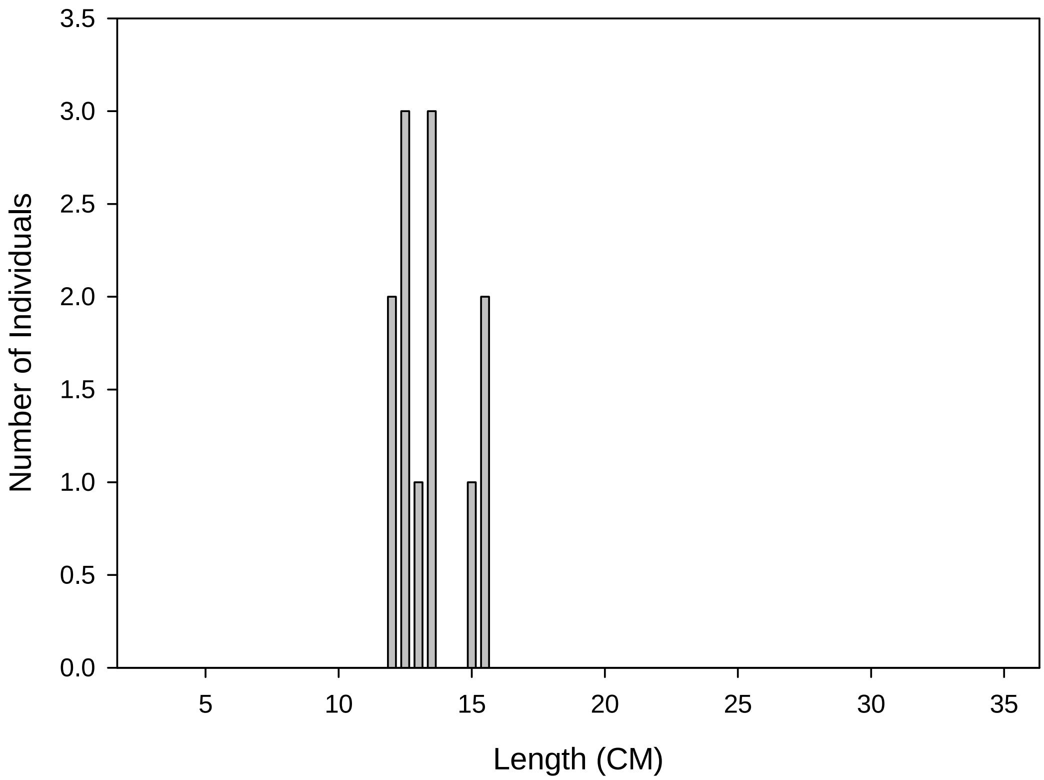
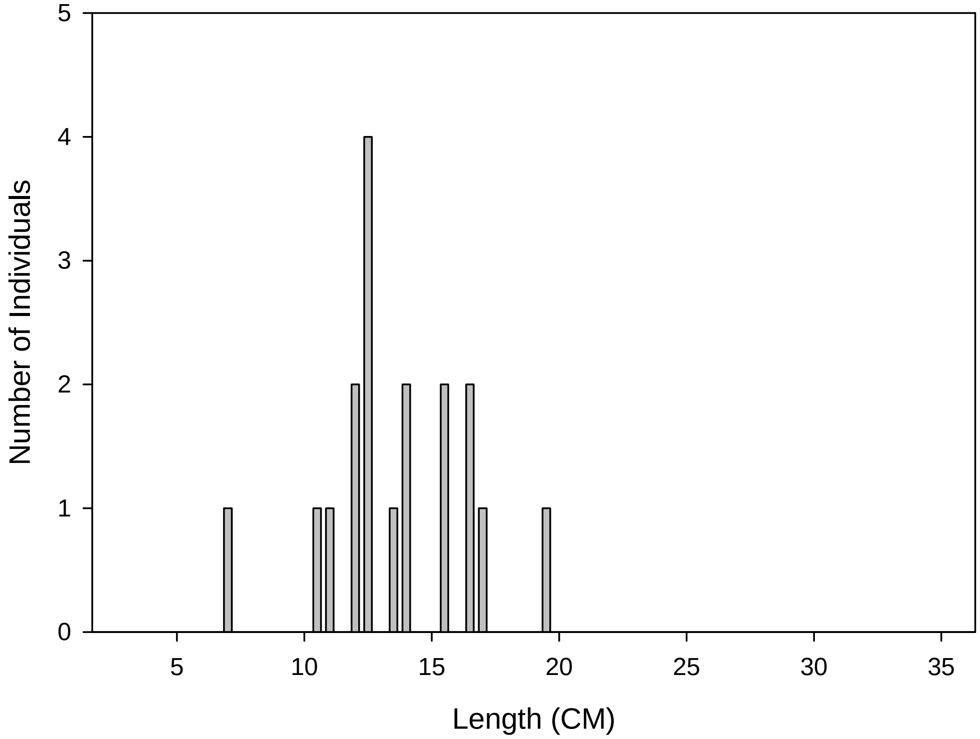


