ZOOPLANKTON DISTRIBUTION IN RIVERINE MACROHABITATS OF THE TENNESSEE-TOMBIGBEE WATERWAY

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INTRODUCTION

The Tennessee-Tombigbee Waterway (completed in 1985) has bendway (original Tombigbee River channels cut off by construction of navigation channels), channel (navigation waters), and tailrace (lotic environments immediately downstream from dams) macrohabitats along riverine sections of the system. Jackson and Dillard (1993) described fisheries associated with these locations. White crappie (Pomoxis annularis) and largemouth bass (Micropterus salmoides) were principal components of the catch. Sarnita (1991) and Marler and Jackson (1994) described differential relative abundances and stock structure of white crappie and largemouth bass, respectively, among the macrohabitats. Forage availability was suggested by these studies as a factor responsible for non-uniformity of fish stock characteristics among the macrohabitats.

Zooplankters are initial prey for most fish species (Siefert 1972; O'Brien et al. 1984; Keast and Eadie 1985; Noble 1986). The availability (distribution and abundance) of zooplankton within a system can determine fish stock-specific early life history habitat utilization, growth, and ultimately recruitment processes either directly or indirectly through zooplanktivory by intermediate prey organisms.

Our objective was to determine distribution and abundance of zooplankton among the three riverine macrohabitats. Two null hypotheses were formulated:

1. There is no significant difference among riverine macrohabitats with respect to cumulative zooplankton (rotifers, cladocera, and copepods combined) densities (number/m^3).

2. There is no significant difference among riverine macrohabitats with respect to cumulative zooplankton (rotifer, cladocera, and copepods combined) biomass (µg/m^3).

Significance was established at $P \leq 0.05$.

METHODS

Study Areas

Aberdeen lock-and-dam is situated 1.6 km east of Aberdeen, in Monroe County, Mississippi. Columbus lock-and-dam is located 28.9 km downstream from the Aberdeen lock-and-dam and 7.9 km northwest of Columbus, in Lowndes County, Mississippi. Discharges are predominantly from the epilimnion of the respective upstream reservoir.

Study areas were stream reaches extending from immediately below the respective lock-and-dam downstream approximately 10 km. Each system (Aberdeen and Columbus) contained three distinct macrohabitats: tailrace, channel, and bendways (Figure 1).

Tailraces for both systems were defined as the stream reaches between the respective lock-and-dam and the junction with the first bendway downstream. Tailraces were characterized by relatively fast currents. Channels were navigation sections of the waterway downstream from the respective tailrace. They were lotic environments with more moderate currents than those of tailraces. Bendways are original Tombigbee River stream reaches cut off by construction of the waterway. Bendways tend to have more lentic environmental characteristics than tailraces and channels.

Zooplankton Sampling

Zooplankton was collected from each macrohabitat twice per month in each system from February through July 1989. Collections were made with a Birge closing net sampler having an opening diameter of 12 cm and 63 micron mesh size. Samples were taken by lowering the sampler to 1 m depth and then towing it vertically to the water surface. Samples were preserved in a solution of one-half 5% formalin (2% formaldehyde) added to one-half 70% ethanol (Welch 1948), returned to the laboratory, and concentrated to 10 ml. One 1-ml subsample was then placed into a Sedgewick-Rafter counter chamber (Wildco, Saginaw, Michigan), and organisms identified and counted using a dissecting microscope (Reichert Stereo Star Zoom

580; magnification: 10 to 60X) and a compound microscope (Bausch & Lomb Balplan; magnification: 25 to 1000 X).

Zooplankters (rotifers, cladocerans, and copepods) were identified to genus or to copepodite and nauplius stages of copepods according to the descriptions of Edmondson (1959) and Pennak (1953). Dry-weight of individual zooplankters was calculated using body size-weight equations for each genus, copepodite or nauplius stage (Dumont et al. 1975; Smock 1980; Downing and Rigler 1984; Lawrence et al. 1987). Zooplankton densities were expressed as number/m^3 and zooplankton biomass as µg dry-weight/m^3. Taxon-specific data were combined for analyses and $\log_{10}$ transformed to normalize distributions (Steel and Torrie 1980). A two-factor factorial arrangement in randomized complete block design (Steel and Torrie 1980; Petersen 1985) with month as a blocking factor was used to compare locations.

