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

2009 Summary Report

Natural Resource Data Series NPS/SCPN/NRDS—2011/286

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Glen Canyon National Recreation Area
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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 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 and 2006 for a pilot study designed to develop and test aquatic macroinvertebrate monitoring protocols (Brasher et al. 2010). 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.

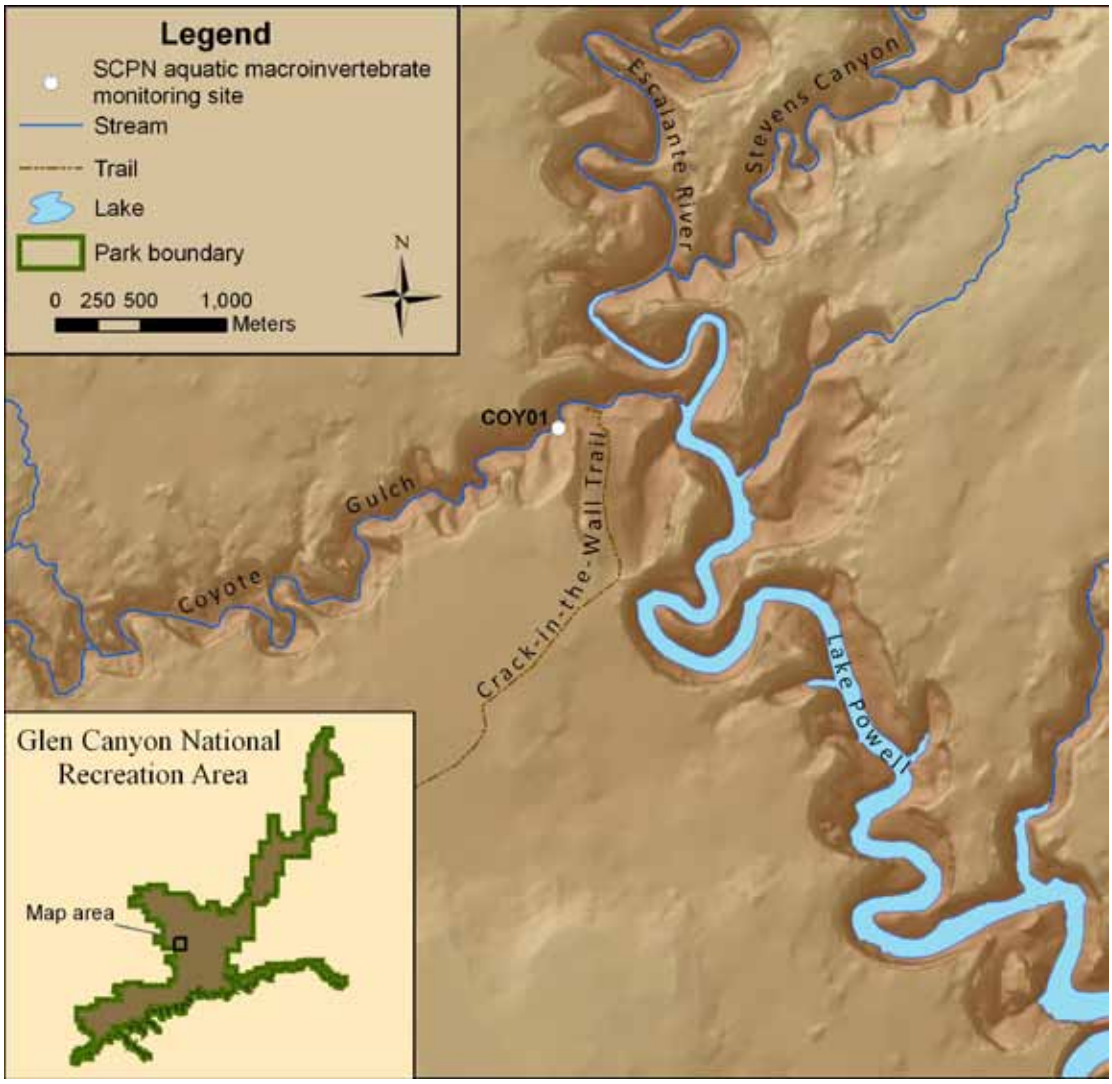


Figure 1. Location map of the COY01 monitoring site at Coyote Gulch in Glen Canyon National Recreation Area, Arizona, 2009

In 2008 SCPN implemented annual 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 sparse narrowleaf cottonwood (*Populus angustifolia*) and coyote willow (*Salix exigua*) woodland. This site is co-located with an established USGS water quality monitoring site, *Coyote Gulch above Escalante River*, station number 372541110591100.

