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FINAL REPORT

F-48-R

STATEWIDE FISHERIES SURVEY AND MANAGEMENT

STUDY V: INVESTIGATIONS OF LARGEMOUTH BASS POPULATIONS INHABITING MARYLAND'S TIDAL WATERS

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Freshwater Fisheries Division

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Annapolis, Maryland

1996

This project was supported in part by funds from the Federal Aid in Fish Restoration Act (Dingell-Johnson) Act, Public Law 81-681, as amended and identified as F-48-R, Study V.

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ABSTRACT

Largemouth bass *Micropterus salmoides* fisheries are among the Chesapeake Bay's most valuable renewable resources. The values of these fisheries, both recreational and economical, are highlighted by the tidal Potomac River fishery which is considered one of the top five bass sport fisheries in the United States. Tidal water anglers place high priority on largemouth bass, in Maryland nearly $38,000,000 is spent annually by anglers pursuing black bass in the tidal rivers.

Maryland has approximately 87,000 ha of tidal waters that support black bass populations. These resources have benefitted from corrective management to alleviate adverse impacts resulting from deteriorating aquatic habitat and increased fishery exploitation. Fish stocking, harvest regulation, habitat protection, and habitat enhancements are several management techniques that have helped to increase the number of tidal water black bass by 43% since 1990. Also, because salinity barriers separate Chesapeake Bay largemouth bass fisheries into distinct communities population dynamics vary from river to river due to local ecological relationships and different exploitation patterns. Consequently, sustaining high quality black bass sport fisheries will entail tailoring research, management, and regulation activities for each community.

The number of bass in the tidal Potomac River has increased by 49% during the past five years and has contributed to a trend of more anglers catching more bass. The estimated number of bass caught has tripled while the number of tournament participants has doubled. High catch rates for bass have attracted both tournament anglers and non-tournament anglers to the River despite crowded fishing conditions and launching facilities.

Overall largemouth bass population densities in the tidal rivers remain well below 1960 levels and continued effort will be needed to restore the black bass fishery to its full potential. Based on the findings of ongoing fishery studies and angler creel surveys, harvest limits, size limits, and stocking will be instituted as needed to rebuild depleted stocks of bass, prevent over-harvest of the fishery, and to maintain and redevelop high quality sport fisheries. Providing black bass sport resources at an optimum level will require concerted management to maintain, restore, and increase the productivity of existing bass populations and their habitats.

A primary purpose of the maintenance of a healthy bass fishery resource is to provide public fishing opportunities of which insuring a variety of bass angling experiences should be an important consideration. Public preferences will be a significant factor in the determination of largemouth bass management strategies.

Tidal Water Largemouth Bass Population Study
By Leon Fewlass

INTRODUCTION

Maryland has approximately 87,000 ha of tidal waters that have the potential to support largemouth bass populations. During recent years these resources have benefitted from management that targeted adverse impacts from deteriorating aquatic habitat and increased fishery exploitation. Salinity barriers separate Chesapeake Bay largemouth bass fisheries into distinct communities and population dynamics vary from river to river due to local ecological relationships and different exploitation patterns. Consequently, sustaining high quality bass sport fisheries will entail separate research and management for individual communities.

METHODS

Tidal water black bass population data were collected using boats equipped with Smith-Root model 5.0 GPP electrofishing units and by haul seining. Catch per unit effort data (CPUE) consisted of electrofishing for 15 minute periods at the 100 stations listed in Table 1. Sample stations were approximately 0.81 km in length and one electrofishing sample was done at each station in the spring and fall. Autumn samples were not collected when water salinity exceeded the electrofishing unit operating range of 6,000 micromhos/cm. Haul seines, 6 m long stretched mesh size 5 mm, were used for capturing fingerling bass. Haul seine CPUE was based on the mean number of fingerling bass collected per seine haul. Tidal waters were seined soon after the bass spawning season in order to reduce the possibility that fingerlings collected had immigrated from impoundments. Electrofishing boats used during this project were equipped with live wells as were haul seine boats. All fish were returned to tidal rivers once data had been collected.

