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Aquatic Macroinvertebrate and Physical Habitat Monitoring for Coyote Gulch and the Escalante River in Glen Canyon National Recreation Area

2011 Summary Report

Natural Resource Data Series NPS/SCPN/NRDS—2012/417

ON THE COVER
Glen Canyon National Recreation Area
Photograph courtesy of SCPN

Errata

Page number, and metric or text containing the error	Error	Correction
9 (Table 2)		
Reach level values for spring 2011:		
Discharge	0.1	1.9
Reach level values for fall 2011:		
Specific conductivity	86	285
Discharge	0.1	1.9
8 (Section 3.3)		
These two sentences reference the Table 2 values that were in error.	Specific conductivity was 297 µS/cm in the spring and 86 µS/cm in the fall.	Specific conductivity was 297 µS/cm in the spring and 285 µS/cm in the fall.
	In addition to these water quality parameters, we also measured stream discharge, and found it to be 0.1 cfs during both sampling periods in 2011.	In addition to these water quality parameters, we also measured stream discharge, and found it to be 1.9 cfs during both sampling periods in 2011.

Aquatic Macroinvertebrate and Physical Habitat Monitoring for Coyote Gulch and the Escalante River in Glen Canyon National Recreation Area

2011 Summary Report

Natural Resource Data Series NPS/SCPN/NRDS—2012/417

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December 2012

U.S. Department of the Interior
National Park Service
Natural Resource Stewardship and Science
Fort Collins, Colorado

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Funding for the SCPN water resources field crew was provided to Northern Arizona University by the National Park Service through Colorado Plateau CESU Agreement H1200090005 (Task NAU-365). Funding for aquatic macroinvertebrate identification and enumeration was provided by the National Park Service to Utah State University through Colorado Plateau CESU Agreement H1200090005 (Task USUCP-51).

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This report is available from the Southern Colorado Plateau Network website (http://science.nature.nps.gov/im/units/scpn/) and the Natural Resource Publications Management website (http://www.nature.nps.gov/publications/nrpm/).

The corresponding author and project manager for this project is Stephen Monroe (stephen_monroe@nps.gov). Stacy Stumpf is the water resources lead technician for the project. The 2011 field crew consisted of Kelly Lawrence, Clay Bliss, Tim Sullivan and Jesse Mike. SCPN staff provided support for the project.

Please cite this publication as:

Stumpf, S. E., and S. A. Monroe. 2012. Aquatic macroinvertebrate and physical habitat monitoring for Coyote Gulch and the Escalante River in Glen Canyon National Recreation Area: 2011 summary report. Natural Resource Data Series NPS/SCPN/NRDS—2012/417. National Park Service, Fort Collins, Colorado.

NPS 608/119290, December 2012

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1 Introduction and background

The National Park Service Inventory and Monitoring Program was designed to determine the current status and monitor long-term trends in the condition of park natural resources, providing park managers with a scientific foundation for making decisions and working with other agencies and the public to protect park ecosystems. Hydrologic vital signs are the fundamental components defining overall riparian and aquatic ecosystem integrity. The Southern Colorado Plateau Network (SCPN) has identified 7 vital signs pertaining to riparian and spring ecosystems, the first 2 of which we focus on in this report: 1) aquatic macroinvertebrates, 2) stream water quality, 3) stream flow and depth to groundwater, 4) spring water quality, 5) channel morphology, 6) riparian vegetation, composition, and structure, and 7) spring, seep and tinaja ecosystems. These vital signs are closely related and are all included in the *Vital Signs Monitoring Plan for the Southern Colorado Plateau Network* (Thomas et al. 2006). The context and ecological significance of these vital signs are further explained in Scott et al. (2005).

Few data exist describing the aquatic ecology of streams in Glen Canyon National Recreation Area (GLCA). In the past, aquatic macroinvertebrates have been sampled from the Escalante River and its tributaries by Vinson (2000, 2001, and 2002), Mueller (1999), and sporadically by others. Coyote Gulch was sampled in 2005 and 2006 to develop and test the *Aquatic Macroinvertebrate Monitoring Protocol for the Southern Colorado Plateau Network* (Brasher et al. 2011). The 2 sites we ultimately selected for monitoring met the following criteria:

- presence of riffle habitats
- feasibility of effectively using sampling equipment throughout the reach
- absence of artificial structures
- lack of spring or tributary flows
- potential impact from high visitor use

In 2008 SCPN implemented annual monitoring of aquatic macroinvertebrates and physical habitat at one site on Coyote Gulch in GLCA (Stumpf and Monroe 2010):

> *Coyote Gulch above Crack-in-the-Wall Trail* (GLCACOY01) is identified within this report as COY01 (see appendix A for site code, name, and location information). The site is located approximately 1.6 km upstream from the confluence of the Escalante River and just above Lake Powell's full pool elevation (fig. 1). Keeping the site above Lake Powell's full pool elevation ensured that it wouldn't ever become inundated with lake water. The channel substrate at the site is primarily fine sediment and bedrock, and the stream flows through a sparse narrowleaf cottonwood (*Populus angustifolia*) and coyote willow (*Salix exigua*) woodland.

The Coyote Gulch watershed is managed by NPS for recreational use within GLCA boundaries. The upper portion of the Coyote Gulch watershed is located within the 769,000 ha (1.9 million acre) Grand Staircase-Escalante National Monument and is managed for multiple uses by the Bureau of Land Management. Coyote Gulch is the largest perennial tributary of the Escalante River, which flows into man-made Lake Powell. In the past, fluctuating water levels in the lake would result in periodic inundation of the Escalante River's confluence with Coyote Gulch. Because Coyote Gulch is an extremely popular hiking destination, park resource managers are concerned about the effects high visitation may have on water quality and the aquatic health of the stream.

In October 2006, late season thunderstorms caused several large flash flood events in Coyote Gulch, depositing large quantities of fine sediments in the lower sections of the stream, and obliterating all riffle habitat at our monitoring site. Because of the loss of riffle habitat, we did not collect quantitative samples in 2011. If after 5 years the sample site has not recovered and riffle habitat is still not available, then SCPN may establish a new sample site elsewhere on Coyote Gulch (Brasher et al. 2011).

In 2010 SCPN implemented annual monitoring of aquatic macroinvertebrates and physical habitat at one site on the Escalante River in GLCA (Stumpf and Monroe 2012):

> *Escalante River below Steven's Canyon* (GLCAESC01), identified in this report as ESC01 (see appendix A for site code, name, and location), is located less than 0.5 km downstream from the confluence of Steven's Canyon and the Escalante River, and just above Lake Powell's full pool elevation (fig. 1). The channel substrate is primarily fine sediments and flows through a willow (*Salix* sp.) and tamarisk (*Tamarix* sp.) shrubland.

