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Changes in the Economy and Ecology at Proposed Lake Sites in the Salt River Basin, Kentucky, During Early Construction of the Dam for Taylorsville Lake

Louis A. Krumholz
University of Kentucky

Stuart E. Neff
University of Kentucky

Edmond J. Bacon Jr.
University of Kentucky

John R. Baker
University of Kentucky

Daryl E. Jennings
University of Kentucky

Authors
Louis A. Krumholz, Stuart E. Neff, Edmond J. Bacon Jr., John R. Baker, Daryl E. Jennings, Andrew C. Miller, Vincent H. Resh, and David S. White

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CHANGES IN THE ECONOMY AND ECOLOGY AT PROPOSED LAKE SITES IN THE SALT RIVER BASIN, KENTUCKY, DURING EARLY CONSTRUCTION OF THE DAM FOR TAYLORSVILLE LAKE

Louis A. Krumholz and Stuart E. Neff
Principal Investigators

Edmond J. Bacon, Jr., John R. Baker, Daryl E. Jennings,
Andrew C. Miller, Vincent H. Resh and David S. White
Graduate Research Assistants

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ABSTRACT

This is an extension of the work reported in Project Nos. B-005-KY, B-016-KY, and B-022-KY that extended from 1 July 1968 through 30 June 1972. Permanent collecting stations have been established at 67 sites throughout the Salt River, Beech Fork, and Chaplin River drainages. Turbidities increase quickly as flow and runoff increase, and subside quickly when the rain stops. Suspended solids range up to 1,700 mg/l in high turbidities and vary considerably as a result of local spates. Water chemistry generally reflects the limestone nature of the substrate and the physico-chemical characteristics of a typically healthy limestone stream. Bottom organisms are abundant and diverse, more than 300 different benthic organisms have been identified to date. Drift samples exhibit extremely high densities ranging from 0.1 to 28 organisms per cubic meter of discharge, with as many as 315,000 organisms passing the same point during peak drift activity. Species diversity of caddisflies was calculated for 85 quantitative samples. The greatest numbers emerge at dusk with sex ratios about 1:1, and with production ranging from 4.3 to 24.3 mg/m^2. Few changes have occurred in the socioeconomic aspects of the study; the only major change involved an upward revision of the amount of land needed for a recreational area from about 200 acres to about 4,300 acres.

Key Words: VI G Ecologic impact of water development

- Ecology
  - Aquatic habitats
  - Limnology
  - Water quality
  - Environmental effects
- Economics
  - Natural resources
  - Benefits
  - Planning
- Descriptors
  - Drift
  - Sediment
  - Turbidity

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INTRODUCTION

The work reported here is an extension of that included in Project Nos. B-005-KY, B-016-KY, and B-022-KY that extended from 1 July 1968, through 30 June 1972 (Krumholz 1971, Krumholz and Neff 1972, Neff and Krumholz 1974). Originally, the U. S. Army Corps of Engineers, Louisville District, had proposed the impoundment of the mainstem of the Salt River approximately 3 miles upstream from the town of Taylorsville and of the 2 principal tributaries, the Beech Fork and the Rolling Fork (Fig. 1). That program has since been modified; the development of Howardstown Lake (Rolling Fork) has been held in abeyance, and Camp Ground Lake (Beech Fork) has been requested but not yet authorized. It is expected that construction of the dam for Taylorsville Lake will commence in Fiscal Year 1974 or 1975 at the latest.

Because of these changes, the study has been confined to the mainstem of the Salt River from its sources to about 5 miles downstream from Taylorsville, and to the Beech Fork and its principal tributary, the Chaplin River, from their respective sources to about 5 miles below their confluence near the town of Maud. That area includes about 90 miles of the Salt River, 60 miles of the Beech Fork, and the entire length (90 miles) of the Chaplin River (Fig. 1). On the basis of these studies, the following graduate dissertations and theses have been completed or are in progress:

"Studies on the water chemistry and bottom fauna of Brashears Creek, Spencer and Shelby counties, Kentucky" by John D. Woodling. Master's thesis. Department of Biology, University of Louisville. August 1971. 101 pp.

"Biology and immature stages of caddisflies of the genus *Athriposdes* in eastern North America" by Vincent H. Resh. Doctoral dissertation.

