Macroinvertebrate sampling in the Missouri River below Fort Randall and Gavins Point dams during 2005 and 2006

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Introduction

A field project initiated in 2005 and completed in 2006 focused on the relative prey use by juvenile pallid sturgeon *Scaphirhynchus albus*, and species composition and diversity of macroinvertebrates in the Missouri River below Fort Randall and Gavins Point dams, South Dakota and Nebraska. Macroinvertebrates are an important component in aquatic food chains (Wilhm et al. 1978) and previous diet studies have shown juvenile pallid sturgeon rely heavily on macroinvertebrates throughout the year, especially caddisfly larvae and chironomids (Kallemeyn 1983; Wanner et al. 2007). However, little information has been collected on macroinvertebrate diversity and distribution concurrently with pallid sturgeon food habits. Also, this project, along with previous pallid sturgeon diet studies, will assist in current bioenergetics modeling and spatial analysis studies on pallid sturgeon and their habitat. The main objective of this study was to quantify habitat associations and densities of macroinvertebrates. Macroinvertebrate assemblage, abundance, and diversity will be compared between the Fort Randall and Gavins Point reachs, as well as between upstream and downstream sites within each reach. Cross-sectional spatial distribution and abundance along bankline to bankline transects and temporal trends during summer will also be compared. Lastly, macroinvertebrates collected in pallid sturgeon stomachs will be compared to those collected in the field.

Although the motivation behind this macroinvertebrate survey was the determination of prey available to juvenile hatchery-reared pallid sturgeon, a concurrent benefit of this project included an active monitoring program for macroinvertebrate aquatic nuisance species, particularly zebra mussels *Dreissena polymorpha*. Although zebra mussel veligers have been identified in plankton samples from the Missouri River downstream of Fort Randall Dam (near Verdel, NE), no adult zebra mussels have yet been found. Extensive sampling, in upstream and downstream locations of the Missouri River below both dams will help elucidate whether adult zebra mussel populations have become established.

Study Area

The study area includes two unchannelized reaches of the Missouri River. The Fort Randall reach is located below Fort Randall Dam (river kilometer [RK] 1,416) downstream to Springfield, South Dakota (Figure 1). The Gavins Point reach is located below Gavins Point Dam (RK 1,305) downstream to Ponca, Nebraska (Figure 2). Habitat types at both sites included inside bends, outside bends, secondary connected channels, channel crossovers, and braided areas. Four transects for each site were randomly selected from topographic maps sectioned off into 250-m intervals for a 6 km area surrounding each boat ramp. Each transect formed a cross-section of the river (Figure 3).

The Fort Randall reach included three sites (Figure 1). The most upstream site was located at Sunshine Bottoms, 3 km upstream and downstream of the Boyd County boat ramp. The middle site was located upstream of the Verdel boat ramp to downstream of the Ponca Creek confluence. The most downstream site was located 3 km upstream and downstream of the Santee boat ramp on the Nebraska side, and 3 km upstream and downstream of the Springfield boat ramp on the South Dakota side. This most downstream site, referred to as the Santee/Springfield site, is unique because it represents the braided section of the Missouri River formed from sedimentation into Lewis and Clark Lake downstream of the confluence with the Niobrara River. This study was the first macroinvertebrate survey within this braided habitat of the Missouri River.

The Gavins Point reach also included three sites (Figure 2). The most upstream site was located 3 km upstream of the St. Helena boat ramp to the downstream tip of James River Island. The middle site was located upstream of the Clay county boat ramp to Goat Island and downstream to the Clay County boat ramp. The most downstream site was located 3 km upstream and downstream of the Ponca State Park boat ramp in Nebraska. Ponca State Park is just upstream of where the Missouri River becomes channelized for navigation at Sioux City, Iowa. Downstream of Sioux City is the location where the first adult zebra mussel was found in the Missouri River in 1999 (USGS-NAS 2006).