We were not able to collect data from the Escalante River site (ESC01) in 2011 because of large storms. The protocol explicitly prohibits sampling streams during or immediately following flood events, and elevated stream flow prevented our crew from reaching the monitoring site safely.

The purpose of this report is to (a) document SCPN aquatic macroinvertebrate monitoring activities that occurred at Coyote Gulch in GLCA in 2011, (b) summarize the data collected, and (c) where appropriate, place the data in the context of current environmental conditions.

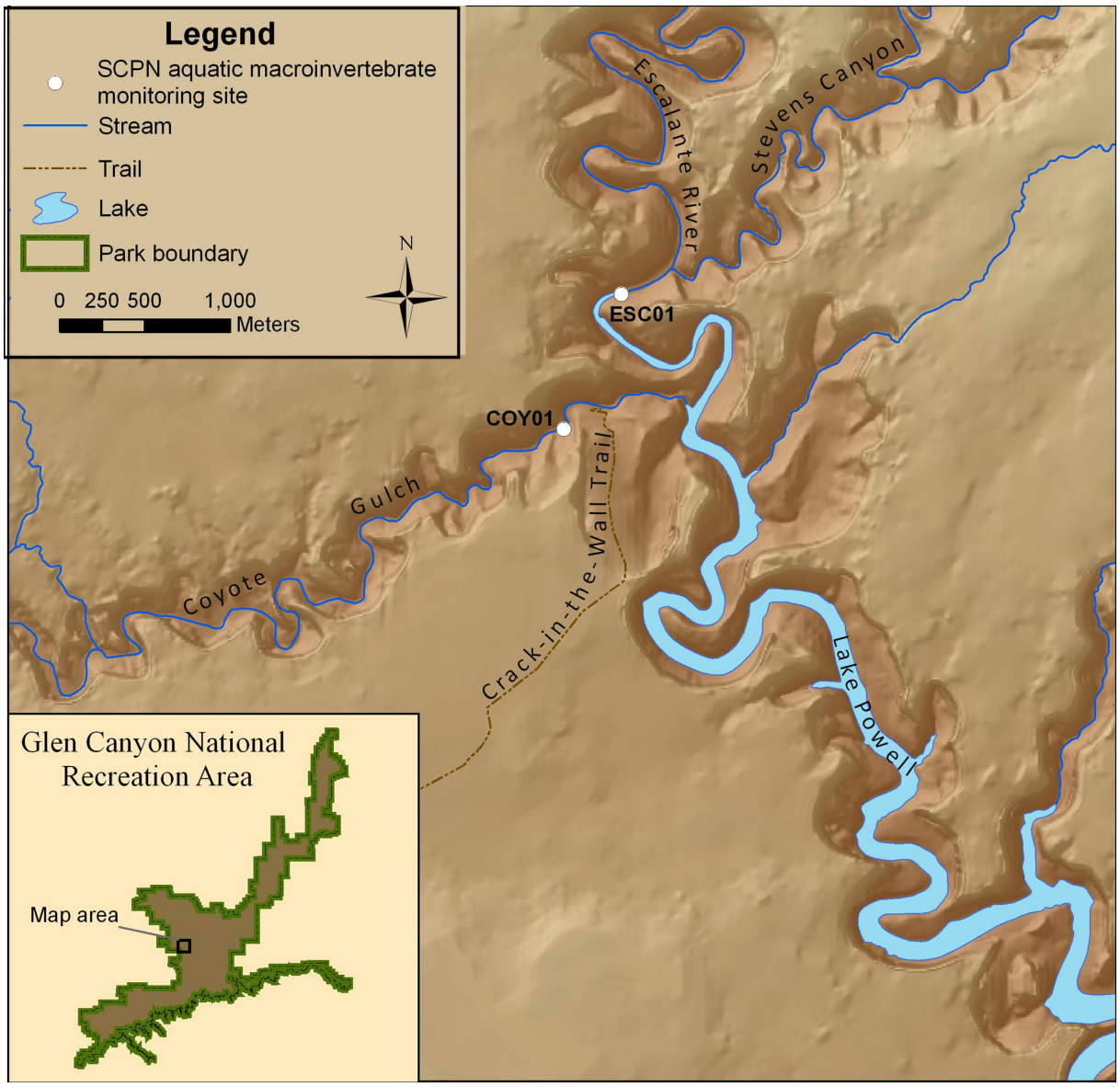


Figure 1. Location of the COY01 and ESC01 monitoring sites at Coyote Gulch and the Escalante River in Glen Canyon National Recreation Area, Arizona, 2011

2 Methods

2.1 Field methods

The state of Utah recommends collecting aquatic macroinvertebrate samples from perennial streams during September to October (Utah Department of Environmental Quality, Division of Water Quality 2006), however, in Arizona the state recommends collecting aquatic macroinvertebrate samples from warm water perennial sites (below 1,500 m elevation) during April to May (Arizona Department of Environmental Quality, Water Quality Division 2006). Based on results of a previous pilot study, and because Coyote Gulch is close to the Arizona-Utah state line, SCPN decided to collect samples during both spring and fall months. Aquatic macroinvertebrate samples were collected from COY01 on 09 June 2011 and 28 October 2011. As mentioned in the Introduction section above, large storms and elevated stream flow prevented us from reaching the ESC01 monitoring site safely in 2011, so no data were collected from the site this year.

All data were collected within one 150 m reach divided into 11 transects and spaced 15 meters apart (see fig. 2 for reach layout diagram). A brief description of field methods is provided here, and a detailed description of sampling methods can be found in Brasher et al. (2011).

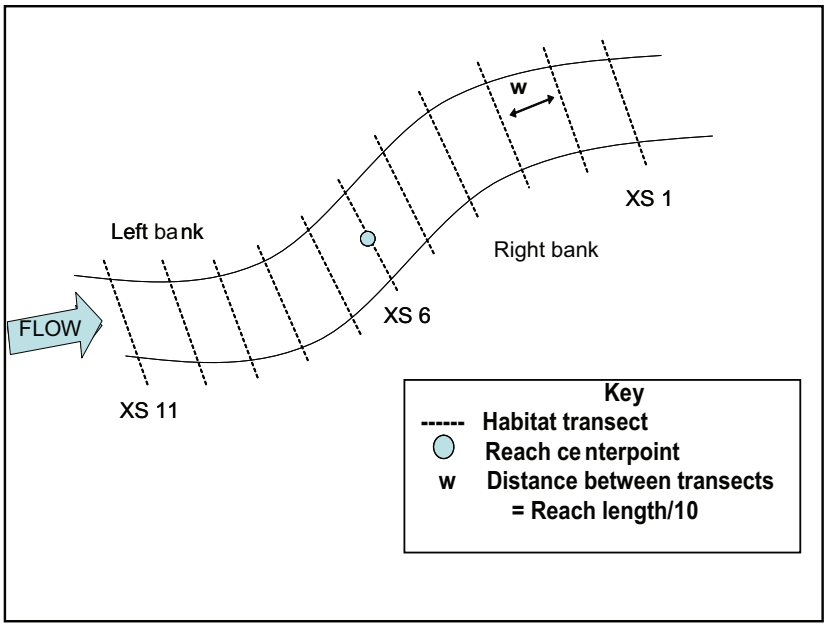


Figure 2. General aquatic macroinvertebrate sampling reach layout

To develop a comprehensive list of aquatic macroinvertebrate species present in the site, a qualitative sample was collected from COY01. We used a Slack sampler to collect samples from all habitat types within the monitoring site and compiled them into one composite sample. A list of existing habitat types from which qualitative samples were collected can be found in section 3.2 of this report. Due to absence of riffle habitat, we did not collect quantitative samples of aquatic macroinvertebrates at COY01 during site visits in 2011.