Fish were measured to the nearest mm (total length) and weighed to the nearest gram. Largemouth bass proportional stock density (PSD) was calculated from lengths according to methods discussed by Weithman et al. (1979). The normal range (50% to 70%) was used to evaluate the status of tidal water largemouth bass populations (Weithman et al. 1979). The equation Log W = log a + n log L was used to describe the length-weight relationship. The coefficient of condition K_{TL} was calculated using the formula $K = W\ 10^5 / L^3$ where W = weight in grams and L = length in mm (Carlander 1977). The normal K_{TL} range was (1.3 to 1.5). The largemouth bass relative weight index (Wr) was calculated according to methods described by Wege and Anderson (1978). Bass population assessment was conducted according to methods described by Kruse (1988). Points were assigned for size structure, fish abundance, and recruitment. Largemouth bass mortality rates were calculated for Maryland tidal rivers based on age composition of electrofishing catch.

Scale samples for aging were removed from fish at a point ventral to the lateral line behind the posterior tip of a depressed pectoral fin. Scale radii were measured using a microfiche reader. Back-calculations were performed using the equation (Lagler 1952):

$$L_1 = S_1\ (L_2 - a)/S_2 + a$$

Where: L_1= Fish length at annulus
S_1= Scale length at annulus
L_2= Fish length at capture
S_2= Scale length
a= Correction factor

The back-calculation correction factor (a) was derived from the scale-body equation (Carlander 1977).

Autumn electrofishing data for young of the year (YOY) and age 1 largemouth bass from the Potomac River was used to evaluate affects of the 381-mm minimum length limit for black bass during the spawning season. A repeated-measures analysis of variance (ANOVA) SAS PROC GLM procedure (SAS 1988) was used to determine if the new regulation affected electrofishing CPUE for age 0 and age 1 largemouth bass. Because the ANOVA had missing data and was unbalanced, Type III sums of squares were used to calculate mean squares errors. Gabriel's (1964) multiple-comparison procedure was used to compare mean values of factors measured. Statistical differences were declared significant at $P < 0.05$. The electrofishing CPUE coefficient of variation for Potomac River age 0 largemouth bass was 117.

Submerged aquatic vegetation (SAV) growth patterns were obtained from Potomac River vegetation maps (Potomac SAV 1985, 1990, 1991, 1993, Orth et al. 1993) and a photo coordinate grid was used to measure SAV distribution at sample sites. The number of grid and vegetation intersections were recorded as SAV Frequency in Table 33. The effect of SAV distribution on age 0 bass CPUE was evaluated using a SAS linear regression model.

Tidal water largemouth bass population estimates were conducted for 417 ha segments of the Northeast, Potomac, and Choptank Rivers using the modified Schnable mark and recapture method (Ricker 1975). Fish were collected by electrofishing and marked by removing a portion of the left pelvic fin. Although fish were not confined to the study area, it is assumed that lack of a barrier did not significantly bias the population estimate. These studies were conducted during the fall when daily movement by bass is at a minimum (Mesing and Wicker 1986) and no bass tournaments, which might have resulted in large numbers of fish being transported into or out of the study area, were being conducted. Site descriptions including physical and chemical characteristics were prepared for each population estimate study area.

Electrofishing catch per effort (CPE) was used to predict tidal water largemouth bass population density (D) (Coble 1992). The regression equation $\log^{10}D=0.841549 \log^{10}CPE - 0.88805$ ($r=0.827$) was developed from autumn electrofishing catch/hour (CPE) and corresponding bass population density per hectare from seven modified Schnable mark and recapture population estimates conducted during the period 1988 through 1994 (Table 41). Autumn CPE at the electrofishing sample stations in Table 42 was entered in this equation to calculate largemouth bass population density for individual rivers. Data from samples were not included in calculations when water salinity exceeded the electrofishing unit operating range 6,000 micromhos/cm.

Multiparameter water quality dataloggers (Hydrolab-$DataSonde_R$ 3) were placed in the Pocomoke River. Water quality data was collected during 1993 and 1995.

Fingerling largemouth bass stocking referred to or analyzed in this report was conducted as part of the Maryland Freshwater Fisheries Resource Conservation Sport Fish Restoration Project F-53-D (Table 27).

