

Macrobenthic prey and physical habitat characteristics in a western Gulf sturgeon population: differential estuarine habitat use patterns

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Supplement. Supplemental materials include summary data on benthos, physical characteristics and reported diet data used in this study

Table S1. Summary of descriptive statistics (mean \pm SD) of the reduced set of macrobenthic density (ind. m⁻²) data by zone and season. Min: minimum value, Max: maximum value, LPTL = lowest possible taxonomic level, na: not present, Fall: 13–15 December 2010, Spring: 30 March–1 April 2011, P: phylum, C: class, SC: subclass, SP: subphylum, O: order

Higher taxonomy	Taxon	West		East	
		Fall (n = 54)	Spring (n = 52)	Fall (n = 27)	Spring (n = 25)
Nemertea (P)	Nemertean (LPTL)	187.6 \pm 227.4	35.1 \pm 68.4	204.5 \pm 258.3	114.7 \pm 101.9
		Min = 0.0	Min = 0.0	Min = 0.0	Min = 0.0
		Max = 1000.0	Max = 391.3	Max = 1173.9	Max = 391.3
Annelida (P) Polychaeta (C)	<i>Amphicteis floridus</i>	6.4 \pm 21.4	48.5 \pm 135.2	4.8 \pm 18.4	1.7 \pm 8.7
		Min = 0.0	Min = 0.0	Min = 0.0	Min = 0.0
		Max = 130.4	Max = 739.1	Max = 86.9	Max = 43.5
	<i>Capitella capitata</i>	16.9 \pm 45.8	10.9 \pm 36.4	3.2 \pm 11.6	24.3 \pm 98.1
		Min = 0.0	Min = 0.0	Min = 0.0	Min = 0.0
		Max = 260.9	Max = 217.4	Max = 43.5	Max = 478.3
	<i>Heteromastus filiformis</i>	0.8 \pm 5.91	21.7 \pm 46.8	1.6 \pm 8.4	6.9 \pm 27.1
		Min = 0.0	Min = 0.0	Min = 0.0	Min = 0.0
		Max = 43.5	Max = 217.4	Max = 43.5	Max = 130.4