We collected physical habitat data at 2 spatial scales—transect, and reach:

- For each of the 11 transects, we
  - measured wetted and active channel widths
  - measured water depth, velocity, canopy closure at 5 equally spaced points along each transect
  - observed and recorded the presence or absence, and types of aquatic macroinvertebrate habitats, represented by point data (5 points/transect) across the entire site
  - measured geomorphic channel units (GCU) at 5 equally spaced points along each transect

- For the entire reach, we
  - identified and measured the length of GCUs (reach characterization data represents the proportion of the reach representing that particular GCU)
  - identified the dominant vegetation and land cover
  - recorded descriptions of flow conditions
  - recorded weather conditions
  - observed and recorded evidence of anthropogenic or natural disturbances
  - measured NPS core water quality parameters of temperature, specific conductivity, pH, dissolved oxygen, turbidity, and stream discharge
  - conducted a zig-zag pebble count measuring the size of a minimum of 400 randomly-selected particles using a modified Wolman pebble count across the length of the entire site (this reach-based method differs from transect-based methods conducted in 2007–2008)

2.2 Laboratory methods

Aquatic macroinvertebrate samples were sent to the National Aquatic Monitoring Center's Bug Lab, a Bureau of Land Management laboratory at Utah State University in Logan, Utah. Samples were sorted under a 10X dissecting scope, and a 500-organism, fixed-count method was used for sub-sampling large samples. Ten percent of the sorted samples were re-sorted for quality assurance.

A taxonomist, certified by the North American Benthological Society, identified all aquatic macroinvertebrates to the family or genus level. To ensure data quality, 10 percent of the identified samples were re-identified by a second certified taxonomist.

Quantitative and qualitative aquatic macroinvertebrate samples will be maintained by the contract aquatic laboratory for at least 5 years to allow for repeat subsampling should any data questions arise. For a more detailed description of laboratory methods see Brasher et al. (2011).

2.3 Data analysis

In this report we summarize aquatic macroinvertebrate data in terms of community structure and function. Genera were classified into functional feeding guilds using the classifications presented in Barbour et al. (1999). If functional class information was not available for a particular genus, we applied a more generalized, family-level classification.

We selected aquatic macroinvertebrate metrics that are generally considered to be sensitive, reliable indicators of water quality and/or stream health (see appendix B for a list of metrics and their definitions). Most of these metrics have been used to detect changes in water quality and habitat conditions in other streams in the Southern Rocky Mountains ecoregion (Griffith et al. 2005). Also, they enable a comprehensive assessment of multiple aspects of community structure because they represent a range of ecological characteristics. SCPN will periodically evaluate the interpretive value of the listed metrics and may drop or add additional metrics based upon these evaluations.

3 Results

3.1 Aquatic macroinvertebrate community data for Coyote Gulch

Data describing aquatic macroinvertebrate communities from samples collected during the spring and fall of 2011 from COY01 at Coyote Gulch in GLCA are presented below. Key metrics for samples collected during 2008 to 2011 are presented in Table 1. Appendix C lists all aquatic macroinvertebrate species detected at the site.

Table 1. Qualitative metrics for aquatic macroinvertebrate samples collected from COY01 at Coyote Gulch in Glen Canyon National Recreation Area, Utah, 2008–2011. Richness-based metrics are expressed as the percentage of taxa in a given order, tolerance or functional feeding group.

	2008		2009		2010		2011	
Qualitative metric	**Spring**	**Fall**	**Spring**	**Fall**	**Spring**	**Fall**	**Spring**	**Fall**
Taxa richness	18	21	21	—	14	16	24	19
Tolerance group								
Richness of tolerant taxa (%)	11.76	16.67	15.79	—	8.33	14.29	15.00	11.76
Richness of moderately tolerant taxa (%)	64.71	55.56	63.16	—	58.33	57.14	65.00	52.94
Richness of intolerant taxa (%)	23.53	27.78	21.05	—	33.33	28.57	20.00	35.29
Functional group								
Richness of collector-filterers (%)	11.11	9.52	11.11	—	14.29	13.33	9.09	11.76
Richness of collector-gatherers (%)	22.22	33.34	38.89	—	50.00	20.00	27.27	35.29
Richness of scrapers (%)	5.56	4.76	0.00	—	0.00	13.33	4.55	5.88
Richness of shredders (%)	11.11	9.52	5.56	—	7.14	6.67	13.64	11.76
Richness of predators (%)	50.00	42.86	44.44	—	28.57	46.67	45.45	35.29
Taxonomic group								
Number of EPT taxa	3	6	4	—	4	3	4	7
Richness of EPT taxa (%)	16.67	28.57	19.05	—	28.57	18.75	16.67	36.84
Richness of Ephemeroptera (%)	11.11	23.81	9.52	—	14.29	6.25	8.33	21.05
Richness of Plecoptera (%)	0.00	0.00	0.00	—	7.14	0.00	0.00	5.26
Richness of Trichoptera (%)	5.56	4.76	9.52	—	7.14	12.50	8.33	10.53
Richness of noninsect taxa (%)	11.11[a]	23.81[a]	19.05	—	14.29	18.75	29.17	15.79
Richness of Chironomid Diptera (%)	16.67	14.28	14.29	—	21.43	18.75	12.50	15.79
Richness of non-Chironomid Diptera (%)	33.33	9.52	28.57	—	21.43	18.75	20.83	15.79
Richness of Coleoptera (%)	16.67	23.81	19.05	—	14.29	12.50	20.83	5.26
Richness of Odonata (%)	5.56	0.00	0.00	—	0.00	12.50	0.00	10.53

[a]Pre-2009 reports labeled the "noninsect" category as "Other". The "Other" category was less inclusive of species, resulting in a different richness count.

Taxa richness. There were 24 different taxa in the sample collected at COY01 in the spring of 2011 and 19 taxa in the sample collected during the fall of the same year (fig. 3).