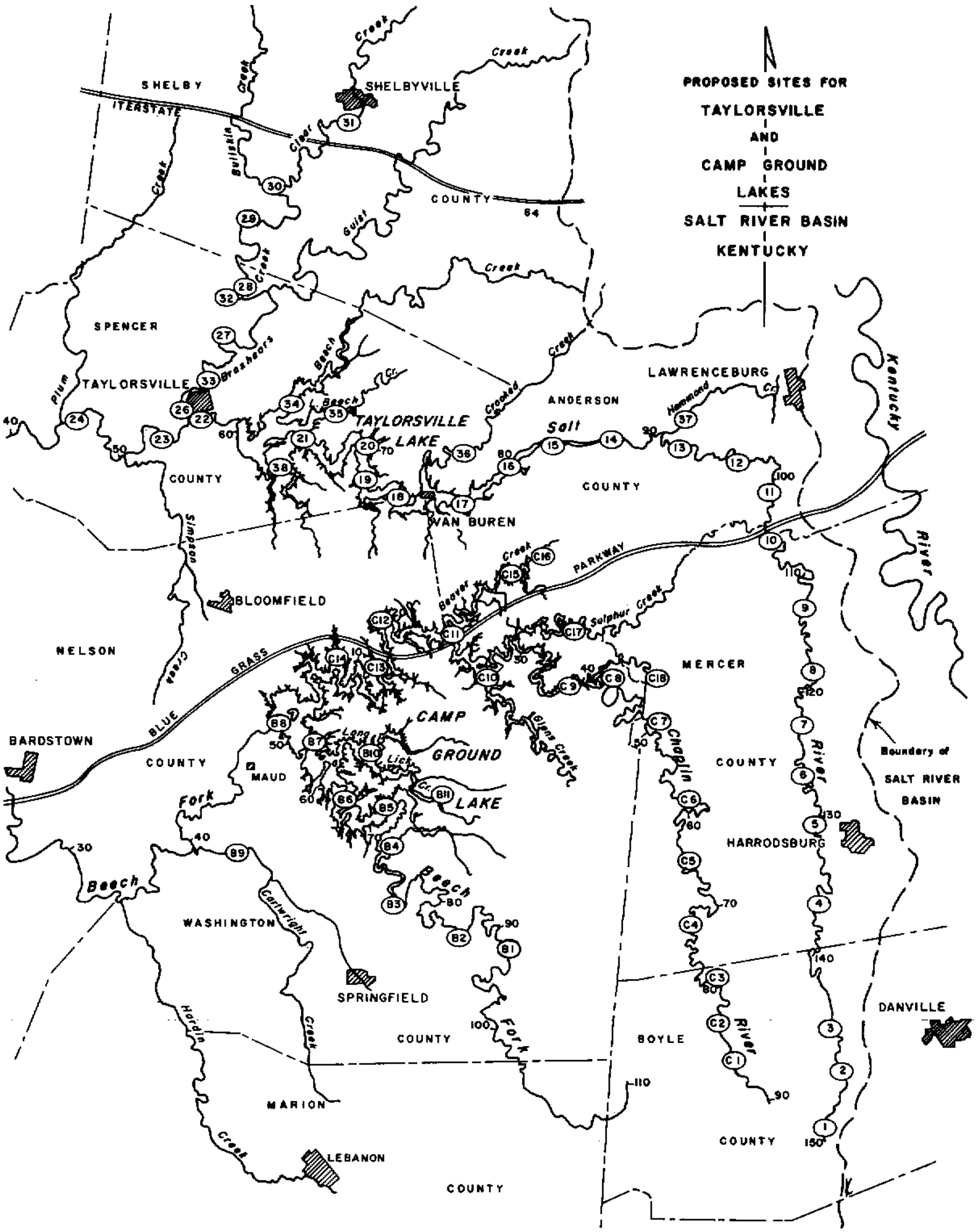

Fig. 1. The Salt River, Beech Fork, and Chaplin River showing the locations of the principal sampling stations for water, bottom fauna, and fishes.

Department of Biology, University of Louisville. August 1973. 165 pp.
"Life history of the fantail darter *Etheostoma flabellare* Rafinesque in the Salt River drainage, Kentucky" by John R. Baker. Master's thesis. Department of Biology, University of Louisville. May 1974.
"The biology of the spotted sucker *Minytrema melanops*" by David S. White. Doctoral dissertation. Department of Biology, University of Louisville. To be completed December 1974.
"Analysis of selected chemical parameters of the water in the Salt River, Kentucky" by Jerry S. Parsons. Master's thesis. Department of Biology, University of Louisville. To be completed in 1975.
"Seasonal changes in species composition and relative abundance of drift organisms as related to environmental factors" by Daryl E. Jennings. Doctoral dissertation. Department of Biology, University of Louisville. To be completed in 1975.
"Seasonal changes in water quality and suspended materials in the Salt River, Kentucky" by Andrew C. Miller. Doctoral dissertation. University of Louisville, Department of Biology. To be completed in 1975.

Data for each of these graduate studies have been gathered in large part from the Salt River Basin, Kentucky, and each of the graduate research assistants has been supported in part by OWRR funds. At the same time, each of them along with other graduate and undergraduate students, has worked in all phases of the project in the field as well as in the laboratory.

With this background of experience, we continued to improve and consolidate our baseline data on the ecological aspects of the Salt River Project and to enhance our information on the economic and sociological areas with these objectives: (1) to study and describe changes in the ecological conditions during construction of Taylorsville Dam in the areas of the Salt River, Kentucky to be inundated. Physical, chemical, and biological data will be collected regularly to document changes in those aspects along with the disruption to the stream system in terms of downstream water quality and biota; (2) to assess changes that occur in the economic status of the communities and agricultural areas in the Salt River Basin and to determine the effects of damsite preparation and dam construction on economic and political structures in the immediate areas; and (3) to observe changes in sociological status and attitudes of persons living in the areas as dam construction become imminent and community displacement a certainty. This third objective has largely been undertaken by personnel at the University of Kentucky and only limited remarks on that phase of the project will be included here.

Because of the lack of funds and authorization to proceed with the purchase of land, construction of the dam for Taylorsville Lake has been postponed until Fiscal Year 1975. Funding has now been authorized, and land acquisition will begin in February 1974. Personnel of the U. S. Army Corps of Engineers, Louisville District have informed us that construction of the access road and clearing of the damsite will be underway during the spring of 1974. The access road will tie into State Highway 248 east of Taylorsville and will extend to the damsite. The damsite for Taylorsville Lake will be at about Salt River Mile 60.0, about 6.4 km (4 miles) upstream from Taylorsville. This will provide an opportunity to assess the full effect of dam construction on the quality of the water in the stream and any effects it may have on the stream biota. Also, there will be ample opportunity to assess changes in the economy brought about by the construction of that facility now that it has become a reality.

METHODS

Physical and chemical parameters of waters in the Salt River, the Beech Fork, and the Chaplin River and their tributaries have continued to be measured by accepted limnological methods as described in our previous completion reports (Krumholz 1971, Krumholz and Neff 1972, Neff and Krumholz 1974) following the procedures described in the 13th edition of "Standard Methods for the Examination of Water and Wastewater" (Taras et al. 1971). Similarly, benthic samples and fishes, as well as drift samples, were collected and processed as described in previous reports. All such organisms are being added to the biological collections at the University of Louisville where they will remain available for future studies.