The primary purpose of this report is to (a) document the monitoring activities that occurred at COY01 in 2009, (b) summarize data that were collected, and (c) where appropriate, place these data in the context of aquatic habitat, 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 levels 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 monitoring site. Because of the loss of riffle habitat, we did not collect quantitative samples during our 2009 sampling trips. If after 5 years the sample site has not recovered and riffle habitat is still not available, then SCPN will consider establishment of a new sample site elsewhere on Coyote Gulch (Brasher et al., in press).

2 Methods

2.1 Field methods

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, 2009, the SCPN water resources field crew collected aquatic macroinvertebrate samples and physical habitat data at one site (COY01) on Coyote Gulch in GLCA. Samples were not collected during the fall of 2009 because of inclement weather during our defined sampling window. 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 press).

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. A list of the habitat types from which qualitative samples were

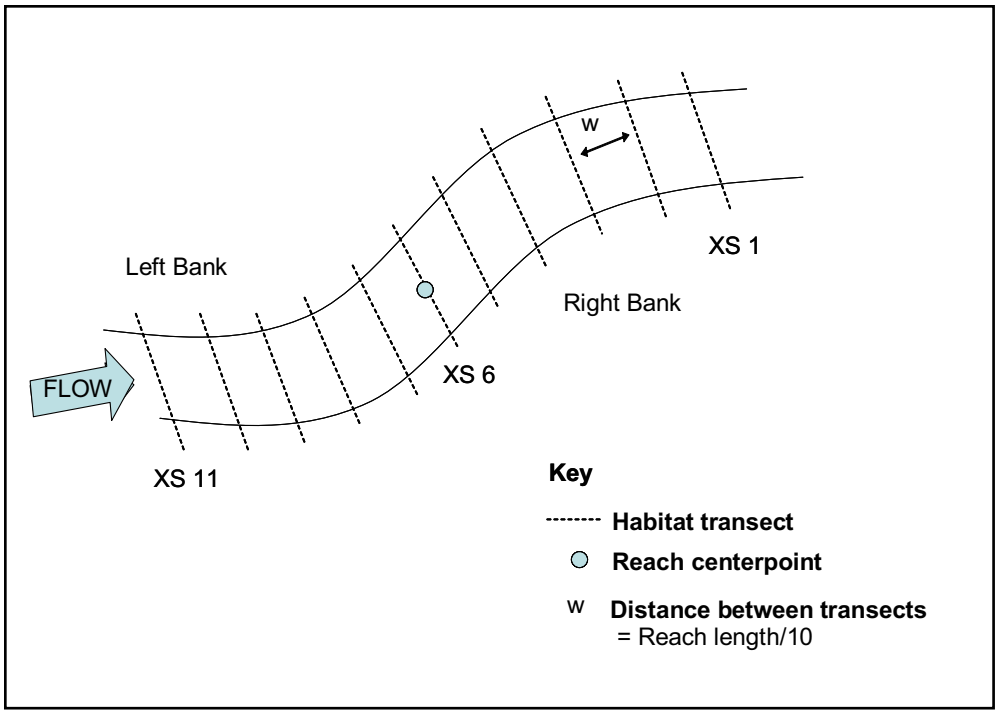


Figure 2. General aquatic macroinvertebrate sampling reach layout

collected can be found in section 3.2 of this report.

In addition to the qualitative macroinvertebrate samples, we collected physical habitat data at two spatial scales: transect, and reach.

- 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, represented by point data (5 points/transect) across the entire reach
  - measured geomorphic channel units (GCU) at multiple points along each transect
- At the reach level, we
  - identified and measured the length of GCUs (reach characterization data represents the proportion of the reach characterized by that particular GCU)
  - 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
  - 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, and turbidity

2.2 Laboratory methods

Aquatic macroinvertebrate samples were sent to be sorted and identified at the Utah State University National Aquatic Monitoring Center's Bug Lab, a Bureau of Land Management 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.

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 press).

2.3 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.