Figure 2. Length Distribution of Cutthroat Trout in the Above Pad Station in Winter Quarters Canyon Creek, 2013



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ESTIMATES OF THE FALL, 2013, CUTTHROAT TROUT POPULATION DENSITIES IN ECCLES CREEK, TRIBUTARY TO SCOFIELD RESERVOIR

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TABLE OF CONTENTS

INTRODUCTION

In the late summer and fall of 2001, water entering Skyline Mine of Canyon Fuel Company was allowed to discharge water from an underground aquifer into Eccles Creek to prevent mine flooding. At that time, a series of studies was initiated to assess the impact of the increased flows on the biota of Eccles Creek. Most of the assessment focused on the invertebrate communities of the stream, but electrofishing surveys were included to evaluate the response of fish to the flows. In the initial qualitative sampling survey in 2001, no fish were collected. However by 2004, fish had been seen in the stream, and fish survey stations were established at each of the three benthos sampling stations in Eccles Creek In addition a very small side stream, the South Fork of Eccles Creek was sampled. This side stream is too small to hold large trout but may serve as a nursery/refuge for young of the year fish. This report compares the fish densities and species composition in the three reaches in October, 2013, with that recorded in October, 2004, October, 2007, and October, 2010.

METHODS

On October 5, 2004, three 100 meter sample stations were established at each of three sections of Eccles Creek (Table 1). A fourth station was established in the South Fork of Eccles Creek. The sites were initially marked with flagging to allow easy site location when the population estimates were conducted. The first series of population estimates were conducted in October, 2004. In 2007, samples were completed in late September and early October, in 2010 and 2013 sampling was completed in October.

Table 1. Sampling Stations on Eccles Creek

Station	GPS Coordinates Start Location	GPS Coordinates End Location
Lower Eccles Creek	N 39^0 41' 0.87" W 111^0 9' 57.47"	N 39^0 41' 0.06" W 111^0 10' 1.86"
Middle Eccles Creek (above Whisky Canyon)	N 39^0 40' 55.54" W 111^0 10' 40.11"	N 39^0 40' 54.48" W 111^0 10' 44.82"
Upper Eccles Creek	N 39^0 40' 58.20" W 111^0 11' 34.74"	N 39^0 40' 55.79" W 111^0 11' 27.39"
South Fork Eccles Creek	N 39^0 40' 55.79" W 111^0 11' 27.39"	N 39^0 40' 53.06" W 111^0 11' 30.90"

Fish population estimates were based on removal summation sampling (Moran 1951; Zippen 1956, 1958; Van Deventer and Platts 1985) applied to the measured sections of stream.

The fish were captured with a Smith-Root Model 12 battery-powered backpack electrofisher. All captured fish were transferred to buckets and were held in flow-through holding pens until two electrofishing passes had been completed. Fish were then identified and counted.

Fish from each station were also measured so that length frequency could be examined. The length frequency of the trout collected allowed separation of fish into size classes, but accurate age estimation would require scale or otolith examination. It is likely that the largest fish collected in this survey were age 2+ or 3+ age classes (in October a 2+ fish will be approximately 2 years and six months in age). The high elevation of the site suggests that the larger fish are 3+ to 4+ or older, but the increased stream temperature resulting from the mine discharge could confound the elevation effect by favoring more rapid annual growth because of an extended growing season.

RESULTS AND DISCUSSION

The trout collected in 2013 were not separated in to rainbow, hybrids, and cutthroat trout. By this sampling period the fish appeared to be well introgressed and showed a dominance of cutthroat trout characteristics. The population density was highest in the downstream-most station and was about double that found in both the Middle Eccles and Upper Eccles station. One tiger trout was collected in the Middle Eccles station, likely gaining access to the stream from Scofield Reservoir. The 2013 sampling resulted in high density estimates of trout relatively narrow confidence ranges (Table 2) indicating that the estimates made in the three sections were relatively accurate. The lower Eccles Creek station had a total population estimate of 232 fish in 2013 (Table 2). The middle Eccles station had an estimated 102 fish in 100 meters and the Upper Eccles station had an estimated 92 trout. Three young of the year trout were collected in the South Fork of Eccles Creek.