Methods

Substrate and deep main channel benthos were sampled using two gears. The main gear used in the deep water of the main channel was a ponar dredge with a scoop volume of 8.2 L, and a sampling area of 58.1 cm^2 (9 in^2). Samples were collected at 0.25-x channel width, 0.50-x channel width, and 0.75-x channel width (Figure 3). In areas where the ponar dredge did not adequately sample benthos after three attempts the substrate sample was collected using a hess sampler. The hess sampler is a large metal tube of 10.2 cm (4 in) diameter used to sample integrated sediment by dragging the tube along the bottom. All ponar and hess samples were preserved in the field with 10% formalin. Additional habitat variables measured include: water temperature, depth, dissolved oxygen, turbidity, and surface water velocity.

Deep-water sampling for macroinvertebrates was conducted using a 0.5-m diameter 1.5-m long conical zooplankton drift net with 500 µm mesh. The drift net had a lead weight attached to the bottom and a flow meter attached in the center that calculated the volume of water filtered. Two types of drift samples were collected: bottom and column drifts. Bottom drift collections consisted of deploying the drift net to the bottom and allowing it to set for three to five minutes; soak time varied due to turbidity, detritus load, and presence of macrophytes. Column drifts consisted of deploying the drift net to the bottom and immediately retrieving the net to the surface. Column drift was collected to see if deploying and retrieving the net significantly affected the sample compared to the net resting on the bottom. Time was recorded as the net is deployed to the bottom and retrieved to the surface. All drift samples were preserved in the field with 70% ethanol.

Active sampling of deep main channel benthos and placement of colonization plates in the Missouri River resulted in a spatially expansive monitoring program for zebra mussels in South Dakota and Nebraska. Macroinvertebrates were sampled in shallow water using hester-dendy 14-plate artificial substrate sampler (pictured on the title page) and a surber sampler. Hester-dendy samplers were wired to stable logs along the shore or wired to a t-bar stake and placed at an adequate sampling depth. The hester-dendy has a total exposed surface area of approximately 1,300 cm^2 and were deployed for 50 to 60 days to allow adequate colonization (Turner and Trexler 1997; Hilsenhoff 1969; and Wilhm et al. 1978) and invertebrates were preserved with 10% formalin. A standard surber sampler, with a sampling area of 0.09 m^2 (one square foot), was modified with a PVC pipe handle which allowed sampling in waist deep waters. The surber sampler was deployed facing upstream allowing the collection net to deploy and an extendable three-pronged rake was used to disrupt the substrate to collect the sample which was then preserved in 70% ethanol. Substrate was sampled in shallow waters simply by grabbing a handful of the substrate (i.e., a hand grab) near the location where invertebrates were collected.

Samples for 2005 and 2006 were processed the in lab at South Dakota State University (Tables 1-4). Ponar dredge sediment samples and hess samples were processed utilizing a sugar solution to float the invertebrates to the surface of the sample. Samples were soaked in a sugar solution for approximately 20 minutes then the invertebrates were collected out of the sample (Anderson 1959). While the ponar and hess samples were soaking in the sugar formalin solution, the sample was stirred and visually checked for the presence of mussels. Hester-dendy samples were scraped to collect colonized macroinvertebrates. Surber and drift samples were rinsed in a sieve and placed in a sorting tray. Invertebrates in all samples, both aquatic and terrestrial, were picked, placed in vials, labeled, and preserved in 70% ethyl alcohol. Invertebrates will be identified to genus with some exceptions (i.e., Family Chironomidae). To date, all samples have been sorted and over 50% of macroinvertebrates have been indentified.