It is expected that the preimpoundment phase of the study will be completed during the next fiscal year. At that time, complete lists of the flora and fauna of the Salt River Basin as exemplified by this study will be compiled and included in a comprehensive report of that phase. It is also anticipated that at least 2 new stations will be established, one about 0.75 km upstream from the proposed damsite and another about 0.75 km downstream from that location. Those stations will be selected to provide maximum information on the effects of preliminary phases of construction of the outlet works and the preliminary clearing of the site prior to the initiation of construction. Such a study will also include the effects of building the access road to the damsite. The precise location of those sites will be determined as soon as the exact site of the dam is established.

As the construction of the new access road is begun, samples above and below the damsite will be collected on a regular basis, probably weekly, and whenever there are rainfalls of more than 0.1 inch (0.25 cm) within 24 hours. Following such a procedure, it will be possible to document precisely the changes in sediment load in the main stem of the Salt River that is attributable directly to all phases of the construction of the dam. It is anticipated that that phase of the project will continue throughout construction of the dam (through Fiscal Year 1978).

As in previous studies, data for the economic base for Spencer County were gathered from professional real estate agents, county tax records, land owners and tenants, business men, soil conservationists, bankers, and private citizens.

THE STUDY AREA

The study area has been described in previous completion reports and will not be repeated in detail here. The area to be impounded for Taylorsville Lake will drain portions of Boyle, Mercer, Anderson, Nelson, Shelby, and Spencer counties and will have a drainage area above the damsite of 354 square miles (917 km^2), whereas the area to be impounded for Camp Ground Lake will drain portions of Boyle, Mercer, Anderson, Nelson, Marion, and Washington counties (Fig. 1), and will have a drainage area of 438 square miles (1,134 km^2) above the damsite. These combined drainage basins make up 27.1 percent of the entire Salt River Basin.

Permanent collecting stations have been established at 27 sites in the Salt River and its tributaries upstream from Taylorsville, along with 11 sites on the Salt River and Brashears Creek downstream from Taylorsville. Eleven collecting stations have been established on the Beech Fork and its tributaries, and 18 such sites have been designated in the Chaplin River and its tributaries. Thus, there are 67 permanent collecting stations in the drainage areas of the proposed impoundments (Fig. 1).

The stations in Brashears Creek will serve as a monitor for the Salt River and the station in Cartwright Creek will serve as a monitor for the Beech Fork and Chaplin River. Each of those stations has been described previously, those for the Salt River in the Completion Reports for Project Nos. B-005-KY and B-016-KY, and those for the Beech Fork and Chaplin River in the Completion Report for Project No. B-022-KY, all of which encompass the time period from 1 July 1968 through 30 June 1972 (Krumholz 1971, Krumholz and Neff 1972, and Neff and Krumholz 1974).

PHYSICAL AND CHEMICAL CHARACTERISTICS OF THE STUDY AREA

During this phase of the study, water samples were collected at each of the permanent collecting stations, but early in the study period, principal emphasis was placed on a series of 8 selected stations in an effort to assess the influence of the sewage disposal facility at Lawrenceburg (population ca. 2,500) on the Salt River near the upper end of the proposed pool. Four of those stations were concerned directly with Hammond Creek as follows:

Station H1. This station is directly upstream from the bridge for U. S. Highway 127 across Hammond Creek about 100 m downstream from the effluent of the sewage disposal facility at Lawrenceburg. The bottom of the stream consists essentially of dark brown to black muck or silt, and at times of low flow is covered with large quantities of sludge from the effluent. During the summer months, the depth of the water seldom exceeds 0.5 m and the width of the stream is about 2-3 m. During periods of low flow, there is a marked odor from the sewage effluent.

Station H2. This station is at the low water bridge about 0.4 mile above the confluence of Hammond Creek with the Salt River. The bottom is mainly sand and coarse rubble and the stream is about 10-12 m wide. This station is identical with Station 37 described earlier by Krumholz and Neff (1972). Station H3. This station is in the Salt River about 300 m upstream from the confluence of Hammond Creek with the Salt River. The bridge retards the flow of the river so there is a pool formed at time of low flow. The bottom consists of large rubble, sand, and silt, and the stream is about 30 m wide. At times of high flow, the bridge is completely inundated. Station H4. This station is the counterpart of Station H3 and is about 300 m downstream from the mouth of Hammond Creek. There are large beds of *Dianthera* over much of the stream bottom that form islands, giving the stream a braided appearance. The bottom consists of large and small rubble, sand, and some silt, and the flow in the area is laminar. The stream is about 30 m wide.

The remaining 4 stations (Fig. 1) have been described in previous reports and are in the Salt River at Goodnight Bridge (Station 17), Taylorsville (Station 22), and downstream from Taylorsville (Station 23) (see Krumholz 1971), and near the mouth of Brashears Creek (Station 26) (see Krumholz and Neff 1972).

Water samples from each of those stations indicate that the effluents from the sewage disposal facility at Lawrenceburg have marked effects on the welfare of Hammond Creek, traceable directly to nutrient overload, particularly during the summer and early fall when temperatures are high and discharges low, and that those effects are significantly ameliorated by natural processes as the water passes downstream toward Taylorsville. Maximum and minimum values during parts of 1972 and 1973 for specific conductance, dissolved oxygen, percentage saturation of dissolved oxygen, turbidity, selected cations and anions, and suspended solids are listed in Table 1 for Hammond Creek near U. S. Highway 127 (Station H1) and for the Salt River at Taylorsville (Station 22). The data for the Salt River

Table 1. Maximum and minimum values for selected parameters for Hammond Creek at U. S. Highway 127 (Station H1) and the Salt River at Taylorsville (Station 22) from August 1972 through July 1973.

