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

2008 Summary Report

Natural Resource Data Series NPS/SCPN/NRDS—2010/032

ON THE COVER
Coyote Creek, Glen Canyon National Recreation Area
Photograph by Stacy Stumpf

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Stacy E. Stumpf
Stephen A. Monroe

National Park Service
Southern Colorado Plateau Network
Northern Arizona University
P.O. Box 5765
Flagstaff, AZ 86011-5765

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The corresponding author and project manager for this project is hydrologist Stephen Monroe (stephen_monroe@nps.gov). Stacy Stumpf is the Water Resources Crew Leader for the project. The 2008 crew consisted additionally of Ellen Soles. SCPN staff provided support for the project.

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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 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 in network parks as an overall indicator of aquatic ecosystem integrity (Thomas et al. 2006), and selected Coyote Gulch in Glen Canyon National Recreation Area (GLCA) for long-term monitoring of aquatic macroinvertebrates (fig. 1). Coyote Gulch was sampled in 2005 for a pilot study designed to develop and test aquatic macroinvertebrate monitoring protocols (Brasher et al. 2006). 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 streams.

In 2008 SCPN implemented aquatic macroinvertebrate and physical habitat monitoring at one site on Coyote Gulch in GLCA. Our monitoring site, *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. The channel substrate at the site is primarily fine sediment and bedrock, and the stream flows through a narrowleaf cottonwood (*Populus angustifolia*) and coyote willow (*Salix exigua*) sparse woodland. This site is co-located with an established USGS water quality monitoring site, *Coyote Gulch above Escalante River*, station number 372541110591100. Samples were collected during the spring and fall of the 2008 field season.

The purpose of this report is to (a) document monitoring activities that have occurred in 2008, (b) summarize data that were collected, and (c) place these data in the context of aquatic habitat and biological condition, and management actions within the park through time.

The Coyote Gulch watershed is managed for recreational use within GLCA boundaries. The upper portion of the Coyote Gulch watershed is located within the 1.9 million acre Grand Staircase-Escalante National Monument and is managed for multiple uses by the Bureau of Land Management (BLM). Coyote Gulch is the largest perennial tributary of the Escalante River, which flows into man-made Lake Powell. Fluctuating water levels in the lake 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. These floods deposited large quantities of fine sediments in the lower sections of the stream, obliterating all riffle habitat within our sampling reach. Because of the loss of riffle habitat, we did not collect quantitative samples during our 2008 sampling trips. If after 5 years the sample site has not recovered and riffle habitat is still not available, then SCPN will establish a new sample site elsewhere on Coyote Gulch (Brasher et al. *in review*).