STUDY AREA

Approximately 87,000 ha of surface waters make up the tidal bass study area. These waters are characterized as having the potential to support productive largemouth bass populations and have salinity levels less than 5 ppt during the spring of the year. Tidal waters studied include the upper Chesapeake Bay, Pocomoke River, Back River, Manokin River, Wicomico River, Nanticoke River, Choptank River, Chester River, Stillpond Creek, Fairlee Creek, Worton Creek, Middle River, Patapsco River, Magothy River, Marley Creek, Severn River, South River, Chicamacomico River, Transquaking River, Blackwater River, Patuxent River, and the Potomac River. Still Pond Creek, Worton Creek, and Fairlee Creek were grouped as one study area due to their location, small size, and similar bass habitat.

RESULTS

Back River

Three bass were caught by electrofishing at two stations during 1994. These fish ranged in length from 255 mm to 260 mm and in weight from 266 g to 270 g. No bass were found in the Back River during four electrofishing samples in 1988 and 1989. No YOY bass were caught during 1994 by haul seining.

Blackwater River

Thirteen YOY largemouth bass were collected in 1991 by haul seining (CPUE 0.4). Micro-tagged bass fingerlings (21,078) had been stocked prior to seining and approximately 50% of the fingerlings collected were tagged (Table 2). While this indicates that bass did reproduce in 1991 the high percentage of tagged bass fingerlings collected indicates that survival was poor of bass spawned in the river.

Three YOY largemouth bass, one of which was micro-tagged, were collected by haul seining (CPUE 0.27) during 1992. The River had been stocked with 9,862 micro-tagged bass fingerlings prior to seining (Table 2). CPUE (0.18) for fingerlings not stocked indicated that although bass reproduced in the River during 1992 they did not survive well. The small bass were found either in Buttons Creek or near MD Route 335 where water salinity levels were low. No YOY bass were collected from the Little Blackwater River.

A water quality sensor was placed in the Big Blackwater River upstream from MD Route 335 for two weeks during April and May and for another three-week period in July and August. Dissolved oxygen concentration (DO), temperature (^{0}F), salinity (0/00), and pH were monitored hourly. Water salinity levels during the bass spawning season ranged from 2.0 to 3.9 $^{0}/_{00}$ and exceeded the upper limits (2.5 - 3.0 $^{0}/_{00}$) for successful bass reproduction (Heidinger 1975) throughout most of the sample period. Also water temperature on 7 May declined from 16^{0} to 10^{0} C, a large enough change to cause male bass to abandon a nest. During the summer sample period, DO declined to potentially fatally levels for bass, concentrations less than 0.1 mg/l. Water salinity ranged from $3.1^{0}/_{00}$ to $6.6^{0}/_{00}$ and exceeded limits for productive bass fisheries (Heidinger 1975). During October 1995 water salinity reached 13 $^{0}/_{00}$ in the Big Blackwater River upstream from MD Route 355, exceeding the level (12 $^{0}/_{00}$) that can be fatal to largemouth bass.

Thirty-seven tidal water largemouth bass were collected from the Blackwater River by electrofishing during 1992. The mean length of these fish was 286 mm and their mean weight was 442 g (Table 3). Seven electrofishing samples were collected at four stations during June through October. Mean electrofishing CPUE was 5.29 and YOY CPUE was 0.71.

Micro-tagged largemouth bass were stocked in the Big Blackwater River during 1990, 1991, and 1992. The Little Blackwater was stocked during 1990 and 1991. A total of 24 bass in age groups 0, 1, and 2 for the years stocked were caught by electrofishing during 1992 and 38% of these fish had micro-tags. Five YOY were found during fall and 40% had micro-tags. No micro-tagged YOY were found that had moved from the Big Blackwater to the Little Blackwater. Forty-four percent of the age 1 fish collected had micro-tags and 30% of the age 2 fish had micro-tags.