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 selected aquatic macroinvertebrate metrics and their definitions). 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). They also 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

Data describing aquatic macroinvertebrate communities from samples collected during May 2009 from COY01 at Coyote Gulch in GLCA, as well as from 2008 are presented in Table 1. Appendix C lists all aquatic macroinvertebrate species detected at the site.

Taxa richness. Taxa richness for our qualititative multi-habitat sample was 21 taxa (fig. 3).

Tolerant taxa. Richness of aquatic macroinvertebrate tolerance classes was dominated by moderately tolerant taxa at 63.1%. Intolerant taxa were the second most abundant at 21.1% followed by tolerant taxa at 15.8% (fig. 4).

EPT taxa. EPT taxa (orders Ephemeroptera [mayflies], Plecoptera [stoneflies], and Trichoptera [caddisflies]) were rare in our qualitative sample. Richness of Ephemeroptera and Trichoptera each made up 9.5% of the total taxa collected. There were no Plecopterans in our sample (fig. 5).

Aquatic macroinvertebrate orders. Aquatic macroinvertebrate orders were dominated by Dipteran (true flies) taxa which made up 28.6% of our samples. Coleopterans (beetles) and taxa fitting into our "noninsect" category each made up 19.1% of the sample. Organisms included in the "noninsect"

Table 1. Qualitative metrics for aquatic macroinvertebrate samples collected from COY01 at Coyote Gulch in Glen Canyon National Recreation Area, 2008–2009. Richness-based metrics are expressed as the percentage of taxa in a given order, tolerance or functional feeding group.

	2008		2009	
Qualitative metric	**Spring**	**Fall**	**Spring**	**Fall**[a]
Taxa richness	18.00	21.00	21.00	n.d.
Tolerance group				
Richness of tolerant taxa (%)	11.76	16.67	15.79	n.d.
Richness of moderately tolerant taxa (%)	64.71	55.56	63.16	n.d.
Richness of intolerant taxa (%)	23.53	27.78	21.05	n.d.
Functional group				
Richness of collector-filterers (%)	11.11	9.52	11.11	n.d.
Richness of collector-gatherers (%)	22.22	33.34	38.89	n.d.
Richness of scrapers (%)	5.56	4.76	0.00	n.d.
Richness of shredders (%)	11.11	9.52	5.56	n.d.
Richness of predators (%)	50.00	42.86	44.44	n.d.
Taxonomic group				
Number of EPT taxa	3.00	6.00	4.00	n.d.
Richness of EPT taxa (%)	16.67	28.57	19.05	n.d.
Richness of Ephemeroptera (%)	11.11	23.81	9.52	n.d.
Richness of Plecoptera (%)	0.00	0.00	0.00	n.d.
Richness of Trichoptera (%)	5.56	4.76	9.52	n.d.
Richness of noninsect taxa (%)	11.11[b]	23.81[b]	19.05	n.d.
Richness of Chironomid Diptera (%)	16.67	14.28	14.29	n.d.
Richness of non-Chironomid Diptera (%)	33.33	9.52	28.57	n.d.
Richness of Coleoptera (%)	16.67	23.81	19.05	n.d.
Richness of Odonata (%)	5.56	0.00	0.00	n.d.

[a]No data was collected.
[b]Pre-2009 reports labeled the "noninsect" category as "Other". The "Other" category was less inclusive of species, resulting in a different richness count.

category included worms, water mites, and water striders. Chironomids (midges) made up 14.3% of our sample. Ephemeroptera and Trichoptera were each found to make up 9.5% of the sample. We did not find any Odonates (damselflies/dragonflies) or Plecopterans in our sample (fig. 6).

Functional feeding groups. Predators were the most abundant functional group found in our sample, making up 44.4% of the taxa collected. Collector-gatherers made up 38.9% of the sample. Collector-filterers and shredders made up 11.1% and 5.6% of the sample respectively. We found no scrapers in our sample (fig. 7).