	Hammond Creek		Salt River	
	Max.	Min.	Max.	Min.
Specific conductance (μmhos)	1300	320	470	190
Dissolved oxygen (ppm)	10.1	.25	10.8	1.8
Oxygen saturation (%)	100	2.7	104	20.4
Turbidity (ppm SiO_2)	59	10.2	816	5.5
Nitrate (ppm)	13.0	.52	1.3	.12
Phosphate (ppm)	75	3.5	1.76	.16
Potassium (ppm)	19.4	3.1	5.6	1.0
Sodium (ppm)	152.3	16.2	20.3	3.2
Calcium (ppm)	98.2	54	74.8	51.3
Magnesium (ppm)	20.4	2.0	10.2	1.6
Suspended solids (mg/1)	420	10.0	1684	4.0
Suspended solids (%)	63	3.5	88.6	2.0

fall in line with comparable data from other streams in that region of Kentucky and continue to indicate that the stream is quite healthy and typical of the clean water streams in the area so far as those parameters are concerned. Specific conductance ranged from 190 to 470 μmhos, and dissolved oxygen from 1.8 to 10.8 ppm and from 20 to 104 percent saturation. The low oxygen levels were short lived and occurred only during low flow during late summer and early fall when there were large amounts of plant detritus in the stream that caused high oxygen demand. Perhaps the most interesting measurements were for turbidity and suspended solids, which clearly indicate the high amount of erosion that occurs in the watershed. Such turbidities follow local spates and usually clear up within a relatively short time. The various anions and cations fall within their expected ranges.

When the data from the Salt River are compared with those from Hammond Creek, it is readily apparent that the latter data reflect the organic enrichment from the sewage disposal facility at Lawrenceburg. Maximum levels of anions and cations listed from Hammond Creek (Table 1), with the single exception of calcium, were at least twice those from the Salt River, even though the effluents carried by Hammond Creek entered the Salt River directly. The highest nitrate concentration in Hammond Creek was 13.0 ppm, 10 times that found in the Salt River, and the highest concentration of phosphates in Hammond Creek was 75.0 ppm, more than 40 times as great as the highest in the Salt River at Taylorsville, some 35-40 miles (ca. 60 km) downstream from the sewage outfall. These high concentrations of electrolytes in the waters of Hammond Creek, as compared with those in the main stem of the Salt River, are readily apparent in the marked differences in measurements of specific conductance at the 2 stations. Similarly, the concentrations of dissolved oxygen in Hammond

Creek ranged from about 3 to 100 percent, the lowest saturations occurred in the late summer and early fall during periods of low flow and the highest during late winter and early spring during periods of highest discharge.

The lessening of concentrations of nitrates and phosphates from the upper reaches of Hammond Creek near Lawrenceburg (Station H1) to the mainstem of the Salt River near Taylorsville (Station 22) at different times of the year are clearly shown by the data collected at those stations on 16 February 1973 (Table 2) and 31 July 1973 (Table 3). In the February samples, the concentrations of nitrates were only a third as great at Taylorsville as near Lawrenceburg whereas in the July samples they were less than a fourth as great. The differences in concentrations of phosphates were much more dramatic, being only a tenth as great at Taylorsville as in the upper reaches of Hammond Creek, but in July, the difference between the 2 stations was almost twice as great as it was in February. Furthermore, the levels of concentration of each anion were consistently lower at each station in February. There was a general increase in the amounts of dissolved oxygen downstream, but the most obvious difference in that parameter was at the different times of the year when the levels in winter were consistently higher than in summer. In the study area, much of those differences are related to water temperature and rate of discharge; seasonally, low discharges usually occur during periods of high temperature and high discharges during periods of low temperature.

Although the data in the tables do not include figures for other anions and cations, much the same trends were observed for other nutrients as well, such as sodium and potassium. Usually, the levels of all nutrients in the Salt River below Hammond Creek are at acceptable levels,

Table 2. Selected data on water quality from 5 stations in Hammond Creek and the Salt River, 16 February 1973.

	Hammond Creek		Salt River		
	Station H1	Station 37	Station H4	Station 17	Station 22
Dissolved oxygen (ppm)	9.6	11.0	9.9	9.1	10.2
Specific conductance (μmhos)	520	420	372	340	360
Nitrate (ppm)	1.9	1.1	1.0	1.2	0.6
Phosphate (ppm)	6.7	1.1	1.5	0.7	0.6

Table 3. Selected data on water quality from 5 stations in Hammond Creek and the Salt River, 31 July 1973.

	Hammond Creek		Salt River		
	Station H1	Station 37	Station H4	Station 17	Station 22
Dissolved oxygen (ppm)	2.7	9.2	6.9	6.8	6.6
Specific conductance (μmhos)	675	410	410	420	390
Nitrate (ppm)	3.7	1.3	1.2	1.3	0.8
Phosphate (ppm)	26.0	5.0	3.0	1.5	1.4

and the mainstem does not appear to experience deleterious effects from the sewage effluents emanating from Lawrenceburg. At this time, it is difficult to predict what effects the accumulation of such materials may have when the Salt River is no longer a free-flowing stream, and the materials become trapped in the lake.

Streams in the Salt River drainage are subject to rather violent fluctuations in discharge. As pointed out in an earlier report (Krumholz 1971), the depths of water in the streams increase rapidly following rainfalls, largely because of the impermeable nature of the limestones and shales that underlie the basin. Water levels at most stations fluctuate dramatically (Hendrickson and Krieger 1964), and those fluctuations have a major effect on sediment transport. The turbidity of the water increases quickly as flow and runoff increase, and subsides in a relatively short time and distance when the rain stops. Such seasonal changes in turbidity and the effects of local showers are demonstrated clearly by the data from 3 stations in the mainstem of the Salt River within the proposed Taylorsville pool, Station 17 at Goodnight Bridge, Station 22 at Taylorsville, and Station 23 about 1.3 miles (2.1 km) downstream from Taylorsville and the mouth of Brashears Creek, a major tributary to the Salt River. Station 22 is 19.2 miles (30.9 km) downstream from Goodnight Bridge.