Results

Macroinvertebrate and substrate samples were collected in the Missouri River downstream of the Fort Randall and Gavins Point Dams on three occasions during 2005: June 2-17th, August 1-12th, and September 26th through October 6th (Tables 1 and 2). A total of 1,208 samples were collected of which, 625 were collected below Fort Randall Dam and 583 were collected below Gavins Point Dam. During the June sample period, 192 samples were collected below Fort Randall Dam and 176 samples were collected below Gavins Point Dam. In August, 209 samples were collected below Fort Randall Dam and 205 samples were collected below Gavins Point Dam. For the late September through October sample period, 224 samples were collected below Fort Randall Dam and 202 samples were collected below Gavins Point Dam. In 2005, 84% of samples downstream of Fort Randall Dam and 86% of samples downstream of Gavins Point Dam collected macroinvertebrates. A total of 224 substrate samples were collected below Fort Randall Dam and 204 samples were collected below Gavins Point Dam. Substrate samples were dried and sieved to determine the percent composition of gravel, sand, and silt. The sampling goal was to average 8-10 bankline samples per site and 12-14 main channel samples per site three times during the summer. However, the number of hester-dendy samples varied due to the public finding and disposing of them, the river claiming them, or drastic water level fluctuations rendering the samples useless.

Transects at each study area were re-randomized and samples were collected on three occasions during 2006: June 5-13th, July 31st through August 6th, and September 28th through October 15th (Tables 3 and 4). A total of 1,097 samples were collected of which, 615 were collected below Fort Randall Dam and 482 were collected below Gavins Point Dam. During the June sample period, 191 samples were collected below Fort Randall Dam and 162 samples were collected below Gavins Point Dam. In August, 214 samples were collected below Fort Randall Dam and 184 samples were collected below Gavins Point Dam. For the late September through October sample period, 210 samples were collected below Fort Randall Dam and 136 samples were collected below Gavins Point Dam. Similar to 2005, 84% of samples downstream of Fort Randall Dam and 85% of samples downstream of Gavins Point Dam collected macroinvertebrates during summer of 2006. Also, a total of 223 substrate samples were collected below Fort Randall Dam and 177 samples were collected below Gavins Point Dam. Fewer hester-dendy colonization samplers were successfully recovered in 2006 due to lowered water levels, especially below Gavins Point dam, during late summer.

Preliminary results of percent composition by number was calculated for macroinvertebrate samples collected during summer 2006 for the Fort Randall and Gavins Point

Reaches for the Surber sampler, drift net, and ponar dredge. Fort Randall Surber samples were primarily composed of Diptera (46%) and Ephemeroptera (27%), while Gavins Point samples were composed of several taxa including Diptera (29%), Ephemeroptera (16%), Trichoptera (20%), and larval fish (15%) (Figure 4). Fort Randall drift net samples were primarily composed of Diptera (54%) and larval fish (14%), while Gavins Point samples were composed mostly of Diptera (30%), Trichoptera (29%), and larval fish (33%) (Figure 5). Ponar dredge samples were primarily composed of Diptera for both Fort Randall (94%) and Gavins Point (80%) samples (Figure 6). Furthermore, downstream of Gavins Point Dam, Trichopterans composed 20% of the samples, however, a smaller percent was found in the Fort Randall Reach (4%). The lower prevalence of caddis flies downstream of Fort Randall Dam, especially for the Surber samples, may have resulted from diurnal water level fluctuations (> 1 m) for power generation compared to the more consistent discharges from Gavins Point Dam.

Zebra mussels were targeted using three gears: the ponar dredge, hess sampler, and hester-dendy substrate samplers in 2005 and 2006. A grand total of 344 samples were collected below Fort Randall Dam and 295 samples were collected below Gavins Point Dam during this study (Tables 1-4). However, no zebra mussels were found during the processing of these samples. Current evidence suggests that there is not an established adult zebra mussel population in the Missouri River below Fort Randall and Gavins Point dams. Either the original veliger samples were mis-identified (i.e. false positive) or the source of the veligers may be from other upstream sections of the Missouri River or the reservoir, Lake Francis Case, which were not sampled in this study. Colonization by zebra mussels may not be conducive in these reaches of the Missouri River due to the water fluctuations below Fort Randall Dam and the prevalence of shifting sand substrates below both dams.