3.2 Physical habitat characteristics

Physical habitat data collected from COY01 in Coyote Gulch at GLCA during spring and fall of 2008 and spring of 2009 are presented in Table 2. Additional transect data can be found in Appendix D. Macroinvertebrate habitat was described from point data collected along all transects (5 points/

Figure 3. Taxa richness from qualitative multi-habitat samples collected from COY01 at Coyote Gulch in GLCA, 2008-2009

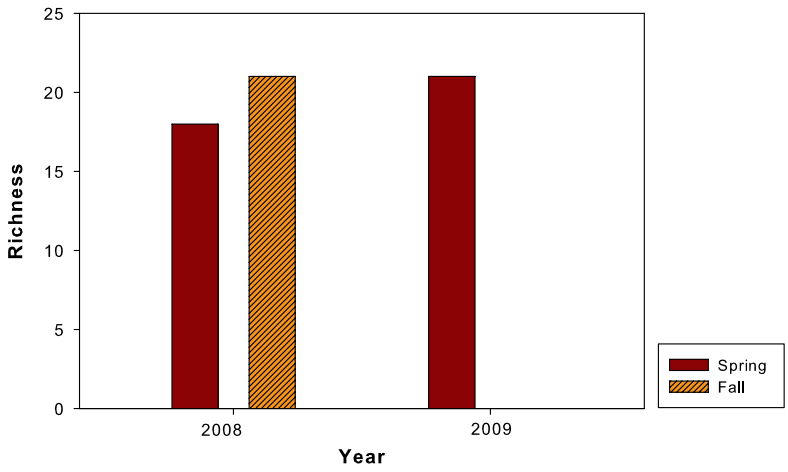


Figure 4. Richness of aquatic macroinvertebrate tolerance classes in qualitative samples collected from COY01 at Coyote Gulch in GLCA, 2008-2009. Tolerance class is based on their tolerance to perturbation.

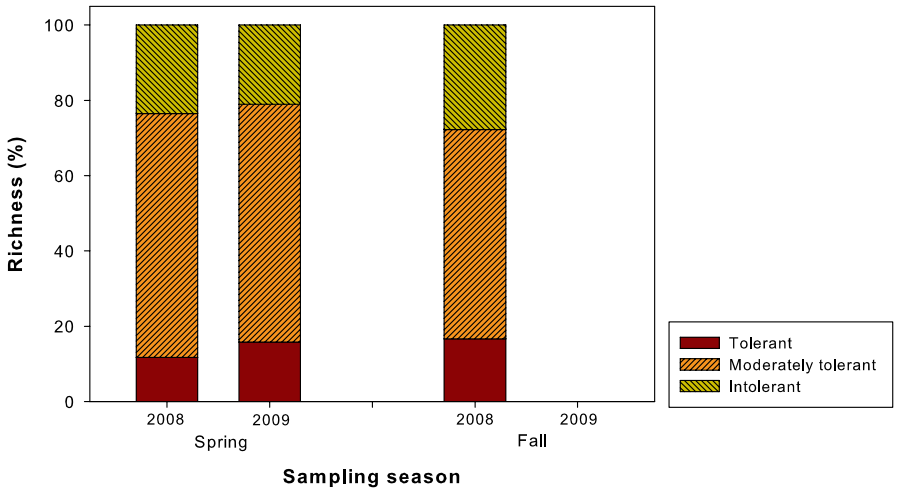
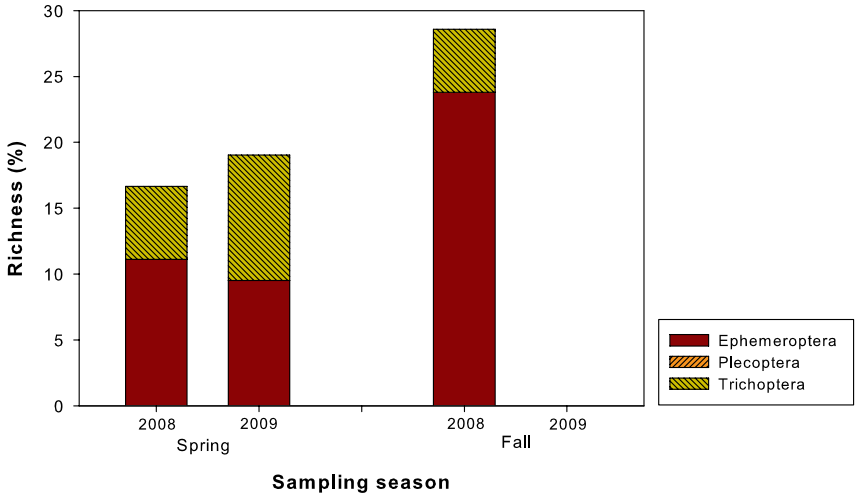


