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Assessment of the Sport Fishery at Markland Pool and Tailwater of the Ohio River

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by

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ABSTRACT

The fishery at Markland Pool of the Ohio River and its tailwater were surveyed from 1978 through 1984 as part of the Ohio River Sport Fishery Investigation Project. The fish population was surveyed utilizing rotenone, gill nets, and boat-mounted electrofishing gear. The game fish standing crop in the Markland Pool equaled or surpassed the standing crop found in many reservoirs in Kentucky. A comparison of electrofishing and gillnetting data between backwater and mainstem areas and between Markland Pool and other pools of the river strongly indicate the importance of backwater habitat to the fish production. Markland Pool has more backwater acreage than any other pool. A striped bass fishery has developed as a result of several years of stocking striped bass into the river. A tailwater creel survey indicated that the harvest goal of at least 1.0 pound per acre was surpassed. The species representing the most pounds of fish creeled at Markland Pool was carp, followed by channel catfish and freshwater drum. The exploitation rates for largemouth bass and white crappie were 29 and 27%, respectively. Both of these species showed very little movement between time of tagging and recapture and were generally recaptured in the same backwater in which they were tagged. The need for more fisherman access was apparent in the tailwater by the lack of a boat ramp near the area, low fishing pressure of 12.1 man-hours per acre, and a yield of only 7.8 pounds of fish per acre. The potential for fisheries improvement is greatest in the tailwater areas of the Ohio River. With good fishing access, Markland Pool tailwater should have a fish yield that is at least 10 times greater.

INTRODUCTION

The Ohio River arises at Pittsburg, Pennsylvania with the confluence of the Monongahela and Allegheny rivers and flows 981 miles in a southwesterly direction to its juncture with the Mississippi River at Cairo, Illinois. The lower 664 miles of the Ohio River forms the northernmost boundary of the Commonwealth of Kentucky (Fig. 1). This vast river system provides approximately 168,566 acres of water to the angler in the main stem alone. This figure does not include several thousand acres of shallow backwater habitat. Markland Pool has the most backwater, 3,087 acres, of any pool of the river bordering Kentucky.

The Ohio River underwent an extended period of severe degradation lasting in excess of 100 years until the late 1940's. A committment to clean up the river was made with the formation of the Ohio River Valley Water Sanitation Commission (ORSANCO). In more recent years, pollution abatement has resulted in noticable improvement of the fisheries in the river (Pearson and Krumholz 1984).

In 1977, the Kentucky Department of Fish and Wildlife Resources initiated Dingell-Johnson Project F-47 to study the fishery in the Ohio River. Since 1978, fishery investigations on the river have been performed under Subsection III (Ohio River Sport Fishery Investigation) of Dingell-Johnson Project F-40 (Statewide Fisheries Research).

This report addresses the fishery investigated in the Markland Pool and tailwater. The construction of Markland Dam in 1963 created a pool above the dam that is 95 miles long with 24,787 surface acres, 3,087 acres of which are in backwater embayments.

Northern Kentucky and the Greater Cincinnati area lie at the

midpoint of Markland Pool; this pool receives more fishing pressure than at the other pools bordering Kentucky largely due to the proximity of a heavily populated area.

Great angler use and abundance of backwater habitat led to Markland Pool being the first pool to be studied. Study results at this pool and its tailwater are the first to be reported in this report from the Ohio River Sport Fishery Investigations. The remaining pools and tailwaters will be reported after data collection is completed at each of those areas.

METHODS

Cove-rotenone sampling was conducted in Markland Pool from 1978-1982. A description of the standard methods employed in cove-rotenone sampling is in Table 1. Sampling was conducted in 1978 and 1979 in a 2.25-acre site at Craigs Creek. Public opposition to the use of this site in 1979 led to the selection of a 3.00-acre site at Steeles Creek during the next 3 years. Rotenone sampling was conducted during July and August.

Electrofishing studies were conducted using a boat-mounted, 230 volt A.C. generator boosted by a Chenault electrofisher. Electrodes were constructed of weighted, tinned copper, cable shielding and were suspended from booms affixed to the bow of the boat. Whenever possible, electrofishing sites were randomly selected and effort was kept constant between backwater and mainstem areas. All fish were weighed, measured, and recorded, with data being reported on a per hour basis. An electrofishing study was performed in the tailwater below Markland Locks and Dam in the fall of 1984. In the spring of

1983, fish captured at Markland Pool by electrofishing were used in a tagging study. Black bass, sauger, white bass, crappie, carp, freshwater drum, and channel catfish were selected for tagging. Creel surveys indicate these species are most actively sought by Ohio River anglers. Tagging was accomplished utilizing a Floy FD-68B anchor tag inserted into the dorsal musculature so that the "T" portion of the tag locked between the fin ray bases of the soft dorsal fin. Initial plans were to tag 100 fish of each of the above-mentioned species. Total length, weight, species, tag number, location, and date of tagging were recorded for each fish. Captured fish were processed and returned to the same backwater area from which they were originally captured.

In an effort to encourage fishermen to report tag recaptures, tags were assigned reward values of 1, 5, 10, 25, 50, 100, or 1,000 dollars by random drawing. A publicity program was conducted to notify anglers of the reward program. Postage-paid, self-addressed, envelopes were distributed to individual anglers, bait shops, and conservation officers for tag return data.

Gillnetting was conducted in both backwater and mainstem areas in conjunction with electrofishing. Sampling gear consisted of experimental gill nets having five panels with bar-mesh sizes of 0.5, 1.0, 1.5, 2, and 2.5 in. Four nets used in backwater areas had 25-ft panels for a total of 125 ft each, while an equal number of nets used in the main stem had 50-ft panels and totaled 250 ft each. Numbers and weights of fish were reported on a per net day basis, where one net day is equal to 300 ft of net fished for one 24-hour period.

Systematic creel surveys, using non-uniform probability, were conducted in the Markland Pool and Markland Pool tailwater. The

Markland Pool survey was an intensive 5-day per week survey of the roving-clerk type, utilizing a hired creel clerk from 30 March to 1 November 1980. The tailwater survey was conducted from 17 May to 16 October 1983 in conjunction with the survey at McAlpine Pool. Creel survey data was analyzed using a Fortran IV program. Each survey period consisted of two time segments: (1) an interview portion for interviewing fishermen on an individual basis, and (2) a count portion for making a count of all fishermen within the survey area for that day. The Markland Pool was divided into five survey areas of near equal size, with one area being surveyed per survey period. The Markland tailwater survey encompassed an area of approximately 216 acres, with the total area being surveyed during each survey period.

Scale samples were taken from selected species of sport fish during fish sampling of the Markland Pool from 1978-1984. Total length to the nearest 0.1 in was recorded for each fish. This information, along with the date, location, and other pertinent information, were recorded on scale envelopes within which approximately 5 scales from each fish were placed. Scales were taken below the lateral line posterior to the tip of the pectoral fin. Striped bass data were compiled from angler responses to the Fisheries Division's mail-in survey program. Scales were cleaned with water and read on an Eberbach scale viewer or a MicroDesign, Model 150, microfiche reader. Annuli were identified and measured to the nearest 0.1 in. Annual growth was computed assuming the Dahl-Lea direct proportion method.

Table 2 is the standard form used for reporting cove-rotenone data. All fish were classified in size groups according to this form.

RESULTS AND DISCUSSION

Fish Population Structure

Results of cove-rotenone studies in 1978-1982 at Markland Pool are in Tables 3-7. Fish standing crops ranged from a low of 186.34 lb/acre in 1980 (Steeles Creek) to 500.51 lb/acre in 1979 (Craigs Creek). Craigs Creek is a 382-acre embayment with a moderately developed shoreline that includes two marinas servicing approximately 75 houseboats. Steeles Creek, on the other hand, is a 29-acre embayment with no shoreline development. Any nutrient inflow into Steeles Creek would be the result of limited agricultural practices in the watershed. Water quality determinations were not made on either of the two embayments, so it is not known whether the differences of standing crop are the result of nutrients, water depth, or other physical or chemical factors. Higher standing crops in Craigs Creek may be partly due to higher nutrient levels contributed from cottages and recreational boats in the area. The total number of harvestable-size game fish was higher in the Craigs Creek embayment, with a total of 15 and 14 individuals being collected per acre in 1978 and 1979, respectively. The Steeles Creek data show a range of from 4-9 harvestable-size game fish per acre in 1980-1982. Largemouth bass and white crappie were the only harvestable-size game species collected at Steeles Creek during 1980-82.

A comparison of fish standing crops between Markland Pool and seven other Kentucky reservoirs in 1978-1982 shows Markland Pool to have numbers of harvestable-size largemouth bass equal to or greater than that found in reservoirs, with the exception of two reservoirs

in 1982. Harvestable-size white crappie in Markland Pool outnumbered white crappie in 54% of the standing crop figures for reservoirs. Likewise, total harvestable-size game species outnumbered those found in 58% of the standing crop figures in reservoirs.