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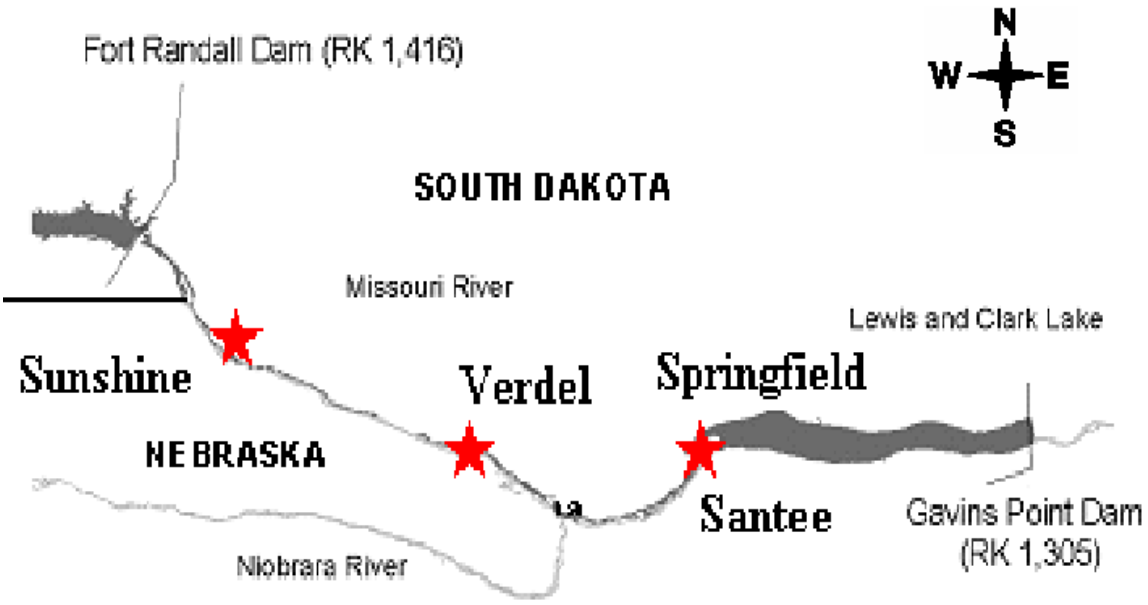

Figure 1: Three locations where macroinvertebrates were collected in the Missouri River downstream of Fort Randall Dam during the summers of 2005 and 2006.

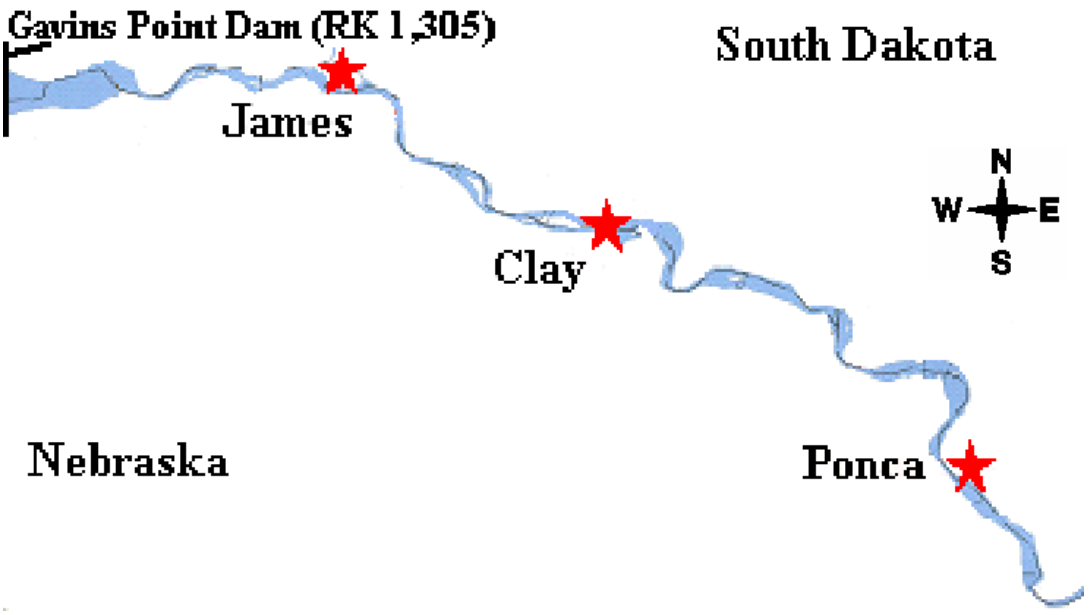

Figure 2: Three locations where macroinvertebrates were collected in the Missouri River downstream of Gavins Point Dam during the summers of 2005 and 2006.