The Blackwater River PSD value confidence interval $(P(0.52<0.67<0.81)=0.90)$ in 1992 exceeded the normal range for productive largemouth bass populations. The condition index K_{TL} (1.5) was in the normal range and relative weight 99% was also in the normal range (95% to 100%) indicating that bass have adequate prey. Back-calculated length at each annulus for Blackwater River bass is shown in Table 5. The bass growth rate during 1992 was slower than rates for other Maryland tidal rivers. In comparison to other Maryland tidal rivers where bass reached harvestable size (305 mm) during their 2nd year Blackwater River bass did not attain harvestable size until their 4th year. Blackwater River bass annual mortality (55%) is excessively high.

<u>Chester River</u>

Electrofishing samples during 1993 collected 121 tidal water largemouth bass ranging in length from 125 mm to 511 mm. The mean length of these fish was 362 mm and their mean weight was 851 g (Table 26). Eight electrofishing samples were collected at five stations during March through October (Table 3). Mean electrofishing CPUE was 15.13 and YOY CPUE was 0.25.

The 1993 electrofishing YOY CPUE and haul seine data showed that bass had reproduced in the Chester River, however, only three YOY largemouth bass were caught by haul seining for a mean CPUE of 0.09 (Table 2). Largemouth bass stocking was resumed in 1993 (844 fish) to compensate for poor reproduction of bass in the River.

New stands of milfoil were noted in the Chester River during 1990 but in 1993 only scarce stands were found near Chestertown and in Morgan Creek.

The Chester River PSD value confidence interval (P(0.79<0.85<0.90)=0.90) exceeded the normal range for productive largemouth bass populations and indicated low recruitment. The bass condition index (K_{TL}=1.5) was in the normal range and relative weight (W_R) by inch group for fish during the fall sample period was near or above the normal range (95% to 100%) indicating that bass have adequate prey. Back-calculated length at each annulus for Chester River bass is shown in Table 7. The bass growth rate during 1993 in the Chester River was similar to bass growth rates found in other Maryland tidal rivers.

Chester River largemouth bass population assessment (Kruse 1988) points were size structure 25, abundance 33, recruitment 14, and overall 72. The size structure value indicates bass longer than 305 mm were present in high numbers.

During September DO dropped to 1.92 mg\l in the Chester River upstream from Crumpton and water salinity exceeded 6 ppt upstream to Crumpton.

Chicamacomico River

Thirty-three largemouth bass were collected by electrofishing during 1992. Mean total length of these fish was 333 mm and their mean weight was 675 g (Table 26). Four electrofishing samples were collected at two stations during June through September (Table 1). Mean electrofishing CPUE was 8.25 (Table 3), YOY largemouth bass CPUE was 1.25.

Electrofishing and haul seine samples showed that bass had reproduced in the Chicamacomico River during 1992, 10 YOY largemouth bass were caught by haul seining (CPUE 1.25)

The Chicamacomico River bass PSD value confidence interval (P(0.67<0.79<0.92)=.090) exceeded the normal range for productive largemouth bass populations and indicated limited reproductive success during previous years. The condition index (K_{TL}=1.3) was within the normal range and mean relative weight (99%) indicated that bass have adequate prey. The growth rate for Chicamacomico River tidal water bass compared favorably to rates for bass from other Chesapeake Bay tidal rivers (Table 8).

Choptank River

Thirty-two YOY tidal largemouth bass were collected by 20 seine hauls at 14 Choptank River sites (CPUE 1.6) during 1991. Haul seine data showed successful reproduction by bass in the Choptank River and its major tributary the Tuckahoe River (Table 2). Approximately 27,000 largemouth bass were stocked in Kings Creek where previous surveys showed that bass had not spawned.

Choptank River electrofishing during 1994 collected 117 tidal water largemouth bass ranging in length from 100 mm to 500 mm. The mean length of these fish was 332 mm and their mean weight was 669 g. Electrofishing samples were collected at six stations (Table 3) during May through September (Table 26). Mean electrofishing CPUE was 9.67 and YOY CPUE was 0.33.

The Choptank River PSD value confidence interval ($P(0.73<0.79<0.86)=0.90$) exceeded the normal range for productive largemouth bass populations. The bass condition index ($K_{TL}=1.57$) was near the normal range and relative weight by inch group for the fall sample period exceeded the normal range (95% to 100%) indicating that bass have abundant prey.