All fish species groups, with the exceptions of game fishes and predatory fishes, were dominated by a single species such as bluegill in the panfish group and carp in the commercial fish group. Gizzard shad influenced the total standing crop by their presence or absence more than any other species. The apparent lack of gizzard shad on occasion is a function of the inability of cove-rotenone studies at obtaining a representative sample of this species.

The mean fish biomass at Markland Pool was 362 lb/acre. On a statewide basis, total standing crops in reservoirs are directly related to their trophic level. Several Kentucky reservoirs were classified as being eutrophic (Kentucky Department of Natural Resources, Division of Water 1984) and exhibited standing crops in excess of 300 lb/acre. Mean standing crops of 249 lb/acre and 112 lb/acre occur in lakes that have been classified as mesotrophic and oligotrophic, respectively. Data relative to the trophic level of various pools on the Ohio River are unavailable; however, it appears that Markland Pool, Meldahl Pool (532 lb/acre), Cannelton Pool (362 lb/acre), and Greenup Pool (329 lb/acre) have fish biomass that fall within the range of values associated with eutrophic conditions. Cove-rotenone studies on the Ohio River have been conducted in backwater areas that are not representative of the main stem.

The Y/C ratio of forage fish to carnivorous fish fluctuated widely during the study period (Table 8), but was for the most part within the 0.02 to 4.8 range indicative of a balanced population. The

single instance when the Y/C value fell outside this range was in 1981. The A_{T1} values for the same period fell well within the 33 to 90 range for balanced populations. The fluctuations and discrepancies found in this data can probably be attributed to the ingress and egress of fish in the riverine environment.

Results from electrofishing Markland Pool in 1979-1982 are presented in Tables 9 and 10. This data indicates the importance of backwater areas to the total fishery resource of the river. Backwater electrofishing produced a total of 28 species compared to 21 species in the mainstem. Of the 18 species common to both backwater and mainstem areas, 14 were captured in greater number in the backwater. Catch in fish/hour by electrofishing in backwaters approached 2.5 times the catch in the main stem. Game fish were well represented in the backwater areas, with only two species, smallmouth bass and spotted bass, being taken in greater number in the main stem as would be expected. These two black bass species prefer deeper water near the river channel.

Gillnetting studies were conducted in backwater and mainstem areas in conjunction with electrofishing. A total of 19 species were collected by gillnetting (Tables 11 and 12). Backwater gillnetting produced only one more species than did mainstem netting, but 86% of the species common to both areas were taken in greater number in backwaters. Total number of fish captured by gillnetting in backwaters was in excess of 2.7 times the number in the main stem. White bass and smallmouth buffalo were the only species taken in greater number in the main stem. Game fish were represented by only four species, with sauger being the only one taken in good number. Channel catfish were taken in backwaters more effectively by gillnetting; whereas,

electrofishing was more effective in the main stem. This is probably due to the tendency of this species to seek deeper water during daylight hours, when electrofishing studies were conducted, and shallower waters at night when they were captured with gill-nets fished overnight.

Relative weight (Wr), an index of condition, is the actual weight of a fish compared to a standard weight for that particular length (Wedge and Anderson 1978). Table 13 shows the calculated relative weights for largemouth bass captured during fall electrofishing in six navigational pools of the Ohio River. The total Wr values for all size groups indicate that largemouth bass were in good condition at all six pools. A Wr value of 95-100 is considered satisfactory for largemouth bass, while those values above 100 represent fish heavier than the standard weight. Sample size was relatively low in some instances, however, it was considered sufficient to indicate that largemouth bass at Markland Pool were in good condition.

Table 14 shows the species composition and relative abundance of fish harvested in the Markland Pool tailwater by gillnetting. A total of 20 species were collected, with all fish being of intermediate-size or above. The absence of fingerling-size fish in the data was due to the size selectivity of the sampling gear. The presence of striped bass and walleye in the sample were of particular interest. The Department has been stocking striped bass into the Ohio River for several years, but this was the first year that our sampling efforts have collected this species. Reports from anglers have indicated that walleye are becoming more numerous in the Ohio River. The 1983 gillnetting results seem to bear this out with walleye being

collected in four of the five tailwaters sampled to date. Sauger were most often captured, with 1.2 harvestable-size fish/net day being taken. Fish that are generally recognized to be of commercial value such as catfish, carp, freshwater drum, and suckers accounted for approximately 24 fish/net day and 50% of the total number captured.

The results of fall electrofishing in the tailwater in 1984 are shown in Table 15. A total of 16 species were captured. Commercially valuable species of harvestable-size accounted for 19.6% of the total number of fish captured. Game fish were represented by five species, with only largemouth bass and sauger being taken at harvestable-size. This tailwater is remarkable in respect to the large amount of shallow water and rocky substrate. This area is locally known as a fine seasonal smallmouth bass fishery. The low numbers of game fish in the electrofishing sample is due in part to the difficulty of electrofishing in the shallow, swift water.

A summary of the species of fish collected during 1978-1984 in the Markland Pool and tailwater is presented in Table 16. A total of 51 species of fish were collected during this period by all methods of sampling. Fewer species were collected in 1983 and 1984, but that was due to only the tailwater being sampled during those 2 years. Mean annual number of species collected in 1978-1982 was 31. A total of 94 species have been reported for the period 1970-1983 from the middle portion (ORM 328-654) of the river (Pearson and Krumholz 1984). Much of the difference in numbers of species collected is likely due to difference in sampling methods.

Fish Harvest

A total of 74,542 fishing trips were made to Markland Pool in 1983, of which 40.3% were successful trips (Table 17). Anglers harvested 3.0 fish/acre and 3.3 lb/acre. The harvest of selected species is shown in Table 18. This data indicates that a majority of anglers (59.5%) were "anything" fishermen. These anglers were not fishing for a particular species. Species preference by anglers was for channel catfish, crappie, black bass, carp, and freshwater drum, in that order. Channel catfish, freshwater drum, carp, and "anything" were listed by 82.6% of the creel survey interviewees when asked what they were fishing for. "Anything" anglers are typically still fishing with natural bait from the bank, so the majority of these anglers were fishing for the first three species listed. Of particular interest were the success rates enjoyed by crappie and black bass anglers of 59.7% and 24.6%, respectively. The greatest success was reported by freshwater drum anglers who experienced a 75.5% success rate.

Creel surveys were also conducted in 1982 in Cannelton Pool and in 1983 in McAlpine Pool. A summary of data relative to selected species from these two pools and Markland Pool is presented in Table 19. Carp, channel catfish, and freshwater drum were first, second, and third in terms of pounds creeled in Markland Pool and represented three of the top four species creeled by number. Crappie ranked third by number. Carp was sixth in weight creeled at Cannelton Pool and was totally absent from the creel at McAlpine Pool. Freshwater drum was not one of the top three species by number of weight in McAlpine pool. Channel catfish contributed the second most weight to the creel at Cannelton and the most weight at McAlpine. Crappie were first in numbers creeled at these two pools. The absence of carp from McAlpine

Pool may be attributed to the small area of backwater habitat in that pool. Markland Pool and Cannelton Pool have 3,087 acres and 2,189 acres, respectively, of backwater habitat. McAlpine Pool, on the other hand, has only 394 acres of backwater habitat. No striped bass were recorded during the 1980 creel at Markland Pool. This is because striped bass were not stocked in adequate numbers to create a fishery until 1980.

Fishing pressure (man hours/acre) on Markland Pool was nearly fourfold the pressure at McAlpine Pool and over double the pressure at Cannelton Pool (Table 20). This can be expected since Cincinnati, Ohio and Covington and Newport, Kentucky border this pool. Also, the large amount of backwater area may attract more anglers. Likewise, the numbers and pounds of fish creeled per acre was much greater at Markland Pool than at the other two pools. The catch rate, however, was much higher at McAlpine Pool, with 0.74 fish/acre being harvested, than that at Markland Pool (0.39) or Cannelton Pool (0.45). The mean standing crops of fish from cove-rotenone studies indicate that fish numbers and biomass in the backwater areas of Markland and Cannelton pools are several times greater than in McAlpine Pool (Kinman 1979, Jackson 1981-1983). This difference again points out the importance of the greater acreage of backwater in the first two pools compared to very little acreage in McAlpine Pool.

Creel survey data at Markland Pool tailwater are shown in Table 21. A total of 5.10 fishing trips were made per acre to the Markland Pool tailwater, of which 59.3% were successful trips. Anglers in the tailwater caught three times as many fish/acre and twice as many lb/acre (7.8 lb/acre) as did anglers fishing Markland Pool. Striped

bass were harvested at the rate of 1.47 pounds/acre, which represents a 23% addition to the total fish yield (Table 22). Carp were not creeled in the tailwater. The number one species harvested in both numbers and weight was channel catfish.