Twelve samples, taken at approximately monthly intervals during the study period, depict the amounts of suspended solids in milligrams per liter of stream water collected at the water surface (Table 4). The means for the amounts of suspended solids at the 3 stations were 71, 209, and 156 mg/l for the year, but there were wide variations at each station, indicating an almost immediate response to the rainfall with an increase concentration in suspended solids. From the data in Table 4, it appears

Table 4. Suspended solids (mg/1) from 3 stations in the Salt River (see Fig. 1), August 1972 through July 1973.

	Station 17	Station 22	Station 23
10 August	16	16	37
28 September	4	17	16
24 October	2	4	12
21 November	114	152	38
13 December	94	128	206
26 January	21	15	45
16 February	90	108	92
30 March	74	176	144
13 April	12	13	18
24 May	146	86	180
13 June	90	1,684	1,000
2 July	194	106	88
Mean	71	209	156

that there must have been a sudden, rather intense shower on 13 June 1973 between Goodnight Bridge and Taylorsville. On that date, the suspended solids at Station 17 were only 90 mg/l whereas at Taylorsville the load was 1,684 mg/l, and that load decreased to 1,000 mg/l within the next 1.3 miles (2.1 km) at Station 23. Although the precise location and extent of the shower are not known, the rain gage at Taylorsville registered 0.4 inch (1.0 cm) of rain in the hour between 1430 and 1530 on 13 June. Such a sudden spate was most likely confined to the area immediately upstream from Taylorsville since none of the effects were in evidence at Goodnight Bridge. Also, more than 1.0 cm of rain could well have fallen in the area upstream from the rain gage, but it must have been confined to that rather small area since the effects were not manifest in the waters entering the Salt River from Brashears Creek, as would have been present in the samples from Station 23, a short distance downstream. The samples from Station 23 contained about 40 percent less suspended solids than the samples from Station 22. The 1,684 mg/l of suspended solids in the sample from Station 22 constituted 88.6 percent of the total weight of the residue weight after evaporating the entire sample to dryness. If the data for 13 June were to be deleted from Table 4, the means for suspended solids at the 3 stations would become 70, 75, and 80 mg/l, respectively, downstream from Station 17.

Suspended solids carried by waters of the Salt River are high in water soluble nutrients as indicated by the relative abundance of anions and cations extracted from sand and clay deposited by high water at Station 23 (Table 5). Determinations were made for calcium, sodium, magnesium, and potassium as well as for nitrates, phosphates, sulfates, and silica. The samples were refluxed for 1-2 hours with distilled water and filtered through 0.45-μ filters. Cations were determined from the

Table 5. Selected anions and cations from sand and clay deposited by high water at Station 22 in the Salt River, 1973. All values are in micrograms per gram of sediment.

	Sand	Clay
Nitrates (NO_3)	5.4	4.6
Phosphates (PO_4)	43.5	51.4
Sulfate (SO_4)	408.0	381.0
Silica (SiO_2)	259.0	332.0
Sodium (Na)	13.7	14.8
Potassium (K)	30.3	41.5
Magnesium (Mg)	11.7	15.3
Calcium (Ca)	29.7	42.9
Total	801.3	883.5

filtrate with atomic absorption spectrophotometry and anions were determined spectrophotometrically. All values are listed in micrograms of nutrient per gram of sample. From these limited data, it appears that suspended solids carried by the Salt River are richest in sulfates and silica, and that there are adequate amounts of sodium, potassium, calcium, and magnesium. Nitrogen:phosphorus ratios, as indicated by the water soluble nitrates and phosphates recovered here, were 1:8 in the sand portion of the deposited material and 1:11 in the clay portion.

BIOLOGICAL CHARACTERISTICS OF THE STUDY AREA

As in the completion report for the period from July 1970 through June 1972, we have not found any species of aquatic or terrestrial plants not listed earlier. A complete list of all plants in the watersheds of Taylorsville and Camp Ground lakes will be included in the report on the preimpoundment phase of the overall study.

Studies were continued on invertebrate drift, the relative abundance of bottom organisms, and the detailed study of life histories of caddisflies of the genus *Athripsodes* in the Salt River. Each of those phases of the overall study will provide data to be used in partial fulfilment of the requirements for an advanced degree in the Department of Biology at the University of Louisville by graduate students supported in part of the project.

The study of invertebrate drift includes intensive sampling of small, medium-sized, and large streams in the Salt River drainage. A small stream, Guist Creek which is a tributary to Brashears Creek was sampled in detail during the spring and summer of 1972. During August, the stream became intermittent and sampling was impossible. However, the data on Guist Creek provided excellent information on the magnitude of drift in a small stream and the effects of a small dam on stream conditions along with detailed information on the extent of drift organisms. In an effort to assess drift on a large stream, the mainstem of the Salt River was sampled routinely whenever conditions permitted; because of its size and the great fluctuations in water level and discharge, sampling was not possible on many occasions. Perhaps the most reliable information, on the basis of being able to obtain drift samples throughout the year, was gained from the medium-sized Brashears Creek which flows year round and only very infrequently is too deep or too swift to allow reliable sampling.

About 30 24-hour samples of invertebrate drift have been taken at the various stations in the Salt River and its tributaries, so that detailed information is available on seasonal variability within and between the streams sampled. Samples have been collected on more than 150 evenings at a single station in an intensive effort to determine short-term effects of environmental changes. Individual samples exhibited an extremely high range of density of drift organisms, from 0.1 to 28 organisms per cubic meter of discharge for an average of about 0.6 organisms per cubic meter per second. For example, on 12 August there was an average of about 4 invertebrate organisms per cubic meter with a total of 24,850 organisms estimated during the 3-hour peak of drift activity. On 15 August, at the same time of day, the density was about 11 organisms per cubic meter with an estimated total of 314,490 organisms passing the same point during the 3-hour period. Such short-term differences reflect changes that take place within 3 days, and such changes are far greater than may be shown by the monthly averages over an entire year.