<i>Mediomastis ambiseta</i>	4712.6 ± 3461.3 Min = 86.9 Max = 13869.6	726.6 ± 1138.8 Min = 0.0 Max = 6565.2	1645.7 ± 2067.7 Min = 0.0 Max = 7130.4	240.0 ± 251.7 Min = 0.0 Max = 956.5
<i>Aphelochaeta (LPTL)</i>	0.8 ± 5.9 Min = 0.0 Max = 43.5	4.2 ± 19.7 Min = 0.0 Max = 130.4	17.7 ± 52.9 Min = 0.0 Max = 260.9	31.3 ± 108.3 Min = 0.0 Max = 521.7
<i>Cossura delta</i>	7.2 ± 42.0 Min = 0.0 Max = 304.3	17.6 ± 126.6 Min = 0.0 Max = 913.0	19.3 ± 38.8 Min = 0.0 Max = 130.4	5.2 ± 19.1 Min = 0.0 Max = 86.9
<i>Podarkeopsis levifuscina</i>	19.3 ± 36.5 Min = 0.0 Max = 173.9	3.3 ± 11.7 Min = 0.0 Max = 43.5	4.8 ± 13.9 Min = 0.0 Max = 43.5	19.1 ± 35.7 Min = 0.0 Max = 130.4
<i>Scoletoma verrilli</i>	34.6 ± 78.9 Min = 0.0 Max = 304.3	2.6 ± 13.4 Min = 0.0 Max = 86.9	12.9 ± 31.5 Min = 0.0 Max = 130.4	20.9 ± 47.2 Min = 0.0 Max = 217.4
<i>Magelona phyllisae</i>	3.2 ± 14.3 Min = 0.0 Max = 86.9	0.8 ± 6.0 Min = 0.0 Max = 43.5	na Min = 0.0 Max = 86.9	12.2 ± 23.5 Min = 0.0 Max = 86.9
<i>Armandia agilis</i>	41.9 ± 139.8 Min = 0.0 Max = 782.6	na Min = 0.0 Max = 43.5	54.7 ± 234.9 Min = 0.0 Max = 1217.4	na Min = 0.0 Max = 86.9
<i>Leitoscoloplos fragilis</i>	175.5 ± 220.6 Min = 0.0 Max = 1086.9	2.5 ± 10.2 Min = 0.0 Max = 43.5	25.8 ± 70.6 Min = 0.0 Max = 347.8	na Min = 0.0 Max = 43.5
<i>Aricidea fragilis</i>	14.5 ± 40.5 Min = 0.0 Max = 173.9	25.9 ± 85.8 Min = 0.0 Max = 478.3	3.2 ± 11.6 Min = 0.0 Max = 43.5	1.7 ± 8.7 Min = 0.0 Max = 43.5
<i>A. philibinae</i>	9.7 ± 32.3 Min = 0.0 Max = 173.9	7.5 ± 38.2 Min = 0.0 Max = 260.9	43.5 ± 159.1 Min = 0.0 Max = 826.1	57.4 ± 171.5 Min = 0.0 Max = 826.1
<i>Glycinde solitaria</i>	47.5 ± 59.3 Min = 0.0 Max = 217.4	na Min = 0.0 Max = 173.9	35.4 ± 46.8 Min = 0.0 Max = 173.9	3.4 ± 12.0 Min = 0.0 Max = 43.5
<i>Parandalia americana</i>	8.0 ± 36.9 Min = 0.0 Max = 260.9	17.6 ± 36.8 Min = 0.0 Max = 173.9	na Min = 0.0 Max = 173.9	1.7 ± 8.7 Min = 0.0 Max = 43.5
<i>Paraprionospio pinnata</i>	37.6 ± 87.8 Min = 0.0 Max = 521.7	25.8 ± 45.1 Min = 0.0 Max = 173.9	46.7 ± 111.1 Min = 0.0 Max = 521.7	27.8 ± 53.1 Min = 0.0 Max = 217.4

	<i>Polydora cornuta</i>	16.9 ± 64.5 Min = 0.0 Max = 434.8	30.1 ± 77.7 Min = 0.0 Max = 391.3	1.6 ± 8.4 Min = 0.0 Max = 43.5	na
	<i>Spiophanes bombyx</i>	3.2 ± 14.3 Min = 0.0 Max = 86.9	na	14.5 ± 36.2 Min = 0.0 Max = 130.4	19.1 ± 28.3 Min = 0.0 Max = 86.9
	<i>Streblospio gynobranchiata</i>	429.9 ± 824.0 Min = 0.0 Max = 4173.9	142.9 ± 263.5 Min = 0.0 Max = 1173.9	46.7 ± 156.3 Min = 0.0 Max = 608.7	5.2 ± 14.4 Min = 0.0 Max = 43.5
Clitellata (C) Oligochaeta (SC)	<i>Paranais litoralis</i>	644.1 ± 1454.7 Min = 0.0 Max = 6434.8	na	123.9 ± 414.3 Min = 0.0 Max = 2086.9	na
	Tubificid (LPTL)	58.8 ± 119.5 Min = 0.0 Max = 565.2	32.6 ± 108.2 Min = 0.0 Max = 739.1	27.4 ± 60.5 Min = 0.0 Max = 217.4	15.6 ± 37.4 Min = 0.0 Max = 130.4
Mollusca (P) Gastropoda (C)	<i>Rictaxis punctostriatus</i>	15.3 ± 30.6 Min = 0.0 Max = 130.4	7.5 ± 18.7 Min = 0.0 Max = 86.9	61.2 ± 87.2 Min = 0.0 Max = 347.8	6.9 ± 16.3 Min = 0.0 Max = 43.5
Bivalvia (C)	<i>Aceteocina canaliculata</i>	99.8 ± 144.2 Min = 0.0 Max = 739.1	61.0 ± 150.7 Min = 0.0 Max = 782.6	170.7 ± 322.2 Min = 0.0 Max = 1391.3	231.3 ± 283.1 Min = 0.0 Max = 826.1
	Unidentified bivalve (LPTL)	11.3 ± 25.6 Min = 0.0 Max = 86.9	5.8 ± 17.3 Min = 0.0 Max = 86.9	41.9 ± 106.1 Min = 0.0 Max = 478.3	1.7 ± 8.7 Min = 0.0 Max = 43.5
	<i>Gemma gemma</i>	na	na	133.6 ± 643.3 Min = 0.0 Max = 3347.8	31.3 ± 119.4 Min = 0.0 Max = 565.2
Arthropoda (P) Crustacea (SP) Cumacea (O)	<i>Cyclaspis varians</i>	184.4 ± 342.9 Min = 0.0 Max = 2086.9	na	14.5 ± 41.8 Min = 0.0 Max = 173.9	na
Isopoda (O)	<i>Edotia triloba</i>	16.9 ± 52.3 Min = 0.0 Max = 260.9	44.3 ± 88.8 Min = 0.0 Max = 434.8	9.7 ± 22.0 Min = 0.0 Max = 86.9	6.9 ± 20.5 Min = 0.0 Max = 86.9
Amphipoda (O)	<i>Cerapus benthophilus</i>	17.7 ± 79.5 Min = 0.0 Max = 521.7	25.9 ± 97.5 Min = 0.0 Max = 521.7	na	na
	<i>Apocorophium lacustre</i>	150.6 ± 1029.6 Min = 0.0 Max = 7565.2	2.5 ± 13.4 Min = 0.0 Max = 86.9	na	na