RESULTS AND DISCUSSION

Considered collectively, numerical density of zooplankton was highest in bendways, intermediate in channels, and lowest in tailraces (Table 1). Biomass was highest per unit volume in bendways; channels and tailraces had lower biomass per unit volume and did not differ from each other.

Fisheries downstream from dams tend to reflect secondary production of macroinvertebrates and fishes associated with utilization of seston (primarily zooplankton) exported through the dam from the immediate upstream reservoir (Armitage 1977; Hutson and Lorenzen 1980; Ney and Mauney 1981; Matter et al. 1983). Exceptional fisheries can result (Eschmeyer and Miller 1949; Miller and Chance 1954; Fry 1967; Moser and Hicks 1970; Jackson and Davies 1988).

Zooplankton density and biomass per unit volume in tailrace macrohabitats in the Tennessee-Tombigbee Waterway are assumed to reflect those of the respective upstream reservoir. The two reservoirs associated with our study are considered moderately to highly productive systems. The tailraces support good fisheries (Jackson and Dillard 1993).

We were surprised, therefore, that bendways had higher zooplankton density and biomass per unit volume than did tailraces (and by association, the upstream reservoirs). Intermediate values for channel macrohabitats suggest transition from allochthonous (upstream derived) zooplankton to more autochthonous, internal zooplankton production dynamics.

Sarnita (1991) measured water temperature, conductivity, and Secchi transparency in each macrohabitat in each system twice/month from January 1987 through August 1988 and once/month from September 1988 through December 1988. He reported no significant difference ($\underline{P} \leq 0.05$) among macrohabitats for these physical parameters. Sarnita's results coupled with those of our zooplankton study suggest that the more lentic environment of bendways, and perhaps their close association with riparian vegetation, benefit zooplankton assemblages. The lentic environment is more stable physically (i.e., less current-induced turbulence). The riparian vegetation serves as a source of allochthonous organic materials that provide energy and nutritional inputs to the macrohabitat (Vannote et al. 1980).

Our study indicates that bendways are important macrohabitats with regard to zooplankton assemblages in the Tennessee-Tombigbee Waterway. This zooplankton should be a factor to consider when addressing fisheries management programs for the system.

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Table 1. Mean zooplankton density (number/m^3) and biomass (μg dry-weight/m^3) in macrohabitats below Aberdeen and Columbus Dams, Tennessee-Tombigbee Waterway (February-July 1989). N=number of samples. SE=standard error (in $\log_{10}$). Means followed by the same letter are not significantly different ($P \leq 0.05$).

Macrohabitat	N	Density Mean	Density SE	Biomass Mean	Biomass SE
Bendways	24	6795 a	0.04	3867 a	0.03
Channels	24	5636 ab	0.05	2969 b	0.05
Tailraces	24	4969 b	0.05	2560 b	0.04

Appendix A. Density (number/m^3) and biomass (µg/m^3) of rotifers in macrohabitats below Aberdeen and Columbus dams, Tennessee-Tombigbee Waterway (February-July 1989).