Stress tolerance. Taxa which were moderately tolerant to disturbance dominated richness counts in the spring, comprising 65.00% of the sample collected (fig. 4). Intolerant taxa were the second most abundant group in the spring, at 20.00% of the sample. Tolerant taxa were the least abundant group of taxa collected from our spring sample, making up 15.00%. Tolerance values for the fall samples were slightly different from those in the spring. Moderately tolerant taxa were the most abundant again at 52.94%. Intolerant taxa increased to 35.29% and tolerant taxa decreased slightly to 11.76%.

EPT taxa. During the spring of 2011, taxa belonging to EPT orders (Ephemeroptera [mayflies], Plecoptera [stoneflies], and Trichoptera [caddisflies]) accounted for 16.67% of the orders collected from the sample (fig. 5). Ephemeropteran and trichopteran taxa each accounted for 8.33% of the taxa collected. No plecopterans were collected in the spring. Fall collections saw an increase in EPT taxa to 36.84%. Ephemeropterans increased to 21.05% and trichopterans increased to 10.53%. Unlike the spring, plecopterans were found in the fall, at 5.26%.

Figure 3. Taxa richness from qualitative multihabitat samples collected from COY01 at Coyote Gulch in GLCA, 2008–2011. No data were collected in fall 2009.

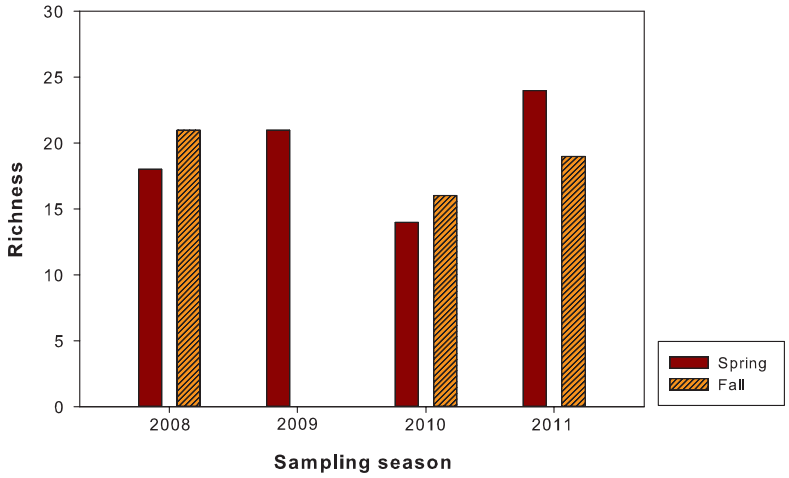


Figure 4. Richness of qualitative aquatic macroinvertebrate samples collected from COY01 at Coyote Gulch in GLCA, 2008– 2011, based on their tolerance to perturbation. No data were collected in fall 2009.

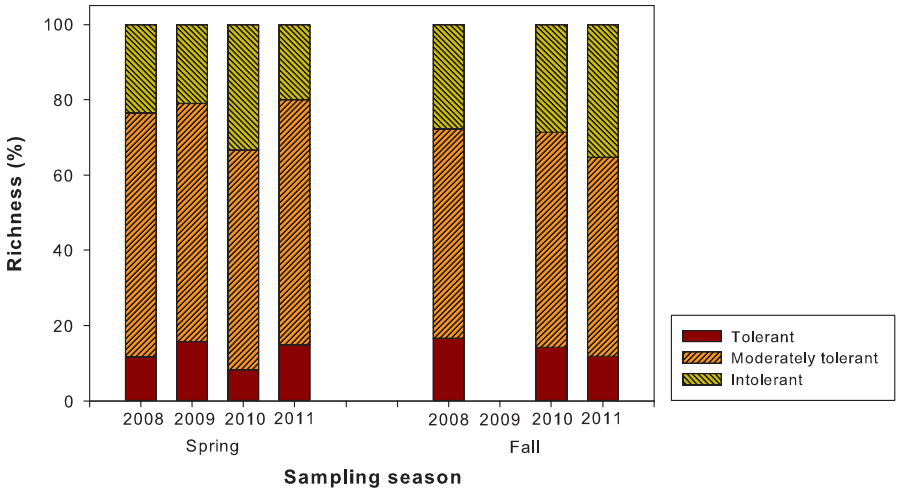
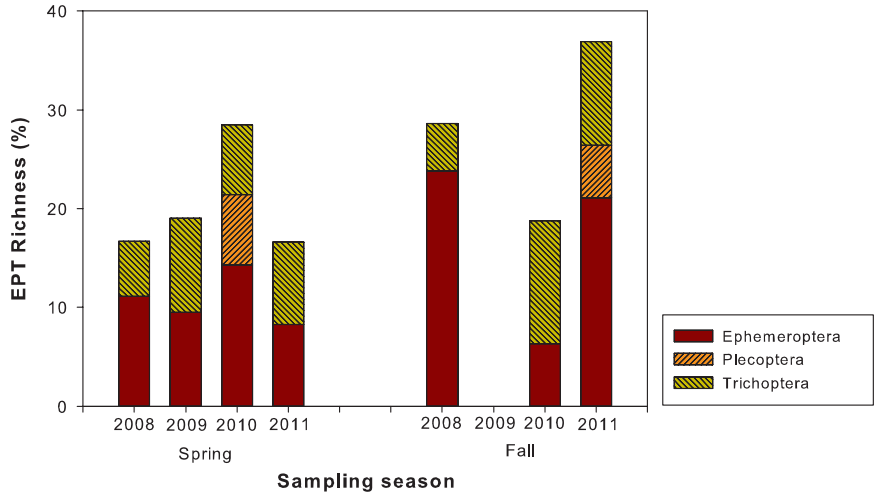


Figure 5. Richness of sensitive EPT taxa collected from COY01 at Coyote Gulch in GLCA, 2008– 2011. Data were not collected in fall 2009.



Aquatic macroinvertebrate orders. During the spring of 2011, noninsect taxa were the most common group sampled, at 29.17% (fig. 6). This group was primarily made up of the phyla Annelida (segmented worms), and the orders Collembola (spring-tails), Trombidiformes (water mites), and Amphipoda (scuds). Coleopterans (beetles) and non-chironomid dipterans (flies) each accounted for 20.83% of the taxa sampled at COY01 in the spring of 2011. Chironomids (midges) accounted for 12.50% of the spring sample, and ephemeropterans and trichopterans each accounted for 8.33%. No odonates (dragonflies/damselflies) or plecopterans were found during the spring sampling effort.

Ephemeropterans were the most common order collected during the fall of 2011, at 21.05%. Noninsect taxa (segmented worms, spring-tails, and water mites), chironomids, and non-chironomid dipterans each accounted for 15.79% of the sample. Trichopterans and odonates each accounted for 10.53% of the sample. Plecopterans and coleopterans were the least common, each accounting for 5.26% of the fall sample from COY01.