The bass growth rate for Choptank River largemouth bass during 1994 was similar to growth rates for other tidal rivers (Table 9).

Choptank River largemouth bass population assessment (Kruse 1988) points were size structure 27, abundance 19, recruitment 15, and overall 61. Recruitment has been good but abundance is low for fish of all sizes.

A bass population estimate was conducted 23 September through 28 September 1994. The same section of the Choptank River was sampled during the 1994 bass population estimate that was sampled in 1990 population estimate and included the 405 ha of tidal waters located downstream from the MD Route 313 bridge and upstream from Ashbury Drive. Water chemical samples were collected at 12 sites (Table 40), data recorded included water temperature, DO, pH, alkalinity, total hardness, nitrogen (nitrate and nitrite as N), ortho phosphate, and turbidity. Alkalinity (49 ppm), pH (7.0), and nitrite (0 mg/l) were all within ranges favorable for the growth and development of largemouth bass. River water tended to be hard averaging 62 mg/l as $CaCo_3$. Ortho phosphate and nitrate levels were within the problem range for Maryland Coastal Plain waters and nitrate levels were higher (13.8 times) than in 1990. Choptank River water turbidity increased downstream from Greensboro, mean secchi depth was 0.9 m.

Emergent aquatic vegetation was abundant in the Choptank River and consisted primarily of water lilies and wild rice. No SAV was located in the sample area although patches of milfoil had been found in the River near Greensboro during 1993.

The Choptank River bass population study area was electrofished four times from 23 September through 28 September and 356 bass were caught. Mean length of bass collected was 351 mm (range 98 mm to 509 mm).

Magothy River

Nine haul seine samples were done in 1992 and CPUE for YOY largemouth bass was 0.33. No samples were collected during the fall when Magothy River water salinity levels exceeded the electrofishing unit operating range. One electrofishing sample was collected during the spring, no bass were found.

Manokin River

Fifty-three largemouth bass were collected during 1992 in two electrofishing samples. The mean length of these fish was 314 mm and their mean weight was 675 g (Table 26). Electrofishing samples were collected at two stations during October. Mean electrofishing CPUE was 25.5 and YOY CPUE was 4.5 indicating that bass had spawned successfully during 1992. During the spring no bass were found in three haul seine samples. Dense new stands of SAV impeded efforts to haul seine.

Micro-tagged bass were stocked in the Manokin during 1989. Eight bass from the 1989 age class were found by electrofishing during 1992 and 38% had micro-tags.

Fish condition indices calculated for Manokin River bass K_{TL} (1.6), W_r (99%), and length-weight relationship were within or near normal ranges. The PSD confidence interval (P(0.77<0.86<0.95)=0.90) exceeded the normal range and indicated limited bass recruitment during previous years. The growth rate for Manokin River bass compares favorably with other Maryland tidal water bass (Table 6).

Marley Creek

Two largemouth bass were collected during 1992 in one electrofishing sample. No YOY bass were found in four haul seine samples. Marley Creek bass grow slower than largemouth bass in other Maryland tidal waters (Table 14). New stands of SAV were observed in the Creek and fingerling largemouth bass stocking was initiated during 1992.

Middle River

Six YOY bass were caught by haul seining in 1994, mean CPUE 0.75. Water salinity was too high during fall months and in the spring of 1995 to electrofish.

Nanticoke River

Sixty-nine YOY largemouth bass were collected (CPUE 3.2) in 25 seine hauls (21 sites) during 1991. Haul seine data showed that successful reproduction by tidal water largemouth bass occurred primarily in Marshyhope Creek of the Nanticoke River (Table 2).

The 133 largemouth bass collected by electrofishing (CPUE 14.78) during 1992 had a mean length of 302 mm and mean weight of 531 g (Table 26). PSD (63%) and fish condition indices calculated, K_{TL} (1.5), W_r (104%), and the length-weight relationship, indicated that bass were within or near normal ranges. Electrofishing CPUE for YOY bass was 2.33. Electrofishing samples were collected at the nine stations shown in Table 1.

