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

2010 Summary Report

Natural Resource Data Series NPS/SCPN/NRDS—2012/237

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

2010 Summary Report

Natural Resource Data Series NPS/SCPN/NRDS—2012/237

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All manuscripts in the series receive the appropriate level of peer review to ensure that the information is scientifically credible, technically accurate, appropriately written for the intended audience, and designed and published in a professional manner. Data in this report were collected and analyzed using methods based on established, peer-reviewed protocols and were analyzed and interpreted within the guidelines of the protocols.

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1 Introduction and background

The National Park Service (NPS) 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 strong scientific foundation for making decisions and working with other agencies and the public to protect park ecosystems. The Southern Colorado Plateau Network (SCPN) is monitoring aquatic macroinvertebrates as an overall indicator of aquatic ecosystem integrity (Thomas et al. 2006). 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). Previously, aquatic macroinvertebrates were sampled from the Escalante River and its tributaries by Vinson (2000, 2001, and 2002), Mueller (1999), and sporadically by others. Few data exist describing the aquatic ecology of these two streams in Glen Canyon National Recreation Area (GLCA).

In 2008 SCPN implemented annual aquatic macroinvertebrate and physical habitat monitoring 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 below Lake Powell's full pool elevation (fig. 1). 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.

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

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

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 1.9 million acre (~769,000 ha) 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 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 2010. 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).

The primary purpose of this report is to (a) document monitoring activities that have occurred during 2010, (b) summarize data that were collected, and (c) where appropriate, place these data in the context of aquatic habitat and biological condition, and management actions within the park through time.

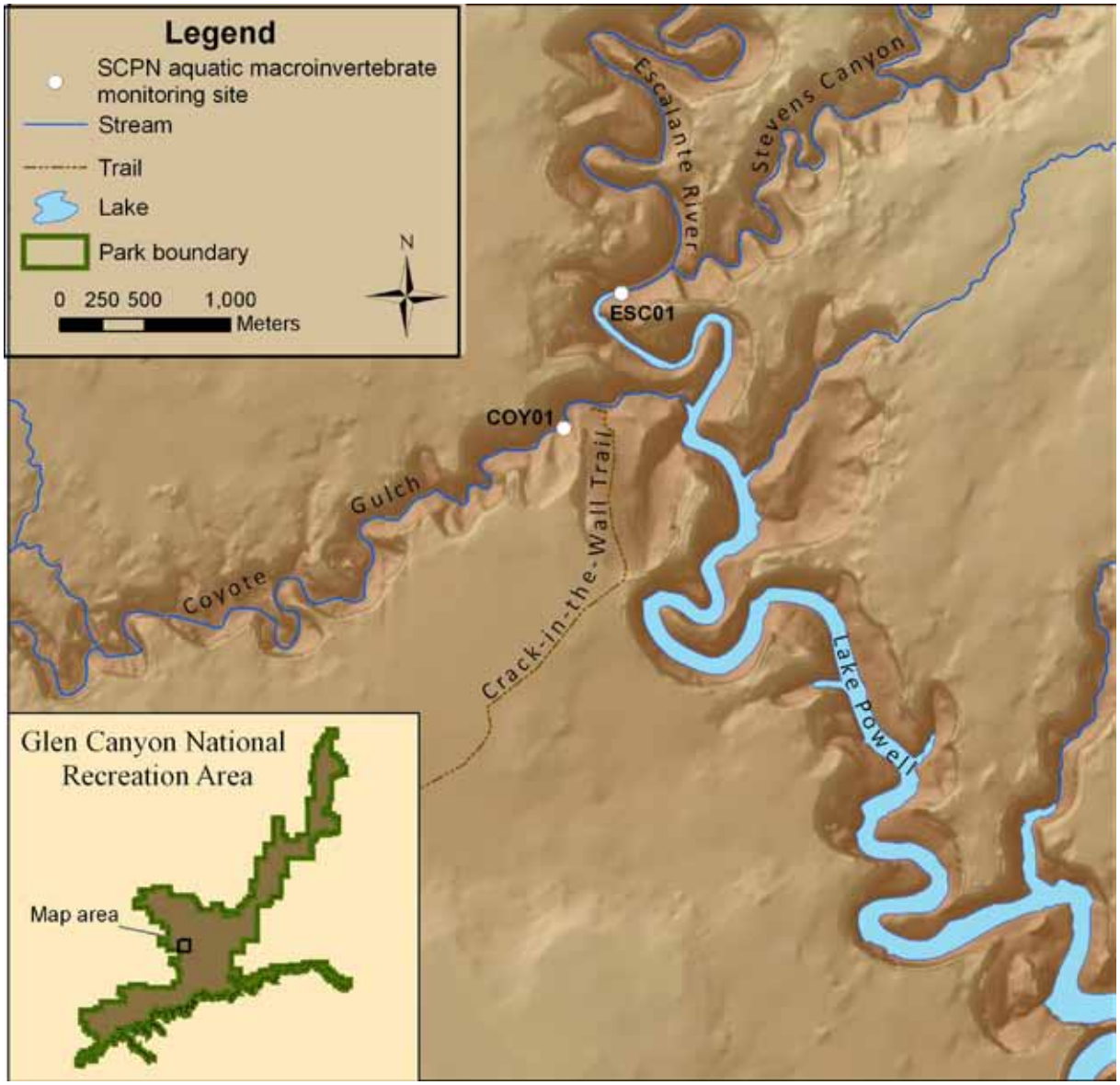


Figure 1. Location map of the COY01 and ESC01 monitoring sites at Coyote Gulch and the Escalante River in Glen Canyon National Recreation Area, Arizona, 2010

2 Methods

2.1 Field methods

The state of Utah recommends collecting aquatic macroinvertebrate samples from perennial streams during September to October (UDEQ-DWQ 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 (ADEQ-WQD 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 May 8, 2010 and September 18, 2010. Because of the amount of snowmelt and high runoff typically occurring on the Escalante River during the spring months SCPN will only sample the Escalante River in fall. We sampled the ESC01 monitoring site on September 19 and 20, 2010.

All data were collected within one 150 m reach (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).

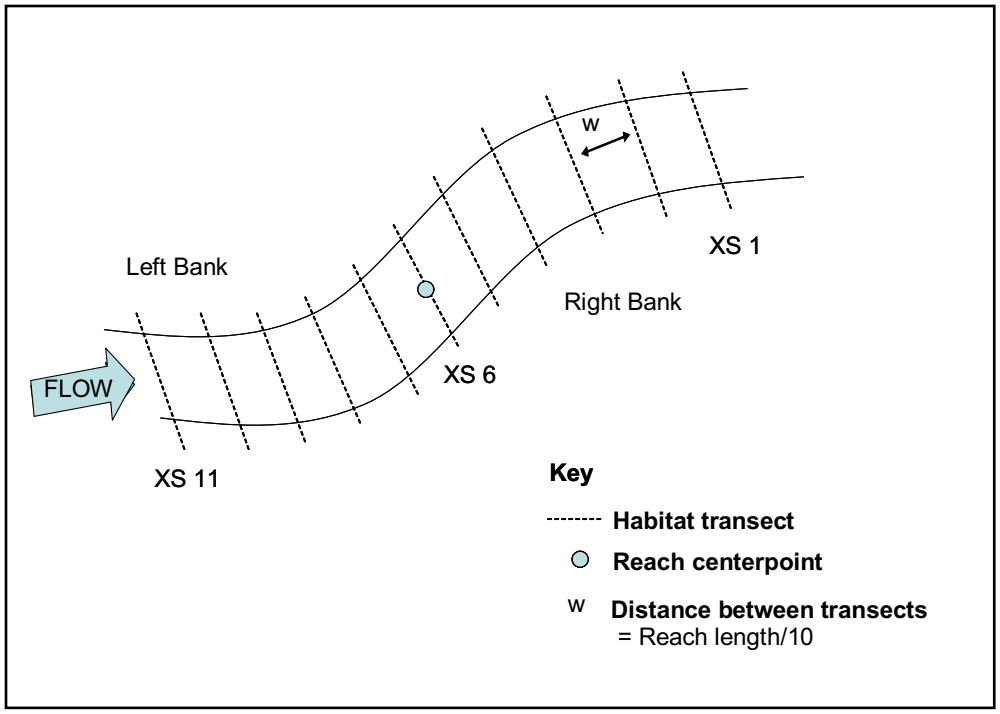


Figure 2. General aquatic macroinvertebrate sampling reach layout

Two types of aquatic macroinvertebrate samples were collected at the Escalante River site:

- Replicate quantitative samples were collected from five targeted riffle habitats to provide estimates of abundances of organisms. We used a Slack sampler to collect a timed sample from a 0.25 m^2 area at each targeted riffle.
- A qualitative sample was collected to develop a comprehensive list of species present in the reach. We used a Slack sampler to collect samples from all habitat types within the sampling reach 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 collected only qualitative samples at COY01 during both site visits in 2010, using the same methodology as for the Escalante River site.