Functional feeding groups. The majority of taxa collected from COY01 in the spring of 2011 belonged to the functional group, predators, which made up 45.45% of the sample (fig. 7). Collector-gatherers were the second most common group, at 27.27%. Shredders made up 13.64% of the sample and collector-filterers made up 9.09%. Scrapers were the least common functional group collected in the spring of 2011, at 4.55%.

Predators and collector-gatherers were the most common functional feeding groups collected from COY01 in the fall of 2011, each accounting for 35.29% of the sample. Collector-filterers and shredders each accounted for 11.76% of the sample. Scrapers were the least abundant functional group collected in the fall, accounting for 5.88% of the sample.

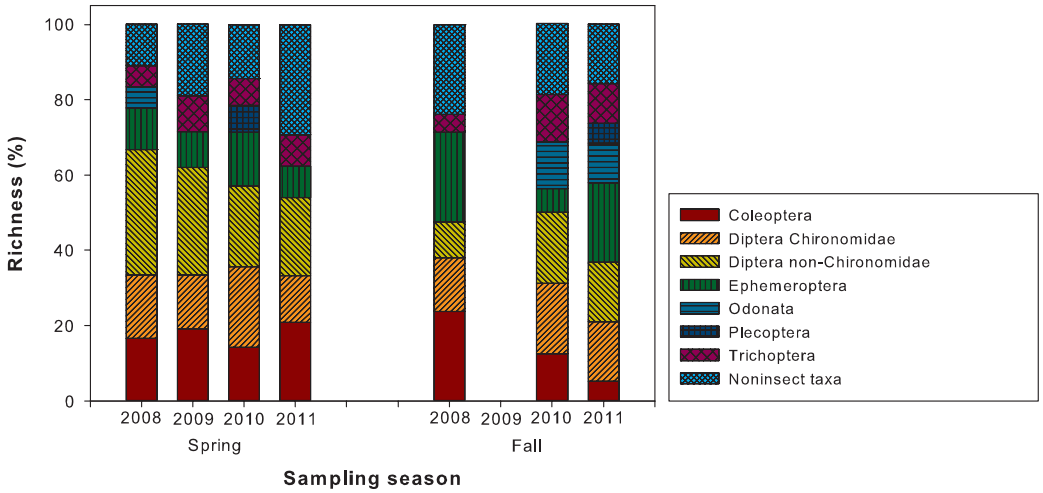


Figure 6. Taxa richness of aquatic macroinvertebrate orders in qualitative multihabitat samples collected from COY01 at Coyote Gulch in GLCA, 2008–2011. Data were not collected in fall 2009.

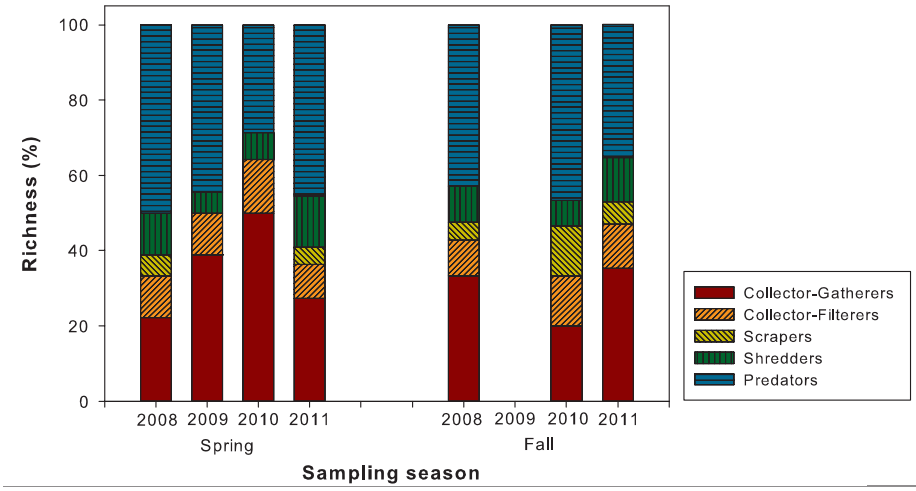


Figure 7. Taxa richness by functional feeding group in qualitative samples collected from COY01 at Coyote Gulch in GLCA, 2008–2011. Data were not collected in fall 2009.

3.2 Physical habitat characteristics for Coyote Gulch

Transect level. Spring active channel widths averaged 17.4 m, compared to 13.2 m in the fall (table 2). Wetted channel width averaged 4.1 m in the spring and 4.2 m in the fall. Velocities averaged 0.38 m/s in the spring and 0.37 m/s in the fall. Average depths were 0.05 m in the spring and 0.08 m in the fall. Additional transect data can be found in Appendix D.

In spring of 2011, rock was the dominant aquatic macroinvertebrate habitat sampled, and was found at 11.5% of our monitoring site (fig. 8). Vegetation and root wads were found along 6.4% and 3.8% of the spring transects, respectively. In fall of 2011, vegetation was the dominant habitat type sampled, and was found along 5.2% of the monitoring site. Root wad was found along 1.3% of the monitoring site. Substrate fitting the category "Absence", meaning it lacked habitat that we define as appropriate for aquatic macroinvertebrates, occurred along 76.9% of our monitoring site in the spring and 93.5% in the fall.

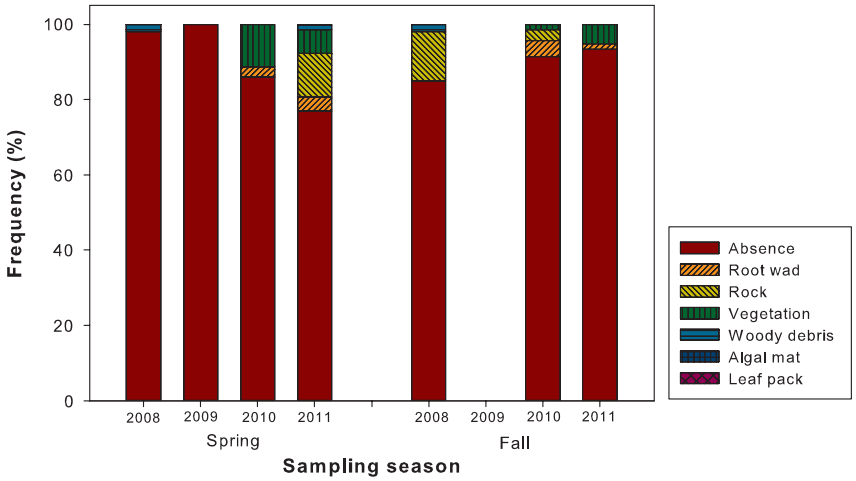


Figure 8. Aquatic macroinvertebrate habitat characterization based upon line point intercept data collected from COY01 at Coyote Gulch in GLCA, 2008–2011. Some habitat structures were not observed, and no data were collected in fall 2009.