	<i>A. louisianum</i>	162.6 ± 855.1 Min = 0.0 Max = 6173.9	36.8 ± 122.5 Min = 0.0 Max = 652.2	3.2 ± 11.6 Min = 0.0 Max = 43.5	na
Hexapoda (SP) Insecta (C)	Chironomid (LPTL)	4.0 ± 24.3 Min = 0.0 Max = 173.9	36.8 ± 194.1 Min = 0.0 Max = 1391.3	na	5.2 ± 14.4 Min = 0.0 Max = 43.5
Phoronida (P)	<i>Phoronis</i> sp. (LPTL)	12.9 ± 47.5 Min = 0.0 Max = 260.9	na	27.4 ± 62.8 Min = 0.0 Max = 260.9	17.4 ± 30.7 Min = 0.0 Max = 130.4

Table S2. Summary of river zone station numbers and depths by transect illustrated in Fig. 1 in the main text

Transect	Station numbers	Relative depth
T1	89–189	Shallow
	88–188	Mid
	87–187	Deep
T2	13–192	Shallow
	12–191	Mid
T3	85–190	Deep
	15–196	Shallow
	14–195	Mid
T4	86–193	Deep
	21–199	Shallow
T5	20–198	Mid
	19–197	Deep
T6	27–202	Shallow
	26–201	Mid
	25–200	Deep
T7	30–205	Shallow
	29–204	Mid
	28–203	Deep
T8	18–211	Shallow
	17–210	Mid
	16–209	Deep
	24–208	Shallow
	22–207	Mid
	23–206	Deep

Table S3. Summary of descriptive statistics (mean \pm SD) based on all stations and all taxa by zone and season. Min: minimum value, Max: maximum value, na: 0 percentage, POC: particulate organic carbon