The growth rate determined for Nanticoke River largemouth bass during 1992 compared favorably to rates from other Maryland tidal waters (Table 13).

Forty-four haul seine samples during 1992 collected 119 YOY tidal largemouth bass (CPUE 2.7). Haul seine data showed that successful reproduction by Nanticoke largemouth bass occurred primarily in MarshyHope Creek near Federalsburg (Table 2).

<u>Patapsco River</u>

Thirty-seven largemouth bass, ranging in length from 222 mm to 397 mm and in weight from 158 g to 940 g, were collected by electrofishing during 1994. The mean length of these fish was 304 mm and their mean weight was 463 g (Table 26). Electrofishing samples (CPUE 18.5) were collected at two stations during September and October (Table 3). No YOY bass were found in the Patapsco River by electrofishing during 1994. However haul seine data showed that bass had reproduced in the River. Fourteen YOY bass were caught by haul seining for a mean CPUE of 1.4 (Table 2).

The Patapsco River PSD value confidence interval ($P(0.32<0.46<0.6)=0.90$) was near the normal range. The bass condition index (K_{TL}= 1.5) was in the normal range and W_R by inch group for fish during the fall sample period was also near the normal range indicating that bass have adequate prey. Back-calculated length at each annulus for Patapsco River bass is shown in Table 10. In comparison to other rivers where fish reached harvestable size (305 mm) during their 2nd year Patapsco River bass did not attain harvestable size until their 3rd year.

Patapsco River largemouth bass population assessment (Kruse 1988) pointd were size structure 23, abundance 34, recruitment 15, and overall 73. Recruitment has been good but abundance is low for large bass.

Patuxent River

Eighty-three largemouth bass, ranging in length from 116 mm to 509 mm, were collected by electrofishing during 1993. The mean length of these fish was 284 mm and their mean weight was 510 g (Table 26). Eleven electrofishing samples were collected at six stations during May through October for a CPUE of 7.55 (Table 3). YOY electrofishing CPUE was 0.64.

Approximately 8,400 largemouth bass and 1,400 smallmouth bass were stocked during July 1993 as part of Sport Fish Restoration Project F-53-D. Micro tags were attached to all fish before stocking. Nineteen YOY largemouth bass and one smallmouth bass were collected by electrofishing three months after fingerlings had been stocked in the River. Of these 11 largemouth bass had micro tags and the one smallmouth bass also had a micro tag. These findings indicate that stocked fish survived in the River and composed in excess of 50% of the fingerlings.

The Patuxent River PSD value confidence interval $(P(0.53<0.64<0.74)=0.90)$ was near the normal range. The bass condition index ($K_{TL}=1.4$) was in the normal range and relative weight (W_R) by inch group for fish during the fall sample period was also near the normal range (95% to 100%) indicating that bass have adequate prey. Back-calculated length at each annulus for Patuxent River bass is shown in Table 18. The bass growth rate during 1993 compared favorably to growth rates found in other Maryland tidal rivers.

Patuxent River largemouth bass population assessment (Kruse 1988) points were size structure 12, abundance 13, recruitment 11, and overall 36.

Pocomoke River

Pocomoke River electrofishing during 1991 collected 152 tidal water largemouth bass. The mean length of these fish was 273 mm and their mean weight was 398 g (Table 26). Eight electrofishing samples were collected at five stations from April through October (Table 3). Mean electrofishing CPUE was 19 and YOY CPUE was 3.89.

The electrofishing YOY CPUE and the haul seine catch of 136 YOY bass (CPUE 10.6) showed that bass had reproduced in the Pocomoke River.

The Pocomoke River PSD value confidence interval $(P(0.57<0.64<0.71)=0.90)$ was within the normal range. The condition index ($K_{TL}=1.4$) was in the normal range and relative weight 97% was also in the normal range (95% to 100%) indicating that bass have adequate prey. Back-calculated length at each annulus for Pocomoke River bass is shown in Table 15.