Reach level. Channel structure dynamics are represented by particle size distributions in Figures 9a (spring samples) and 9b (fall samples), based on modified Wolman pebble counts. Particle size distributions were dominated by sand (0.06–2 mm) during both sampling periods in 2011. Sand was found along 98.1% of the COY01 monitoring site in spring, and 99.8% in the fall. Gravels (3–64) were found along 1.9% of the monitoring site in spring and bedrock (>4000 mm) was found along 0.2% of the monitoring site in the fall. Runs were the only geomorphic channel unit found along the monitoring site during either fall or spring sampling periods in 2011 (fig. 10).

3.3 Hydrologic conditions for Coyote Gulch

This was the fourth consecutive year in which we collected water quality data while sampling aquatic macroinvertebrates at Coyote Gulch. Values presented in Table 2 represent recorded measurements at or near midday of the sample date. The midday water temperature was 24.6°C in the spring and 5.6°C in the fall. Specific conductivity was 297 µS/cm in the spring and 86 µS/cm in the fall. pH values were 8.6 during the spring and 8.4 during the fall. Dissolved oxygen measured 102.7% saturation and 7.4 mg/L in the spring, and 101.0% and 11.3 mg/L in the fall. Turbidity measured 355 NTU during the fall. We did not collect a turbidity sample in the spring. In addition to these water quality parameters, we also measured stream discharge, and found it to be 0.1 cfs during both sampling periods in 2011.

Table 2. Physical habitat and hydrologic data from COY01 at Coyote Gulch in Glen Canyon National Recreation Area, Utah, 2008–2011. Canopy closure measurements are expressed as percentages.

	Spring 2008		Fall 2008		Spring 2009		Fall 2009	Spring 2010		Fall 2010		Spring 2011		Fall 2011	
Physical habitat metric	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**		**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**
Transect level															
Channel dimensions															
Velocity (m/s)	0.31	0.24	0.29	0.10	0.31	0.07	—	0.55	0.4	0.32	0.33	0.38	0.13	0.37	0.11
Depth (m)	0.05	0.04	0.07	0.05	0.06	0.03	—	0.12	0.13	0.19	0.14	0.05	0.02	0.08	0.06
Wetted channel width (m)	4.0	2.9	1.6	0.6	3.3	1.8	—	2.9	1.8	1.8	0.9	4.1	2.3	4.2	3.0
Active channel width (m)	7.1	3.6	9.3	2.6	9.0	3.6	—	7.6	3.7	17.0	3.0	17.4	2.8	13.2	3.7
Riparian cover															
Canopy closure (%)	9.7	20.5	8.9	17.5	7.7	16.9	—	4.5	7.9	15.3	21.2	7.2	15.4	12.4	23.4
Reach level															
Water quality	**Value**		**Value**		**Value**			**Value**		**Value**		**Value**		**Value**	
Temperature (°C)	24.4		21.3		25.5		—	15.0		15.6		24.6		5.6	
Specific conductivity (µS/cm)	328		316		277		—	292		349		297		86	
pH	8.6		8.7		8.5		—	8.7		8.7		8.6		8.4	
Dissolved oxygen (% saturation)	100.1		111.9		112.8		—	—		—		102.7		101.0	
Dissolved oxygen (mg/L)	—		—		7.1		—	—		—		7.4		11.3	
Turbidity (NTU)	39		39		3.6[a]		—	34		314		—		355	
Discharge (cfs)	—		—		—		—	—		1.2		0.1		0.1	

[a]Reading occurred 9 days after sample was collected.

Figure 9a. Particle size distribution, based on modified Wolman pebble counts (minimum 400 particles) from COY01 at Coyote Gulch in GLCA, during the spring sampling visits for 2008– 2011. CM represents particles that are completely cemented into the stream channel, which precludes size measurements. No data were collected in 2009.

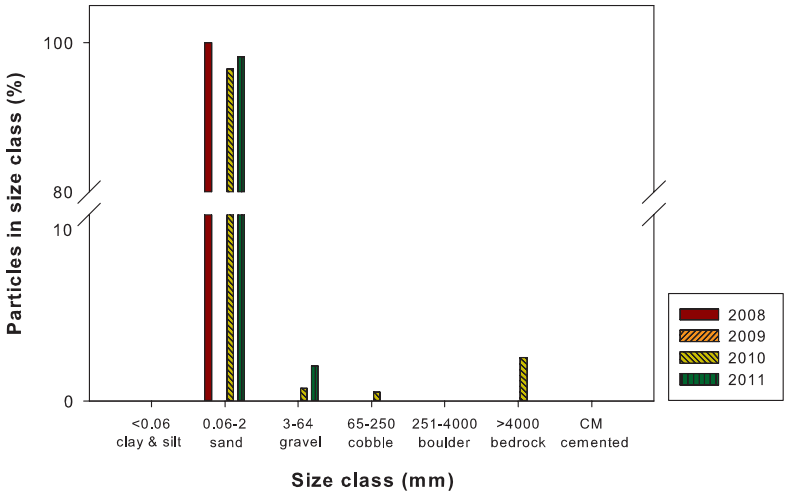


Figure 9b. Particle size distribution, based on modified Wolman pebble counts (minimum 400 particles) from COY01 at Coyote Gulch in GLCA, during the fall sampling visits 2008–2011. CM represents particles that are completely cemented into the stream channel, which precludes size measurements. No data were collected in 2009.

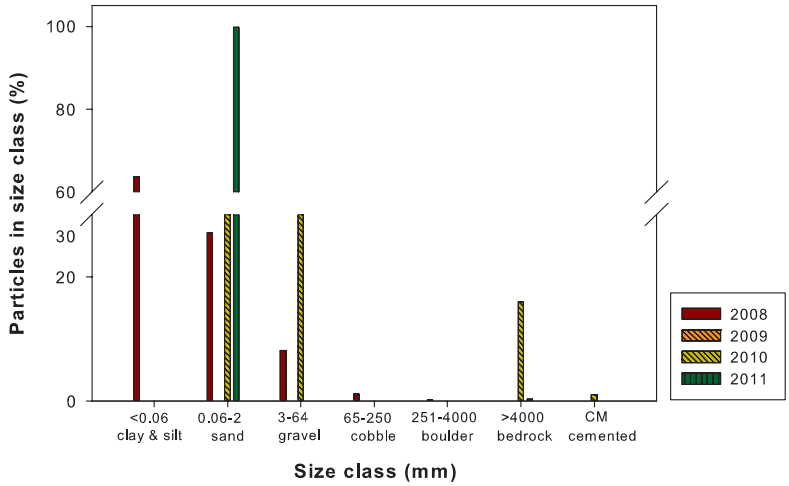
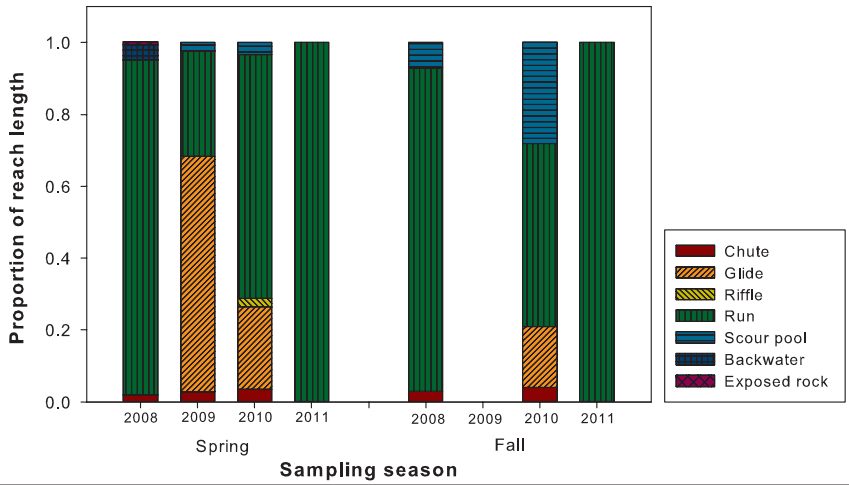