Fish tagging efforts in the Markland Pool resulted in the tagging of all but two of the target species. Only a few sauger and white bass were tagged, not enough to get a good estimate of the exploitation rate. The annual exploitation rate for largemouth bass was 29% (Table 23). This rate is similar to a statewide exploitation rate of 27.5% in 1978-79 during a study on several bodies of water, and a 23.7% exploitation rate for the Markland Pool during the same period (Crowell 1984). Tagging data revealed that recaptured largemouth bass had only traveled an average of 1 mi from the point of tagging. Mean "time-out" between tagging date and recapture date was 67 days. Mark-recapture studies from previous years in the Meldahl and Cannelton pools likewise showed that largemouth bass were almost invariably recaptured near the same area in which they were tagged.

White crappie were harvested at a rate of 27% in Markland Pool compared to 20% in the Meldahl Pool (1981) and 10% in the Cannelton Pool (1982). The reasons for the differences in exploitation rates are unclear. The mean distance traveled by tagged white crappie was 2 mi, with an average of 32 days between tagging and recapture. Data collected from the Meldahl and Cannelton pools showed that the mean distance traveled was 3.0 mi and 1.0 mi, respectively.

The above-mentioned data, as relates to largemouth bass and white crappie movement, is in agreement with that observed during electrofishing and gillnetting. Backwater sampling invariably produced many more of these two species than did mainstem studies.

A total of 95 channel catfish were tagged; the exploitation rate was 9%. Previous studies at Cannelton and Meldahl pools showed a 5% expoloitation rate at each pool for both years. The greater mean distance of 13 mi traveled by this species for 1981-1983 indicates that this species has a greater movement than largemouth bass and white crappie.

A relatively small number of freshwater drum were tagged in 1983; consequently, a small number of tag returns were received. Difficulty in capture of this species by electrofishing and high mortality of fish from gillnetting negated attempts to tag large numbers. A total of 39 individuals were tagged, with only 3 tags being returned for an exploitation rate of 8%.

Carp, in contrast to freshwater drum, were plentiful in the backwater areas. Little difficulty was encountered in capturing and tagging near the target number of 100 individuals. In 1981, there were only two returns of tagged carp from Meldahl Pool. There were no returns from tagged carp at Cannelton and Markland pools in 1982 and 1983, respectively.

It should be remembered that the three species with the poorest returns on the tagging survey, channel catfish, freshwater drum, and carp, represented the most pounds creeled of any species at Markland Pool in 1980. The low exploitation rates for these three species are primarily a function of both a very large population size and poor response by anglers to return tags. Also, a larger number of fish should have been tagged.

Striped bass were first stocked into the Ohio River by the Kentucky Department of Fish and Wildlife Resources in 1976. Stocking

was continued for several years at low stocking rates and few fish were known to have been creeled. In 1980, stocking rates were increased to 4-5 fish/acre at 1.5 to 2.0 in long. Scale samples from Ohio River striped bass began being returned by anglers through the mail-in survey program in 1983 (Table 24). Age and growth of those fish revealed that the 1981 year-class was the most abundant age group in the survey. Mean back-calculated growth indicated that striped bass in the Ohio River reach a minimum harvestable-size of 15 in in their second year of life at age I+. Growth of Ohio River striped bass closely parallels that exhibited by striped bass in Herrington Lake and Lake Cumberland (Axon 1979, Kinman 1984).

Of 59 scale samples of striped bass returned by anglers, 54 were captured below Meldahl Locks and Dam (headwater of Markland Pool). Striped bass in the river are congregating below the high-lift locks and dam in the hot summer months. Recent reports relating to the 1984 fishing season indicate that these fish are being harvested below several of the other locks and dams throughout the length of the river.

Back-calculated lengths for Markland Pool sauger captured in 1983 are presented in Table 25. The 26 individuals that were aged were from the 1978-1981 year classes, with only a single fish representing the 1978 year class. With the exception of this lone fish, growth rates for Markland Pool sauger are similar to growth rates exhibited by 282 fish captured throughout the length of the Ohio River during 1978-1983. Kentucky does not have a minimum legal size on sauger; however, 12 in has been arbitrarily selected as a minimum "keeper" size by most anglers. Data indicate that sauger reach this length in the Ohio River late in their third year of life at age 2+.

Growth of largemouth bass at Markland Pool captured in 1978-1983 is presented in Table 26. Growth is similar to that reported from Kentucky reservoirs. This species reached minimum harvestable-length of 12 in in its fourth year of life at age 3+ (Buynak 1984). It appears that mean growth of largemouth bass at all ages is slightly less at Markland Pool. One might expect that growth of fish would be less in the Ohio River because of the dynamic nature of the river and attendant problems such as water fluctuations, turbidity, and possible pollutants.

CONCLUSIONS

Many authors tend to regard the Ohio River as a series of reservoirs. The Markland Pool is not merely a reservoir in this series, but a section of the much larger Ohio River which has been slowed down somewhat and deepened for navigation purposes. Obvious differences that exist between the Ohio River and most reservoirs are less shoreline development (irregularity) and low water retension time, which means the pools in Ohio River are riverine type habitat.

The Ohio River is too vast and dynamic a system to lend itself well to many commonly accepted management practices used in reservoirs. Management schemes for the Markland Pool and the Ohio River, in general, are more or less limited to stocking, harvest restrictions, water quality improvement through pollution abatement, increasing fishing opportunities through access development, and promoting the fishery to better inform anglers of the good fishing that exists in the river.

The stocking of striped bass at the present level should be

continued until stocking success can be fully evaluated. Localized, high quality striped bass fishing has been developed in a few areas, primarily at tailwaters below locks and dams. Creel surveys should be repeated in order to assist in the evaluation of striped bass stocking success. In the event that a self-sustaining population does not develop, stocking should be continued to achieve our management objectives of at least 1 lb/acre creeled or a 10% addition to the total fish yield in Markland Pool.

Regulations developed in the future to control harvest on the river will have to be coordinated with other states that border the river. In most cases, fishing regulations should be the same for each state and not be for only a portion of the river.

Water quality improvements have been dramatic in the last few decades as evidenced by changes in the species composition of the fisheries. Pollution abatement is an ongoing problem that is being handled admirably by several state and federal agencies.

The game fish standing crop in the backwater areas of Markland Pool are equal to or better than those found in most of the major reservoirs throughout Kentucky. Markland Pool has more acres of backwaters than any other pool. The amount of backwater areas appear to highly influence the total fish biomass present in a pool and the yield of fish to the creel.

Creel survey results indicate that fishing pressure (7.9 m-h/acre) and pounds of fish harvested per acre (3.3 lb/acre) in Markland Pool are much less than that found in five reservoirs creeled in Kentucky in 1981-1984. The mean man-hours and pounds per acre were 38.3 and 15.4, respectively. This emphasizes the need for more access to increase pressure and harvest. The harvest rate compares favorably

to rates in reservoirs. Creel data, exploitation rates, and fish population data indicate that anglers are under-utilizing the fishery at Markland Pool. Many anglers are laboring under the mis-conception that the river will not provide a quality fishing and that the fish are unfit for consumption. To rectify this situation, a concerted public relations program must be implemented to change the anglers attitudes. Additionally, access sites should be developed in those prime fishing areas, particularly near tailwaters where access is limited, in order to increase utilization of the fishery by boat anglers. Only 24% of the anglers fished from a boat in Markland Pool in 1980, and 48% did so in the tailwater in 1983. Creel survey data from five Kentucky reservoirs indicate 84% of the fishermen contacted were boat anglers. With improved access, it is possible that fishing pressure by boat anglers could be increased threefold or more. The greatest potential for improving the fishery in tailwaters is by developing better access and additional fishing opportunities as is being accomplished by stocking striped bass. The mean annual pounds of fish creeled per acre in tailwaters below reservoirs in Kentucky is 5,694, far greater than the 7.77 lb/acre creeled in Markland tailwater in 1983. The lowest fish yield recorded below a reservoir in the tailwater area was 1 30 lb/acre in 1982 at Lake Cumberland tailwater where fishing pressure was 408 man-hours per acre. The yield at Markland Pool tailwater is expected to be at least 10 times greater with proper access.