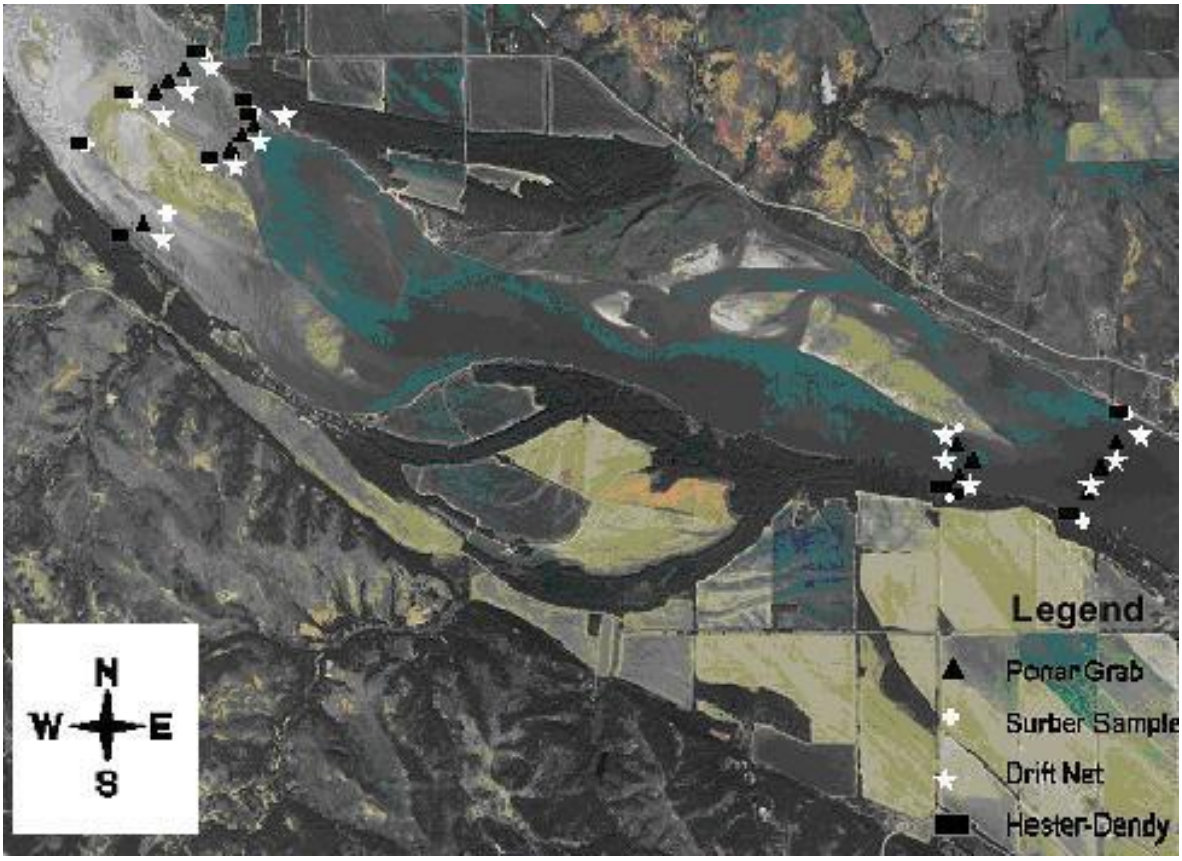

Figure 3: Map of summer 2005 sampling design for the Sunshine Bottoms site of the Missouri River below Fort Randall Dam. Cross-sectional transects included the main channel and bankline habitats. Main channel habitats were sampled at approximately 0.25, 0.50, and 0.75-X channel width using a ponar dredge to collect benthic macroinvertebrates and a conical zooplankton net collected drifting macroinvertebrates. Bankline habitats were sampled using hester-dendy substrate samplers and surber samplers. New transects were randomly selected for summer 2006.