Figure 5. Taxa richness of sensitive EPT orders collected from COY01 at Coyote Gulch in GLCA, 2008–2009



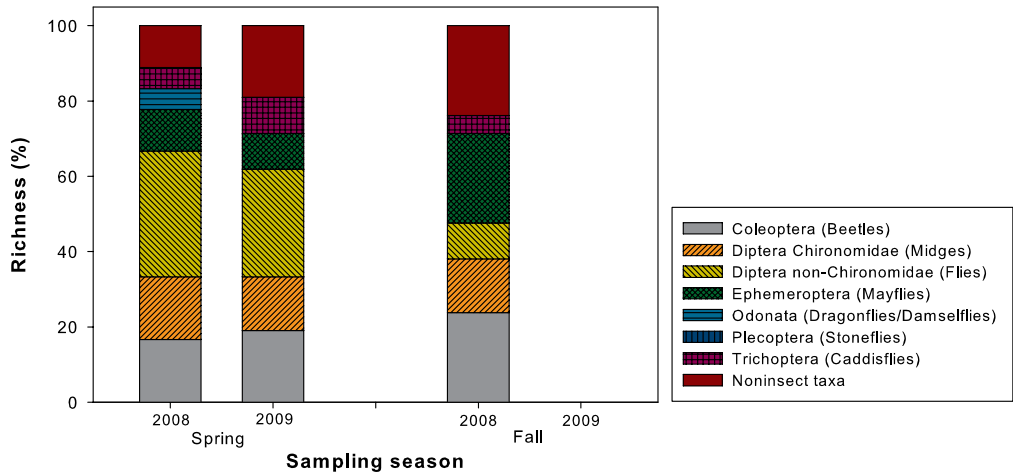


Figure 6. Taxa richness, by order, from qualitative multihabitat samples collected from COY01 at Coyote Gulch in GLCA, 2008–2009

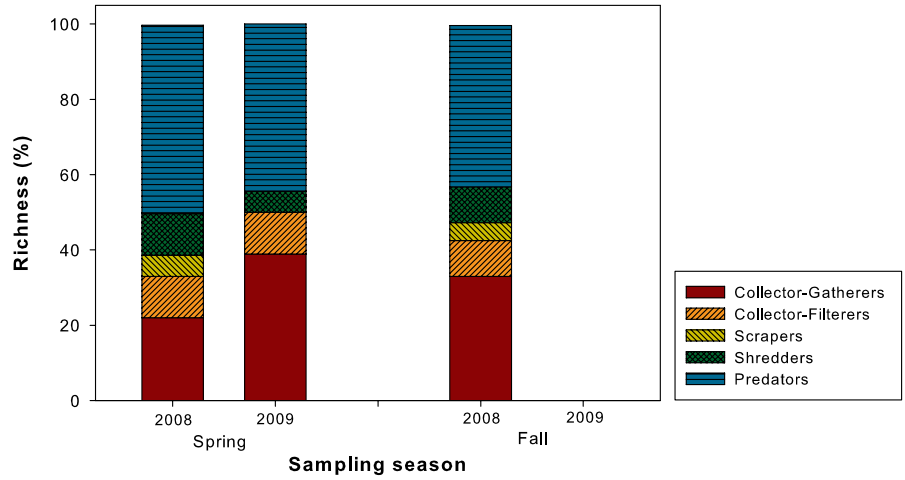


Figure 7. Taxa richness, by functional feeding group, from qualitative samples collected from COY01 at Coyote Gulch in GLCA, 2008–2009

transect). Geomorphic channel units (GCU) are described as the proportion of the reach characterized by a particular GCU. Particle size distribution data are presented as the proportion of particles counted across the entire reach.

Transect. Stream velocity at our habitat transects averaged 0.31 m/s and depth averaged 0.06 m. Wetted channel width averaged 3.3 m. Active channel widths were much larger averaging 9.0 m. Riparian canopy closure averaged 7.6% within the monitoring site (table 2).

Channel structure dynamics are represented by particle size distributions in Figure 8. Particle size distributions were dominated primarily by finer sediments, based on modified Wolman pebble counts of a minimum of 400 particles. Fine particles (<2 mm) made up 82.2% of the reach, fine gravels (2–16 mm) made up 12.1% of the reach, and coarse gravels (16–64 mm) made up 1.4% of the reach. The remaining 3.7% of the reach was composed of boulder and bedrock (>256 mm) (fig. 8).