Variable	West		East		River	
	Fall (n = 54)	Spring (n = 54)	Fall (n = 27)	Spring (n = 27)	Fall (n = 24)	Spring (n = 24)
Depth (m)	1.36 \pm 0.79 Min = 0.30 Max = 3.80	1.71 \pm 0.77 Min = 0.67 Max = 3.75	2.56 \pm 3.3 Min = 0.50 Max = 12.30	3.14 \pm 3.64 Min = 0.58 Max = 14.30	5.04 \pm 2.84 Min = 0.90 Max = 12.10	4.07 \pm 2.92 Min = 0.61 Max = 11.34
Water temperature ($^{\circ}$ C)	8.19 \pm 1.03 Min = 5.10 Max = 10.50	21.27 \pm 0.91 Min = 19.00 Max = 23.10	9.77 \pm 1.43 Min = 6.10 Max = 12.20	21.02 \pm 0.56 Min = 19.80 Max = 22.50	11.1 \pm 0.98 Min = 9.40 Max = 12.70	20.70 \pm 0.41 Min = 19.90 Max = 21.40
Salinity	22.67 \pm 5.46 Min = 7.70 Max = 28.00	10.20 \pm 4.97 Min = 3.00 Max = 17.00	27.86 \pm 3.99 Min = 17.60 Max = 32.90	19.70 \pm 4.07 Min = 10.70 Max = 27.70	22.89 \pm 9.27 Min = 7.10 Max = 32.30	11.26 \pm 8.99 Min = 1.70 Max = 27.60
Dissolved oxygen (mg l^{-1})	8.19 \pm 0.22 ^a Min = 7.10 Max = 11.25	5.62 \pm 0.51 Min = 4.46 Max = 6.74	6.93 \pm 0.55 Min = 6.17 Max = 8.20	5.55 \pm 0.81 Min = 3.93 Max = 6.86	6.72 \pm 0.69 Min = 5.62 Max = 8.06	4.87 \pm 0.63 Min = 3.62 Max = 5.88
Specific conductivity (mS)	36.26 \pm 7.91 Min = 13.32 Max = 43.79	17.23 \pm 8.01 Min = 5.58 Max = 29.59	43.43 \pm 5.61 Min = 28.88 Max = 50.30	31.71 \pm 6.03 Min = 18.26 Max = 43.85	35.95 \pm 13.95 Min = 12.40 Max = 49.60	17.96 \pm 13.46 Min = 3.13 Max = 42.74
% gravel	na	na	na	na	na	2.42 \pm 10.89 Min = 0.0 Max = 53.37
% sand	73.31 \pm 18.27 Min = 20.98 Max = 96.38	70.60 \pm 22.84 Min = 10.02 Max = 97.91	68.35 \pm 26.32 Min = 16.02 Max = 100.00	68.47 \pm 28.67 Min = 19.43 Max = 100.00	65.59 \pm 22.41 Min = 21.77 Max = 96.94	61.21 \pm 20.75 Min = 4.72 Max = 92.57
% silt	23.61 \pm 16.00 Min = 3.06 Max = 68.58	21.70 \pm 15.99 Min = 1.24 Max = 76.88	26.72 \pm 21.52 Min = 0.0 Max = 69.02	23.99 \pm 22.40 Min = 0.0 Max = 69.36	29.37 \pm 18.49 Min = 2.89 Max = 63.36	25.79 \pm 11.43 Min = 2.79 Max = 41.79
% clay	3.07 \pm 2.41 Min = 0.56 Max = 11.05	7.70 \pm 9.79 Min = 0.03 Max = 36.55	4.93 \pm 5.15 Min = 0.0 Max = 17.71	7.53 \pm 10.11 Min = 0.0 Max = 40.72	5.04 \pm 4.15 Min = 0.17 Max = 14.87	10.59 \pm 13.76 Min = 0.02 Max = 55.79
POC ($\mu\text{g mg}^{-1}$)	5.71 \pm 4.81 Min = 1.38 Max = 23.29	4.90 \pm 5.39 Min = 0.40 Max = 26.00	6.17 \pm 6.25 Min = 0.82 Max = 23.97	5.54 \pm 6.34 Min = 0.20 Max = 22.60	10.87 \pm 7.76 Min = 1.13 Max = 28.17	14.22 \pm 12.20 Min = 1.00 Max = 53.00
Shannon (<i>H'</i>)	1.28 \pm 0.35 Min = 0.52 Max = 2.01	1.31 \pm 0.57 Min = 0.00 Max = 2.22	1.71 \pm 0.47 Min = 0.66 Max = 2.57	1.62 \pm 0.55 Min = 0.00 Max = 2.52	1.26 \pm 0.46 Min = 0.32 Max = 1.98	1.20 \pm 0.65 Min = 0.00 Max = 2.26
Simpson ($1-\lambda$)	0.53 \pm 0.15 Min = 0.21 Max = 0.79	0.62 \pm 0.21 Min = 0.00 Max = 0.86	0.68 \pm 0.17 Min = 0.27 Max = 0.90	0.74 \pm 0.13 Min = 0.28 Max = 0.91	0.55 \pm 0.18 Min = 0.17 Max = 0.82	0.64 \pm 0.19 Min = 0.21 Max = 0.88