At both sites, we collected physical habitat data at three spatial scales: microhabitat (Escalante River only), transect, and reach:

- For each of the quantitative targeted riffle microhabitats, we
  - measured depth
  - measured velocity
  - measured substrate particle size
  - measured substrate particle embeddedness

- 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 reach
  - measured geomorphic channel units (GCU) at five 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 characterized by 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 reach (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 five 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 2010 from COY01 at Coyote Gulch in GLCA are presented below. Key metrics for samples collected during 2008 to 2010 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, 2008–2010. Richness-based metrics are expressed as the percentage of taxa in a given order, tolerance or functional feeding group.

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

[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 14 different taxa in the sample collected at COY01 in the spring of 2010 and 16 taxa in the sample collected during the fall of the same year (fig. 3).

Anthropogenic stress tolerance. Taxa which were moderately tolerant to disturbance dominated richness counts in the spring, comprising 58.33% of the sample collected (fig. 4). Intolerant taxa

were the second most abundant group at 33.33% of the sample. Tolerant taxa were the least abundant group of taxa collected from our sample, making up only 8.33%. Tolerance values for the fall sampling collection were slightly different from the spring. Moderately tolerant taxa were the most abundant again at 57.14%. Tolerant taxa increased to 14.29% and intolerant taxa decreased slightly to 28.57%.

EPT taxa. During the spring of 2010, taxa belonging to EPT orders (Ephemeroptera [mayflies], Plecoptera [stoneflies], and Trichoptera [caddisflies]) accounted for 28.57% of the orders collected from the sample (fig. 5). Ephemeroptera taxa made up 14.29% of the taxa collected. Plecopterans and trichopterans each accounted for 7.14% of the taxa collected. Fall collections saw a decrease in EPT taxa to 18.75%. Ephemeropterans decreased to 6.25% and trichopterans increased to 12.50%. No plecopterans were found in our fall sample.

Aquatic macroinvertebrate orders. Diptera was the most abundant order collected from the spring qualitative multihabitat sample (fig. 6). Chironomids (midges) and non-chironomid dipterans (flies) both accounted for 21.43% of the sample each. Organisms belonging to the category "noninsect" made up 14.29% of the sample. These taxa include the phylum Annelida (segmented worms) and the order Amphipoda. Coleopterans (beetles) accounted for 14.29% of the sample. No odonates (damselflies/dragonflies) were found in the spring sample.

In addition to the differences described above for EPT taxa, the fall sample at COY01 showed decreases in chironomids (18.75%), non-chironomid dipterans (18.75%) and coleopterans (12.50%). Odonates (12.50%) and noninsect taxa (18.75%) both increased in the fall.

Functional feeding groups. The majority of taxa collected from COY01 in the spring of 2010 belonged to the functional group, collector-gatherers, which made up 50.00% of the sample (fig. 7). Predators were the second most abundant group at 28.57%. Collector-filterers made up 14.29% of the sample and shredders made up 7.14%. There were no scrapers collected in the spring sample.

All functional feeding groups were represented in the fall sample. Predators dominated the sample, accounting for 46.67% of the taxa collected. Collector-gatherers were the second most taxa rich at 20.00%. Collector-filterers and scrapers both accounted for 13.33% of the taxa collected. Shredders accounted for 6.67% of the taxa collected in the fall.

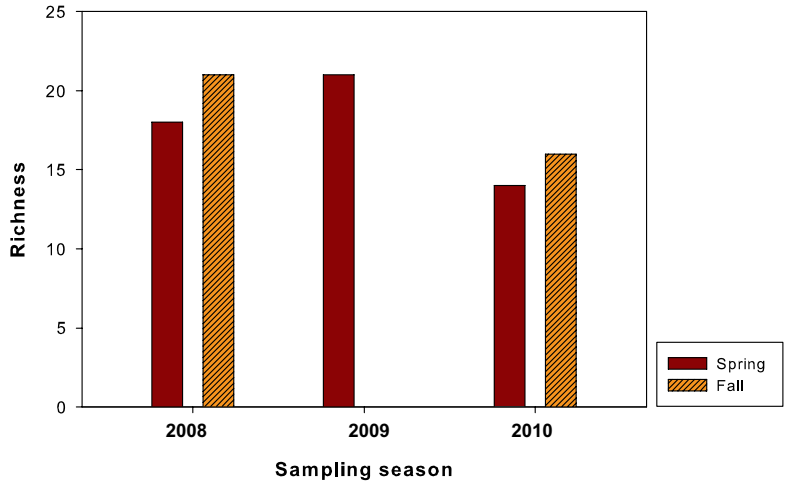


Figure 3. Taxa richness from qualitative multihabitat samples collected from COY01 at Coyote Gulch in GLCA, 2008–2010. No data were collected in fall 2009.

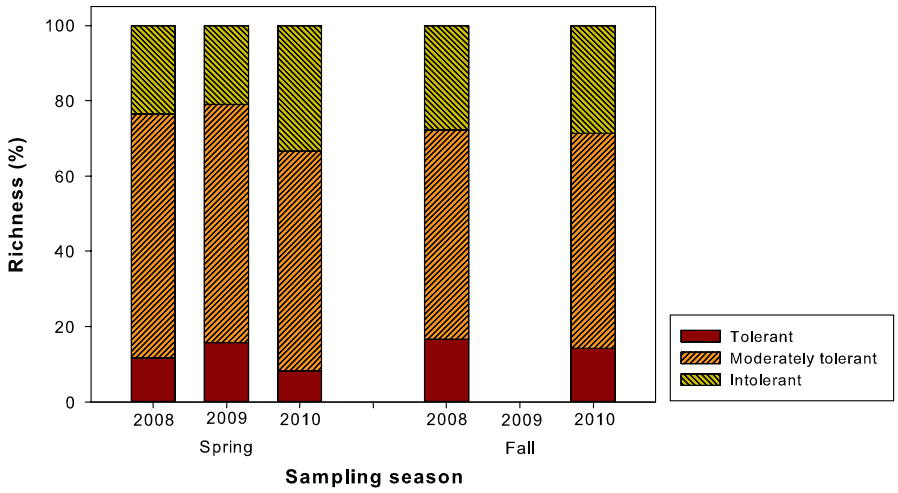


Figure 4. Richness of qualitative aquatic macroinvertebrate samples collected from COY01 at Coyote Gulch in GLCA, 2008–2010, based on their tolerance to perturbation. No data were collected in fall 2009.

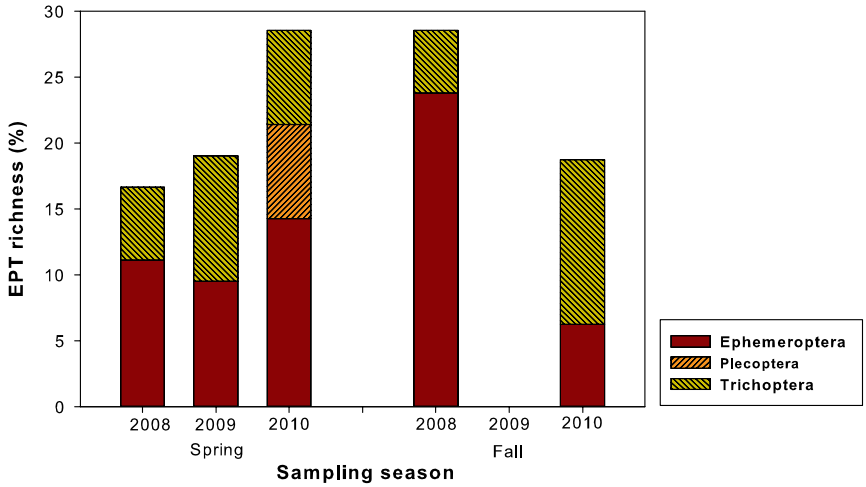


Figure 5. Richness of sensitive EPT taxa collected from COY01 at Coyote Gulch in GLCA, 2008–2010. Data were not collected in fall 2009.