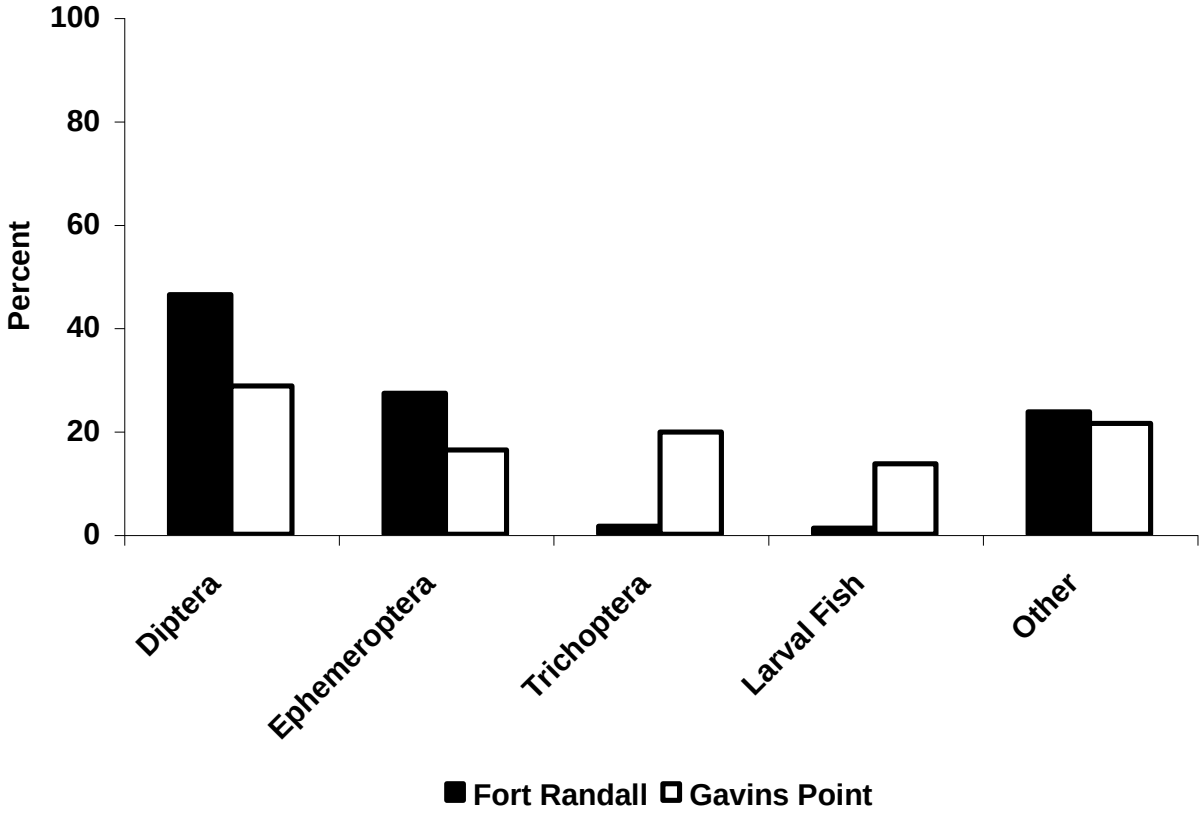

Figure 4: Percent composition by numbers of macroinvertebrates collected with a Surber sampler during summer 2006 below Fort Randall and Gavins Point dams, South Dakota and Nebraska.