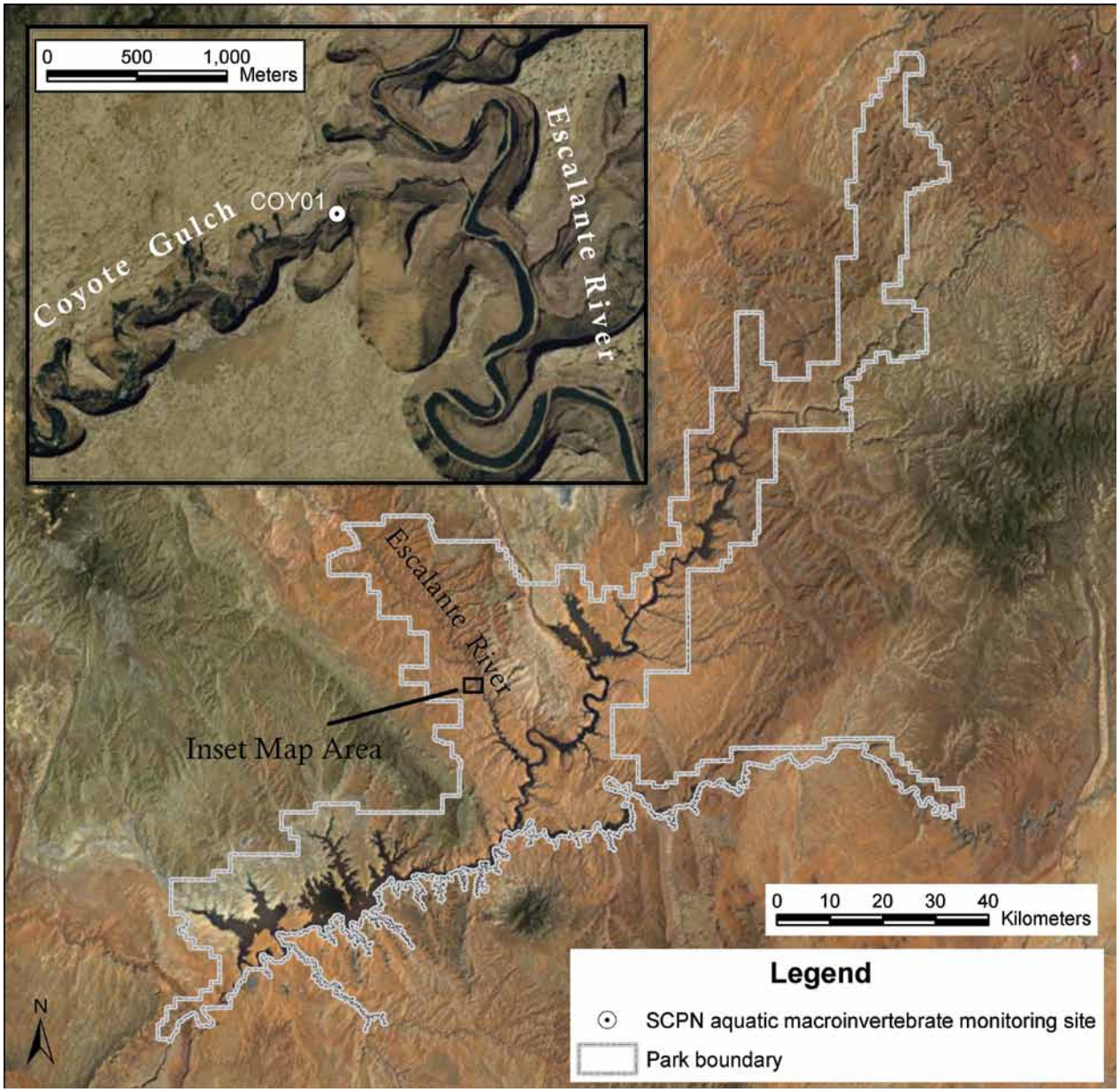

Figure 1. Location map of Coyote Gulch, Glen Canyon National Recreation Area. Aquatic macroinvertebrate monitoring site, COY01 is depicted in the inset. Backdrop imagery source: ESRI, i-cubed, GeoEye.

2 Methods

2.1 Field Methods

The SCPN Aquatic Macroinvertebrate Protocol specifies sampling events should be timed to coincide with sample windows defined by relevant state agencies (Brasher et al. *in review*). In Utah, aquatic macroinvertebrate samples are collected from perennial streams during September–October (UDEQ-DWQ 2006), however, in Arizona, macroinvertebrate samples are collected from warm-water perennial sites (below 1,500 m elevation) during April–May (ADEQ-WQD 2006). Based on results of the 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. On May 12 and

September 14, 2008 SCPN Water Resources field crew collected aquatic macroinvertebrate samples and physical habitat data at one site (COY01) on Coyote Gulch in Glen Canyon National Recreation Area (GLCA). The samples and 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. (*in review*).

We collected qualitative samples from all habitat types within the reach using a Slack sampler. We combined the samples into one composite qualitative sample, which provided a comprehensive species list for this site on this date. (Appendix C). A list of the habitat types from which qualitative samples were collected can be found in section 3.2 of this report.

We collected physical habitat data at the transect and reach scales.

- For each of the 11 transects (see fig. 2), we
  - measured wetted and active channel widths
  - measured water depth, velocity, and canopy closure at multiple points along each transect
  - observed and recorded the presence or absence, and types of macroinvertebrate habitats. Macroinvertebrate habitat cover represents point data (5 points/transect) across the entire reach
  - measured geomorphic channel units (GCU) at multiple points along each transect
  - measured the size of 40-50 randomly-selected particles using a modified Wolman pebble count
- For each 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

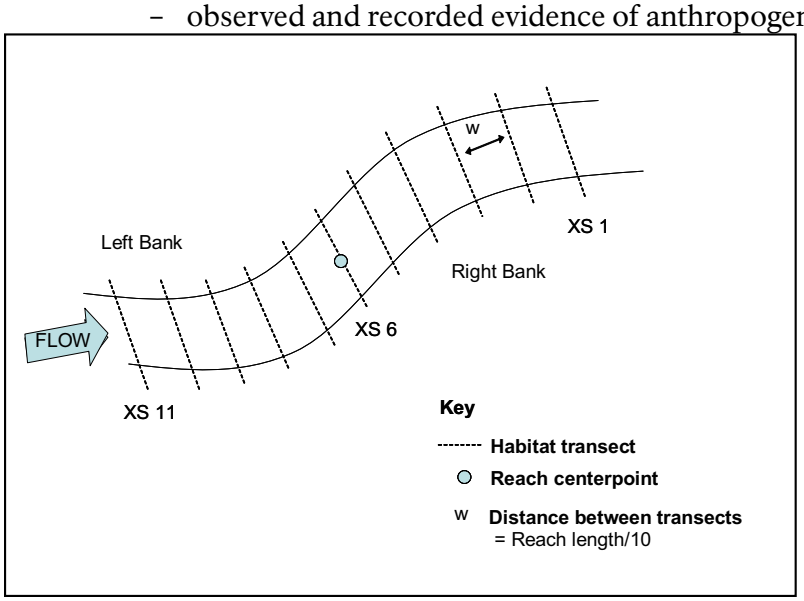

Figure 2. General aquatic-macroinvertebrate sampling reach layout.