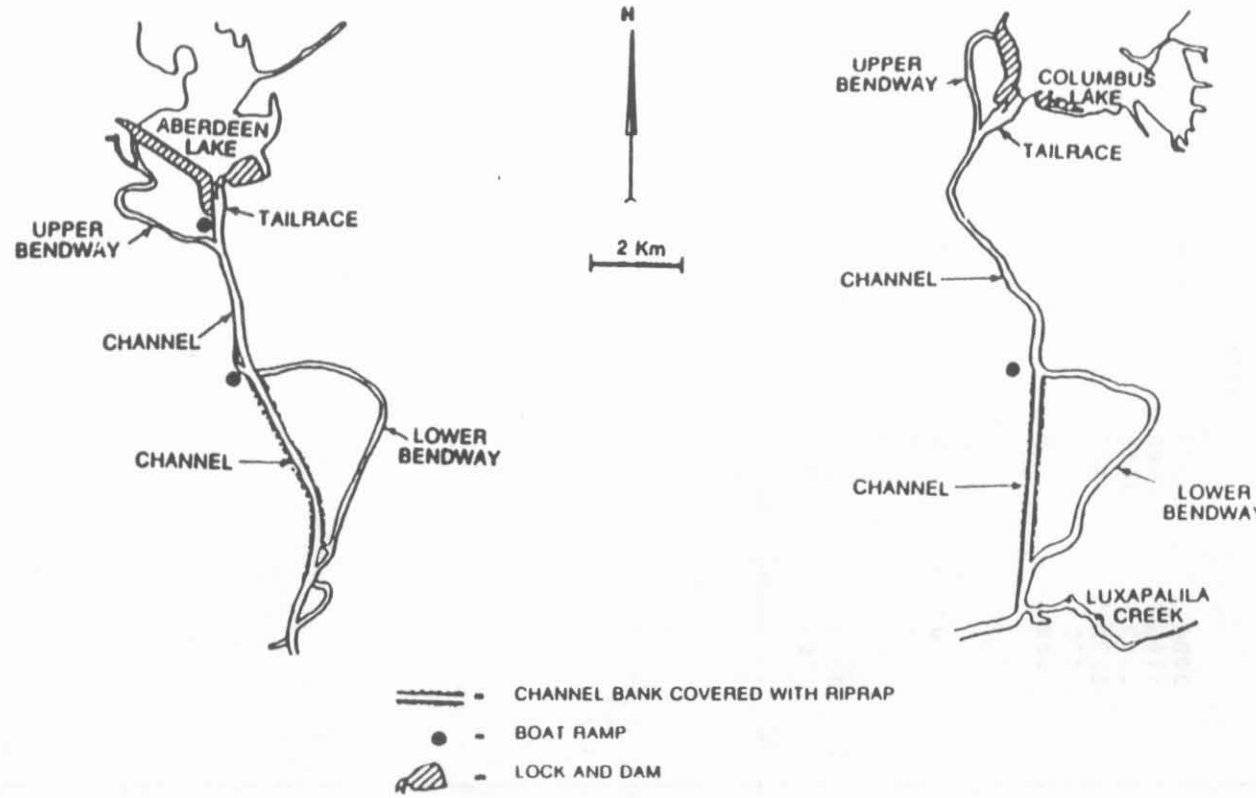
Month	Bendways		Channels		Tailraces	
	Number	Biomass	Number	Biomass	Number	Biomass
			Aberdeen			
February	851	387	718	571	1167	568
March	2054	830	1894	554	1891	712
April	8586	2754	11886	3773	3887	2016
May	4080	1297	5117	1646	2743	889
June	8177	2784	2096	1603	4127	1432
July	8985	3235	3257	1177	4000	1534
			Columbus			
February	5708	3549	5077	1650	5950	1538
March	13618	4458	10000	3250	12300	3250
April	4341	1994	3617	1524	4732	1746
May	6286	3246	11448	3763	12572	3778
June	2635	664	2299	711	761	230
July	5139	1523	4762	1447	5952	1891

Appendix B. Density (number/m^3) and biomass (µg/m^3) of cladocerans in macrohabitats below Aberdeen and Columbus dams, Tennessee-Tombigbee Waterway (February-July 1989).

Month	Bendways		Channels		Tailraces	
	Number	Biomass	Number	Biomass	Number	Biomass
			Aberdeen			
February	420	330	1364	376	229	480
March	559	537	943	807	355	754
April	2229	2397	1829	1919	1059	905
May	296	1326	56	60	152	177
June	100	151	76	88	203	219
July	551	531	711	669	921	833
			Columbus			
February	359	335	0	0	0	0
March	334	312	0	0	0	0
April	716	706	480	537	454	514
May	413	734	2744	310	381	776
June	285	304	243	257	302	391
July	453	409	86	75	257	326

Appendix C. Density (number/m^3) and biomass (µg/m^3) of copepods in macrohabitats below Aberdeen and Columbus dams, Tennessee-Tombigbee Waterway (February-July 1989).

Month	Bendways		Channels		Tailraces	
	Number	Biomass	Number	Biomass	Number	Biomass
			Aberdeen			
February	1646	2084	267	915	220	613
March	3208	4145	3888	2689	1270	1200
April	2092	1662	3073	7423	923	1799
May	1365	1121	1492	1142	1257	2217
June	340	479	63	153	292	508
July	247	399	66	55	223	340
			Columbus			
February	0	0	0	0	52	90
March	0	0	0	0	0	0
April	987	975	1110	1311	730	611
May	687	775	423	1000	381	313
June	1461	2022	1403	1826	747	688
July	256	398	324	380	403	299


ABERDEEN LAKE
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COLUMBUS LAKE
TAILRACE
CHANNEL
CHANNEL
LOWER BENDWAY
LUXAPALILA CREEK
- CHANNEL BANK COVERED WITH RIPRAP
- BOAT RAMP
- LOCK AND DAM