Reach. During our 2009 sampling effort none of the habitat types typically associated with aquatic macroinvertebrates were found along our reach (fig. 9).

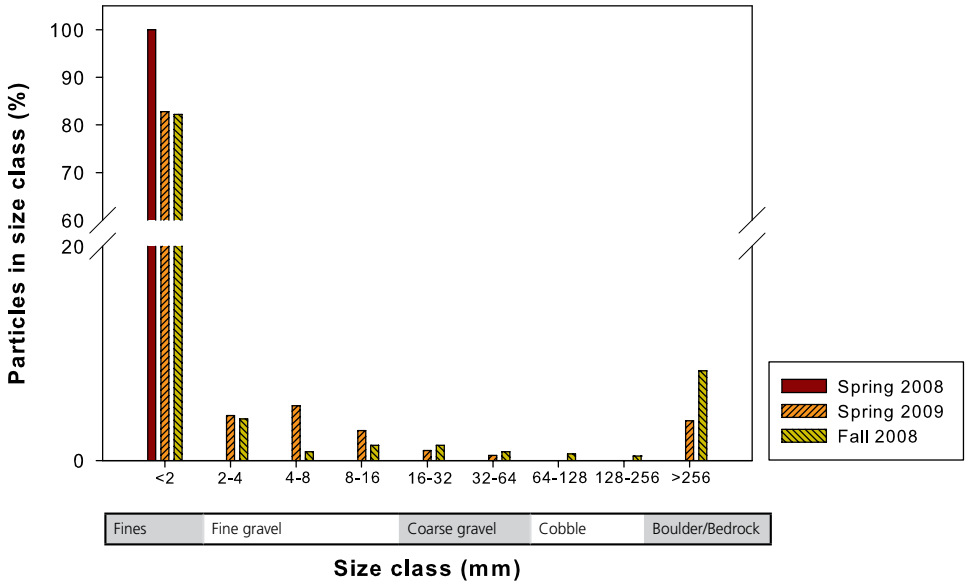
Glides were the dominant geomorphic channel units (GCUs), making up 65.6% of the reach. Runs, which were abundant in 2008, made up only 29.2% of the reach (fig. 10). For a complete

Table 2. Physical habitat transect data from COY01 at Coyote Gulch in Glen Canyon National Recreation Area, Utah, 2008–2009. Particle embeddedness and canopy closure measurements are expressed as percentages.

	Spring 2008		Fall 2008		Spring 2009	
Physical habitat metric	**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
Depth (m)	0.05	0.04	0.07	0.05	0.06	0.03
Wetted channel width (m)	4.01	2.87	1.64	0.58	3.26	1.83
Active channel width (m)	7.13	3.62	9.28	2.58	9.01	3.64
Riparian cover						
Canopy closure (%)	9.74	20.42	8.59	17.22	7.65	16.89
Reach level						
Water quality[a]	**Value**		**Value**		**Value**	
Temperature (°C)	24.4		21.3		25.5	
Specific conductivity (µS/cm)	328		316		277	
pH	8.6		8.7		8.5	
Dissolved oxygen (% saturation)	100.1		111.9		112.8	
Dissolved oxygen (mg/L)	n.d.[b]		n.d.[b]		7.1	
Turbidity (NTU)	38.93		n.d.[b]		3.60[c]	

Note: See Appendix B for detailed description of metrics in this table. Microhabitat level data was not collected from this site in 2009.
[a]One water quality measurement only is reported for the site, based on the sampling event closest to 12:00 noon on the sampling day.
[b]Data was not collected.
[c]Reading occurred 9 days after sample was collected.

Figure 8. Particle size distribution, based on modified Wolman pebble counts, from COY01 at Coyote Gulch, GLCA, 2008–2009. Differences between 2009 and 2008 may be attributed to a change in methodology between sampling years.



