

A METHOD FOR ANALYSIS OF DIFFERENCES IN FISH COMMUNITY SPECIES OCCURRENCES

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ABSTRACT

The occurrences of the 20 most abundant fish species in impoundments of each of seven rivers were compared using Long's (1963) index of faunal resemblance. Higher order systems, i.e., larger rivers, contain more species than smaller rivers. Also, impoundments of larger river systems tend to be more similar, while those on smaller rivers maintain their unique faunal assemblages.

Several workers have investigated the relationship between the number of fish species and stream size. Larimore et al. (1959), showed that some species were collected throughout the entire reach of Smith's Branch, whereas others were collected only in the downstream reaches. None were unique to the upper reaches of the stream. The greatest diversity of species was found at the most downstream station. These findings were supported by those of Harrel et al. (1964), who showed that in the Otter Creek drainage system there was a direct correlation ($r = 0.96$) between stream order (Horton 1946, Strahler 1954, 1957) and species diversity and that all species taken in each lower order stream were also taken in the higher order (i.e. larger) streams. While this continuity of species persists in the Smith's Branch and Otter Creek studies, Burton and Odum (1945) showed that although there was a general continuity of certain fish species, there were interruptions in the occurrences of fish species in the five streams they studied.

Studies of this type have not been done on large river systems. We investigated the similarities and differences in the species occurrences of dominant fish species in reservoirs of seven river systems. To compare the fish species occurrences, we used Long's (1963) index of faunal resemblance.

MATERIALS AND METHODS

TVA owns or operates 48 reservoirs that impound the Tennessee and the Cumberland Rivers. The combined drainage is approximately 150,350 square kilometers. Each river consists of several sub-basins. The river systems compared in this study were impounded portions of the mainstream Tennessee and Cumberland, the Holston (the Holston and French Broad Rivers combine to become the Tennessee), and four river tributary systems; the Clinch, Powell, Emory, and Little Emory Rivers, all ultimately emptying into the upper portion of the Tennessee (Figure 1).

Fish species occurrences and abundance were determined from cove rotenone samples using a standardized technique (Hall, 1974). The average numbers of each species per hectare for all samples from each river system was then determined from the following cove samples:

Tennessee River—274 samples in eight reservoirs (Kentucky, Pickwick, Wilson, Wheeler, Nickajack, Chickamauga, Watts Bar, and Fort Loudoun).

Holston River—53 in three reservoirs (Cherokee, Boone, and S. Holston).

Clinch River—60 samples in three reservoirs (Watts Bar, Melton Hill, and Norris).

Powell—17 samples in Norris Reservoir.

Emory—2 samples in Watts Bar Reservoir.

Little Emory—2 samples in Watts Bar Reservoir.

Cumberland—27 samples in Barkley and Old Hickory Reservoirs.

Because of the great disparity in the number of samples taken in the respective rivers, it was decided to use only the 20 most abundant species for each river system. By limiting the analysis to the abundant species in each system we were able to exclude those rare individuals that show up only if a large number of samples are taken.

The abundance of each species in each system was ranked. In cases where a species was ranked in the top 20 for one river but at some lower level for another, the species were included in the analysis for those rivers wherein it occurred. Where a species was not taken, a score of zero (0) results.

C. A. Long's (1963) method was used to express the faunal resemblances among the seven rivers. This percent resemblance equation is:

$$C (N_1 + N_2) (100) / 2 N_1 N_2 = \text{percent resemblance}$$

where:

C = species common to both assemblages

N₁ = number of species in first assemblage

N₂ = number of species in second assemblage

The resemblance equation was derived from zoogeographical studies of Simpson (1947) and Hershkovitz (1958). Similar relationships were independently demonstrated by Jaccard (1908) in developmental biology and by the botanist Sorenson (1948).

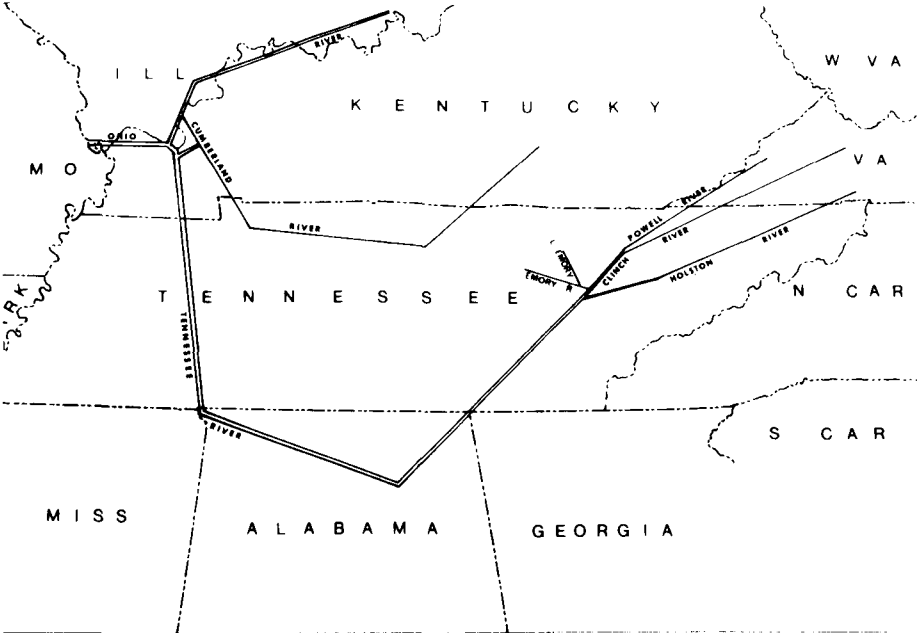


Figure 1. Schematic map showing the size and location of the seven rivers that comprised the study area.