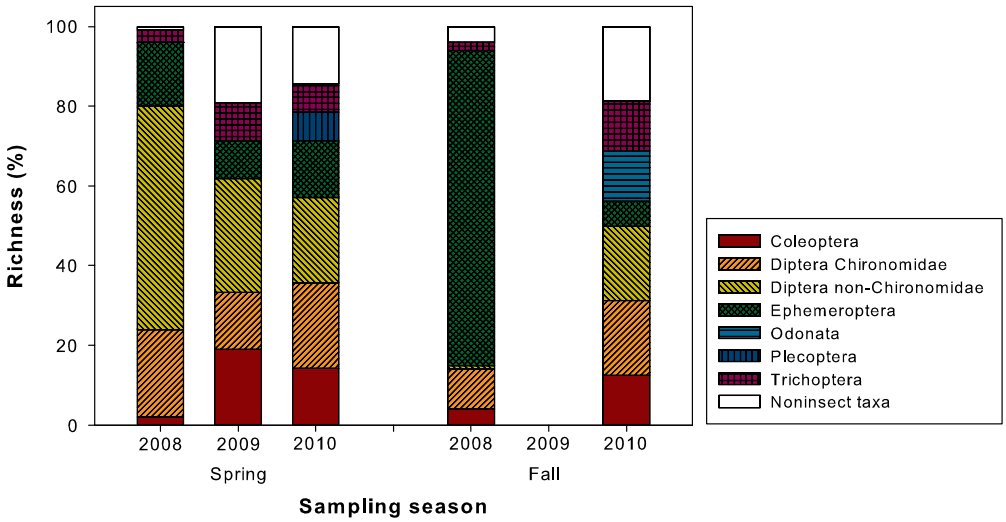


Figure 6. Taxa richness of aquatic macroinvertebrate orders in qualitative multihabitat samples collected from COY01 at Coyote Gulch in GLCA, 2008–2010. Data were not collected in fall 2009.

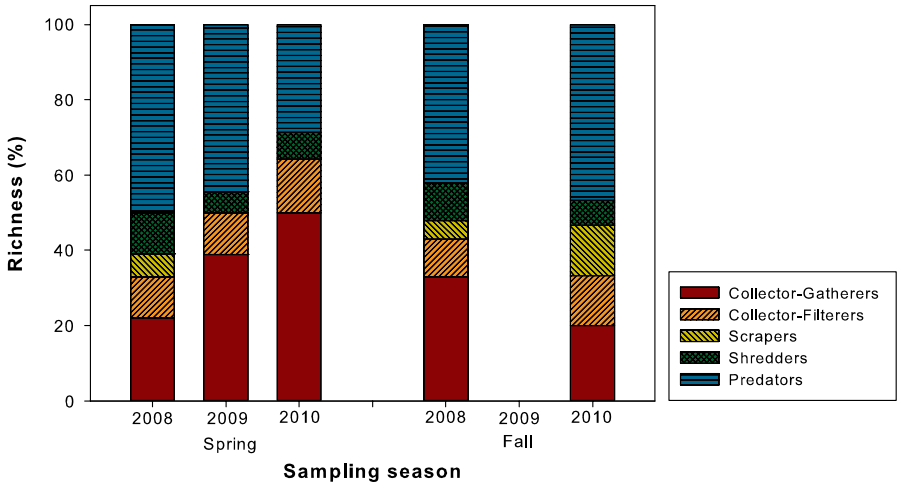


Figure 7. Taxa richness by functional feeding group in qualitative samples collected from COY01 at Coyote Gulch in GLCA, 2008–2010

3.2 Physical habitat characteristics for Coyote Gulch

Transect level. Spring active channel widths averaged 7.6 m, compared to 17.0 m in the fall (table 2). Wetted channel width averaged 2.9 m in the spring and 1.8 m in the fall. Velocities averaged 0.55 m/s in the spring and 0.32 m/s in the fall. Average depths were 0.12 m in the spring and 0.19 m in the fall.

Vegetation and root wads were the only aquatic macroinvertebrate habitat types found along COY01 in the spring of 2010, making up 11.3% and 2.8% of the reach respectively (fig. 8). In the fall of 2010, vegetation decreased to 1.4% and root wads increased to 4.3%. Rock was also found along 2.9% of the sampling reach in the fall. The majority of the sampling reach lacked known aquatic macroinvertebrate habitat ("Absence") during both the spring (85.9%) and fall (91.4%) sampling seasons.

Reach level. Channel structure dynamics are represented by particle size distributions in Figure 9, based on modified Wolman pebble counts. Particle size distributions were dominated by fine particles (<2 mm) during both sampling seasons in 2010. Fines were found along 96.1% of the COY01 sampling reach during the spring and 41.0% of the reach in the fall. Bedrock (>256 mm) was the second most abundant size class, at 2.3% in the spring and 16.0% in the fall. Fine gravels (4–8 mm) and gravels (8–16 mm), not present during spring collection, were the second and third most abundant size classes during the fall sampling season at 8.5% and 8.0% of the reach, respectively.

Runs dominated geomorphic channel units during the spring (68.0%) and fall (51.1%) (fig.10). Glides decreased from 22.9% in the spring to 17.3% in the fall. Scour pools were found along 3.4% of the reach in the spring and increased to 27.7% in the fall. Chutes remained constant between seasons at 3.6% and 3.8% in the spring and fall, respectively.

3.3 Hydrologic conditions for Coyote Gulch

3.3.1 SCPN field data

This was the third 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 temperatures on sampling dates were 15.0°C in the spring and 15.6°C in the fall. Specific conductivity ranged from 292 µS/cm in the spring to 349 µS/cm in the fall. pH values were identical during the spring and fall, measuring 8.7. Dissolved oxygen measured 0.8% saturation in the fall. The low fall value is most likely the result of the sensor either being exposed to the air or trapped by sediments. We found very large differences in turbidity between the spring and fall. Spring turbidity values averaged 34 NTU compared to 314 NTU in the fall. In addition to these water quality parameters, stream discharge measured 1.2 cfs in the fall of 2010.

Table 2. Physical habitat and hydrologic data from COY01 at Coyote Gulch in Glen Canyon National Recreation Area, Utah, 2008–2010. Canopy closure measurements are expressed as percentages.

	Spring 2008		Fall 2008		Spring 2009		Fall 2009	Spring 2010		Fall 2010	
Physical habitat metric	**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
Depth (m)	0.05	0.04	0.07	0.05	0.06	0.03	—	0.12	0.13	0.19	0.14
Wetted channel width (m)	4.0	2.9	1.6	0.6	3.3	1.8	—	2.9	1.8	1.8	0.9
Active channel width (m)	7.1	3.6	9.3	2.6	9.0	3.6	—	7.6	3.7	17.0	3.0
Riparian cover											
Canopy closure (%)	9.7	20.5	8.9	17.5	7.7	16.9	—	4.5	7.9	15.3	21.2
Reach level											
Water quality	**Value**		**Value**		**Value**			**Value**		**Value**	
Temperature (°C)	24.4		21.3		25.5		—	15.0		15.6	
Specific conductivity (µS/cm)	328		316		277		—	292		349	
pH	8.6		8.7		8.5		—	8.7		8.7	
Dissolved oxygen (% saturation)	100.1		111.9		112.8		—	—		—	
Dissolved oxygen (mg/L)	—		—		7.1		—	—		—	
Turbidity (NTU)	39		39		3.6 [a]		—	34		314	
Discharge (cfs)	—		—		—		—	—		1.2	

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

Figure 8. Aquatic macroinvertebrate habitat characterization based upon line point intercept data collected from COY01 at Coyote Gulch in GLCA, 2008–2010. Some habitat structures were not observed, and no data were collected in fall of 2009.