Table 2. Population estimates and confidence intervals for Eccles Creek, October, 2013

Station	Population Estimate	Lower 95% Confidence Interval	Upper 95% Confidence Interval	Density per Linear Meter of Stream
Lower Eccles Creek	232	181	283	2.32
Middle Eccles Creek	102	84	120	1.02
Upper Eccles Creek	92	67	117	0.71
South Fork Eccles Creek	3	0	3	0.03
Total Estimate (400 m of stream)	429	332	523	1.02

The trout population density in 2013 was the highest recorded in Eccles Creek over the four sampling periods since 2004 (Table 3) with an average of 4.29 fish per linear meter of stream. The previous high count occurred in 2007 where the Lower Eccles station had a density estimate of 109 fish. In 2010 the density had fallen to 64 fish but in 2014 it increased to 232 fish, over 2-fold greater than 2010 and 3.6-fold higher than in 2010. The Middle Eccles site in 2013 had a 3.2 greater density than in 2007, and was double that recorded in 2010. The upper Eccles station in 2013 was about 30% higher than the 2007 density estimate and 2.7 times higher than the 2010 estimate.

These density estimates appear to have reversed a trend that was developing in 2010. At that time it appeared that the calcareous marl formation in the stream was beginning to significantly reduce in-stream spawning habitat and cover. Thus the physical system was reducing recruitment within the stream. However, in 2013, it appears that successful reproduction within the stream channel increased. The cause of this change is not clearly known. However during the electrofishing it was observed that the encased woody debris was in an advanced state of decay. In several cases encased logs and debris piles collapsed under the weight of the sampling crew. This made the sampling somewhat dangerous since what appeared to sure footing could collapse when stepped on or climbed upon. However such conditions also released marl particles, pea gravel in size. These could accumulate to provide spawning habitat. Likewise the breakup of the marl provided more refugia for small trout.

This condition is unlikely to be at an equilibrium state. The broken marl surface may be cemented together or flushed from the stream bed over time, but in 2013 it is clear that the trout population was doing very well in the stream. If the decomposition of woody debris is indeed the primary factor driving this change, it is likely that the trout population will benefit for a number of years into the future.

Table 3. Comparison of population estimates and densities for Eccles Creek, October, 2004, and October, 2007.

Station	Population Estimate				Density per Linear Meter of Stream			
	2004	2007	2010	2013	2004	2007	2010	2013
Lower Eccles Cr.	90	109	64	232	0.90	1.09	0.64	2.32
Middle Eccles Cr.	93	32	48	102	0.93	0.32	0.48	1.02
Upper Eccles Cr.	15	71	34	92	0.15	0.71	0.34	0.92
So. Fk. Eccles Cr.	1	0	0	3	0.01	0.00	0.00	0.03
Total (400 m of stream)	198	212	146	429	0.50	0.53	0.36	1.07

The South Fork of Eccles Creek only contained young of the year fish since it is too small to support larger trout. The size structure of the trout populations in the mainstem of Eccles Creek appears to have a good assortment of age classes present. Histograms of length frequencies (Figures 1-3) suggest that reasonable recruitment and survival is present in all three Eccles Creek stations. Comparisons of young of the year (YOY) trout from the Eccles Creek stations with those of locations with similar elevations indicates that the Eccles Creek trout grow more rapidly. The Eccles Creek stations are between 2520 to 2560 meters in elevation. The Eccles Creek YOY fish have modal standard lengths of 8 to 10 cm after approximately six to seven months of growth (Figures 1-4). Yet back-calculated standard lengths of cutthroat trout in the North Slope of the Uinta Mountains of Northeastern Utah (2475 to 3200 meters elevation) show a mean standard length of less than six cm at annulus formation (age class 1, approximately 12 months of age; Belk et al 2009). Yellowstone cutthroat trout in the Greybull River system of Wyoming (2300 to 3200 meters elevation) have age 1 fish estimated at less than 8 cm in standard length (Kruse et al. 1997). YOY cutthroat trout in Winter Quarters Creek ranged from three to seven cm in standard length in October of 2010 (Shiozawa 2010). Thus the trout in Eccles are under an accelerated growth rate. This is likely due to the elevated stream temperature from the mine groundwater. Based on the length frequency histograms, Age class 1+, in October of 2013 are about 17 cm in total length. Age class 2+ trout are about 24 to 25 cm in total length, and age class 3+ fish are about 27 to 30 cm in total length.