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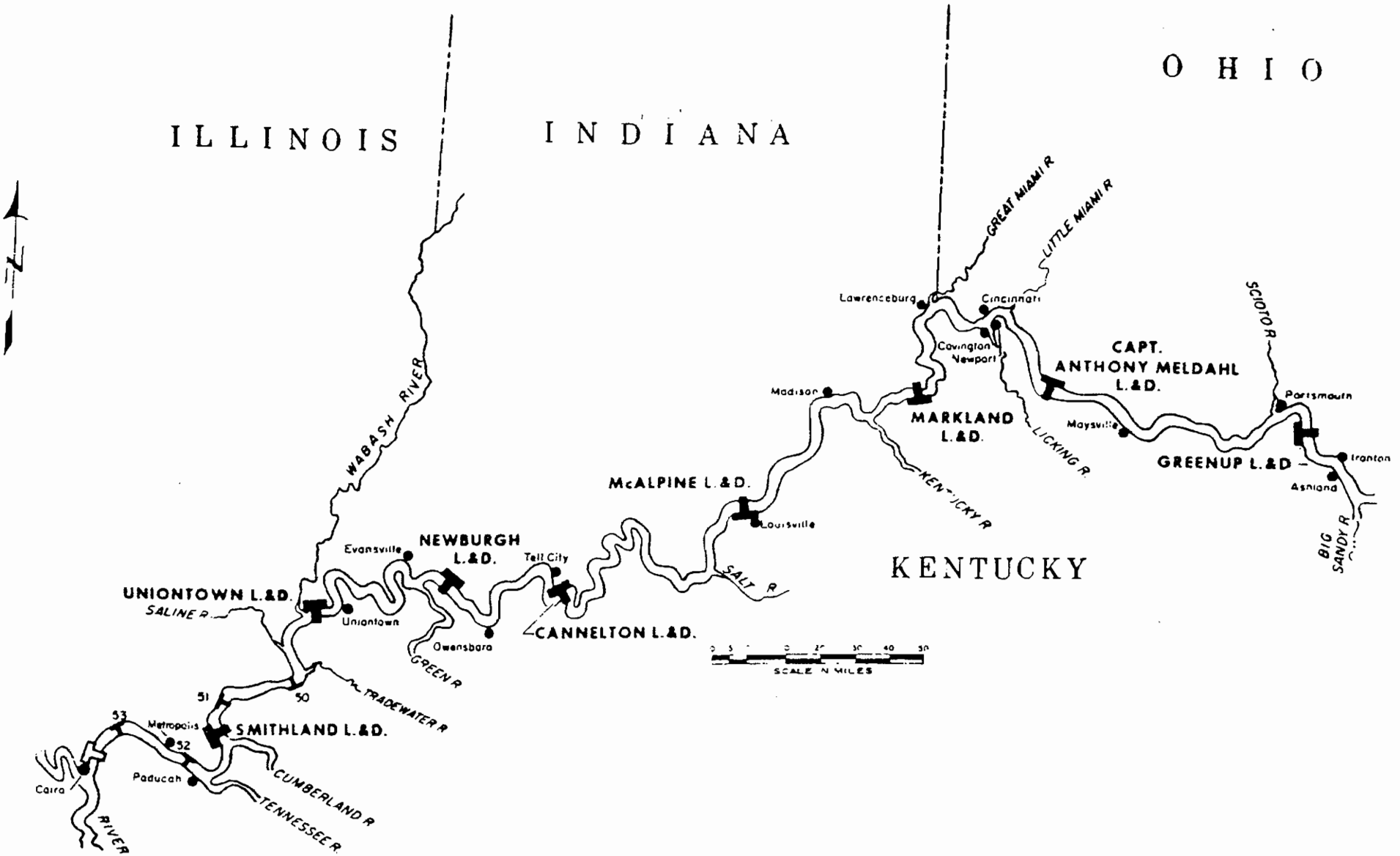

Figure 1. The lower section of the Ohio River that forms the northern boundary of Kentucky.

Table 1. Standard methods for conducting cove-rotenone studies.

1. Cove selected for fish population sampling will be at least one acre in size; two-acre areas are preferable. The sample area should have a mean depth that is similar to the mean depth of the adjacent open water.

2. Coves will be measured by accepted surveying methods, not by visual estimation. Soundings will be made to determine the average depth.

3. A net that effectively blocks the cove mouth from shore to shore and from surface to bottom will be used. (The most widely-used net is 300 feet long, 20 feet deep, with 1/2 inch bar-measure mesh).

4. All population studies will begin between the hours of 7:00 and 8:00 am, the earlier hour being preferrable. The block net is positioned before other activities relevant to the study are to begin.

5. Population studies will not be conducted in water having a surface temperture less than 70F.

6. Liquid fish toxicants will be mixed with water at a 1:10 ratio and applied through the propeller wash via a venturi-type boat trailer. In deep coves, the mud-ball method (powdered cubes) will be used for better penetration of the thermocline.

7. Fish within the study area will be picked up for three days (50-60 hours). Freshly-killed fish will not be counted on the second and third days. Sanitary and esthetical considerations require disposal of floating extra-territorial fish before leaving the lake.

8. Fish will be sorted according to species, measured in inch group, 0.1" to 1.4" = 1 inch, 1.5" to 2.4" = 2 inches, etc., and weighed to the nearest 0.01 pound. Small species, as well as questionable larger specimens, will be preserved in formalin for later identification. Weights will be taken only during the first day.

Table 2. Standard form used by Kentucky Division of Fisheries for reporting fish population study data. A_{Tl} ("legal total availability") applied only to those species that have a legal size limit.

Group/Species	Fingerling size (inch group)	Intermediate size (inch group)	Harvestable size (inch group)
GAME FISHES			
Rainbow trout	0-4	4-7	8
Ohio muskellunge	0-4	5-29	30 (A_{Tl})
Chain pickerel	0-4	5-11	12
Grass pickerel	0-4	5-9	10
White bass	0-4	5-8	9
Striped bass	0-4	5-14	15 (A_{Tl})
Sauger	0-4	5-11	12
Walleye	0-4	5-14	15 (A_{Tl})
Largemouth bass	0-4	5-11	12 (A_{Tl})
Smallmouth bass	0-4	5-11	12 (A_{Tl})
Spotted bass	0-4	5-11	12 (A_{Tl})
Black crappie	0-4	5-7	8
White crappie	0-4	5-7	8
FOOD FISHES			
Blue catfish	0-4	5-9	10
Channel catfish	0-4	5-9	10
Flathead catfish	0-4	5-9	10
PREDATORY FISHES			
Skipjack herring	0-4	5-9	10
Goldeye	0-4	5-9	10
Mooneye	0-4	5-9	10
Longnose gar	0-4	5-23	24
Shortnose gar	0-4	5-23	24
Spotted gar	0-4	5-23	24
Bowfin	0-4	5-13	14
American eel		8-15	16
PANFISHES			
Rock bass	0-2	3-5	6
Bluegill	0-2	3-5	6
Green sunfish	0-2	3-5	6
Hybrid sunfish	0-2	3-5	6
Longear sunfish	0-2	3-5	6
Redear sunfish	0-2	3-5	6
Warmouth	0-2	3-5	6
COMMERCIAL FISHES			
Sturgeons	0-7	8-23	24
Paddlefish	0-7	8-23	24
Buffalofishes	0-4	5-11	12
Carpsuckers	0-4	5-11	12

Table 2 continued.

Group/Species	Fingerling size (inch group)	Intermediate size (inch group)	Harvestable size (inch group)
Northern hog sucker	0-4	5-11	12
Redhorses	0-4	5-11	12
White sucker	0-4	5-11	12
Spotted sucker	0-4	5-11	12
Carp	0-4	5-11	12
Bullhead	0-4	5-8	9
Freshwater drum	0-4	5-9	10
FORAGE FISHES			(Above forage size)
Lampreys	0-3	4-7	8
Gizzard shad	0-3	4-7	8
Threadfin shad	0-3	4-7	8
Shiners	0-3	4-7	8
Miscellaneous cyprinids	0-3	4-7	8
Madtom	0-3	4-7	8
Topminnows	0-3	4-7	8
Darters	0-3	4-7	8
Orangespotted sunfish	0-3	4-7	8
Brook silverside	0-3	4-7	8
Sculpins	0-3	4-7	8
PISCIVOROUS TOTAL (Game-Food-Predatory)			
NON-PISCIVOROUS TOTAL (Pan-Commercial-Forage)			
GRAND TOTAL			

Table 3. Fish standing crop in the backwater area of Craig's Creek in Markland Pool during 1978.

	Harvestable size (per acre)		Total (per acre)		Percent of total population	
	No.	Lb	No.	Lb	No.	Lb
GAME FISHES						
Largemouth bass	5	8.66	25	11.34	1.4	2.5
White bass			1	0.13	t	t
Black crappie	1	0.20	10	0.74	0.6	0.2
White crappie	9	3.04	65	6.33	3.7	1.4
Sauger			3	0.25	0.2	t
Total	15	11.90	103	18.79	5.8	4.2
FOOD FISHES						
Channel catfish	79	83.68	95	85.40	5.4	19.2
Flathead catfish	4	13.90	4	14.02	0.2	3.1
Total	83	97.58	99	99.42	5.6	22.3
PREDATORY FISHES						
Goldeye			1	0.05	t	t
Mooneye			1	0.03	t	t
Longnose gar			1	t	t	t
Total			3	0.08	t	t
PISCIVOROUS TOTAL	98	109.48	203	118.29	11.5	26.5
PANFISHES						
Bluegill	213	33.54	516	40.47	29.1	9.0
Green sunfish	7	0.44	107	1.86	6.0	0.4
Longear sunfish	13	1.14	206	12.33	11.6	2.8
Warmouth	8	1.59	88	3.31	5.0	0.7
Pumpkinseed			t	t	t	t
Total	241	36.71	916	57.97	51.7	13.0
COMMERCIAL FISHES						
Carp	84	175.35	85	175.74	4.8	39.4
River carpsucker	17	20.35	18	20.52	1.0	4.6
Smallmouth buffalo	2	3.96	116	33.23	6.5	7.5
Black buffalo	1	1.71	2	1.80	t	0.4
Spotted sucker	1	0.80	6	1.12	0.3	0.3
Golden redhorse	1	1.25	2	1.30	t	0.2
Black bullhead	5	0.93	15	2.13	0.8	0.5
Yellow bullhead	6	2.41	99	10.06	5.6	2.3
Freshwater drum	12	8.65	168	18.76	9.5	4.3
Total	129	215.41	501	264.66	28.5	59.5

Table 3 continued.