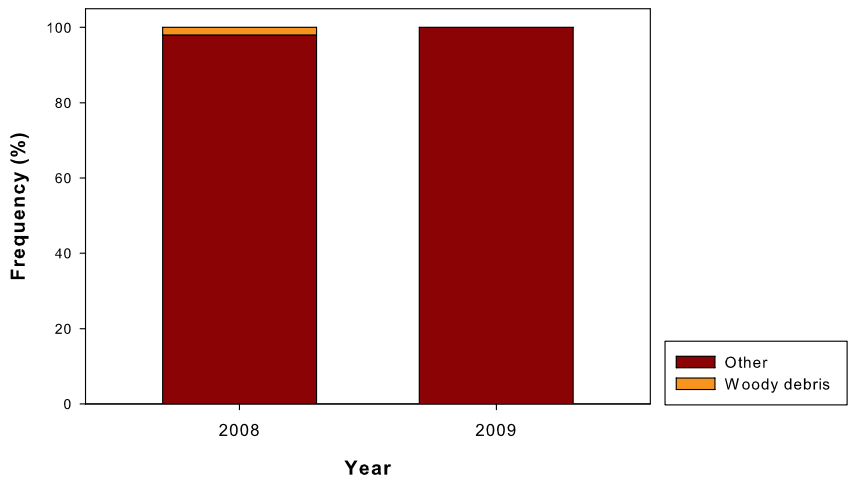


Figure 9. Macroinvertebrate habitat characterization based upon line point intercept data collected from habitat transects at COY01 in Coyote Gulch, GLCA, 2008–2009. The category, "Other", at this monitoring site is represented by sandy substrates.

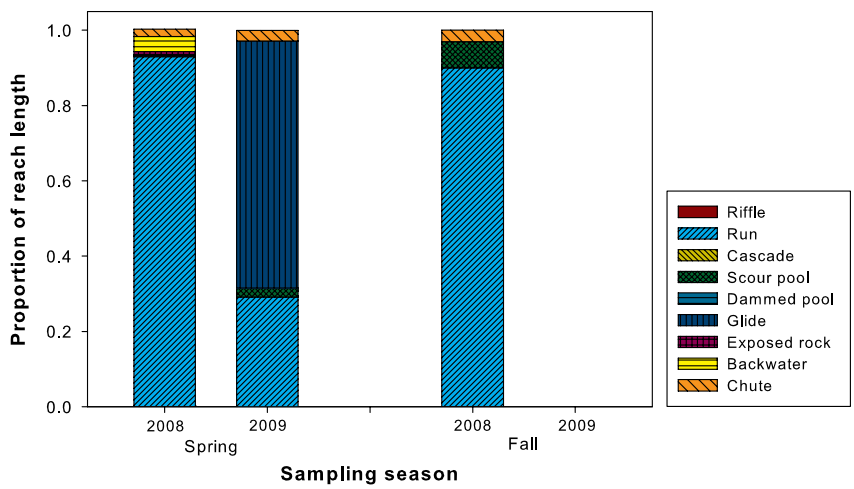


Figure 10. Geomorphic channel unit characterization of monitoring site COY01 at Coyote Gulch in GLCA, 2008–2009

description of GCUs, see Brasher et al. (in press).

NPS water quality core parameter data were collected at or near midday on the day of the sampling event. Temperature measured 14.1°C, specific conductivity was 499 µS/cm, and pH was 8.3. Dissolved oxygen measured 106.5% and 8.5 mg/L. Turbidity was 3.60 NTU. Turbidity readings may not be accurate because samples sat for 9 days before they were read by the nephelometer, which is beyond the recommended time frame for a sample to sit (table 2).

4 Discussion

Data included in this report represent SCPN's second year of monitoring aquatic macroinvertebrates and physical habitat at Coyote Gulch in Glen Canyon National Recreation Area, Utah. The incomplete sampling at this site, caused by weather conditions and a previous year flood event, limits our results. We will attempt to collect a spring and fall sample from this site during 2010, and continue to check for the return of riffle habitat in the area of the past flooding event to enable quantitative analysis.

Data collected in 2009 suggests that poor conditions exist for aquatic macroinvertebrate community

structure and diversity. Although we found 21 different taxa in 2009, physical habitat data over the two years indicate that known aquatic macroinvertebrate habitat types are rare, or do not exist at our monitoring site. Particle size data collected suggests that smaller particles did move into the site during 2009. If particle sizes continue to increase, known habitat types could become more available in our reach over time.