Figure 10. Geomorphic channel unit characterization from COY01 at Coyote Gulch in GLCA, 2008– 2011. Some GCUs were not found and no data were collected in fall 2009.



4 Discussion

This report presents data from SCPN's fourth year of monitoring aquatic macroinvertebrates and physical habitat at Coyote Gulch in Glen Canyon National Recreation Area, Utah. We stress that any differences between sampling years and locations should not to be interpreted as ecologically significant trends, as trends cannot be determined with confidence by a few years of sampling data.

Differences may be attributed to multiple factors, including ecological variability, sampling error, or observer bias. SCPN attempts to minimize sampling error and observer bias by thoroughly training crew members in the proper field techniques prior to each sampling season.

We were unable to collect quantitative samples at our COY01 site again in 2011. A large flash flood and multiple subsequent smaller flood events that occurred in October of 2006 deposited large quantities of sand and fine particles in the reach. This condition has persisted through 2011.

We were unable to collect any data from ESC01 on the Escalante River in 2011 because of safety concerns created by large storm floods and elevated stream flow. The protocol also prohibits collecting samples during or immediately after storm conditions.

4.1 Aquatic macroinvertebrate community

Qualitative samples from COY01 indicate that the aquatic macroinvertebrate organisms living in Coyote Gulch are well adapted to the conditions of the stream. Taxa that are moderately tolerant to intolerant of disturbance accounted for 85.0% (spring) and 88.2% (fall) of the taxa found. While the lack of substrate and physical habitat diversity typically found in southwestern streams may exclude some taxa from Coyote Gulch, the tolerance characteristics of taxa sampled at COY01 suggests that those present are well suited for the current conditions of the stream.

The purpose of sampling in 2 seasons at Coyote Gulch was to determine which sampling window was the most appropriate for our monitoring goals. The 4 years of data collected suggest that the fall season samples have greater taxa richness, more moderately tolerant and intolerant taxa, and a higher diversity of orders than samples collected during the spring.

4.2 Physical habitat

Appropriate macroinvertebrate habitat occupied less than 24% of our monitoring site at COY01 in the spring and less than 7% of our monitoring site in the fall. Overall there was less available habitat for aquatic macroinvertebrates in the fall compared to the spring. Rock, which was found along 11.5% of the monitoring site in the spring, was not found in the fall, suggesting that larger flow events may have washed much of that habitat out of our monitoring site.

In 2011, five years had passed since the large flood of 2006 altered the aquatic habitat at Coyote Gulch. Reconnaissance trips along the length of Coyote Gulch in 2008 and 2010 confirmed that conditions were similar along the entire stream. Since 2008 we have not been able to collect a single quantitative measurement. Because of this, along with the difficulty associated with reaching our monitoring site on the Escalante River, SCPN has decided to suspend monitoring operations at Glen Canyon National Recreation. We plan on revisiting our sites in a few years to see if conditions have changed.

The data in this report should be viewed as a snapshot of conditions existing within the aquatic community at the time of our visit.

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Appendix A Aquatic macroinvertebrate monitoring sites at Glen Canyon National Recreation Area, Utah. GLCAESC01 was not sampled in 2011.

Site Code	Common name	Report name	UTM X	UTM Y	Elevation (m)
GLCACOY01	Coyote Gulch above Crack-in-the-Wall Trail	COY01	500945	4142251	1147
GLCAESC01	Escalante River above Steven's Canyon	ESC01	501293	4143055	1134

Appendix B Selected aquatic macroinvertebrate metrics

Metric type	Metric	Definition
Abundance/Richness/ Diversity	Total abundance	Total number of individuals.
	Taxa richness	Total number of taxa (measures the overall variety of aquatic macroinvertebrates in a sample).
	Simpson's diversity	A measure of the variety of taxa that takes into account the relative abundance of each taxon. $D = \sum(n_i(n_i -1)/N(N-1))$
Tolerance	Dominant taxa	Measures the dominance of the most abundant taxa. Typically calculated as dominant 2, 3, 4, or 5 taxa.
	Relative abundance tolerant taxa	Percent of individuals considered to be sensitive to perturbation.
	Percent richness of tolerant taxa	Percent of taxa considered to be sensitive to perturbation.
Functional-Feeding	Relative abundance collector-filterers	Percent of individuals that filter fine particulate organic matter from the water column.
	Percent richness collector-filterers	Percent of taxa that filter fine particulate matter from the water column.
	Relative abundance scrapers	Percent of individuals that scrape or graze upon periphyton.
Functional-Habit	Relative abundance burrowers	Percent of individuals that move between substrate particles (typically fine substrates).
	Percent richness burrowers	Percent of taxa that move between substrate particles (typically fine substrates).
	Relative abundance clingers	Percent of individuals that have fixed retreats or adaptations for attachment to surfaces in flowing water.
	Percent richness clingers	Percent of taxa that have fixed retreats or adaptations for attachment to surfaces in flowing water.
Composition	Number of EPT taxa	Number of taxa in the insect orders Ephemeroptera (mayflies), Plecoptera (stoneflies), and Trichoptera (caddisflies).
	Relative abundance EPT	Percent of individuals in the insect orders Ephemeroptera (mayflies), Plecoptera (stoneflies), and Trichoptera (caddisflies).
	Relative abundance Ephemeroptera	Percent of individuals that are mayflies.
	Relative abundance Plecoptera	Percent of individuals that are stoneflies (for streams >1,500 m in elevation).
	Relative abundance Trichoptera	Percent of individuals that are caddisflies.
	Hydroptilidae+ Hydropsychidae/Trichoptera	Percent of trichopteran individuals in Hydroptilidae plus Hydropsychidae (ratio of tolerant caddisfly abundance to total caddisfly abundance).
	Relative abundance noninsect taxa	Percent of individuals that are not insects.
	Relative abundance Chironomidae	Percent of individuals that are midges.