	Harvestable size (per acre)		Total (per acre)		Percent of total population	
	No.	Lb	No.	Lb	No.	Lb
FORAGE FISHES						
Gizzard shad	2	0.94	59	1.43	3.3	0.3
Goldfish	1	0.82	1	0.82	t	0.2
Emerald shiner			19	0.32	1.0	0.1
Misc. cyprinids			1	t	t	t
Brindled madtom			12	0.08	0.6	t
Orangespotted sunfish	2	0.20	45	2.15	2.5	0.5
Logperch			4	0.09	0.2	t
Total	5	1.97	141	4.89	7.6	1.1
NON-PISCIVOROUS TOTAL	375	254.09	1,558	327.52	87.8	73.6
GRAND TOTAL	473	363.57	1,761	445.81	99.3	100.1

Table 4. Fish standing crop in the backwater area of Craig's Creek in Markland Pool during 1979.

	Harvestable size (per acre)		Total (per acre)		Percent of total population	
	No.	Lb	No.	Lb	No.	Lb
GAME FISHES						
Largemouth bass	4	4.25	28	7.18	0.9	1.4
White bass			1	0.04	t	t
Black crappie			2	0.16	0.1	t
White crappie	10	2.86	215	13.90	7.1	2.8
Sauger			1	0.07	t	t
Total	14	7.11	245	21.35	8.0	4.3
FOOD FISHES						
Channel catfish	20	34.56	34	35.55	1.1	7.1
Flathead catfish	1	3.11	9	3.30	0.3	0.7
Total	21	37.67	43	38.85	1.4	7.8
PREDATORY FISHES						
Longnose gar			1	t	t	t
Total			1	t	t	t
PISCIVOROUS TOTAL	35	44.78	288	60.20	9.5	12.02
PANFISHES						
Bluegill	186	30.75	690	53.33	22.7	10.7
Green sunfish	6	1.13	39	2.37	1.3	0.5
Longear sunfish	11	1.57	80	6.30	2.6	1.3
Warmouth	8	1.19	71	3.26	2.3	0.7
Total	211	34.64	880	65.26	28.9	13.1
COMMERCIAL FISHES						
Carp	56	131.87	61	134.98	2.0	27.0
River carpsucker	6	9.48	7	10.06	0.2	2.01
Smallmouth buffalo	17	15.60	68	56.82	2.2	11.4
Spotted sucker	2	1.49	10	4.28	0.3	0.9
Golden redhorse			1	0.01	t	t
Black bullhead	2	0.86	17	3.09	0.6	0.6
Yellow bullhead	2	0.80	41	5.87	1.4	1.1
Freshwater drum	19	14.22	505	48.81	16.6	9.8
Total	104	174.32	710	263.92	23.3	52.7
FORAGE FISHES						
Gizzard shad	18	3.68	1,149	109.29	37.8	21.9
Goldfish	1	1.46	1	1.46	t	0.3
Golden shiner			1	0.06	t	t
Tadpole madtom			5	0.06	0.2	t

Table 4 continued.

	Harvestable size (per acre)		Total (per acre)		Percent of total population	
	No.	Lb	No.	Lb	No.	Lb
Orangespotted sunfish			6	0.20	0.2	t
Logperch			3	0.06	0.1	t
Total	19	5.14	1,165	111.13	38.3	22.2
NON-PISCIVOROUS TOTAL	334	214.10	2,755	440.31	90.5	88.0
GRAND TOTAL	369	258.88	3,043	500.51	100.0	100.0

Table 5. Fish standing crop in the backwater area of Steele's Creek in Markland Pool in 1980.

	Harvestable size (per acre)		Total (per acre)		Percent of total population	
	No.	Lb	No.	Lb	No.	Lb
GAME FISHES						
White bass			t	0.07	t	t
Largemouth bass	6	7.07	28	9.15	2.3	4.9
White crappie	3	1.89	43	4.42	3.6	2.4
Walleye			t	0.01	t	t
Total	9	8.96	71	13.65	5.9	7.3
FOOD FISHES						
Channel catfish	12	7.86	38	10.26	3.1	5.5
Flathead catfish			t	0.07	t	t
Total	12	7.86	38	10.33	3.1	5.5
PREDATORY FISHES						
Longnose gar			1	0.01	t	t
Total			1	0.01	t	t
PISCIVOROUS TOTAL	21	16.82	110	23.99	9.0	12.8
PANFISHES						
Bluegill	53	9.47	446	25.04	36.8	13.4
Green sunfish	t	0.06	3	0.25	0.2	0.1
Longear sunfish	t	0.06	29	1.42	2.4	0.8
Warmouth	7	0.92	104	4.12	8.6	2.2
Total	60	10.51	582	30.83	48.1	16.5
COMMERCIAL FISHES						
Carp	31	75.51	33	76.01	2.7	40.8
River carpsucker			t	0.01	t	t
White sucker	1	0.74	3	1.70	0.2	0.9
Smallmouth buffalo	1	1.39	6	1.91	0.5	1.0
Bigmouth buffalo			1	0.01	0.1	t
Spotted sucker	1	0.49	1	0.52	0.1	0.3
Golden redhorse	1	1.26	2	1.69	0.2	0.9
Black bullhead	2	0.79	14	1.70	1.2	0.9
Yellow bullhead	1	0.52	9	1.72	0.7	0.9

Table 5 continued.

	Harvestable size (per acre)		Total (per acre)		Percent of total population	
	No.	Lb	No.	Lb	No.	Lb
Freshwater drum	2	0.78	82	10.87	6.8	5.8
Total	40	81.48	151	96.14	12.5	51.5
FORAGE FISHES						
Gizzard shad	129	19.93	364	35.38	30.1	19.0
Emerald shiner			1	t	0.1	t
Misc. cyprinids			1	t	0.1	t
Tadpole madtom			t	t	t	t
Darters			2	t	0.2	t
Total	129	19.93	368	35.38	30.5	19.0
NON-PISCIVOROUS TOTAL	229	111.92	1,101	162.35	91.1	87.0
GRAND TOTAL	250	128.74	1,211	186.34	100.0	100.0

Table 6. Fish standing crop in the backwater area of Steele's Creek in Markland Pool in 1981.

	Harvestable size (per acre)		Total (per acre)		Percent of total population	
	No.	Lb	No.	Lb	No.	Lb
GAME FISHES						
Largemouth bass	5	4.53	90	7.79	2.3	2.1
White crappie	3	1.41	38	2.76	1.0	0.7
Sauger			1	0.15	t	t
Total	8	5.94	129	10.70	3.3	2.8
FOOD FISHES						
Channel catfish	11	5.92	62	7.89	1.6	2.1
Flathead catfish			t	0.02	t	t
Total	11	5.92	62	7.91	1.6	2.1
PREDATORY FISHES						
Longnose gar	t	1.05	3	1.13	0.1	0.3
Total	t	1.05	3	1.13	0.1	0.3
PISCIVOROUS TOTAL	19	12.91	194	19.74	5.0	5.2
PANFISHES						
Bluegill	72	12.80	751	30.52	19.5	8.1
Green sunfish	t	0.05	5	0.31	0.1	0.1
Longear sunfish	t	0.04	53	1.82	1.4	0.5
Warmouth	10	1.83	90	5.45	2.3	1.5
Total	82	14.72	899	38.10	23.3	10.2
COMMERCIAL FISHES						
Carp	56	147.62	69	148.88	1.8	39.7
Smallmouth buffalo	1	0.83	49	4.25	1.3	1.1
Spotted sucker	1	1.49	2	1.70	0.1	0.5
Black bullhead	2	1.19	289	4.76	7.5	1.3
Yellow bullhead	3	1.13	49	2.68	1.3	0.7
Freshwater drum	1	0.41	289	14.17	7.5	3.8
Total	64	153.05	748	177.40	19.5	47.1

Table 6 continued.

	Harvestable size (per acre)		Total (per acre)		Percent of total population	
	No.	Lb	No.	Lb	No.	Lb
FORAGE FISHES						
Gizzard shad	534	75.18	2,009	139.77	52.1	37.3
Goldfish	t	0.38	1	0.96	t	0.3
Emerald shiner			t	t	t	t
Bluntnose minnow			1	t	t	t
Tadpole madtom			5	0.04	0.1	t
Orangespotted sunfish			1	0.02	t	t
Total	534	75.56	2,017	140.79	52.2	37.6
NON-PISCIVOROUS TOTAL	680	243.33	3,664	356.29	95.0	94.9
GRAND TOTAL	699	256.24	3,858	376.03	100.0	100.0

Table 7. Fish standing crop in the backwater area of Steele's Creek in Markland Pool in 1982.