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

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Appendix A Coyote Gulch monitoring site at Glen Canyon National Recreation Area, 2009

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

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 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. $DS = 1-[(\sum n(n-1))/(N(N-1))]$
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 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 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.
	Relative abundance of Hydroptilidae or Hydropsychidae within Trichoptera	Percent of Trichopteran individuals belonging to Hydroptilidae or Hydropsychidae families (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.

Source: Data from Brasher et al. (in press)

Appendix C Aquatic macroinvertebrate species list from the COY01 monitoring site, Glen Canyon National Recreation Area, Utah, 2009

Phylum	Class	Order	Family	SubFamily	Genus	Species	Common name
Annelida	**Clitellata**						segmented worms
Arthropoda	**Arachnida**	**Trombidiformes**	**Sperchonidae**				water mites
Arthropoda	Insecta	Coleoptera	Dryopidae		*Helichus* sp.		long-toed water beetles
Arthropoda	Insecta	Coleoptera	Dytiscidae				predaceous diving beetles
Arthropoda	**Insecta**	**Coleoptera**	**Elmidae**				riffle beetles
Arthropoda	Insecta	Coleoptera	Elmidae		*Microcylloepus*	*pusillus*	riffle beetles
Arthropoda	**Insecta**	**Coleoptera**	**Hydrophilidae**				water scavenger beetles
Arthropoda	**Insecta**	**Coleoptera**	**Hydrophilidae**	**Hydrophilinae**	***Tropisternus* sp.**		water scavenger beetles
Arthropoda	Insecta	Diptera	Ceratopogonidae	Forcipomyiinae	*Atrichopogon* sp.		biting midges
Arthropoda	Insecta	Diptera	Ceratopogonidae	Ceratopogoninae	*Probezzia* sp.		biting midges
Arthropoda	Insecta	Diptera	Chironomidae	Chironominae			non-biting midges
Arthropoda	Insecta	Diptera	Chironomidae	Orthocladiinae			non-biting midges
Arthropoda	Insecta	Diptera	Chironomidae	Tanypodinae			non-biting midges
Arthropoda	**Insecta**	**Diptera**	**Dixidae**				meniscus midges
Arthropoda	**Insecta**	**Diptera**	**Simuliidae**				black flies
Arthropoda	**Insecta**	**Diptera**	**Stratiomyidae**				soldier midges
Arthropoda	**Insecta**	**Diptera**	**Stratiomyidae**		***Euparyphus* sp.**		soldier midges
Arthropoda	Insecta	Diptera	Tabanidae		*Tabanus* sp.		soldier midges
Arthropoda	Insecta	Ephemeroptera	Leptohyphidae				mayflies
Arthropoda	Insecta	Ephemeroptera	Baetidae				small minnow mayflies
Arthropoda	Insecta	Ephemeroptera	Baetidae		*Baetis* sp.		small minnow mayflies
Arthropoda	Insecta	Hemiptera	Gerridae				water striders
Arthropoda	Insecta	Hemiptera	Naucoridae	Ambrysinae	*Ambrysus* sp.		creeping water bugs
Arthropoda	Insecta	Trichoptera	Hydropsychidae				netspinning caddisflies
Arthropoda	Insecta	Trichoptera	Hydropsychidae	Hydropsychinae	*Hydropsyche* sp.		netspinning caddisflies
Arthropoda	**Insecta**	**Trichoptera**	**Hydroptilidae**				microcaddisflies

Note: Bold denotes a new record for this SCPN monitoring site.

Appendix D Channel characteristics at the COY01 monitoring site, Glen Canyon National Recreation Area, Utah, 2009

	Velocity (m/s)		Depth (m)		Wetted channel width (m)	Active channel width (m)
Transect	Mean	Std Dev	Mean	Std Dev	Value	Value
1	0.35	0.00	0.05	0.02	4.26	11.60
2	n/a	n/a	0.03	0.02	5.55	11.45
3	0.36	0.06	0.07	0.02	1.90	14.36
4	0.23	0.02	0.04	0.01	7.21	14.92
5	0.35	0.03	0.06	0.03	3.02	7.10
6	0.35	0.11	0.08	0.02	2.30	7.39
7	0.23	0.07	0.05	0.02	3.66	7.79
8	0.27	0.08	0.06	0.00	2.81	9.10
9	0.45	0.05	0.13	0.01	0.86	4.10
10	0.33	0.05	0.08	0.01	1.77	4.69
11	0.23	0.08	0.06	0.02	2.50	6.59