Source: Data from Brasher et al. (2011)

Appendix C Aquatic macroinvertebrate species list from the COY01 monitoring site in Glen Canyon National Recreation Area, Utah, 2011. "NEW" under the site column denotes a new record for this SCPN monitoring site.

Phylum	Class	Order	Family	SubFamily	Genus	Species	Common name	COY01
Annelida	Clitellata						segmented worms	x
Arthropoda	Arachnida	Trombidiformes	Sperchonidae		*Sperchon* sp.		water mites	x
Arthropoda	Arachnida	Trombidiformes					water mites	x
Arthropoda	Entognatha	Collembola					springtails	x
Arthropoda	Insecta	Coleoptera	Dytiscidae	Laccophilinae	*Laccophilus*	*maculosus*	predaceous diving beetles	NEW
Arthropoda	Insecta	Coleoptera	Dytiscidae		*Stictotarsus* sp.		predaceous diving beetles	NEW
Arthropoda	Insecta	Coleoptera	Dytiscidae				predaceous diving beetles	x
Arthropoda	Insecta	Coleoptera	Dryopidae		*Helichus* sp.		long-toed water beetles	x
Arthropoda	Insecta	Coleoptera	Dryopidae		*Postelichus* sp.		long-toed water beetles	x
Arthropoda	Insecta	Coleoptera	Elmidae		*Microcylloepus*	*pusillus*	pusillanimous riffle beetle	x
Arthropoda	Insecta	Coleoptera	Hydrophilidae				water scavenger beetle	x
Arthropoda	Insecta	Diptera	Dolichopodidae				longlegged flies	NEW
Arthropoda	Insecta	Diptera	Empididae	Hemerodromiinae	*Hemerodromia* sp.		dance flies	x
Arthropoda	Insecta	Diptera	Empididae				dance flies	x
Arthropoda	Insecta	Diptera	Ceratopogonidae	Ceratopogoninae	*Probezzia* sp.		biting midges	NEW
Arthropoda	Insecta	Diptera	Ceratopogonidae	Forcipomyiinae			biting midges	x
Arthropoda	Insecta	Diptera	Ceratopogonidae				biting midges	x
Arthropoda	Insecta	Diptera	Chironomidae	Chironominae			midges	x
Arthropoda	Insecta	Diptera	Chironomidae	Orthocladiinae			midges	x
Arthropoda	Insecta	Diptera	Chironomidae	Tanypodinae			midges	x
Arthropoda	Insecta	Diptera	Chironomidae				midges	x
Arthropoda	Insecta	Diptera	Simuliidae	Simuliinae	*Simulium* sp.		black flies	x
Arthropoda	Insecta	Diptera	Tipulidae	Tipulinae	Tipula sp.		large crane flies	x
Arthropoda	Insecta	Diptera					midges	x
Arthropoda	Insecta	Ephemeroptera	Baetidae		*Baetis* sp.		small minnow mayflies	x
Arthropoda	Insecta	Ephemeroptera	Baetidae		*Fallceon*	*quilleri*	small minnow mayflies	x
Arthropoda	Insecta	Ephemeroptera	Baetidae		*Pseudocloeon* sp.		small minnow mayflies	NEW
Arthropoda	Insecta	Ephemeroptera	Baetidae				small minnow mayflies	x
Arthropoda	Insecta	Ephemeroptera	Furcatergalia	Leptohyphidae	*Tricorythodes*		little stout crawler mayflies	x

Appendix C *(continued)*

Phylum	Class	Order	Family	SubFamily	Genus	Species	Common name	COY01
Arthropoda	Insecta	Hemiptera	Gerridae				water striders	x
Arthropoda	Insecta	Hemiptera	Naucoridae	Ambrysinae	*Ambrysus* sp.		creeping water bugs	x
Arthropoda	Insecta	Hemiptera	Veliidae				small water striders	x
Arthropoda	Insecta	Odonata	Gomphidae				clubtail dragonflies	x
Arthropoda	Insecta	Odonata	Coenagrionidae		*Argia* sp.		narrow-winged damsel-flies	x
Arthropoda	Insecta	Odonata	Coenagrionidae				narrow-winged damsel-flies	x
Arthropoda	Insecta	Plecoptera	Taeniopterygidae				winter stoneflies	NEW
Arthropoda	Insecta	Trichoptera	Hydropsychidae	Hydropsychinae	*Hydropsyche* sp.		netspinning caddisflies	x
Arthropoda	Insecta	Trichoptera	Hydropsychidae				netspinning caddisflies	x
Arthropoda	Insecta	Trichoptera	Hydroptilidae				microcaddisflies	x
Arthropoda	Insecta	Trichoptera	Limnephilidae				northern caddisflies	NEW
Arthropoda	Malacostraca	Amphipoda	Hyalellidae		*Hyalella* sp.		amphipods	x

Appendix D Measured velocity and channel characteristics at the COY01 monitoring site, Glen Canyon National Recreation Area, Utah, 2011

	Velocity (m/s)		Depth (m)		Wetted channel width (m)	Active channel width (m)
Transect	**Mean**	**Std Dev**	**Mean**	**Std Dev**	**Value**	**Value**
COY01 Spring						
1	0.40	0.19	0.05	0.02	4.0	14.7
2	0.40	0.13	0.06	0.04	6.9	20.8
3	0.15	0.06	0.03	0.01	8.4	19.3
4	0.32	0.10	0.03	0.02	6.4	19.6
5	0.32	0.23	0.05	0.01	4.3	12.9
6	0.14[a]	n/a[a]	0.01	0.01	4.6	16.4
7	0.49	0.12	0.07	0.04	2.6	19.7
8	0.46	0.30	0.07	0.02	2.3	18.4
9	0.50	0.12	0.07	0.03	2.0	20.3
10	0.48	0.07	0.05	0.01	2.7	13.9
11	0.50	0.35	0.08	0.03	1.5	15.5
COY01 Fall						
1	0.37	0.29	0.07	0.03	3.2	10.6
2	0.22	0.09	0.02	0.02	6.9	17.1
3	0.33	0.19	0.04	0.01	10.5	14.9
4	0.42	0.00	0.05	0.05	4.9	11.8
5	0.33	0.32	0.07	0.05	2.7	14.8
6	0.19	0.13	0.05	0.04	8.0	10.6
7	0.49	0.20	0.11	0.01	2.4	15.1
8	0.36	0.17	0.08	0.03	1.9	17.6
9	0.43	0.18	0.06	0.02	2.4	10.8
10	0.52	0.21	0.08	0.03	2.5	16.7
11	0.47	0.10	0.23	0.05	0.7	5.6

[a]Only one reading was possible for velocity on this transect, therefore, standard deviation is not applicable.