- measured NPS core water quality parameters of temperature, specific conductivity, pH, dissolved oxygen, and turbidity

2.3 Laboratory Methods

Macroinvertebrate samples were sent to be sorted and identified at the Utah State University National Aquatic Monitoring Center's Bug Lab, a BLM laboratory based in Logan, Utah. Samples were sorted under a dissecting scope at 10× magnification, and a 500-organism, fixed-count method was used for subsampling 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. Ten percent of the identified samples were re-identified by a second certified taxonomist to ensure data quality.

Quantitative and qualitative 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. (*in review*).

2.4 Data Analysis

Aquatic macroinvertebrate data were summarized 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, a more generalized, family-level classification was applied.

Metrics presented in this report were selected because they are generally considered to be sensitive, reliable indicators of water quality and/or stream health. The majority of these metrics have previously been used to detect changes in water quality and habitat conditions in other streams in the Southern Rocky Mountains ecoregion (Griffith et al. 2005). Metrics are a useful analysis tool for macroinvertebrate data because they address a range of ecological characteristics and enable a comprehensive assessment of multiple aspects of community structure. SCPN will periodically evaluate the interpretive value of the listed metrics and may drop or add additional metrics based upon these evaluations. See Appendix B for a list of selected aquatic macroinvertebrate metrics.

3 Results

3.1 Summary of Aquatic Macroinvertebrate Community Data

Data describing aquatic macroinvertebrate communities from samples collected during two sampling periods in 2008 at COY01 on Coyote Gulch in GLCA are presented in Table 1.

Taxa richness was greatest in samples collected during the fall. We found 21 taxa in the fall, as compared to 18 taxa in the spring (fig. 3).

Tolerant taxa. Richness was greatest for moderately tolerant taxa in samples collected during both sampling seasons. Moderately tolerant taxa comprised 65% of the spring sample and 56% of the fall sample. There were no large differences in the richness of tolerant or intolerant taxa between spring or fall samples (fig. 4).

EPT taxa. Percent richness of EPT (Ephemeroptera, Plecoptera, Trichoptera) taxa was nearly twice as high during the fall sampling season as compared to the spring. Nearly 30% of the taxa

Table 1. Summary of macroinvertebrate metrics based on samples collected from COY01 in Coyote Gulch at GLCA during the spring and fall of 2008. Richness-based metrics are expressed as the number of different taxa in a particular sample.

Qualitative Multihabitat	Spring	Fall
Taxa richness	18.00	21.00
Richness of Tolerant taxa (%)	11.76	16.67
Richness of Filterer-collectors (%)	11.11	9.52
Richness of Scrapers (%)	5.56	4.76
Number of EPT taxa	3.00	6.00
Richness of EPT taxa (%)	16.67	28.57
Richness of Ephmeroptera (%)	11.11	23.81
Richness of Plecoptera (%)	0.00	0.00
Richness of non-insect taxa (%)	5.56	9.52
Richness of Chironomids (%)	16.67	14.29

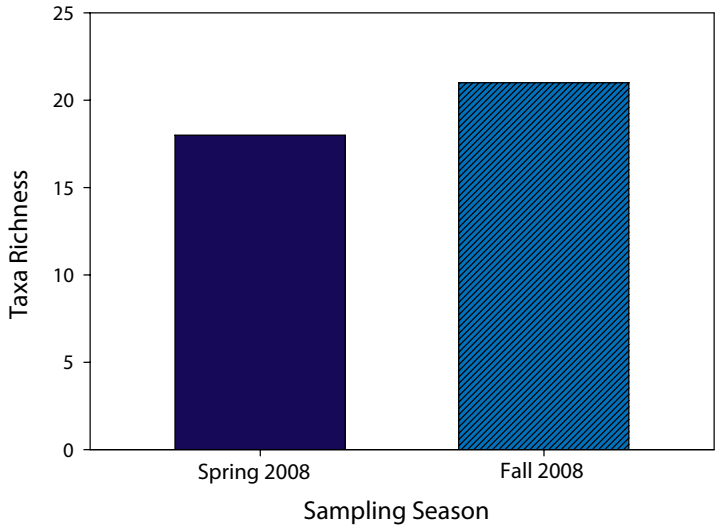

Figure 3. Taxa richness. Taxa richness of qualitative multihabitat samples collected from COY01 in Coyote Gulch at GLCA during the spring and fall of 2008.

in the fall sample belonged to EPT orders. Ephemeroptera (mayflies) represented 83% of the EPT taxa collected in the fall and 67% of EPT spring taxa. Trichoptera (caddisflies) richness was much lower at 6% of spring and 5% of fall samples. We found no Plecoptera (stoneflies) during either sampling season (fig. 5).