^aValue appears too high

Table S4. *Acipenser oxyrinchus desotoi*. Gulf sturgeon diet data based on stomach contents and lavaged fishes. na: not available, TL: total length, FL: fork length. Scientific names were corrected based on updated taxonomy

State	Drainage	Size class (mm)	Dates	Diet	Source
General	na	na	na	Mollusks, worms, insects, crustaceans	Vladykov & Greeley (1963)
Mississippi ^a	na	na	na	Small animals and plants	Cook (1959)
Alabama ^b	Off coast near Dauphin Island	na	December 1953	Lancelet <i>Brachistostoma caribaeum</i> (= <i>B. floridae</i>)	Boschung & Mallory (1956)
Florida	Choctawhatchee	Adult (> 40 kg; n = 1)	1999–2001	Ghost shrimp <i>Lepidophthalmus louisianensis</i> , alpheid shrimp <i>Leptalpheus</i> cf. <i>forceps</i> , and haustoriid amphipods (<i>Lepidactylus</i> spp.)	Heard et al. (2002)
	Blackwater Bay	967 mm TL, n = 1)	30 April–4 May 2002	Gammarid amphipods (100%)	Murie & Parkyn (2002)
	Suwannee	Adults and juveniles	1972–1973	East Pass (pre-spawning adults): partially digested green vegetable material, crab hard parts (probably <i>Callinectes sapidus</i>) Alligator Pass (juveniles): mainly haustoriid amphipods and other items like isopods (<i>Cyathura burbanki</i>), midge larvae, mud shrimp (Callianassidae, <i>Callianassa</i> sp. [= <i>L. louisianensis</i>]), and an eel (<i>Moringua</i> sp.) (combined <5% by weight)	Huff (1975)
	Suwannee	All sizes	Spring migration (mouth of river)	Brachiopods (<i>Lingula</i> [= <i>Glottidia</i>] <i>pyramidata</i> , little crabs, and algae	Carr (1983)
	Suwannee	Adults (~18–85 kg; n = 145)	16 April–8 June 1984	Brachiopods (<i>Glottidia pyramidata</i> [53.7%], crustaceans [14.1%], and vegetable matter [6.1%])	Tatum (1984)
	Suwannee	Sub-adult (11.3 kg, n = 1)	March 1988–August 1990	Contributed 1986 sub-adult specimen (collected in Gulf): brachiopods (<i>G. pyramidata</i>), lancelet <i>B. caribaeum</i> (= <i>B. floridae</i>), polychaetes (Arenicolidae, Nereidae, Orbiniidae, Sabellidae, Capitellidae), oligochaetes (Tubificidae), cumaceans (<i>Oxyurostylis smithi</i>), isopods (<i>C. polita</i> , <i>Apanthura</i> [= <i>Amakusanthura</i>] <i>magnifica</i>), amphipods (<i>Parahaustorius</i> cf. <i>longimerus</i> , <i>Acanthohaustorius</i> cf. <i>longimerus</i> , <i>A. cf. millisi</i> , <i>Amplesca</i> [= <i>Ampelisca vadorum</i> , and <i>Trichophoxus</i> sp.), globular bivalves (Cardiidae, Tellinidae), echinoderms (<i>Mellita</i> sp.), sponges, juvenile starfish, and other shelf organisms	Mason & Clugston (1993)