	Harvestable size (per acre)		Total (per acre)		Percent of total population	
	No.	Lb	No.	Lb	No.	Lb
GAME FISHES						
White bass			1	t	t	t
Largemouth bass	2	3.81	71	8.30	2.5	2.8
White crappie	2	0.64	11	2.74	0.4	0.9
Black crappie			2	0.11	0.1	t
Sauger			3	t	0.1	t
Total	4	4.45	88	11.15	3.1	3.7
FOOD FISHES						
Channel catfish	10	7.08	285	17.65	9.9	5.8
Flathead catfish			1	0.18	t	0.1
Total	10	7.08	286	17.83	9.9	5.9
PREDATORY FISHES						
Longnose gar			25	0.06	0.9	t
Mooneye			3	0.03	0.1	t
Total			28	0.09	1.0	t
PISCIVOROUS TOTAL	14	11.53	402	29.07	14.0	9.6
PANFISHES						
Bluegill	37	9.16	688	26.79	24.0	8.9
Green sunfish			1	0.03	t	t
Longear sunfish			45	1.07	1.6	0.4
Redear sunfish	t	0.04	6	0.15	0.2	t
Warmouth	5	0.80	67	4.25	2.3	1.4
Total	42	10.00	807	32.29	28.1	10.7
COMMERCIAL FISHES						
Carp	22	60.97	28	63.50	1.0	21.0
River carpsucker			31	1.33	1.1	0.4
Quillback			25	1.36	0.9	0.4
Smallmouth buffalo	t	1.13	37	4.59	1.3	1.5
Golden redhorse			2	0.12	0.1	t
Black bullhead			23	3.03	0.8	1.0
Yellow bullhead			3	0.55	0.1	0.2

Table 7 continued.

	Harvestable size (per acre)		Total (per acre)		Percent of total population	
	No.	Lb	No.	Lb	No.	Lb
Brown bullhead			t	0.06	t	t
Freshwater drum	5	2.38	381	26.48	13.3	8.8
Total	27	64.48	530	101.02	18.5	33.4
FORAGE FISHES						
Gizzard shad	276	55.18	1,113	139.62	38.8	46.2
Silver chub			10	0.14	0.3	0.1
Golden shiner			1	0.02	t	t
Tadpole madtom			2	0.03	0.1	t
Orangespotted sunfish			3	0.05	0.1	t
Total	276	55.18	1,129	139.86	39.4	46.3
NON-PISCIVOROUS TOTAL	345	129.66	2,466	273.17	86.0	90.4
GRAND TOTAL	359	141.19	2,868	302.24	100.0	100.0

Table 8. Standing crop, A_{T1} and Y/C values of the fish population derived from cove-rotenone studies in Markland Pool in 1978-1982.

Year	No./acre	Lb/acre	A_{T1}	Y/C
1978	1,771	446	69.1	0.1
1979	3,043	501	51.8	0.8
1980	1,211	186	69.1	0.8
1981	3,857	375	68.2	4.9
1982	2,867	302	46.7	2.4

*1978-1979 data from Craigs Creek arm.
1980-1982 data from Steeles Creek arm.

Table 9. Fish captured during 3.50 hours of electrofishing effort in the mainstem of Markland Pool in 1979-1982.

	Inch group																				Number of fish	Fish per hour	% of total number
	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21			
White bass		1					1														2	0.6	0.5
Smallmouth bass		3	3	1			1														8	2.3	2.0
Spotted bass		3								1											4	1.1	1.0
Largemouth bass					1		2									1					4	1.1	1.0
Sauger					1								1								2	0.6	0.5
Channel catfish				1						1			1	4		1		1			9	2.6	2.2
Flathead catfish																1					1	0.3	0.2
Skipjack herring		1																			1	0.3	0.2
Longnose gar								1													1	0.3	0.2
Bluegill			5	23	4	1															33	9.4	8.0
Longear sunfish			1	3	3																7	2.0	1.7
Carp													1	1	1		2		1	2	8	2.3	2.0
River carpsucker														1							1	0.3	0.2
Quillback													1								1	0.3	0.2
Highfin carpsucker																1					1	0.3	0.2
River redhorse														1							1	0.3	0.2
Spotted sucker										1											1	0.3	0.2
Freshwater drum						1		3	4	2	1	4							1		16	4.6	3.9
Gizzard shad	1		2	6	8	62	133	80	11												303	86.6	73.9
Silver chub	2		1	1																	4	1.1	1.0
Logperch			2																		2	0.6	0.5
Total																					410	117.3	100.0

Table 10. Fish captured during 4.72 hours of electrofishing effort in backwater areas of the Markland Pool in 1979-1982.

	Inch group																							Number of fish	Fish per hour	% of total number
	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24			
White bass		2	2	1																				5	1.1	0.4
Striped bass	1																							1	0.2	0.1
Smallmouth bass			1				1																	2	0.4	0.1
Spotted bass		1																						1	0.2	0.1
Largemouth bass			4		2	2	5	3	4	6	4	8	1	2	3	1	1	1						46	9.7	3.4
White crappie		1		1	8	3	1	9	4	3	1	1	1											33	7.0	2.4
Black crappie				1																				11	0.2	0.1
Sauger					3										1									44	0.8	0.3
Channel catfish				1	1	1	1		1				2	2										9	1.9	0.7
Flathead catfish							1					1	1	1		1		2						7	1.5	0.5
Skipjack herring				1	1																			2	0.4	0.1
Longnose gar							1															1		2	0.4	0.1
Green sunfish				2	1																			3	0.6	0.2
Warmouth			1	1	2																			4	0.8	0.3
Bluegill	3	8	33	38	38	15																		135	28.6	9.9
Longear sunfish		9	16	19	4																			48	10.2	3.5
Carp					2			1	1	1	1	2	5	3	8	1	3	3	1		2		1	37	7.8	2.7
River carpsucker		1			1	3				3	3		2	3	1		1							21	4.4	1.5
Quillback				1			2		1															4	0.8	0.3
Smallmouth buffalo							2	2	2	3	3	1		1		1								15	3.2	1.1
Spotted sucker		1						1	1	1	2	1	1		1									9	1.9	0.7
Black redhorse		1																						1	0.2	0.1
Golden redhorse													1											1	0.2	0.1
Yellow bullhead									1															1	0.2	0.1
Freshwater drum		7	3	3	19	13	14	5	3		2	1	2											72	15.3	5.3
Gizzard shad	495	20	71	14	54	82	126	31	4	1														898	190.3	65.8
Goldfish											1													1	0.2	0.1
Logperch		1																						1	0.2	0.1
Total																								1,364	288.7	100.0

Table 11. Fish captured during 57.48 net-days of gillnetting activity in the mainstem of Markland Pool in 1979-1981.

	Inch group																									Number of fish	Fish per net-day	% of total number
	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	32			
White bass			1			1			1		1	1		1													6	0.11	2.7
Largemouth bass			1																								1	0.02	0.4
Sauger					4	1		1		1			1	1		1	1										11	0.19	4.9
Channel catfish						1			2	1	1	3	2	6	5	3	2	6	5	1		3	1				42	0.73	18.8
Flathead catfish								1								2	2	1	2	1		1					10	0.18	4.5
Longnose gar												1							1								2	0.03	0.9
Paddlefish																										1	1	0.02	0.4
Carp												1	1	2	2	7	17	7	3	4	1			1	1		47	0.82	21.1
River carpsucker								1						1	7	8	2	1									20	0.35	9.0
Quillback														2													2	0.03	0.9
Smallmouth buffalo												2				1			1								4	0.07	1.8
River redhorse												1															1	0.02	0.4
Spotted sucker													1														1	0.02	0.4
Freshwater drum	3	1				8	13	2	6	1	1																35	0.61	15.7
Gizzard shad						15	6		12	6																	39	0.68	17.5
Silver chub					1																						1	0.02	0.4
Total																											223	3.90	100.0

Table 12. Fish captured during 25.02 net-days of gillnetting activity in backwater areas of Markland Pool in 1979-1981.

	Inch group																									Number of fish	Fish per net-day	% of total number
	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27			
White bass										2																	2	0.08	0.7
Largemouth bass										1																	1	0.04	0.4
White crappie					2	1	1	3	3		1	1	1														13	0.52	4.8
Sauger				5	3				3	1				2		2											16	0.64	5.9
Channel catfish								1					1	2	3	5	4	2	2	6	4	1	1			1	33	1.32	12.3
Flathead catfish																	1	3	2	1	1	1					9	0.36	3.3
Lognose gar																			1								1	0.04	0.4
Paddlefish													1														1	0.04	0.4
Carp													1	1	1	9	17	4	1	1			1				36	1.44	13.4
River carpsucker												1		3	2	3	2	2	1								14	0.56	5.2
Quillback																			1								1	0.04	0.4
Highfin carpsucker													1														1	0.04	0.4
Smallmouth buffalo													1														1	0.04	0.4
Spotted sucker											1	1															2	0.08	0.7
Freshwater drum	4		1		1	17	4	1	6	4																	38	1.52	14.1
Gizzard shad					28	15	4	9	27	7	2	2	3	1	1												99	3.96	36.8
Goldfish															1												1	0.04	0.4
Total																											269	10.76	100.0

Table 13. Relative weight (Wr) for largemouth bass captured during fall electrofishing in selected pools of the Ohio River in 1982.