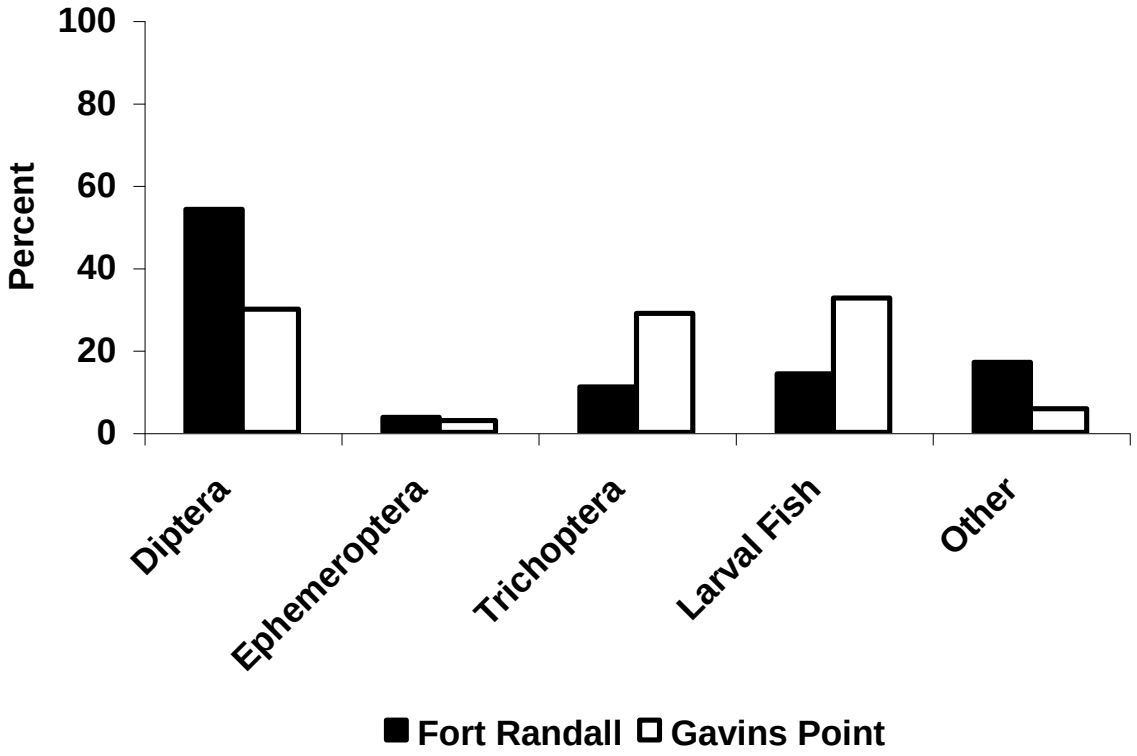

Figure 5: Percent composition by number of macroinvertebrates collected with a drift net during summer 2006 below Fort Randall and Gavins Point dams, South Dakota and Nebraska.