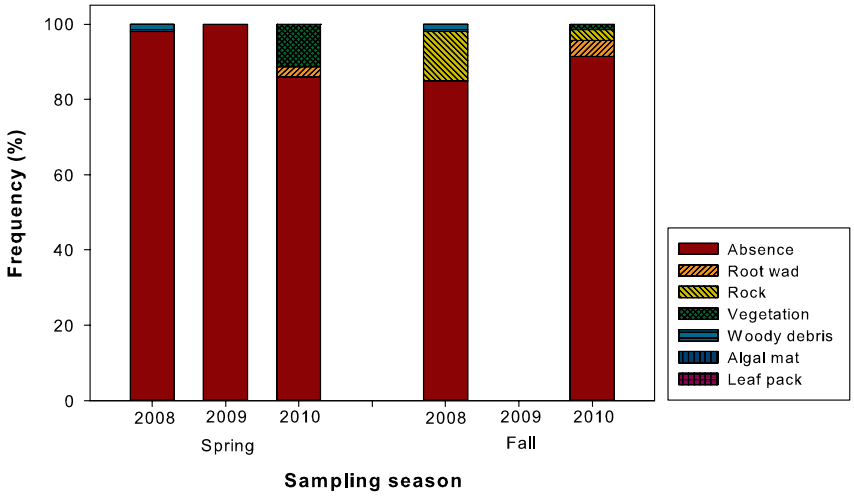


Figure 9. Particle size distribution based on modified Wolman pebble counts from COY01 at Coyote Gulch in GLCA, 2008–2010. EB represents particles that are completely embedded into the stream channel, which precludes size measurements. No data were collected in fall 2009.

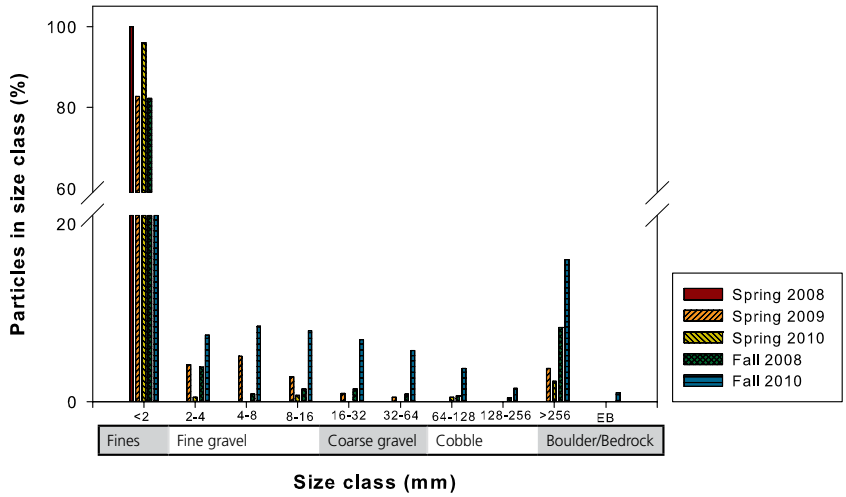
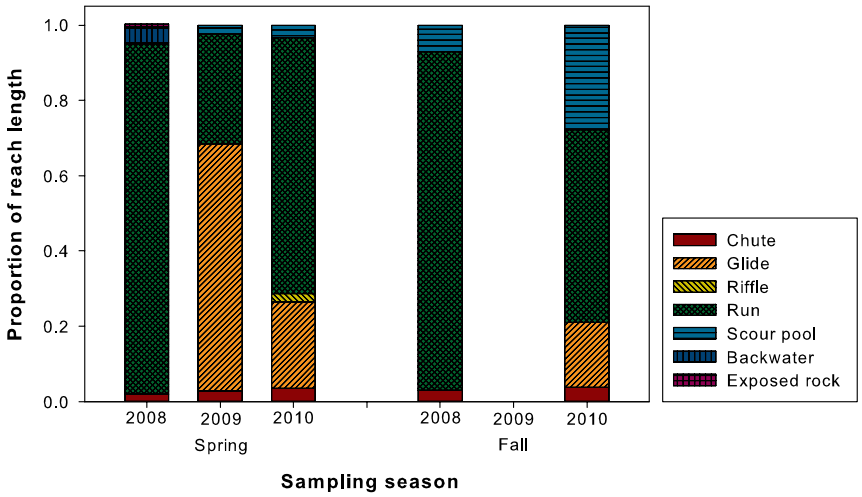


Figure 10. Geomorphic channel unit characterization of COY01 at Coyote Gulch in GLCA, 2008–2010. Some GCUs were not found and no data were collected in fall 2009.



3.3.2 Grand Staircase-Escalante National Monument station data

Daily air temperature and precipitation totals were recorded at the *40 Mile Ridge* weather station operated by the Grand Staircase-Escalante National Monument. Data is maintained by the University of Utah (http://mesowest.utah.edu). The weather station is located approximately 4.0 km to the southwest of the *Crack in the Wall* trailhead. Average air temperature for 2010 was 13.6°C (fig. 11). A high temperature of 39.0°C occurred on 16 July. A low temperature of –10.7°C occurred on 31 December. Precipitation followed the expected pattern of precipitation events during the winter months followed by a period of relative drying until the summer monsoon (fig. 12). The largest precipitation event recorded at the weather station occurred on 05–06 October.

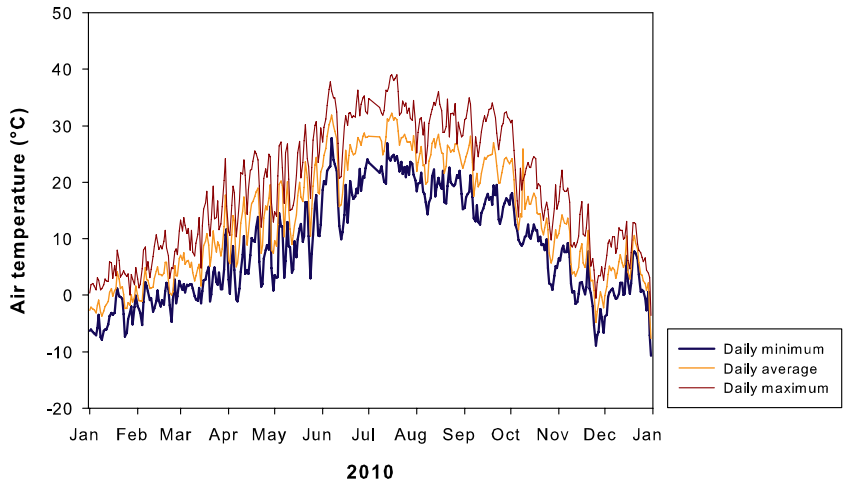


Figure 11. Daily air temperature statistics from 40 Mile Ridge, UT, 2010

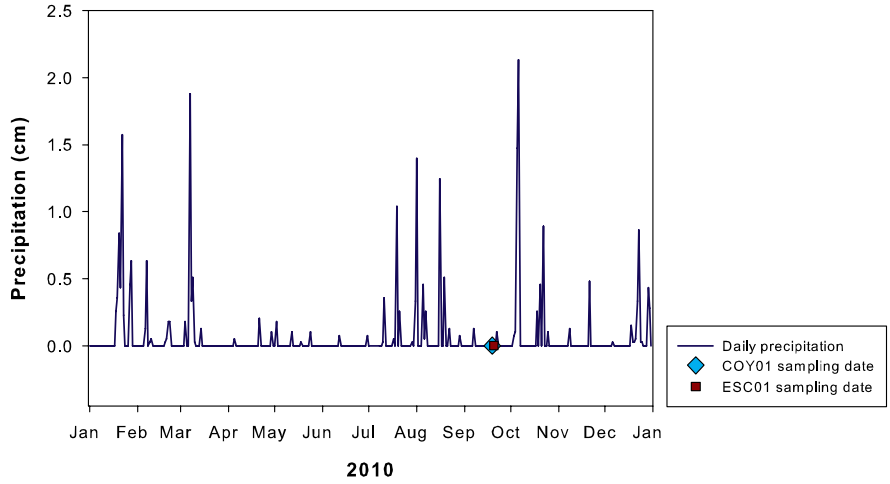


Figure 12. Daily precipitation values from 40 Mile Ridge, UT, 2010

3.4 Aquatic macroinvertebrate community data for the Escalante River

Key metrics are presented in Table 3 (qualitative) and in Table 4 (quantitative), describing aquatic macroinvertebrate communities from samples collected at ESC01 in 2010. Figures in this section refer to quantitative data unless otherwise noted, and error bars in figures represent one standard deviation from the mean. Appendix C lists all aquatic macroinvertebrate species detected at the site, from both quantitative and qualitative methods.