Aquatic macroinvertebrate orders. Spring samples collected from Coyote Gulch were dominated by Chironomid dipterans (midges) and non-Chironomid dipterans (flies). These orders combined comprised 78% of the sample collected during the spring. Ephemeropterans were dominant in fall samples, making up 79% of the taxa found. Few (<5%) Colepterans (beetles), Odonates (dragon/damselflies) or Trichopterans (caddisflies) were collected during either spring

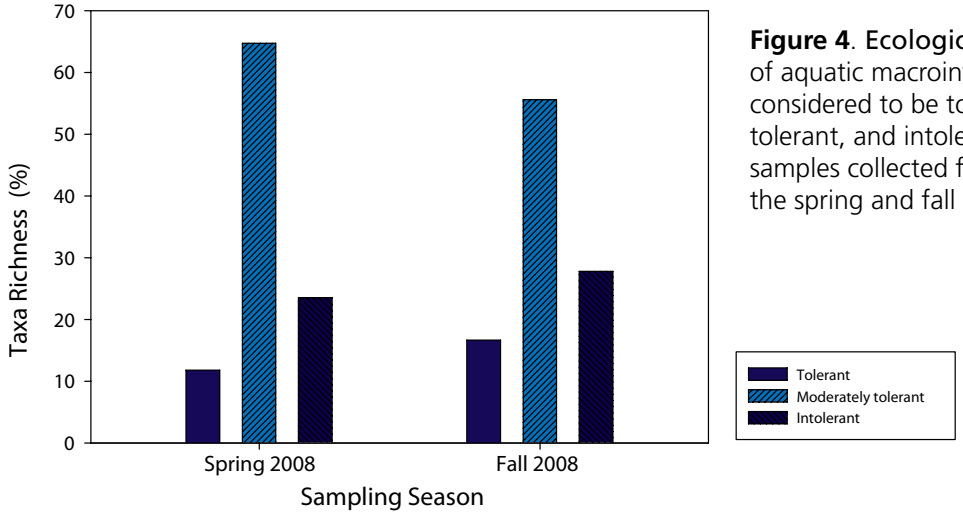

Figure 4. **Ecological tolerance**. Percent of aquatic macroinvertebrate taxa considered to be tolerant, moderately tolerant, and intolerant to perturbation in samples collected from COY01 at GLCA in the spring and fall of 2008.

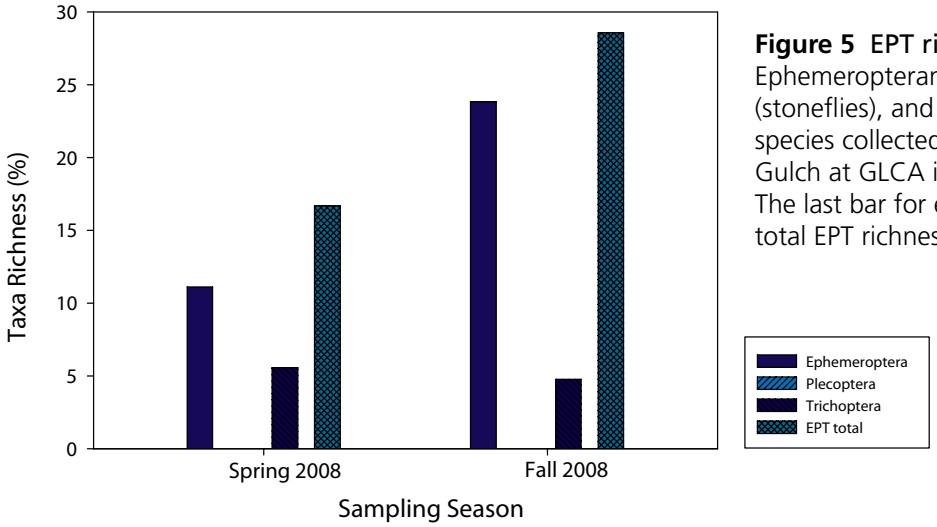

Figure 5 EPT richness. Taxa richness of Ephemeropteran (mayflies), Plecopteran (stoneflies), and Trichopteran (caddisflies) species collected from COY01 in Coyote Gulch at GLCA in spring and fall of 2008. The last bar for each season represents the total EPT richness.

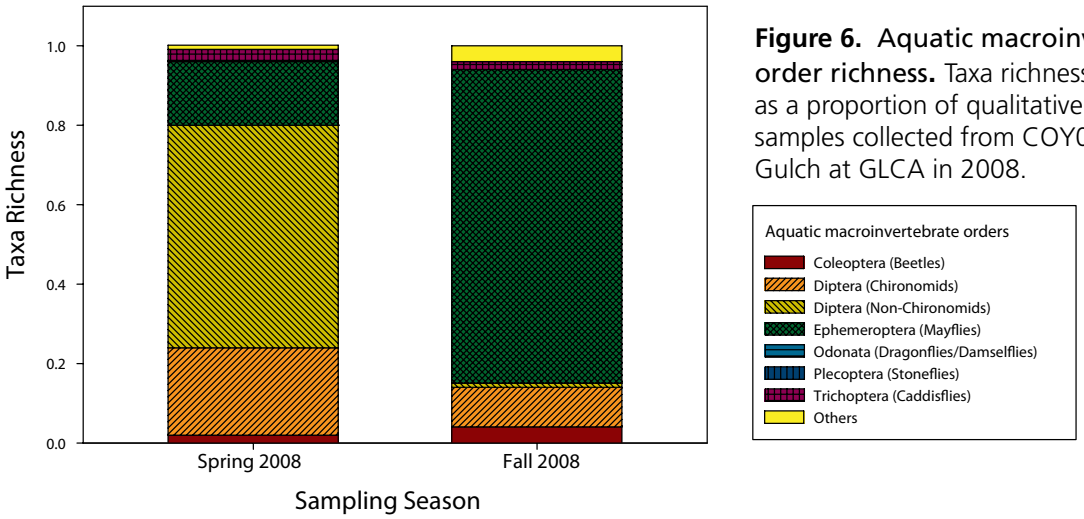

Figure 6. Aquatic macroinvertebrate order richness. Taxa richness, by order, as a proportion of qualitative multihabitat samples collected from COY01 in Coyote Gulch at GLCA in 2008.