	Length group						
	8.0-11.9		12.0-14.9		≥15.0		
	Wr	No. of fish	Wr	No. of fish	Wr	No. of fish	Total Wr
Greenup	105	30	103	5	110	3	105
Meldahl	106	10	105	7	110	2	106
Markland	104	4	101	16	101	4	101
Cannelton	99	12	92	3	94	2	97
Newburgh	119	8	117	3	122	1	119
Smithland	118	19	109	6	103	1	115

Table 14. Species composition and relative abundance of fish captured by gillnetting in this tailwater of Markland Pool in 1983.

	Inch group																						Number of fish	Number for net day	Percent of total number
	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26			
	27	*28*	*29*	*30*	*31*	*32*	*33*	*34*	*35*	*36*	*37*	*38*	*39*	*40*	*41*	*42*	*43*	*44*	*45*	*46*	*47*	*48*			
White bass									1		2												5	1.0	2.2
Striped bass							1								1								2	0.4	0.9
Smallmouth bass								1															1	0.2	0.4
Largemouth bass			3				1	1															5	1.0	2.2
White crappie					1		1																2	0.4	0.9
Sauger							4		1	2	2	1											10	2.0	4.4
Walleye												1			2		1						4	0.8	1.8
Channel catfish					1									1		2		1	1			1	7	1.4	3.1
Longnose gar																		2		4	10	7			
	8	*6*	*15*	*3*	*8*	*8*	*4*	*3*	*6*			*1*		*1*			*1*	*1*	*1*	*1*		*1*	71	14.1	31.4
Bluegill	2																						2	0.4	0.9
Carp									1		1	3	9	5	6	3	5	1	1	3		1			
			1																				40	7.9	17.7
River carpsucker								1	3	13	7	5	4	1	1	1							36	7.2	15.9
Quillback									2	7	10	4	1										24	4.8	10.6
Highfin carpsucker										2		1											3	0.6	1.3
Blue sucker																		1					1	0.2	0.4
Golden redhorse												1		2									3	0.6	1.3
Shorthead redhorse												1											1	0.2	0.4
Freshwater drum					1			2	3			1											7	1.4	3.1
Gizzard shad									1														1	0.2	0.4
Logperch	1																						1	0.2	0.4
Total																							226	45.0	100.0

*Inch groups in italics are numbers of longnose gar and carp captured at that length.

Table 15. Species composition and relative abundance of fish captured by electrofishing for 1.0 hour in the tailwater of Markland Pool in 1984.

	Inch group																					Number of fish	Fish per hour	% of total number
	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	23	28	31			
White bass						2																	2	2	2.2
Smallmouth bass									2														2	2	2.2
Spoted bass			1					2	1														4	4	4.3
Largemouth bass									1			1		1									3	3	3.3
Sauger										1	1												2	2	2.2
Lognose gar																					1	1	2	2	2.2
Skipjack herring		1	4								2	1	2										10	10	10.9
River carpsucker																1							1	1	1.1
Quillback														1	1								2	2	2.2
Highfin carpsucker												1											1	1	1.1
Blue sucker																			1	1			2	2	2.2
Shorthead redhorse												3			1	1							5	5	5.4
Freshwater drum										2		1	2	2									7	7	7.6
Gizzard shad		2	5	13		9	9	2	3														43	43	46.7
Silver chub			1																				1	1	1.1
Emerald shiner	2	3																					5	5	5.4
Total																							92	92	100.0

Table 16. Summary of fishes collected in Markland Pool from the following methods of sampling; cove-rotenone, electrofishing, and gillnetting.

Species		'78	'79	'80	'81	'82	'83	'84
Polyodontidae - paddlefishes								
Polyodon spathula (Walbaum)	Paddlefish		X					
Lepisosteidae - gars								
Lepisosteus osseus (Linnaeus)	Longnose gar	X	X	X	X	X	X	X
Clupidae - herrings								
Alosa chrysochloris (Rafinesque)	Skipjack herring			X	X			X
Dorosama cepedianum (Lesueur)	Gizzard shad	X	X	X	X	X	X	X
Hiodontidae - mooneyes								
Hiodon alosoides (Rafinesque)	Goldeye	X						
Hiodon tergisus Lesueur	Mooneye	X				X	X	
Cyprinidae - minnows and carps								
Carassius auratus (Linnaeus)	Goldfish	X	X	X	X			
Cyprinus carpio Linnaeus	Common carp	X	X	X	X	X	X	
Hybopis storeriana (Kirtland)	Silver chub			X	X	X		X
Notemigonus crysoleucas (Mitchill)	Golden shiner		X			X		
Notropis atherioides Rafinesque	Emerald shiner	X		X	X			X
Pimephales notatus (Rafinesque)	Bluntnose minnow				X			
Catostomidae - suckers								
Carpiodes carpio (Rafinesque)	River carpsucker	X	X	X	X	X	X	X
Carpiodes cyprinus (Lesueur)	Quillback			X	X	X	X	X
Carpiodes velifer (Rafinesque)	Highfin carpsucker			X			X	X
Cycleptus elongatus (Lesueur)	Blue sucker						X	X

Table 16 continued.

Species		'78	'79	'80	'81	'82	'83	'84
Ictiobus bubalus (Rafinesque)	Smallmouth buffalo	X	X	X	X	X		
Ictiobus cyprinellus (Valenciennes)	Bigmouth buffalo			X				
Ictiobus niger (Rafinesque)	Black buffalo	X						
Minytrema melanops (Rafinesque)	Spotted sucker	X	X	X	X	X		
Moxostoma carinatum (Cope)	River redhorse			X				
Moxostoma duquesnei (Lesueur)	Black redhorse			X				
Moxostoma erythrurum (Rafinesque)	Golden redhorse	X	X	X		X	X	
Moxostoma macrolepidotum (Lesueur)	Shorthead redhorse						X	X
Ictaluridae - freshwater catfishes								
Ictalurus furcatus (Lesueur)	Blue catfish					X		
Ictalurus melas (Rafinesque)	Black bullhead	X	X	X	X	X		
Ictalurus natalis (Lesueur)	Yellow bullhead	X	X	X	X	X		
Ictalurus nebulosus (Lesueur)	Brown bullhead					X		
Ictalurus punctatus (Rafinesque)	Channel catfish	X	X	X	X	X	X	
Noturus gyrinus (Mitchill)	Tadpole madtom		X	X	X	X		
Noturus miurus (Jordan)	Brindled madtom	X						
Pylodictus olivaris (Rafinesque)	Flathead catfish	X	X	X	X	X		
Percichthyidae - temperate bass								
Morone chrysops (Rafinesque)	White bass	X	X	X	X	X	X	X
Morone saxatilis (Walbaum)	Striped bass					X	X	X
Centrarchidae - sunfishes								
Lepomis cyanellus Rafinesque	Green sunfish	X	X	X	X	X		
Lepomis gibbosus (Linnaeus)	Pumpkinseed	X						

Table 16 continued.

Species		'78	'79	'80	'81	'82	'83	'84
Lepomis gulosus (Cuvier)	warmouth	X	X	X	X	X		
Lepomis humilis (Girard)	Orangespotted sunfish	X	X		X	X		
Lepomis macrochirus Rafinesque	Bluegill	X	X	X	X	X	X	
Lepomis megalotis (Rafinesque)	Longear sunfish	X	X	X	X	X		
Lepomis microlophus (Gunther)	Redear sunfish					X		
Micropterus dolomieui Lacepede	Smallmouth bass				X	X	X	X
Micropterus punctatus (Rafinesque)	Spotted bass			X	X	X		X
Micropterus salmoides (Lacepede)	Largemouth bass	X	X	X	X	X	X	X
Pomoxis annularis Rafinesque	White crappie	X	X	X	X	X	X	
Pomoxis nigromaculatus (Lesueur)	Black crappie	X	X			X		
Percidae - perches								
Etheostoma flabellare Rafinesque	Fantail darter			X				
Percina caprodes (Rafinesque)	Logperch	X	X		X	X	X	
Stizostedion canadense (Smith)	Sauger	X	X	X	X	X	X	X
Stizostedion vitreum (Mitchill)	Walleye			X			X	
Sciaenidae - drum								
Aplodinotus grunniens Rafinesque	Freshwater drum	X	X	X	X	X	X	X
Total		30	27	33	30	34	25	20

*1983 data reflects a gillnetting effort in the tailwater below Markland Lock and Dam.

**1984 data reflects a fall electrofishing effort in the tailwater below Markland Lock and Dam.

Table 17. Expanded creel survey totals from the creel survey conducted at Markland Pool of the Ohio River from 30 March through 1 November 1980.