Table 3. Qualitative metrics for aquatic macroinvertebrate samples collected from ESC01 at the Escalante River in Glen Canyon National Recreation Area, Utah, 2010. Richness-based metrics are expressed as the percentage of taxa in a given order, tolerance or functional feeding group.

Qualitative metric	2010
Taxa richness	25
Tolerance group	
Richness of tolerant taxa (%)	8.70
Richness of moderately tolerant taxa (%)	52.17
Richness of intolerant taxa (%)	39.13
Functional group	
Richness of collector-filterers (%)	8.33
Richness of collector-gatherers (%)	41.67
Richness of scrapers (%)	12.50
Richness of shredders (%)	4.17
Richness of predators (%)	33.33
Taxonomic group	
Number of EPT taxa	10
Richness of EPT taxa (%)	40.00
Richness of Ephemeroptera (%)	32.00
Richness of Plecoptera (%)	0.00
Richness of Trichoptera (%)	8.00
Richness of noninsect taxa (%)	16.00
Richness of Chironomid Diptera (%)	12.00
Richness of non-Chironomid Diptera (%)	8.00
Richness of Coleoptera (%)	16.00
Richness of Odonata (%)	8.00

Abundance. Mean abundance for quantitative targeted riffle samples was 611.80 individuals. Abundance values ranged from a low of 330 individuals to a high of 968 individuals.

Taxa richness. Taxa richness averaged 9.60 taxa per quantitative sample (fig. 13). Quantitative samples ranged from a low of 8 taxa to a high of 11. In the qualitative multihabitat samples, total richness was much higher, at 25 taxa.

Diversity. We measured taxonomic and functional diversity using the Simpson's Diversity Index (fig. 14). Taxonomic diversity averaged 0.42 per sample. Functional diversity averaged 0.25 per sample.

Anthropogenic stress tolerance. Aquatic macroinvertebrates classified as moderately tolerant of disturbance dominated samples from ESC01 in 2010 (fig. 15), accounting for 83.44% of all the individuals collected. Intolerant taxa abundance averaged 16.21%. Tolerant taxa were the least abundant, averaging 0.35% of each sample.

Table 4. Quantitative metrics for aquatic macroinvertebrate samples collected from ESC01 at the Escalante River in Glen Canyon National Recreation Area, Utah, 2010. For a given order, tolerance or functional feeding group, abundance-based metrics are expressed as the percentage of individuals in the group, while richness-based metrics are expressed as the percentage of taxa in the group.

	2010	
Quantitative metric	**Mean**	**SD**
Total abundance	611.80	239.16
Total richness	9.60	1.14
Simpson's Diversity—taxonomic	0.42	0.20
Simpson's Diversity—functional group	0.25	0.15
Dominant taxa	71.05	20.64
Tolerance group		
Relative abundance of tolerant taxa (%)	0.35	0.47
Relative abundance of moderately tolerant taxa (%)	83.44	9.73
Relative abundance of intolerant taxa (%)	16.21	9.30
Richness of tolerant taxa (%)	10.94	10.62
Richness of moderately tolerant taxa (%)	41.32	10.22
Richness of intolerant taxa (%)	47.74	10.72
Functional group		
Relative abundance of collector-filterers (%)	83.54	12.97
Relative abundance of collector-gatherers (%)	15.07	12.14
Relative abundance of scrapers (%)	0.35	0.32
Relative abundance of shredders (%)	0.10	0.16
Relative abundance of predators (%)	0.94	0.78
Richness of collector-filterers (%)	21.53	2.58
Richness of collector-gatherers (%)	46.41	8.28
Richness of scrapers (%)	10.76	1.29
Richness of shredders (%)	4.50	6.22
Richness of predators (%)	16.80	4.81
Taxonomic group		
Number of EPT taxa	4.00	1.00
Relative abundance of EPT taxa (%)	24.05	19.77
Relative abundance of Ephemeroptera (%)	11.59	11.97
Relative abundance of Plecoptera (%)	0.00	0.00
Relative abundance of Trichoptera (%)	12.46	8.11
Relative abundance of noninsect taxa (%)	0.78	0.55
Relative abundance of Chironomid Diptera (%)	1.40	0.68
Relative abundance of non-Chironomid Diptera (%)	71.05	20.64
Relative abundance of Coleoptera (%)	2.73	1.48
Relative abundance of Odonata (%)	0.00	0.00

Figure 13. Mean taxa richness in quantitative targeted riffle samples and total taxa richness in qualitative multihabitat samples collected from ESC01 at the Escalante River, in GLCA, 2010

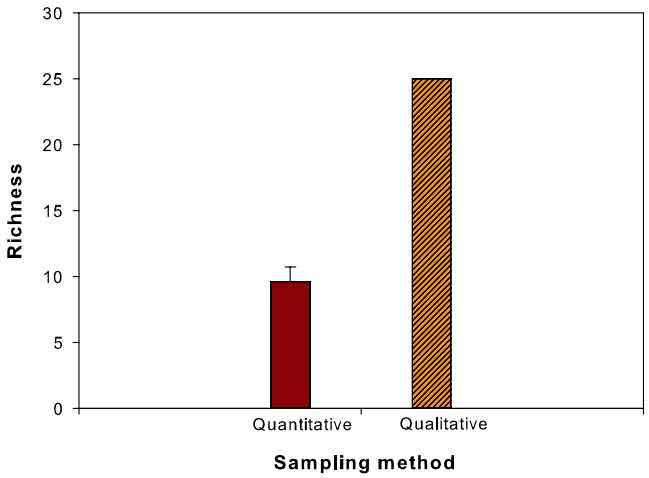


Figure 14. Simpson's Diversity Index for taxonomic and functional diversity in quantitative targeted riffle samples from ESC01 at the Escalante River in GLCA, 2010

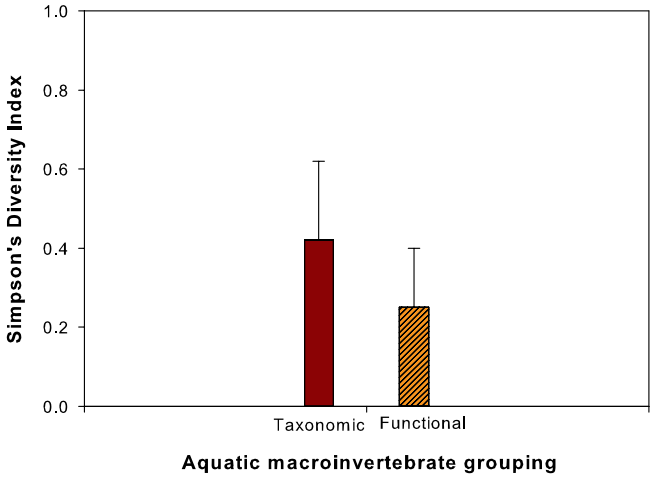
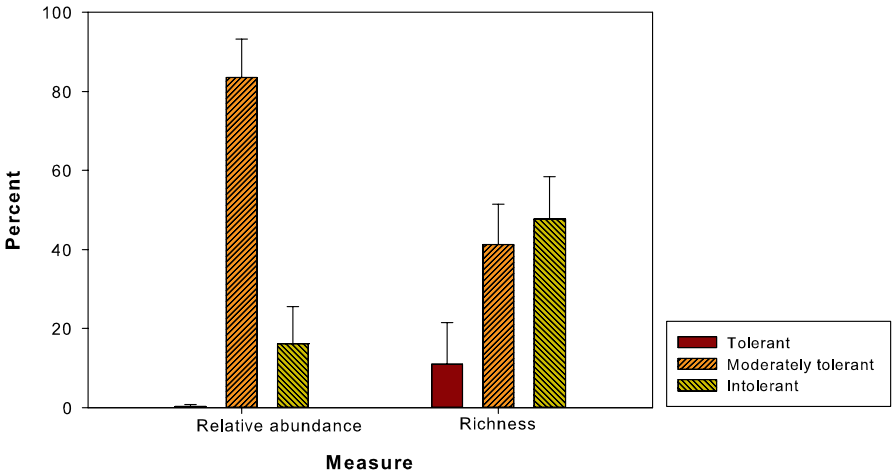


Figure 15. Mean relative abundance and richness of aquatic macroinvertebrate taxa in quantitative targeted riffle samples collected from ESC01 at the Escalante River in GLCA, 2010, based on tolerance to perturbation



EPT taxa. Individuals belonging to the sensitive EPT taxa group (Ephemeroptera, Plecoptera, Trichoptera) accounted for 24.05% of all aquatic macroinvertebrates collected (fig. 16). Trichoptera were the most abundant at 12.46%, followed by Ephemeroptera at 11.59%. No Plecoptera were collected at ESC01 in 2010.