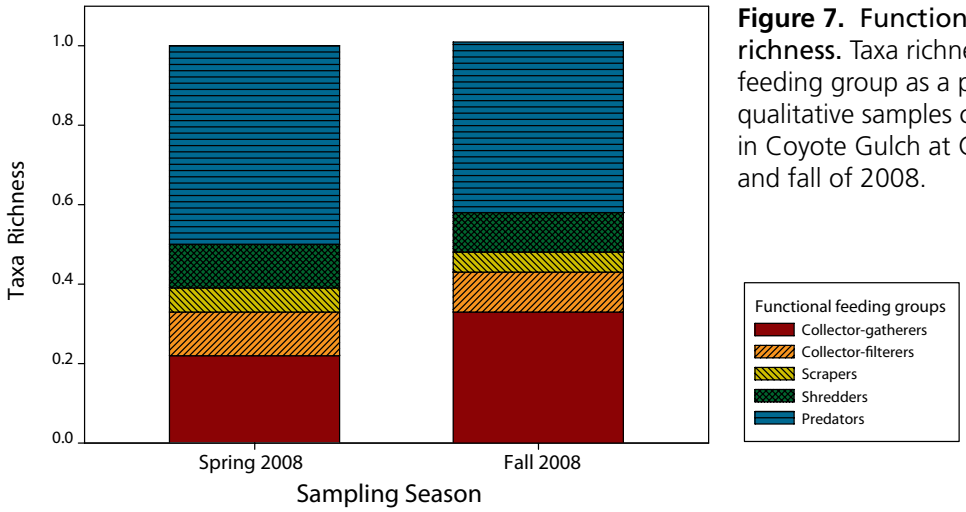

Figure 7. Functional feeding group richness. Taxa richness by functional feeding group as a proportion of qualitative samples collected from COY01 in Coyote Gulch at GLCA during the spring and fall of 2008.

or fall (fig. 6).

Functional feeding groups. Taxa richness based on functional feeding groups was dominated during both seasons by Predators, which made up 50% of the taxa collected in the spring and 43% of the taxa collected in the fall. Collector-gatherer species were the second largest functional group, making up 22% of the spring sample and 33% of the fall sample. Taxa richness for Scrapers and Shredders did not differ greatly between seasons —6% and 11% respectively for the spring sample and 5% and 10% respectively for the fall sample (fig. 7).

3.2 Summary of Physical Habitat Characteristics

Physical habitat data collected from COY01 in Coyote Gulch at GLCA during spring and fall of 2008 is presented in Table 2. Additional transect and microhabitat data can be found in Appendix D. Particle size distribution data are presented as the proportion of particles counted across each transect per reach. Macroinvertebrate habitat cover represents point data (5 points/transect) averaged across the entire reach. Reach characterization data represents the proportion of the reach characterized by a particular geomorphic channel unit (GCU).

Transect level. Mean velocity, depth, and riparian cover did not vary appreciably between the sampling seasons. Wetted channel width decreased more than twofold and active channel width increased by 2 meters between sampling seasons (table 2).

Channel structure dynamics are represented by grain size distributions in Figure 8. Grain size distributions were controlled primarily by finer sediments during both sampling seasons, based on modified Wolman pebble counts. In the spring, we found grain sizes outside of the fines size class (<2 mm) in our sampling reach. In the fall, we found pebbles that fit into each of the size classes possible. Pebble counts represented by the size class >256 mm were represented by bedrock in Coyote Gulch (fig. 8).

Reach level. Ninety-eight percent of our reach lacked appropriate aquatic macroinvertebrate habitat during the spring 2008 sampling period. The remaining 2% sampled was composed of woody debris. During our fall sampling effort, aquatic macroinvertebrate habitat increased to 15%. Rock and woody debris composed 13% and 2% of the sampling reach respectively (fig. 9).

(*continued on page 9)*

Table 2. Summary of physical habitat transect data from COY01 in Coyote Gulch at GLCA in 2008. Wetted and active channel measurements are expressed as widths. Particle embeddedness and canopy closure measurements are expressed as percentages. Water quality measurements were made at or near noon on the day of the sampling event.