On the basis of those 24-hour samples it can be demonstrated that there are essentially no invertebrates in the area that drift during the daylight hours. The data show that peak intensity of drift occurs within the hour after sunset and that the density of invertebrates in the drift usually decreases to the low daytime levels before sunrise. On the basis of continuous short-term sampling, it was determined that maximum efficiency of sampling was achieved by collecting a single 10-min sample per half hour during periods of high discharge and a single 15-20-min sample per half hour during periods of low discharge. In another area, an effort is being made to determine the validity of the assumption that density of drift organisms is constant at any point along a stream at any time. In addition, the relationship between density of drift organisms and differing rates of discharge on a day-to-day basis is being investigated.

In a recent paper attempting to update the theory of invertebrate drift, Elliott (1970) generalized that "Total discharge is one of the chief factors affecting the magnitude of invertebrate drift." He presented data gathered on a monthly basis for 2 years at 2 sites,and provided a regression relationship. He conceded that the correlation was not high but failed to give any correlation coefficient, citing seasonal changes in density and growth of the animals, changes in day to night ratios, and the differences in the 2 sites as the sources of variability. He speculated that in a short period of time, such as a week, the number of invertebrates per volume of water may be relatively constant, and that the total number of organisms moving past a point is directly proportional to the volume of water. In contrast, our data, taken over a period of 10 days, indicate that the number of organisms per volume of water is not constant, and the relationship between the numbers of organisms moving past a point and the volume of water is not linear.

Our findings further indicate that the density of drifting organisms may become relatively constant under conditions of very high flow, but the density drops off very sharply under conditions of low flow. Because of the density relationship, the total number of organisms moving past a point cannot be proportional to the volume of flow. The implication here is that in order to estimate drift activity from one month to the next, the magnitude of the density of the drift must be determined at conditions of both high and low discharge, and then, using those records the total invertebrate movement can be estimated.

The benthic fauna of the Salt River drainage includes 61 species of caddisflies of which 41 are new distributional records for Kentucky. Life histories and immature stages of 19 species of the caddisfly genus *Athripsodes* in eastern North America were documented, and an illustrated key to the genera of larvae of the Leptoceridae is being prepared for publication in the open literature. Keys to the larvae and descriptions of the immature stages and cases have been prepared for the following species: *Athripsodes alagmus* Ross, *A. alces* Ross, *A. ancylus* (Vorhies), *A. angustus* (Banks), *A. annulicornis* (Stephens), *A. cancellatus* (Betten), *A. dilutus* (Hagen), *A. flavus* (Banks), *A. mentius* (Walker), *A. miscus* Ross, *A. nephus* Ross, *A. punctatus* (Banks), *A. neffi* sp. n., *A. resurgens* (Walker), *A. slossonae* Banks, *A. spongillovorax* sp. n., *A. submacula* (Walker), *A. tarsipunctatus* (Vorhies), and *A. transversus* (Hagen).

The larvae of those 19 species of caddisflies exhibit 2 modes of feeding and case construction. Fifteen species feed on detritus and incorporate particles of sand or stone into their cases, and there is evidence of diurnal feeding by *ancylus* with peak activity in early morning. During case construction, they secrete an adhesive that binds the sand grains and other materials together. The other 4 species feed on the freshwater sponge *Spongilla lacustris*. All larvae of the sponge feeders, *angustus*, *alces*, and *resurgens*, had sponge spicules in their guts, and their cases consisted entirely of secreted material, but the larvae of another sponge feeder, *spongillovorax*, had some sponge spicules incorporated into their cases.

All of the larvae examined pass through 5 instars. Larvae of *punctatus*, *submacula*, *resurgens*, and *alces* pass through a brief prepupal period in early spring.

Larval populations of *A. angustus* in the Salt River, Kentucky, have 2 cohorts: one overwinters as a prepupa and emerges early in the spring, and the other overwinters as a third or fourth instar larva and emerges in the summer. Larval case construction for *A. ancylus*, a detritus feeder with a case composed largely of sand grains, and for *A. angustus*, a sponge feeder with a completely secreted case were described in detail in his doctoral dissertation by Resh (1973). Particle size selection in case construction by *A. ancylus* indicates that there is a posterior-anterior gradient of increasing particle size range preference that increased in later instars. Like *A. ancylus*, *A. angustus* begins case construction almost immediately upon hatching. The first case is temporary, formed with a mixture of egg mass matrix, detritus, and body secretion. The larva then lays down secreted silk threads one by one and continues the process throughout its larval life.

Estimates of population size and standing crop of *A. ancylus* larvae and pupae were made, based on stream transects in the Salt River. Thirty transects, each averaging 70 square-meter samples, were made between May 1971 and July 1972. Computer programs were used in analysis of population dynamics, standing crop, survivorship, and production. The population of pupae in spring was 30 percent of the early fall peak of instars. Production estimates using the instantaneous growth method and Allen's curves were 9.847 and 9.844 mg/m^2 dry weight, with respective turnover ratios of 5.75 and 5.73. Production ranged from 4.3 to 24.3 mg/m^2 in the different habitats and substrates, with maximum influence on production due to an increase in sizes and numbers of substrate particles.

Quantitative ultraviolet light trap collections were made from the Salt River from March to November 1971. Those collections began 20 min after sunset and were either 1 hour in duration or were made up of 3 consecutive 20-min periods. More than 87,000 caddisfly adults were collected, 20,000 of which were identified after subsamples had been taken. Forty-one of the 61 species collected during this study had not previously been recorded from Kentucky, an indication of the sparseness of our information on species composition of bottom organisms in our streams.