			March 1988– November 1989	Sub-adults (n = 66) and adults (n = 28)	<p>West Pass:</p> <p>Small sub-adults (1–2 kg): amphipods (<i>Gammarus</i> sp., <i>Neohaustorius</i> sp., <i>P. cf. longimerus</i>, <i>Pseudohaustorius</i> sp.), chironomids (<i>Paratendipes basidens</i>, <i>Cryptochironomous fulvus</i>, <i>C. blarina</i>, and <i>Polypedilum</i> spp.), ceratopogonid larvae (<i>Culicoides</i> sp. and <i>Probezzia</i> sp.) (intertidal prey)</p> <p>Large sub-adults (>2 and <10 kg): tube-dwelling corophiid amphipods (<i>Cerapus tubularis</i>, <i>Corphium</i> [= <i>Monocorophium</i>] cf. <i>turburculatum</i>), isopods (<i>C. polita</i>), small grass shrimp (<i>Palaeomonetes</i> sp.), mysids (<i>Mysis</i> [= <i>Taphromysis</i>] cf. <i>louisianae</i>), oligochaetes (<i>Limnodrilus hoffmeisteri</i>), some polychaetes (<i>Laeonereis culveri</i> and Ampharetidae), and Xanthidae crabs</p>	Mason & Clugston (1993)
		March 1988– November 1989	<p>East Pass:</p> <p>Sub-adults (10–19 kg): ghost shrimp <i>L. louisianensis</i> and unidentified shrimps</p> <p>Large (>20 kg): lancelet <i>B. caribaeum</i> (= <i>B. floridae</i>), brachiopods (<i>G. pyramidata</i>), unidentified pelagic shrimp, polychaetes, amphipods, shrimp, mollusks, sea stars, unidentified fish</p>		Mason & Clugston (1993)	
		Summer/fall	<p>Middle reaches:</p> <p>River 25–55 km: 6 sub-adults fed on aquatic insects, numerous oligochaetes, snails, and gastropods; 7 sub-adults from July 1989 were empty; 3 sub-adults were also empty in fall 1990 (few chironomids)</p> <p>River 70–184 km: digested ghost shrimp <i>L. louisianensis</i>, physid snail, oligochaete, and some clam remains. Fragments of baetid mayfly, amphipods, oligochaetes, unidentified snail in six 7 kg fish</p>	Sub-adults (~6 kg; n = 24)	Mason & Clugston (1993)	
		August–September	<p>River 200–221 km: 1 amphipod, detritus, and sand. Four sub-adults and a 25 kg fish were empty. One 0.3 kg fish had recently fed on Baetidae mayflies, chironomids, insects, bivalve, Asian clams <i>Corbicula fluminea</i>, detritus, and biofilm</p>	Sub-adult (17 kg; n = 2)	Mason & Clugston (1993)	
		Fall 1989/1990	<p>Brachiopods (<i>Glottidia pyramidata</i>) and ghost shrimp <i>L. louisianensis</i> (32% frequency of occurrence), lancelet <i>B. caribaeum</i> (= <i>B. floridae</i>), brittlestars, echinoderms, small bivalves (11%); 57% empty</p>	Sub-adults (≤25 kg, n = 8)	Mason & Clugston (1993)	
	Suwannee	February–May	<p>Brachiopods (<i>Glottidia pyramidata</i>) and ghost shrimp <i>L. louisianensis</i> (32% frequency of occurrence), lancelet <i>B. caribaeum</i> (= <i>B. floridae</i>), brittlestars, echinoderms, small bivalves (11%); 57% empty</p>	Adults (869–2108 mm FL; n = 157)	Carr et al. (1996)	

	Suwannee	814–1995 mm TL (n = 36)	April 2001	Brachiopods (<i>G. pyramidata</i>), polychaetes, brittle stars, mud shrimp	Murie & Parkyn (2001)
	Suwannee	919–1919 mm TL (n = 84)	Late February– mid-April 2002 (70% mid-April)	Brachiopods (<i>G. pyramidata</i> ; 79% frequency), gammarid amphipods (40%), brittlestars (19%), polychaetes, crabs, shrimps or bryozoans (9%), isopods, nemertean, mole crabs (<i>Emerita</i> , 7%)	Murie & Parkyn (2002)

^aListed as Atlantic sturgeon

^bIdentified as *Acipenser sturio*

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