Anglers	
Total count (trips)	74,542
% successful	40.3
Fishing pressure	
Total man-hours (m-h)	196,730
M-h/acre	7.9
Harvest (yield)	
Number of fish	73,390
No./acre	3.0
Pounds	81,450
Lb/acre	3.3
Catch rate	
Fish/hour	0.37
Lb/hour	0.41
Misc. characteristics (%)	
Male	91.5
Female	8.5
Resident	98.1
Non-resident	1.9
Boat	21.8
Bank	78.2
Method (%)	
Still fishing	93.0
Casting	6.9
Fly fishing	0.0
Trolling	0.0
Other	0.1

Table 18. Harvest of selected species from Markland Pool, Ohio River, derived from expanded creel survey data collected between 30 March and 1 November 1980.

	Black bass	Crappie	Sauger	White bass	Channel catfish	Flathead catfish	Freshwater drum	Carp	Blue catfish	Anything[a]
Number harvested (per acre)	3,126 (0.14)	14,733 (0.68)	796 (0.04)	1,383 (0.06)	19,896 (0.92)	898 (0.04)	21,650 (1.00)	8,161 (0.38)	54 (t)	33,358 (1.54)
% of total number	4.3	20.1	1.1	1.9	27.1	1.2	29.5	11.1	0.1	45.5
Pounds harvested (per acre)	4,900 (0.23)	6,295 (0.29)	293 (0.01)	838 (0.04)	24,824 (1.14)	2,637 (0.12)	11,685 (0.54)	27,773 (1.28)	200 (0.01)	39,043 (1.80)
% of total pounds	6.0	7.7	0.4	1.0	30.5	3.2	14.3	34.1	0.2	47.9
Mean length (in)	14.4	9.6	10.8	11.1	15.7	19.4	10.7	19.5	21.5	
Mean weight (lb)	1.57	0.43	0.37	0.61	1.25	2.94	0.54	3.40	3.70	
No. of fishing trips for	5,057	6,529	1,156	194	12,041		1,684	3,765		43,965
% of total trips	6.8	8.8	1.6	0.3	16.2		2.3	5.1		59.0
Hr fished for (per acre)	16,137 (0.74)	14,836 (0.68)	3,039 (0.14)	259 (0.01)	33,492 (1.54)		4,859 (0.22)	11,026 (0.51)		112,886 (5.20)
No. caught fishing for	2,870	13,336	18	219	10,997		4,862	2,873		33,358
Lb caught fishing for	4,635	5,687	7	136	15,768		2,941	9,345		39,043
No/hr caught fishing for	0.18	0.90	0.06	0.85	0.33		1.00	0.26		0.30
% success fishing for	24.6	59.7	10.0	38.7	44.0		75.5	39.0		33.8

[a]Includes all species caught by "anything" fisherman.

t = less than 0.005 lb/a or f/a.

Table 19. Harvest of selected fish species per acre from Markland, Cannelton, and McAlpine pools of the Ohio River, derived from expanded creel survey data.

	Markland(1980)		Cannelton(1982)		McAlpine(1983)	
	No.	Lb.	No.	Lb.	No.	Lb.
White bass	0.06	0.04	0.01	0.01	0.17	0.10
Striped bass					0.03	0.08
Black bass	0.14	0.23	0.06	0.07	0.07	0.07
Bluegill	0.07	0.01	0.10	0.01	0.30	0.08
Crappie	0.68	0.29	0.78	0.01	0.45	0.15
Sauger	0.04	0.01	0.04	0.02	0.02	0.02
Channel catfish	0.92	1.14	0.17	0.15	0.37	0.39
Flathead catfish	0.04	0.12				
Carp	0.38	1.28	0.05	0.06		
Freshwater drum	1.00	0.54	0.32	0.19	0.08	0.07
Buffalo	0.03	0.06	0.09	0.13		
Total	3.35	3.71	1.62	0.79	1.50	0.91

Table 20. Expanded totals from creel surveys conducted at Markland, Cannelton, and McAlpine pools of the Ohio River.

	Markland (1980)	Cannelton (1982)	McAlpine (1983)
Mainstem acreage	21,700	22,800	18,800
Backwater acreage	3,087	2,189	394
% of total area in backwater	12.5	8.8	2.1
Angler trips (per acre)	74,542 (3.01)	56,632 (2.27)	15,539 (0.83)
Man-hours/acre	7.90	3.60	2.00
Fish/hour	[illegible]	[illegible]	0.74
Fish/acre	3.00	1.46	1.50
Pounds/acre	3.3	0.79	0.90

Table 21. Expanded creel survey totals from the creel survey conducted at Markland tailwater of the Ohio River (216 acres) from 17 May through 16 October 1983.

Anglers	
Total count (trips)	1,102 (5.10)
% successful	59.3
Fishing pressure	
Total man-hours (m-h)	2,619
M-h/acre	12.1
Harvest (yield)	
Number	2,155
No./acre	10.0
Pounds	1,678
Lb/acre	7.8
Catch rate	
Fish/hour	0.82
Lb/hour	0.64
Misc. characteristics (%)	
Male	95.3
Female	4.7
Resident	77.7
Non-resident	22.3
Method (%)	
Still-fishing	58.5
Casting	41.5
Fly fishing	0.0
Trolling	0.0
Other	0.0
Mode	
Boat	48.4
Bank	51.6

Table 22. Harvest of selected species from Markland tailwater (216 a) of the Ohio River derived from expanded creel survey data collected between 17 May and 16 October 1983.

	Small-mouth bass	White bass	Striped bass	Channel catfish	Drum	Anything[a]
Number harvested (per acre)	12 (0.05)	504 (2.33)	430 (1.99)	1,105 (5.11)	104 (0.48)	425 (1.96)
% of total number	0.6	23.4	20.0	51.3	4.8	19.7
Pounds harvested (per acre)	11 (0.05)	385 (1.78)	318 (1.47)	908 (4.20)	55 (0.25)	394 (0.82)
% of total pounds	0.6	1.4	18.9	54.0	3.3	23.5
Mean length (in)	13.0	11.4	12.8	13.7	10.6	
Mean weight (lb)	0.91	0.76	0.73	0.82	0.52	
Number of fishing trips for	25	125	304	300	0	349
% of all trips	2.3	11.3	27.5	27.2	0	31.6
Hr fished for (per acre)	53 (0.24)	300 (1.38)	435 (2.01)	1,308 (6.05)	0 (0)	523 (2.42)
No. caught fishing for	0	486	402	843	0	425
Lb caught fishing for	0	325	302	657	0	394
No./hr caught fishing for	0.00	1.49	0.92	0.61	0.00	0.81
% success fishing for	0.0	85.5	22.7	57.8	0	86.0

[a]Includes all species caught by "anything" fishermen.

Table 23. Summary of mark-recapture data collected from the Markland Pool during 1983.

	No. tagged	Exploitation rate (%)	Time out-range (days)	Time out-mean (days)	Miles traveled (range)	Miles traveled (mean)
Largemouth bass	99	29	2 - 194	67	0 - 21	1
White crappie	97	27	1 - 192	32	0 - 13	2
Channel catfish	95	9	2 - 74	38	0 - 66	13
Carp	99	0	0	0	0	0
Freshwater drum	39	8	32 - 43	37	0	0
Total	429	16				

Table 24. Back calculated lengths (in) for striped bass as determined by mail-in survey returns in the Ohio River in 1983.

Year class	No.	Age 1	2	3
1982	2	10.6		
1981	56	8.7	17.0	
1980	1	9.9	15.7	21.7
Total	59			
Mean		8.8	17.0	21.7

Table 25. Back calculated length (in) for sauger captured in Markland Pool of the Ohio River in 1983 and Ohio River sauger captured in the entire river in 1978-1983.

Year class	No.	Age 1	2	3	4	5
1981	10	7.9	10.8			
1980	8	6.3	9.0	12.3		
1979	7	6.3	8.6	11.4	13.4	
1978	1	6.8	11.3	15.5	16.4	18.4
Total	26					
Mean		6.9	9.7	12.1	13.8	18.4
Mean during 1978-1983 (entire river)	282	7.0	10.2	12.7	14.6	16.8

Table 20. Back-calculated mean lengths for largemouth bass captured in 1978-1983 in the Markland Pool of the Ohio River.

Year captured	No.	Age 1	2	3	4	5	6	7	8	9
1978	100	4.3	7.1	9.1	12.5	14.4	15.9	17.4	17.4	
1979	114	5.0	7.8	10.2	12.0	14.0	15.5	16.8	17.6	18.3
1980	60	4.6	7.6	10.2	12.1	13.6	15.2			
1981	57	4.9	7.8	9.9	12.2	13.7	15.1	14.8		
1982	12	4.5	7.1	9.9	11.5	14.6				
1983	22	4.3	6.9	9.5	11.1	12.5	15.5			
Total	365									
Mean		4.7	7.5	9.8	12.1	14.0	15.6	16.8	17.5	18.3