Species diversity of the adult caddisfly fauna was calculated for 85 quantitative samples. Flight activity, frequency and seasonal range of abundance, and sex ratios of various caddisflies indicated that the removal of adults through light trapping served as a measure of abundance of newly emerged individuals. The pattern of capture of adults indicated that the greatest numbers emerged at dusk and continued to emerge in smaller numbers through the night in agreement with the findings of Scott and Opdyke (1941), Sprules (1947), Corbet (1964), Morgan and Waddell (1961), and Anderson and Wold (1972). Sex ratios of *A. ancylus* adults from light trap collections and mature pupae from bottom samples in the transects provided a ratio of 112 females to 100 males.

A new record of a larval mite that parasitizes members of the caddisfly genus *Athripsodes* along with *Leptocella exquisita*, *Triaenodes melaca*, and *Protoptila maculata* was reared to the deuteronymph stage and identified as *Sphaerolophus* (Acarina:Erythraidae).

Comparisons of populations of species of *Athripsodes* collected during the 1920's from Lake Erie and the Rock River, Illinois, indicate a differential tolerance toward water quality among members of the genus (Smith 1971); such indigenous species as *A. saccus*, *A. erullus*, and *A. mentius* were replaced by the more pollution tolerant species *transversus* and *tarsipunctatus*.

In addition to the detailed studies on caddisflies, the benthic fauna of the Beech Fork and Chaplin River has been studied to some extent. Duplicate samples of bottom organisms were collected from 13 of the 29 collecting stations in the drainage areas of those streams (Fig. 1), and have been sorted and identified. Other samples have been collected, but the sorting and identification has not been completed. In those preliminary samples, we have identified members of 17 major groups of bottom organisms that include flatworms, annelids, water mites, isopod and decapod crustaceans, 10 orders of insects, and gastropod and pelecypod mollusks. In a previous report (Neff and Krumholz 1973, we listed nearly 300 different kinds of benthic organisms of which there were representatives of more than 80 families of insects, by far the most abundant and diverse group of bottom-dwelling organisms.

The foregoing discussion of the detailed study of a single genus of caddisflies provides an indication of the kinds of studies that are needed for us to obtain a clearer understanding of the many ways in which a stream ecosystem functions.

Another segment of the benthic fauna that has received some special attention if the pelecypod mollusks, the freshwater clams or mussels. That study was incidental to the gathering of other data and was confined to only a few stations, mostly in the Salt River around Taylorsville where the stream provides a suitable habitat, although some collections were made in other parts of the study area. On many occasions, the small fingernail clams (Sphaeriidae) were taken in the routine bottom samples, but this discussion will be confined to the pearly mussels or naiads of the family Unionidae. These preliminary collections provide a nucleus of information on the species composition, relative abundance, and distribution of these invertebrates in the entire area to be occupied by Taylorsville Lake along with a stretch of the Salt River for several miles below the proposed damsite.

Freshwater mussels are most active during the warm months of the year, and female unionids usually are gravid from April through August. Sexes are separate, and many species exhibit a sexual dimorphism with the posterior part of the shell in females being swollen or rounded to compensate for the enlarged and distended gills filled with developing eggs and young. Sperm are released by the males through the exhalent opening into the surrounding water and some are taken fortuitously into the body of a female in the vicinity through the incurrent siphon (Pennak 1953). Eggs are transferred from the ovaries to the gills, and the sperm, which pass through the openings in the female's gill lamellae, and fertilize the eggs in the water tubes. The gills thus become brood chambers (marsupia) as well as respiratory organs. The embryos are retained only during the early stages of development. When the embryo reaches a certain stage of development (glochidium), it is released through the excurrent siphon by the mother into the surrounding water. In some species, as many as several hundred thousand such embryos may be released in a single brood. Further development of the glochidia must take place as a parasite in the skin, gills, or fins of a host fish. These newly released larvae are extremely sensitive and clamp tightly to the superficial tissues of the host. Within a short time, the tissues of the host fish begin to encase the glochidium, and the larva remains in this parasitic stage for 10-30 days, or as long as 3 months in some species. During encystment, the structures within the larva change drastically and the rudiments of most of the adult organ systems are formed. Some studies (Baker 1928, Coker et al. 1921) have shown that some species of mussels are host specific whereas others may parasitize several species of fishes, or a single species of fish may serve as host for many kinds of mussels. In any event, most infestations are light and apparently do no damage to the host. When development has proceeded to a certain stage, the newly formed young mussel breaks through the surrounding tissue and commences its independent life. Adult organ systems develop rapidly, and the length of time required to reach maturity varies with the different species and may require several years. The known life span of freshwater mussels may be as much as 30 years (Baker 1928), although most species do not live more than half that length of time (Pennak 1953).

Mention must be made of the differences in reproductive habits of the other bivalve mollusks common to the Salt River. The fingernail clams are hermaphroditic, and an adult may contain from 1 to 20 young in various stages of development (Pennak 1953). When released, the young are fully formed, having all the morphological features of the adult. The most recent invader of the Salt River is the Asiatic clam *Corbicula* sp. of the family Cyrenidae. That little clam, usually not more than an inch or so in length, was introduced from Asia to the West Coast of the United States and has since spread throughout much of the country. The released young to not require an intermediate host for development, and because of this feature it is believed that this clam offers severe competition to the unionids.

The following list includes the scientific and common names of the unionids collected from the Salt River during this phase of the study:

Anodontinae

Alasmidonta calceolus	Slipper shell
Anodonta grandis	Floater
Lasmigona complanata	White heel-splitter
Lasmigona costata	Fluted shell

Lampsilinae

Lampsilis siliquoidea	Fat mucket
Lampsilis ventricosa	Pocketbook
Leptodea fragilis	Fragile papershell
Proptera alata	Pink heel-splitter
Ptychobranchus fasciolaris	Kidney shell
Tritogonia verrucosa	Pistol grip
Truncilla truncata	Deer toe

Unioninae

Amblema plicata	Three ridge
Fusconaia undata	Pig toe
Megalonaias gigantea	Washboard
Quadrula pustulosa	Pimpleback
Quadrula quadrula	Maple leaf

A series of collections of living unionid mussels from the Salt River in September 1972 indicated that there were marked differences in the species composition and relative abundance of those organisms in the 35-mile stretch of the stream from near the upper end of the proposed reservior (Station 14) to below the confluence of Brashears Creek (Station 23) (Table 6). At Station 14, only 13 species of mussels were found, but there was a great preponderance of the fat mucket

Table 6. Numbers, relative abundance, and percentage composition of live unionid mollusks collected from the Salt River near the head of the proposed Taylorsville Lake (Station 14), the damsite, and below the confluence of Brashears Creek (Station 23) in September 1972.