The length frequencies for the 2004 collection (Shiozawa 2010) covered a range from 5 cm to 29 cm with dominance of small trout, age 0+. Lower numbers of larger size classes suggested an additional 2 or more cohorts. The size structure profile of the Middle Eccles Creek population indicated high reproduction and a rapid expansion of this population. The weakest size structure profile was in the Upper Eccles station where low numbers of all size classes occurred.

In 2007 the Middle Eccles Creek station had a significant drop in the proportion of small trout in the population as well as a significant reduction in the density of fish. Approximately half of the fish were YOY, and the others were over 20 cm in length. This skewing of the size distribution may be an artifact of the low frequency of fish at this station. Only one fish appeared to be a hybrid, and no rainbow trout were collected at this station. The Upper Eccles station had a length frequency distribution that was more similar to the 2004 Middle Eccles station. While several rainbow trout were collected, they were small and likely immature. No evidence of F1 hybrids was detected. Despite the decline in fish in the Middle Eccles station, the overall size structure of the stations in 2007 suggested that the stream trout population was robust, possibly in better condition than in 2004.

In 2010 both the Lower and the Upper Eccles Creek stations had shown significant declines in numbers of trout. This was thought to be related to a gradual shift in habitat conditions as the calcareous marl precipitation worked its way downstream. This would progressively eliminate spawning habitat as well as cover for both invertebrates and small fish. At this point it appeared that the population in the stream could continue in decline, potentially having very little successful reproduction and thus relying on recruitment from surrounding downstream drainages.

The 2013 electrofishing surveys indicate a significant reversal of the trends observed in 2010. The fish populations were the most robust recorded in the stream system since the surveys began. All stations had YOY fish present and they made up from 40% to 62% of the fish population. Densities were the highest recorded at all stations over the study period. As noted earlier, this change appears to be due to the increased decomposition of the marl encrusted wood which has allowed for more spawning habitat in the stream. At this point in time the cutthroat trout population appears to be healthy. Of course this system is obviously very dynamic and the community has not yet reached an equilibrium.

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Figure 1. Length Frequency, Lower Eccles Creek, 2013.

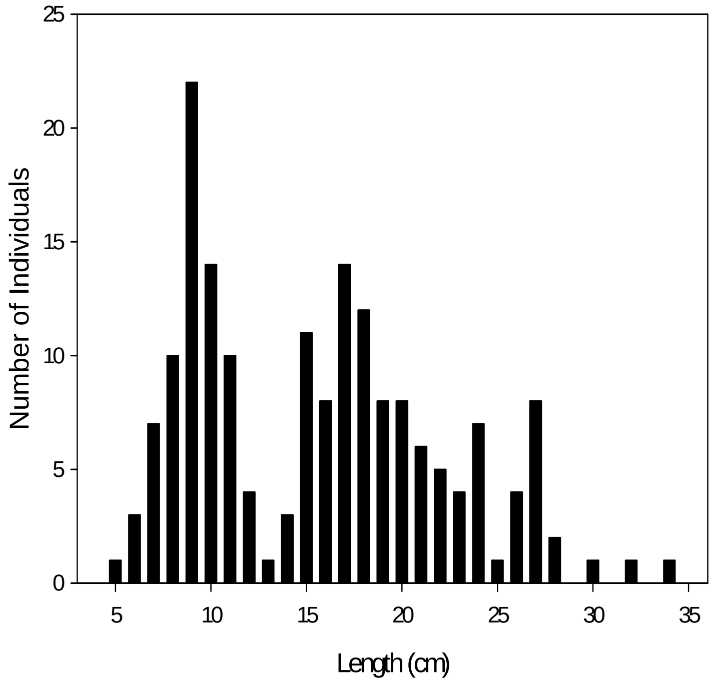


Figure 2. Length Frequency, Middle Eccles Creek, 2013.