Aquatic macroinvertebrate orders. Non-chironomid dipterans were the most abundant of all aquatic macroinvertebrates sampled at ESC01 in 2010 (fig. 17). Relative abundance of non-chironomid dipterans averaged 71.05%. Trichopterans were the second most abundant, at 12.46%, followed by ephemeropterans at 11.59%. Coleopterans averaged 2.73% of each sample and chironomids averaged 1.40%. Relative abundance of noninsect taxa (those taxa that are not benthic insects or insect taxa, e.g., water boatmen/striders, and water mites) was 0.78%. No odonates were collected in 2010.

Functional feeding groups. Relative abundance by functional feeding group was overwhelmingly dominated by collector-filterers (fig. 18), which averaged 83.54%. Collector-gatherers were the second most abundant functional feeding group, at 15.07%. Predators, scrapers, and shredders all averaged <1% abundance.

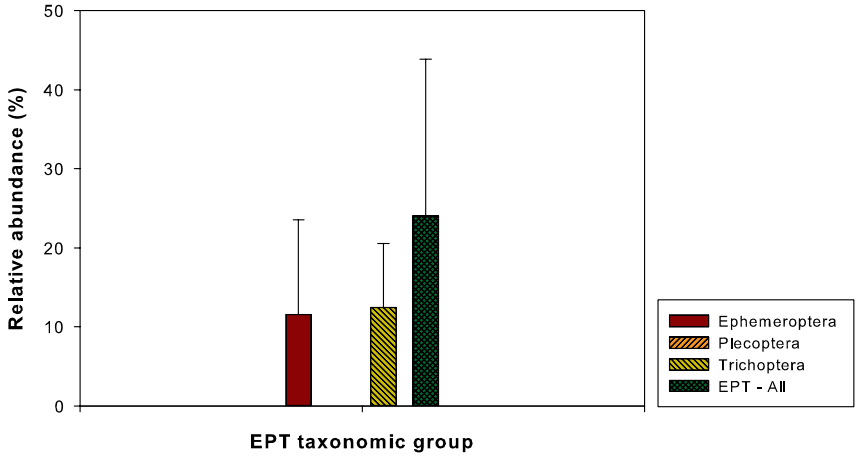


Figure 16. Relative abundance of sensitive EPT orders in quantitative targeted riffle samples from ESC01 at the Escalante River in GLCA, 2010

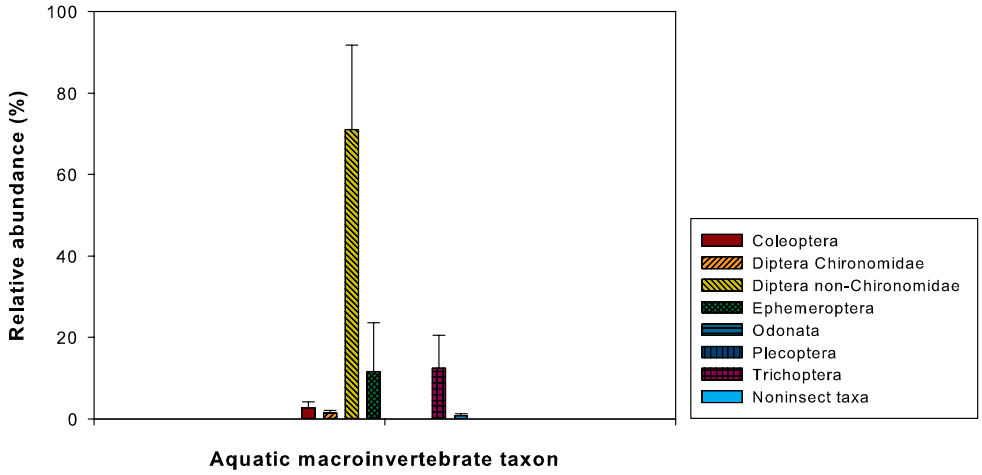


Figure 17. Relative abundance of individuals by taxonomic order in quantitative targeted riffle samples collected from ESC01 at the Escalante River in GLCA, 2010

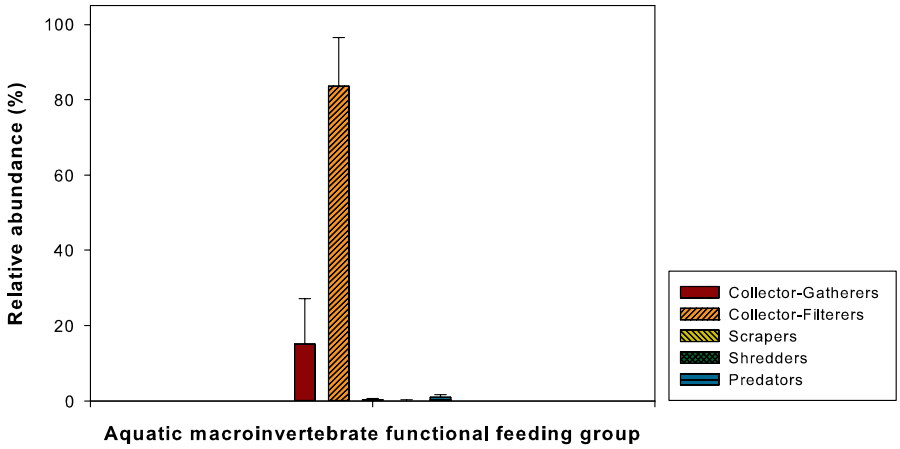


Figure 18. Relative abundance of functional feeding groups in quantitative targeted riffle samples from ESC01 at the Escalante River, in GLCA, 2010

3.5 Physical habitat characteristics for the Escalante River

Microhabitat level. The average velocity of stream flow at the targeted riffle sampling sites was 0.73 m/s (table 5). Depths averaged 0.13 m. Particle embeddedness averaged 37.8%.

Transect level. The active channel widths along ESC01 averaged 46.0 m (table 5). Wetted channel widths averaged 12.5 m. Velocity along reach transects averaged 0.38 m/s and depths averaged 0.24 m. Riparian canopy cover along transects averaged 13.6% cover.

Rock was the dominant aquatic macroinvertebrate habitat type found along ESC01, making up 33.8% of the reach (fig. 19). Root wads (4.2%) and vegetation (5.6%) were the only other habitat types found along our sampling reach. Approximately 56% of the sampling reach lacked habitat ("Absence") that we define as appropriate for aquatic macroinvertebrates.

Reach level. Channel structure dynamics are represented by particle size distributions in Figure 20, based on modified Wolman pebble counts. Fine particles (<2 mm) were the dominant particle size. Fines were found along 42.7% of the sampling reach. The remaining 57.3% of particles were well distributed among the other particle size classes.

Geomorphic channel units along our sampling reach at ESC01 were dominated by glides, which made up 43.1% of the reach (fig. 21). Riffles were the second most abundant GCU at 31.1%. Runs were found along 26.1% of the sampling reach.