COY01	Spring 2008		Fall 2008	
Transect level	**Mean**	**SD**	**Mean**	**SD**
Channel dimensions				
Velocity (m/s)	0.31	0.24	0.29	0.10
Depth (m)	0.05	0.04	0.07	0.05
Wetted channel (m)	4.01	2.87	1.64	0.58
Active channel (m)	7.13	3.62	9.28	2.58
Riparian cover				
Canopy closure (%)	9.74	20.42	8.59	17.22
Reach level				
Water quality				
Temperature (°C)	24.4	–	21.4	–
Specific conductivity (µS/cm)*	328	–	316	–
pH	8.6	–	8.7	–
Dissolved oxygen (% Saturation)	100.1	–	111.9	–
Turbidity (NTU)**	38.9	–	38.9	–

* Microsiemens per cm
** Nephelometric Turbidity Units

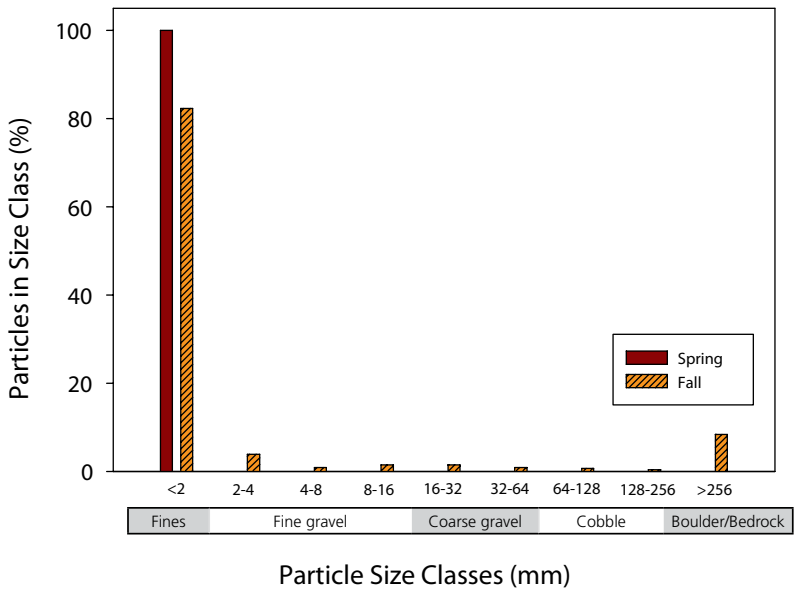

Figure 8. Channel surface substrate particle size distribution. Particle size distribution, based on modified Wolman pebble counts, for COY01 in Coyote Gulch at GLCA in spring and fall, 2008.

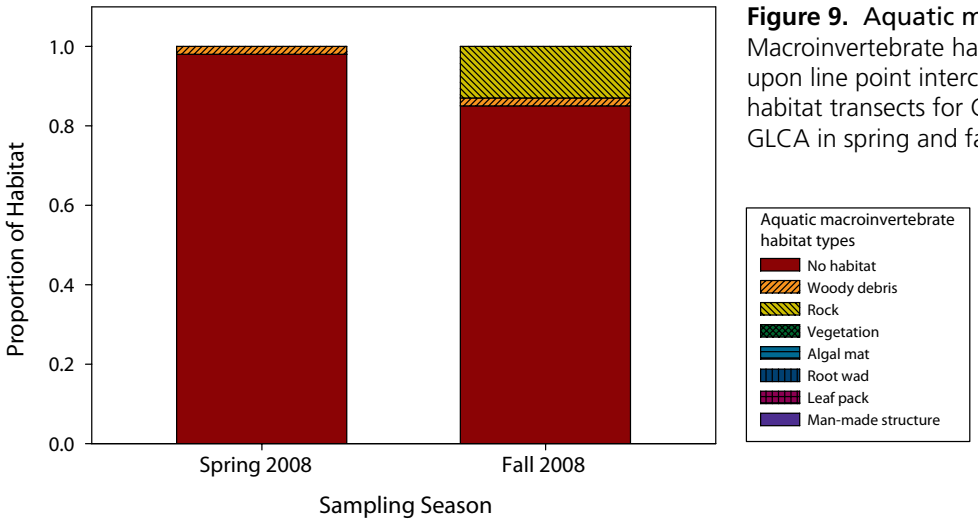

Figure 9. Aquatic macroinvertebrate habitat. Macroinvertebrate habitat characterization based upon line point intercept data collected along habitat transects for COY01 in Coyote Gulch at GLCA in spring and fall of 2008.