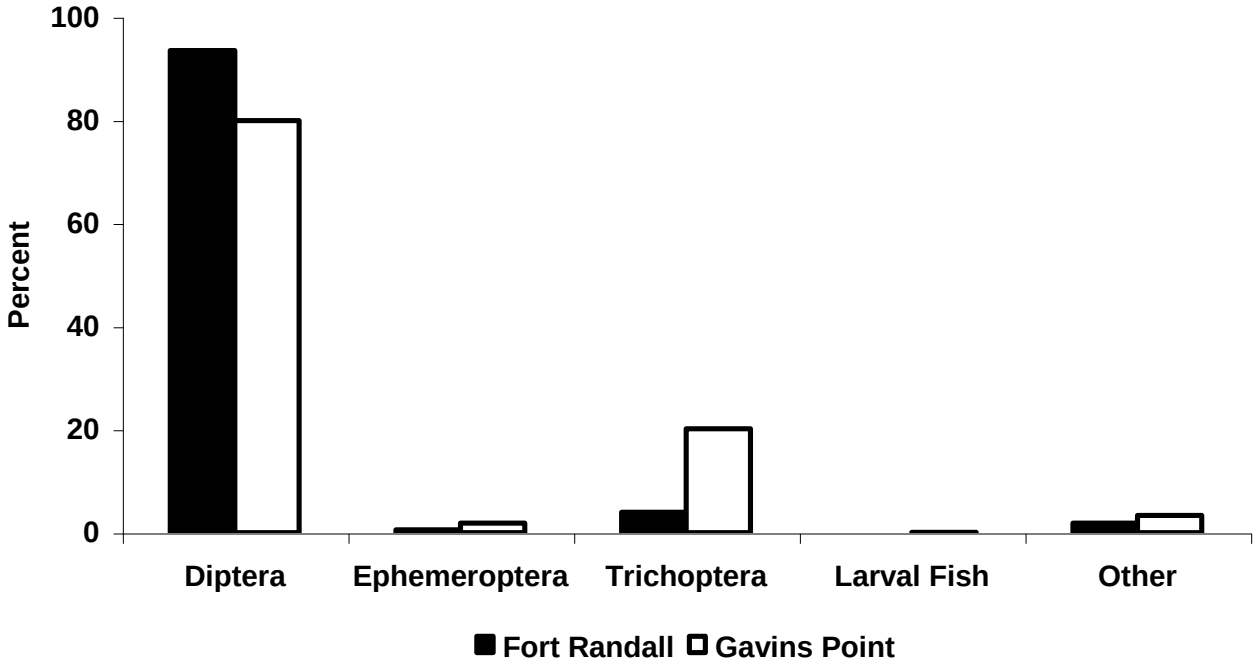

Figure 6: Percent composition by number of macroinvertebrates collected with a ponar dredge during summer 2006 below Fort Randall and Gavins Point dams, South Dakota and Nebraska.

Table 1: Total samples collected on three occasions in summer of 2005 at four sites downstream of Fort Randall Dam for each gear type used. For Hester-dendy, numbers in parentheses are the total samplers deployed. Not all hester-dendy samplers were recovered.

Sample type	Study site			
	Sunshine	Verdel	Santee	Springfield
Hester-Dendy	14 (20)	12 (15)	10 (13)	13 (13)
Surber Sampler	29	25	24	24
Hand Grab	27	23	24	24
Bottom Drift	41	36	24	24
Column Drift	41	36	24	24
Ponar Dredge	40	35	24	24
Hess Sampler	1	2	0	0

Table 2: Total samples collected on three occasions in summer of 2005 at three sites downstream of Gavins Point Dam for each gear type used. For Hester-dendy, numbers in parentheses are the total samplers deployed. Not all hester-dendy samplers were recovered.

Sample type	Study Site		
	James	Clay	Ponca
Hester-Dendy	18 (21)	20 (20)	13 (20)
Surber Sampler	33	28	27
Hand Grab	33	26	25
Bottom Drift	42	42	36
Column Drift	42	42	36
Ponar Dredge	40	40	34
Hess Sampler	2	2	2

Table 3: Total samples collected on three occasions in summer of 2006 at four sites downstream of Fort Randall Dam for each gear type used. For Hester-dendy, numbers in parentheses are the total samplers deployed. Not all hester-dendy samplers were recovered.

Sample type	Study site			
	Sunshine	Verdel	Santee	Springfield
Hester-Dendy	11 (18)	10 (16)	10 (16)	15 (16)
Surber Sampler	28	24	24	24
Hand Grab	28	24	24	24
Bottom Drift	39	36	24	24
Column Drift	39	36	24	24
Ponar Dredge	39	36	24	24
Hess Sampler	0	0	0	0

Table 4: Total samples collected on three occasions in summer of 2006 at three sites downstream of Gavins Point Dam for each gear type used. For Hester-dendy, numbers in parentheses are the total samplers deployed. Not all hester-dendy samplers were recovered.

Sample type	Study Site		
	James	Clay	Ponca
Hester-Dendy	9 (18)	4 (20)	6 (16)
Surber Sampler	22	29	25
Hand Grab	22	27	23
Bottom Drift	31	41	33
Column Drift	31	41	33
Ponar Dredge	31	41	33
Hess Sampler	0	0	0