RESULTS AND DISCUSSION

A total of 43 species ranked in the 20 most abundant species in at least one of the river systems (Table 1). Of these species, 42 were taken in the mainstream Tennessee whereas the Emory and Little Emory each contained only 21 species, this is due largely to the differences in the number of samples taken (274 in the Tennessee and 2 each in the latter rivers). All rivers had 13 fish species in common, with three of these (*Dorosoma petenense*, *D. cepedianum*, and *Lepomis macrochirus*) being within the top four abundance positions for all rivers. Long's (1963) indices are presented in a matrix of faunal resemblance (Table 2). The matrix shows that the Tennessee, Clinch, and Cumberland Rivers have a greater faunal similarity with one another than with the smaller systems. However, this is not

Table 1. Occurrence of the 20 most abundant fish species in seven river systems.

Fish Species	River						
	Tennessee	Holston	Clinch	Powell	Emory	Little Emory	Cumberland
<i>Dorosoma petenense</i> *	+	+	+	+	+	+	+
<i>Dorosoma cepedianum</i> *	+	+	+	+	+	+	+
<i>Lepomis macrochirus</i> *	+	+	+	+	+	+	+
<i>Aplodinotus grunniens</i>	+		+	+	+	+	+
<i>Lepomis megalotis</i>	+	+	+				+
<i>Micropterus salmoides</i> *	+	+	+	+		+	+
<i>Ictalurus punctatus</i> *	+	+	+	+	+	+	+
<i>Pomoxis annularis</i> *	+	+	+	+	+	+	+
<i>Lepomis cyanellus</i>	+	+					+
<i>Alosa alabamae</i>	+						
<i>Morone mississippiensis</i>	+						+
<i>Lepomis microlophus</i>	+		+				+
<i>Micropterus punctulatus</i>	+		+			+	+
<i>Alosa chrysochloris</i>	+		+		+		+
<i>Minytrema melanops</i>	+				+		+
<i>Pimephales notatus</i> *	+	+	+	+		+	+
<i>Lepomis gulosus</i> *	+	+	+	+		+	+
<i>Micropterus dolomieu</i>	+	+	+	+			+
<i>Morone chrysops</i> *	+	+	+	+			+
<i>Lepomis humilis</i>	+						
<i>Cyprinus carpio</i> *	+	+	+	+	+	+	+
<i>Ictalurus nebulosus</i>	+		+				+
<i>Gambusia affinis</i>	+		+	+		+	+
<i>Pomoxis nigromaculatus</i>	+	+	+	+		+	+
<i>Ictiobus bubalus</i>	+		+		+	+	+
<i>Pimephales vigilax</i>	+	+	+	+			+
<i>Carpoides carpio</i>	+	+	+	+			+
<i>Notropis spilopterus</i>	+	+	+	+			+
<i>Lepomis gibbosus</i>	+	+					+
<i>Moxostoma erythrum</i> *	+	+	+	+	+	+	+
<i>Flycatcher olivaris</i> *	+	+	+	+	+		+
<i>Ambloplites rupestris</i>	+	+	+	+			+
<i>Moxostoma macrolepidotum</i>	+	+	+	+	+		+
<i>Carpoides cyprinus</i>	+	+	+				+
<i>Moxostoma duquesnei</i>	+	+	+				+
<i>Lepisosteus platystomus</i>	+				+		+
<i>Labidesthes sicculus</i>			+	+	+		
<i>Percina caprodes</i> *	+	+	+	+	+	+	+
<i>Notropis whipplei</i>	+	+	+	+			+
<i>Stizostedion canadense</i>	+		+			+	+
<i>Notropis atherinoides</i>	+	+	+				+
<i>Lepomis auritus</i>	+	+	+	+	+		+
<i>Notropis galacturus</i>	+	+	+		+	+	

*Fish species present in all rivers.

Table 2. Matrix of the percent of faunal resemblance among the 20 most abundant fish species in each of seven rivers in the Tennessee Valley Region.

	From--	Tennessee	Holston	Clinch	Powell	Emory	Little Emory	Cumberland
Tennessee	100.00	—	—	—	—	—	—	—
Holston	87.15	100.00	—	—	—	—	—	—
Clinch	91.29	85.71	100.00	—	—	—	—	—
Powell	78.14	85.71	88.89	100.00	—	—	—	—
Emory	68.40	62.50	75.40	70.83	100.00	—	—	—
Little Emory	72.01	66.67	79.17	70.83	80.95	100.00	—	—
Cumberland	90.03	77.14	92.98	80.36	76.19	76.19	100.00	—

reflected in the small rivers; they each tend to maintain their own species assemblage although there is a small increase in similarity of the Little Emory-Emory pair, presumably because they join in the same reservoir. Neither the Emory nor Little Emory shows a high degree of resemblance to any of the other rivers considered.

A similar pattern was observed in the faunal assemblages of the Powell-Clinch pair, probably because the Powell joins the Clinch in Norris Reservoir.

The Holston River, a major tributary of the Tennessee, showed a resemblance of 87.15 percent to the Tennessee and values of 85.7 percent to both the Clinch and Powell Rivers. The two smaller rivers (Emory and Little Emory) in the same area (Figure 1) were considerably lower in resemblance, again suggesting that smaller rivers maintain their identity.

The method used here probably underestimates the actual disparity between the river systems because of the use of only those occurrences which are among the 20 most abundant fish species in at least one of the rivers. If all species were used, faunal assemblage indices would assuredly go down. This method is also based only on presence-

absence data with no weighting of species for their rank or abundance in the fish community. The use of weighting functions for abundance and within river rankings of the species would show greater differences in the fish communities.

In summary, we believe that the Long (1963) index of faunal resemblance provides a simple and effective method for demonstrating the differences in fish communities in different river systems.

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