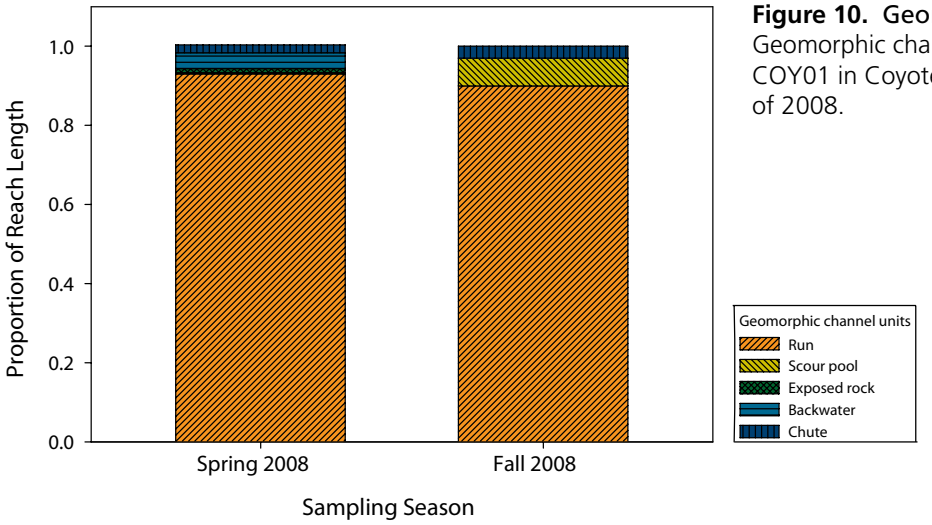

Figure 10. Geomorphic Channel Units. Geomorphic channel unit characterization of COY01 in Coyote Gulch at GLCA in spring and fall of 2008.

(*continued from page 7*)

Runs were the dominant geomorphic channel units (GCUs) found in our reach during both spring and fall, making up 93% of the reach in the spring and 90% in the fall. Scour pool presence increased from 0.03% of the reach in the spring to 7% in the fall. Exposed rock and backwaters were found in low quantities—0.01% and 0.04% respectively—during the spring, but were absent in the fall effort (fig. 10). For a complete description of GCUs see Brasher et al. (*in review*).

4 Discussion

Data included in this report represent SCPN's first year of monitoring aquatic macroinvertebrates and physical habitat at Coyote Gulch in Glen Canyon National Recreation Area (GLCA), Utah.

We were unable to collect quantitative samples at our site in the spring or fall of 2008. The large flash flood that occurred in October of 2006 and the subsequent smaller flood events appeared to

have affected riffle development within Coyote Gulch.

The conditions at our sampling site suggest that fall may be a better sampling period than spring. Overall, taxa richness and the number of EPT taxa were higher in the fall sample than in the spring sample. Richness of Coleopterans was double, and Ephemeropterans richness was almost fivefold greater in samples collected during the fall. We also found a more even distribution among tolerance values for the organisms collected in the fall as compared to spring. Tolerant and intolerant taxa increased in sample richness as the year progressed.

Physical habitat differed little between the spring and fall—low velocity, depth, and diversity of geomorphic channel units were nearly identical for both seasons. Aquatic macroinvertebrate habitat cover was one of the few metrics that did change between seasons. Spring samples lacked appropriate habitat, with only minor amounts of wood debris present. Rock habitat increased by 13% from the spring to the fall sampling effort. This increase may be one of the contributing factors for the increase in taxa richness, EPT taxa, and tolerance diversity that we found in the fall samples.

This report represents one year of monitoring data at Coyote Gulch, and should be viewed as a snapshot of conditions existing within the aquatic community at the time of our visit. In future years, as we add to the data set for this site, we will conduct trend analyses to interpret how stream and macroinvertebrate conditions change over time.

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Appendix A Monitoring site codes, names, and location information for Glen Canyon National Recreation Area.

Horizontal coordinates are reported in Universal Transverse Mercator (UTM) Projection, Zone 12, North American Datum of 1983 (NAD 83). Vertical coordinates are referenced to the North American Vertical Datum of 1988 (NAVD 88).

Site Code	Common Name	Report Name	UTM X	UTM Y	Elevation (m)
GLCACOY01	*Coyote Gulch above Crack-in-the-Wall Trail*	COY01	660576	4142251	1147

Appendix B Selected aquatic macroinvertebrate metrics*

Metric type	Metric	Definition
Abundance	Total abundance	Total number of individuals.
Richness	Taxa richness	Total number of taxa (measures the overall diversity of aquatic macroinvertebrates in a sample).
Diversity	Simpson's diversity	A measure of the variety of taxa that takes into account the relative abundance of each taxon. $D_S = 1-[(\Sigma n(n-1))/(N(N-1))]$
Tolerance	Dominant taxa	Measures the dominance of the most abundant taxa. Typically calculated as dominant 2, 3, 4, or 5 taxa.
	Relative abundance for tolerant taxa	Percent of individuals considered to be tolerant to perturbation.
	Percent richness for tolerant taxa	Percent of taxa considered to be tolerant to perturbation.
Functional-Feeding	Relative abundance filtering-collectors	Percent of individuals that filter fine particulate organic matter from the water column.
	Percent richness filtering-collectors	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 finer substrates).
	Percent richness burrowers	Percent of taxa that move between substrate particles (typically finer 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	Percent of Trichopteran individuals in Hydroptilidae plus Hydropsychidae (ratio of tolerant caddisfly abundance to total caddisfly abundance).
	Relative abundance non-insect taxa	Percent of individuals that are not insects.
	Relative abundance Chironomidae	Percent of individuals that are midges.

* from Brasher et al. (*in review*)

Appendix C Aquatic macroinvertebrate taxa collected from COY01 in Coyote Gulch at GLCA in the spring and fall of 2008.