	Head of Lake		Damsite		Below Lake		Total	
	No.	%	No.	%	No.	%	No.	%
Fat mucket	145	93.5			15	14.3	160	51.5
White heel-splitter			16	31.4	50	47.6	66	21.2
Three ridge			7	13.7	18	17.1	25	8.0
Maple leaf			14	27.4	8	7.6	22	7.1
Pink heel-splitter			8	15.7	8	7.6	16	5.1
Floater	9	5.8			2	1.9	11	3.5
Pocketbook			2	3.9	2	1.9	4	1.3
Pimpleback			2	3.9			2	0.7
Fluted shell			1	2.0	1	1.0	2	0.7
Pig toe					1	1.0	1	0.3
Washboard			1	2.0			1	0.3
Slipper shell	1	0.7					1	0.3
Total	155	100.0	51	100.0	105	100.0	311	100.0
Number of species	3		8		9		12	

Lampsilis siliquoidea in the area. Near the proposed damsite and below the confluence of Brashears Creek, however, 8 and 9 species, respectively, were found, but in neither instance were there as many individuals as at Station 14. Such differences in numbers and species composition are not readily traceable to differences in the physical characteristics of the stream bottom, and it may be that the organic enrichment from Hammond Creek (Tables 1-3) prompted the abundance of the fat mucket at Station 14. Other workers (Baker 1922, Bedford et al. 1968) have shown that that species cannot withstand high levels of organic enrichment but that it thrives in low to moderate levels. It is also possible that the effluents from Hammond Creek may have caused some disruption in the species composition of the mussels and analyses of water samples throughout the drainage area may provide greater insight into this segment of the benthic fauna.

Although collections of vertebrates have continued throughout the study period, no new species of fishes have been added to those listed by Neff and Krumholz (1973), nor have there been any additions to the list of amphibians and reptiles. A complete list of all kinds of vertebrates collected and/or observed in the Salt River drainage will be included in a comprehensive report of the preimpoundment phase of the study.

Over the past several years there have been numerous fish kills in various parts of the main stem of the Salt River. Of particular note is the area immediately downstream from Harrodsburg where repeated incidents have occurred as a result of the inadequacy of the municipal sewage treatment facility. Very nearly every summer when stream discharge is low and air temperatures are high, fish may be killed for several miles downstream. The effluent from the sewage treatment facility empties directly into Town Creek, a small tributary to the Salt River about 130 miles upstream from its mouth and about 45 miles upstream from the proposed headwaters of Taylorsville Lake. If remedial measures in the operation of the sewage treatment facility are not made, this recurring condition may constitute a hazard in the upper end of Taylorsville Lake.

Examples of fish kills in the Salt River downstream from Harrodsburg supplied by the Kentucky Department of Fish and Wildlife Resources include one of 10 June 1969 in which 64,485 fish that weighed 4,594 pounds were killed in a 4-mile stretch of the Salt River in Mercer County, and one of 17 August 1971 in which 3,479 fish that weighed 122 pounds were killed in a 1.5-mile stretch of the river. Other kills recorded include one on Brashears Creek on 22 July 1969 that resulted from the dumping of 2,000 gallons of milk from the Kraft plant at Taylorsville in Spencer County, in which 880 fish that weighed 306 pounds were killed in a three-quarter-mile stretch of stream. Another was caused by wastes from the Seagram distillery in Anderson County that started on 6 July 1972 and continued through 9 July and killed 810 fish that weighed 127 pounds in a reach of 200 yards downstream from where Kentucky Highway 513 crosses the Salt River.

SOCIOECONOMIC ASPECTS

There has been little change in the sociological and economic picture in the study area largely because there has been no definite date set for commencement of construction of the dam. Many residents of Spencer County, however, are pretty much resigned to the fact that the lake will be built eventually. Prices of land, especially in the area of the proposed shoreline, are continuing to increase, and probably will continue to do so until all the land within the taking line is purchased. The latest information available is that the purchase of land for the damsite will be initiated before the end of Fiscal Year 1974.

During the latter part of the current study period, a controversy was under way regarding the amount of land required for a recreational area at Taylorsville Lake. Originally, the Taylorsville Lake Project included a parcel of land about 200 acres to provide general recreation, with additional areas to be purchased for access sites and boat ramps. General public reaction was favorable to that idea except for those landowners who would lose their properties. Following that original plan, and with the passage of several years, the anticipated use of the area for recreation was revised upward rather drastically, and an agreement was reached between the Corps and the Commonwealth of Kentucky for participation in the project. The original estimates of some 650,000 to 700,000 visitor days per year in 1965 was revised upward to an initial use estimate of 2.5 million visitor days per year that would ultimately reach nearly 4.5 million visitor days. That upward revision was the cause of the controversy since the amount of land needed for the recreational area was reestimated to be in the neighborhood of 4,300 acres. At a public meeting on real estate held in the High School Gymnasium at Taylorsville early in September 1973, there was very strong and intense opposition to the drastic increase in the size of the recreational area. Much mention was made of the fact that the people of Spencer County did not want to have to clean up the anticipated litter and offal left by visitors from Louisville and other cities and towns in the region. Attempts are being made to ameliorate this difficulty.

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