3.6 Hydrologic conditions for the Escalante River

In conjunction with collecting aquatic macroinvertebrate and physical habitat data at ESC01, we also collected water quality data. Values presented in Table 5 represent recorded measurements at or near midday of the sample date. The midday temperature at ESC01 was 21.1°C. Specific conductivity measured 576 µS/cm. pH measured 8.5. Dissolved oxygen measured 2.5% saturation and 0.2 mg/L. Turbidity averaged 21 NTU. Stream discharge at our sampling reach was 26.1 cfs.

Table 5. Physical habitat and hydrologic data from ESC01 at the Escalante River in Glen Canyon National Recreation Area, Utah, 2010. Particle embeddedness and canopy closure measurements are expressed as percentages.

	2010	
Physical habitat metric	**Mean**	**SD**
Microhabitat level		
Riffles		
Velocity (m/s)	0.73	0.41
Depth (m)	0.13	0.05
Embeddedness (%)	37.8	13.2
Transect level		
Channel dimensions		
Velocity (m/s)	0.38	0.14
Depth (m)	0.24	0.06
Wetted channel width (m)	12.5	3.1
Active channel width (m)	46.0	19.9
Riparian cover		
Canopy closure (%)	13.6	25.0
Reach level		
Water quality	**Value**	
Temperature (°C)	21.1	
Specific conductivity (µS/cm)	576	
pH	8.5	
Dissolved oxygen (% saturation)	2.5	
Dissolved oxygen (mg/L)	0.2	
Turbidity (NTU)	21	
Discharge (cfs)	26.1	

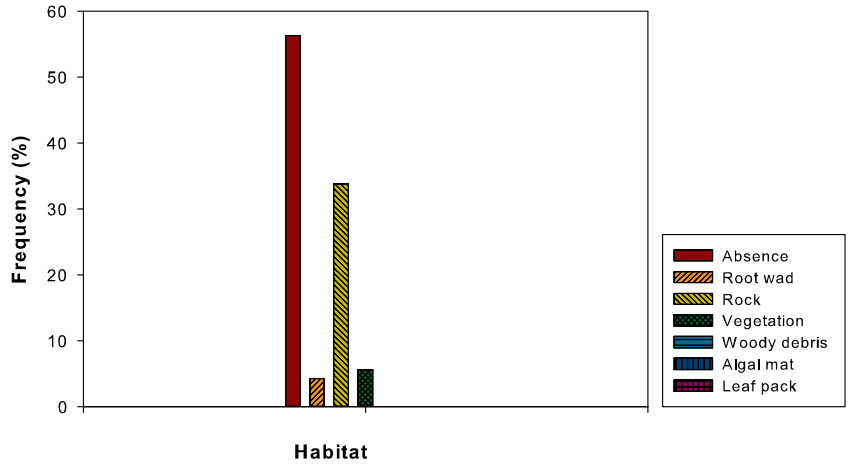


Figure 19. Aquatic macroinvertebrate habitat characterization based upon line point intercept data collected at habitat transects from ESC01 at the Escalante River in GLCA, 2010. Some habitat structures were not observed.

Figure 20. Particle size distribution, based on a minimium of 400 particles collected from ESC01 at the Escalante River in GLCA, 2010. EB represents particles that are completely embedded into the stream channel, which precludes size measurements.

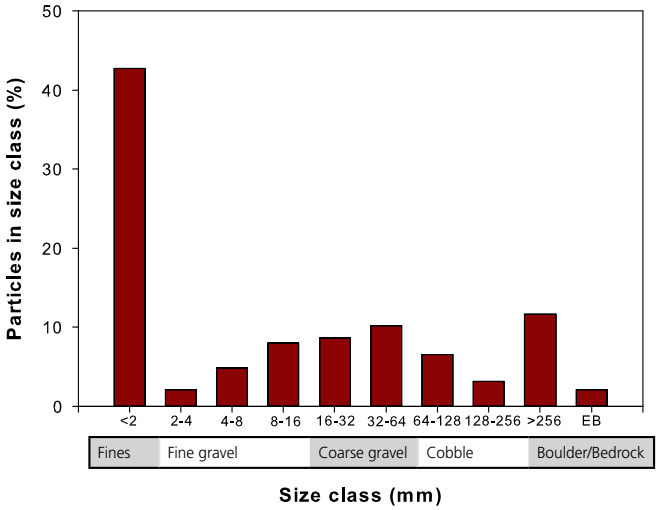
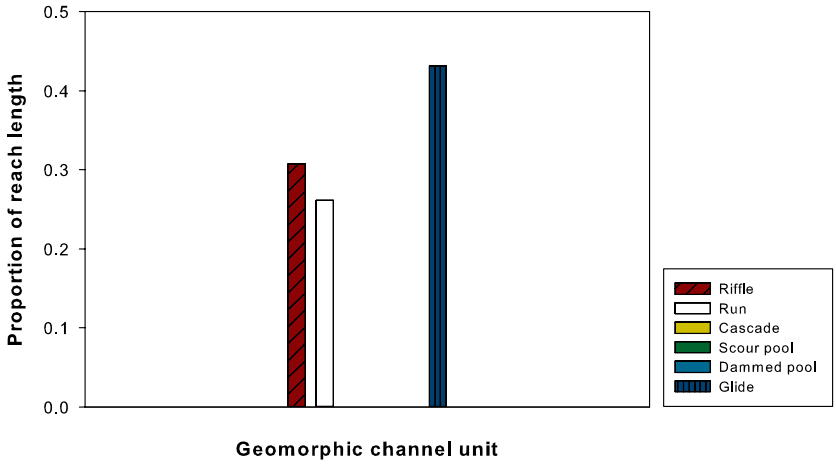


Figure 21. Geomorphic channel unit characterization from ESC01 at the Escalante River in GLCA, 2010. Some geomorphic channel units were not observed.



4 Discussion

This report presents data from SCPN's third year of monitoring aquatic macroinvertebrates and physical habitat at Coyote Gulch, as well as our first year of monitoring aquatic macroinvertebrates and physical habitat at the Escalante River 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 one or three 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 2010. 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 2010.

4.1 Aquatic macroinvertebrate community

Qualitative samples from COY01 indicate that the organisms living in Coyote Gulch are well adapted to the conditions of the stream. Moderately tolerant and intolerant taxa accounted for 91% (spring) and 86% (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 of taxa sampled at COY01 suggests that those present are well suited for the current conditions of the stream.

Quantitative samples from ESC01 indicate that relative abundance is fairly high (611.80), but richness and diversity are low. On average, only 9.6 different taxa were found in each sample taken from the Escalante River. Taxonomic diversity averaged 0.42 and functional diversity only 0.25. On average, 71.05% of the individuals collected from each sample were non-chironomid dipterans, and their large abundance contributed to the low diversity found along riffles at ESC01. This result was not consistent across sample types, as Ephemeroptera were the most taxa rich aquatic macroinvertebrate from our qualitative multihabitat sample.

4.2 Physical habitat

Aquatic macroinvertebrate habitat diversity remains low at Coyote Gulch. During both sampling seasons, the majority of the site lacked habitat known to be associated with aquatic macroinvertebrates. Although vegetative habitats existed at the site, the majority of those habitats were allochthonous inputs from riparian vegetation and thus mobile and not stable habitat. We did not find any aquatic vegetation in Coyote Gulch.

While aquatic macroinvertebrate habitat at our monitoring site on the Escalante River was dominated by the "Absence" category, like COY01, rock (gravel to cobble sized particles) habitat composed a third of the reach. Root wads and vegetation were also present, allowing for a greater diversity of known habitat types.

Substrate particle diversity was greater at the ESC01 site at the Escalante River compared to the COY01 site at Coyote Gulch. During the spring of 2010 at COY01, over 98% of the site was composed of either fine particles (silt and sand) or bedrock. The fall sampling period saw a small increase in gravel size classes. Fine particles were the most abundant size class at our site on the Escalante River as well. However, we did see a large distribution of particles across all gravel and cobble size classes. These size classes provide habitat for aquatic macroinvertebrate taxa.

The data in this report should be viewed as a snapshot of conditions existing within the aquatic community at the time of our visit. When sufficient data are available, SCPN plans to produce an interpretive report including trend analysis of aquatic macroinvertebrate metrics and physical habitat data for both Coyote Gulch and the Escalante River.