Phylum	Class	Order	Suborder	Family	*Genus*	species	Common Name
Arthropoda	Arachnida	Trombidiformes					water mites
Arthropoda	Arachnida	Trombidiformes	Prostigmata	Lebertiidae	*Lebertia*		water mites
Arthropoda	Arachnida	Trombidiformes	Prostigmata	Sperchonidae	*Sperchon*		water mites
Arthropoda	Insecta	Coleoptera	Polyphaga	Dryopidae	*Helichus*		long-toed water beetles
Arthropoda	Insecta	Coleoptera	Polyphaga	Dryopidae	*Postelichus*		long-toed water beetles
Arthropoda	Insecta	Coleoptera	Adephaga	Dytiscidae			predacious diving beetles
Arthropoda	Insecta	Coleoptera	Adephaga	Dytiscidae	*Agabus*		predacious diving beetles
Arthropoda	Insecta	Coleoptera	Polyphaga	Elmidae	*Microcylloepus*	*pusillus*	riffle beetles
Arthropoda	Insecta	Coleoptera	Polyphaga	Hydrophilidae	*Berosus*		water scavenger beetles
Arthropoda	Insecta	Diptera		Ceratopogonidae	*Probezzia*		biting midges
Arthropoda	Insecta	Diptera		Ceratopogonidae	*Atrichopogon*		biting midges
Arthropoda	Insecta	Diptera		Muscidae			house flies
Arthropoda	Insecta	Diptera	Brachycera	Empididae	*Clinocera*		dance flies
Arthropoda	Insecta	Diptera	Brachycera	Tabanidae	*Tabanus*		horse flies
Arthropoda	Insecta	Diptera	Nematocera	Chironomidae			midges
Arthropoda	Insecta	Diptera	Nematocera	Simuliidae	*Simulium*		black flies
Arthropoda	Insecta	Diptera	Nematocera	Tipulidae			crane flies
Arthropoda	Insecta	Ephemeroptera	Pisciforma	Baetidae			small minnow mayflies
Arthropoda	Insecta	Ephemeroptera	Pisciforma	Baetidae	*Baetis*		small minnow mayflies
Arthropoda	Insecta	Ephemeroptera	Pisciforma	Baetidae	*Callibaetis*		small minnow mayflies
Arthropoda	Insecta	Ephemeroptera	Pisciforma	Baetidae	*Fallceon*	*quilleri*	small minnow mayflies
Arthropoda	Insecta	Ephemeroptera	Pisciforma	Baetidae	*Pseudocloeon*		small minnow mayflies
Arthropoda	Insecta	Ephemeroptera	Furcatergalia	Leptohyphidae	*Tricorythodes*		mayfly spinner
Arthropoda	Insecta	Hemiptera	Heteroptera	Gerridae			water striders
Arthropoda	Insecta	Hemiptera	Heteroptera	Naucoridae	*Ambrysus*		creeping water bugs
Arthropoda	Insecta	Hemiptera	Heteroptera	Veliidae			broad-shouldered water striders
Arthropoda	Insecta	Odonata	Zygoptera	Lestidae	*Archilestes*		spreadwing damselflies
Arthropoda	Insecta	Trichoptera		Hydropsychidae			netspinning caddisflies
Arthropoda	Insecta	Trichoptera		Hydropsychidae	*Hydropsyche*		netspinning caddisflies

Appendix D Physical habitat data collected from COY01 in Coyote Gulch at GLCA in 2008

Transect	Velocity (m/s)		Depth (m)			
Spring	**Mean**	**SD**	**Mean**	**SD**	**Wetted Channel (m)**	**Active Channel (m)**
1	0.04	0.09	0.01	0.03	7.25	8.05
2	0.00	0.00	0.00	0.00	9.06	9.96
3	0.06	0.13	0.01	0.02	7.17	15.50
4	0.17	0.24	0.03	0.04	5.71	7.22
5	0.51	0.18	0.07	0.02	2.57	6.50
6	0.17	0.24	0.03	0.04	4.20	8.75
7	0.64	0.27	0.11	0.04	1.05	7.55
8	0.48	0.29	0.08	0.05	1.29	4.90
9	0.36	0.22	0.04	0.02	2.35	3.80
10	0.25	0.16	0.05	0.03	2.73	3.50
11	0.69	0.08	0.12	0.02	0.76	2.71
Fall	**Mean**	**SD**	**Mean**	**SD**	**Wetted Channel (m)**	**Active Channel (m)**
1	0.24	0.27	0.02	0.02	1.45	10.40
2	0.36	0.09	0.03	0.01	2.45	11.60
3	0.36	0.15	0.06	0.02	1.70	12.50
4	0.20	0.07	0.04	0.01	2.30	7.15
5	0.28	0.06	0.05	<0.01	2.27	5.50
6	0.37	0.23	0.06	0.03	1.90	9.90
7	0.50	0.15	0.04	0.02	1.15	8.95
8	0.21	0.08	0.09	0.02	1.33	8.70
9	0.19	0.19	0.11	0.04	1.48	4.70
10	0.15	0.04	0.07	0.05	1.55	11.80
11	0.29	0.02	0.19	0.02	0.48	10.90