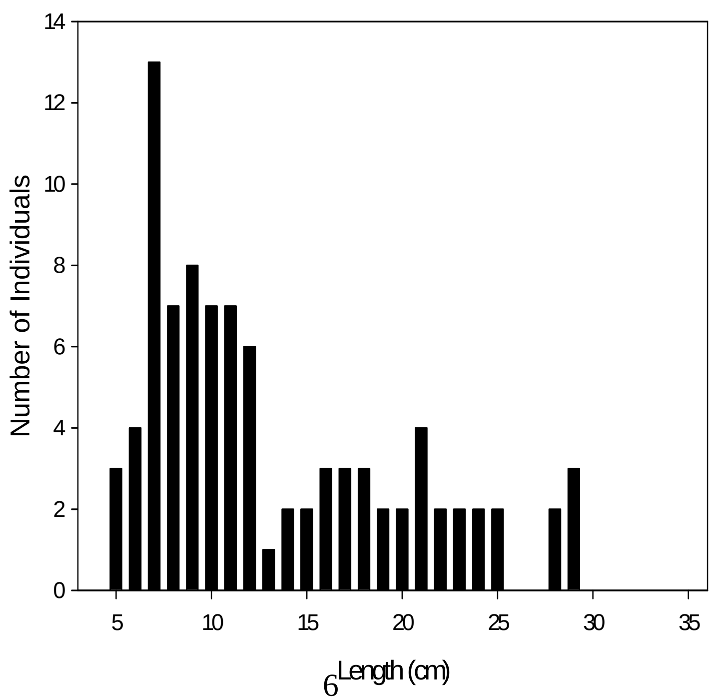


Figure 3. Length Frequency, Upper Eccles Creek, 2013

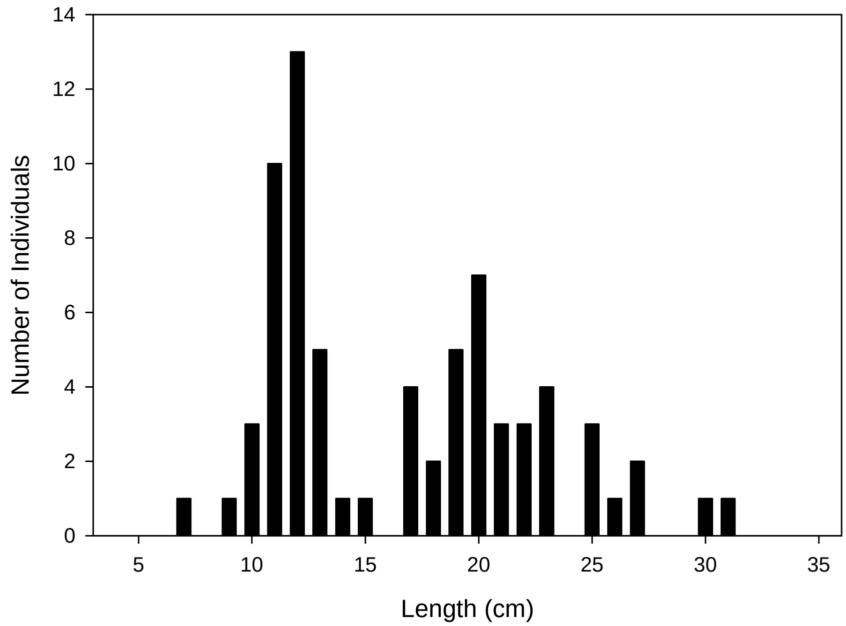
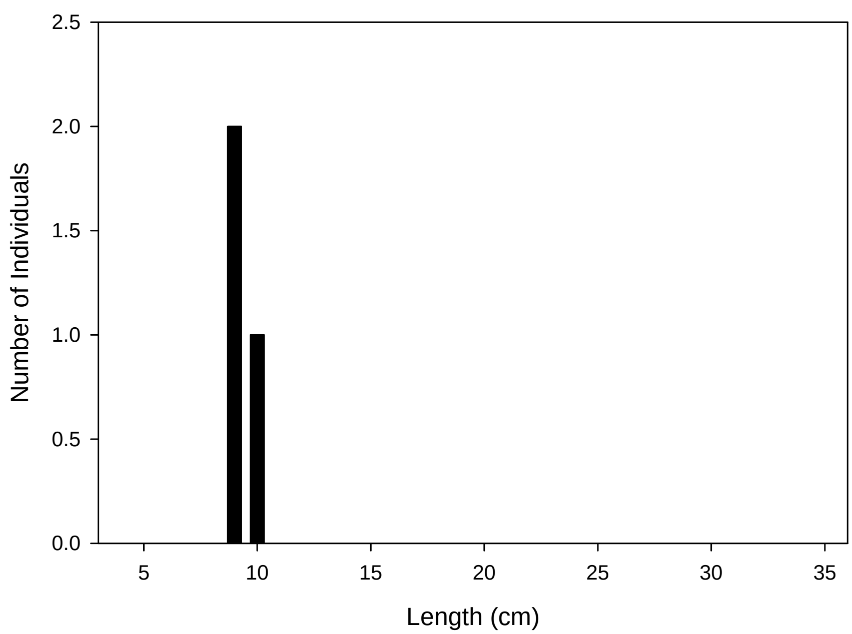


Figure 4. Length Frequency, South Fork Eccles Creek, 2013



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