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Appendix A Aquatic macroinvertebrate monitoring sites at Glen Canyon National Recreation Area, Utah, 2010

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 two monitoring sites in Glen Canyon National Recreation Area, Utah, 2010. A bold **X** under the site column denotes a new record for this SCPN monitoring site.

Phylum	Class	Order	Family	SubFamily	Genus	Species	Common name	COY01	ESC01
Annelida							segmented worms	X	**X**
Arthropoda	Arachnida	Trombidiformes					water mites	X	
Arthropoda	Arachnida	Trombidiformes					water mites		**X**
Arthropoda	Arachnida	Trombidiformes	Sperchonidae				water mites		**X**
Arthropoda	Arachnida	Trombidiformes	Sperchonidae		*Sperchon* sp.		water mites		**X**
Arthropoda	Insecta	Coleoptera	Dytiscidae	Hydroporinae	*Liodessus* sp.		predaceous diving beetles	**X**	**X**
Arthropoda	Insecta	Coleoptera	Dryopidae		*Helichus* sp.		long toed water beetles	X	**X**
Arthropoda	Insecta	Coleoptera	Elmidae				riffle beetles	X	**X**
Arthropoda	Insecta	Coleoptera	Elmidae		*Microcylloepus*	*pusillus*	pusillanimous riffle beetle	X	**X**
Arthropoda	Insecta	Coleoptera	Elmidae		*Stenelmis* sp.		riffle beetles		**X**
Arthropoda	Insecta	Coleoptera	Hydrophilidae				water scavenger beetle	X	
Arthropoda	Insecta	Diptera					flies	X	**X**
Arthropoda	Insecta	Diptera	Tabanidae		*Tabanus* sp.		horse flies	X	
Arthropoda	Insecta	Diptera					long-horned flies	X	
Arthropoda	Insecta	Diptera	Ceratopogonidae				biting midges	X	**X**
Arthropoda	Insecta	Diptera	Ceratopogonidae	Ceratopogoninae	*Probezzia* sp.		biting midges	X	
Arthropoda	Insecta	Diptera	Ceratopogonidae	Forcipomyiinae	*Atrichopogon* sp.		biting midges		**X**
Arthropoda	Insecta	Diptera	Chironomidae				midges	X	**X**
Arthropoda	Insecta	Diptera	Chironomidae	Chironominae			non-biting midges	X	
Arthropoda	Insecta	Diptera	Chironomidae	Chironominae	*Chironomus* sp.		midges		**X**
Arthropoda	Insecta	Diptera	Chironomidae	Orthocladiinae			non-biting midges	X	**X**
Arthropoda	Insecta	Diptera	Chironomidae	Tanypodinae			midges	X	**X**
Arthropoda	Insecta	Diptera	Simuliidae				black flies		**X**
Arthropoda	Insecta	Diptera	Simuliidae	Simuliinae	*Simulium* sp.		black flies	X	**X**
Arthropoda	Insecta	Diptera	Simuliidae	Simuliinae	*Simulium*	*bivittatum*	black flies	X	
Arthropoda	Insecta	Diptera	Tipulidae				crane flies	X	
Arthropoda	Insecta	Ephemeroptera	Leptohyphidae		*Tricorythodes* sp.		little stout crawler mayflies	X	X

Appendix C (*continued*)

Phylum	Class	Order	Family	SubFamily	Genus	Species	Common name	COY01	ESC01
Arthropoda	Insecta	Ephemeroptera	Baetidae				small minnow mayflies	X	**X**
Arthropoda	Insecta	Ephemeroptera	Baetidae		*Acentrella* sp.		small minnow mayflies		**X**
Arthropoda	Insecta	Ephemeroptera	Baetidae		*Baetis* sp.		small minnow mayflies	X	**X**
Arthropoda	Insecta	Ephemeroptera	Baetidae		*Callibaetis* sp.		small minnow mayflies		**X**
Arthropoda	Insecta	Ephemeroptera	Baetidae		*Camelobaetidius* sp.		small minnow mayflies		**X**
Arthropoda	Insecta	Ephemeroptera	Baetidae		*Fallceon*	*quilleri*	small minnow mayflies		**X**
Arthropoda	Insecta	Ephemeroptera	Baetidae		*Pseudocloeon* sp.		small minnow mayflies	X	**X**
Arthropoda	Insecta	Ephemeroptera	Heptageniidae				stream mayflies		**X**
Arthropoda	Insecta	Hemiptera	Naucoridae	Ambrysinae	*Ambrysus* sp.		creeping water bugs	X	**X**
Arthropoda	Insecta	Hemiptera	Veliidae	Rhagoveliinae	*Rhagovelia* sp.		small water striders		**X**
Arthropoda	Insecta	Odonata	Aeshnidae				darners	**X**	
Arthropoda	Insecta	Odonata	Gomphidae		*Erpetogomphus* sp.		ringtailed dragonflies		**X**
Arthropoda	Insecta	Odonata					dragonflies		**X**
Arthropoda	Insecta	Odonata	Calopterygidae		*Hetaerina* sp.		broad-winged damsel-flies		**X**
Arthropoda	Insecta	Odonata	Calopterygidae				broad-winged damsel-flies		**X**
Arthropoda	Insecta	Odonata	Coenagrionidae				narrow-winged dam-selflies	**X**	
Arthropoda	Insecta	Plecoptera					stoneflies	X	
Arthropoda	Insecta	Trichoptera	Hydropsychidae	Hydropsychinae	*Hydropsyche* sp.		netspinning caddisflies	X	**X**
Arthropoda	Insecta	Trichoptera	Hydropsychidae				netspinning caddisflies	X	
Arthropoda	Insecta	Trichoptera	Hydroptilidae				microcaddisflies		**X**
Arthropoda	Insecta	Trichoptera	Uenoidae		*Oligophlebodes* sp.		stone case caddiflies	**X**	**X**
Arthropoda	Malacos-traca	Amphipoda					amphipods	X	
Nemata							nematodes		**X**

Appendix D Measured velocity and channel characteristics at the COY01 and ESC01 monitoring sites, Glen Canyon National Recreation Area, Utah, 2010

	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	0.50	0.20	0.04	0.03	5.1	7.1
2	0.19	—	0.03	0.04	4.5	13.0
3	0.39	0.20	0.05	0.04	3.6	15.3
4	0.42	0.16	0.06	0.02	6.0	6.9
5	0.53	0.15	0.08	0.01	3.3	5.4
6	0.43	0.14	0.07	0.03	3.0	7.8
7	1.73	0.73	0.11	0.02	1.0	6.6
8	0.47	0.12	0.12	0.03	1.8	6.8
9	0.48	0.17	0.15	0.03	1.1	2.8
10	0.42	0.33	0.12	0.05	1.8	3.7
11	0.44	0.11	0.51	0.01	0.8	7.7
COY01 Fall						
1	0.28	0.06	0.07	0.02	2.6	17.1
2	0.49	0.11	0.06	0.02	1.5	19.6
3	0.22	0.18	0.06	0.01	1.7	17.6
4	0.14	0.07	0.09	0.04	2.3	14.6
5	0.06	0.05	0.41	0.02	2.0	12.3
6	0.08	0.07	0.16	0.06	3.6	11.5
7	1.02	0.07	0.08	0.03	0.8	19.3
8	0.07	0.11	0.41	0.10	1.6	19.8
9	0.16	0.10	0.38	0.03	1.4	19.7
10	0.16	0.04	0.19	0.03	1.8	18.7
11	0.83	0.20	0.17	0.03	0.5	16.9
ESC01 Fall						
1	0.70	0.18	0.19	0.07	9.3	17.4
2	0.52	0.32	0.18	0.06	13.1	23.7
3	0.33	0.06	0.23	0.14	19.7	35.7
4	0.20	0.11	0.41	0.13	11.2	42.5
5	0.42	0.15	0.29	0.12	12.1	47.9
6	0.36	0.29	0.26	0.07	11.7	—
7	0.24	0.09	0.21	0.12	15.4	—
8	0.31	0.09	0.22	0.13	14.8	68.3
9	0.31	0.07	0.25	0.06	9.6	68.6
10	0.35	0.25	0.21	0.10	10.0	64.0
11	0.38	0.21	0.18	0.02	10.6	—