Pocomoke River electrofishing during 1993 collected 111 tidal water largemouth bass, ranging in length from 72 mm to 512 mm. The mean length of these fish was 251 mm and their mean weight was 407 g (Table 26). Ten electrofishing samples were collected at five stations from May through October (Table 3). Mean electrofishing CPUE was 11.1 and YOY CPUE was 3.1.

The electrofishing YOY CPUE and haul seine data showed that bass had reproduced in the Pocomoke River. Twenty-four YOY largemouth bass were caught by haul seining for a mean CPUE of 0.89 (Table 2). Two of the YOY had micro tags and were from the 10,542 fish stocked in the Pocomoke during June 1993.

The Pocomoke River largemouth bass PSD value confidence interval ($P(0.59<0.68<0.78)=0.90$) was near the normal range. PSD ($P(0.31<0.33<0.35)=0.90$) was in the normal range (20% to 40%) for 272 sunfish collected during fall electrofishing samples. The bass condition index ($K_{TL}=1.4$) was in the normal range and W_R by inch group for fish during the fall sample period was also near the normal range indicating that bass have adequate prey. The 1992 W_R pattern differed greatly from the fall 1991 pattern when W_R declined from normal for 12 inch bass to below normal for 17 inch bass. Back-calculated length at each annulus for Pocomoke River bass is shown in Table 16. The bass growth rate during 1993 in the Pocomoke River was slower than bass growth rates found in other Maryland tidal rivers. In comparison to other rivers where fish reached harvestable size (305 mm) during their 2nd year Pocomoke River bass did not attain harvestable size until their 4th year.

Pocomoke River largemouth bass population assessment (Kruse 1988) points were structure 25, abundance 14, recruitment 12, and overall 59. These numbers represent a 20 point decrease from 1991 when points were size structure 34, abundance 30, recruitment 15, and overall 79. Fishermen have also reported a decline in fishery quality. Recruitment each year has been good and the small fish have been in good condition. A substantial decline has occurred for the number of large bass (> 381-mm). Preceding this decline during the fall of 1991 large bass were in poor condition.

Acidity (pH) in the segment of the River studied ranged from 5.1 - 8.4 pH and exceeded the limits for successful bass reproduction (Heidinger 1975). During August DO dropped to 1.14 mg/l in Nassawango Creek and 1.42 mg/l at Snow Hill. Table 33 contains daytime DO data collected during 1993 and 1995 by Hydrolab for the Snow Hill, Nassawango Creek area and Table 34 has daytime DO data for the Pocomoke City Area.

Pocomoke River aquatic vegetation was inventoried on 30 June 1993 from Shad Landing upstream to the US 50 Bridge at Snow Hill and to the Nassawango Creek Bridge. Plankton blooms were present and filamentous algae occurred in coves near Snow Hill. Emergent vegetation consisted primarily of spatterdock, water hyacinth, and wild rice. No SAV was located. Emergent vegetation abundance had increased since the 1982 National Wetlands Inventory, from 161 acres to 207 acres. Vegetation stand locations had changed since 1982 and appeared to be smaller but more numerous. No mud flats were found at low tide that lacked vegetation.

Pocomoke River electrofishing during 1994 collected 122 largemouth bass ranging in length from 90 mm to 485 mm and in weight from 10 g to 2,157 g. The mean length of these fish was 299 mm and their mean weight was 470 g (Table 26). Electrofishing samples were collected at five stations during April through October (Table 3). Mean electrofishing CPUE was 12.1 and YOY CPUE was 1.1 in 1994. Approximately 22,400 largemouth bass fingerlings were stocked during 1994 as part of Sport Fish Restoration Project F-53-D.

The Pocomoke River PSD value confidence interval ($P(0.61<0.69<0.76)=0.90$) was near the normal range. The bass condition index ($K_{TL}= 1.5$) was in the normal range and relative weight (W_R) by inch group for fish during the fall sample was also near the normal range indicating that bass have adequate prey. Back-calculated length at each annulus for Pocomoke River bass is shown in Table 17. The bass growth rate during 1994 in the Pocomoke River remained slower than bass growth rates found in other Maryland tidal rivers. In comparison to other rivers where fish reached harvestable size (305 mm) during their 2nd year Pocomoke River bass did not attain harvestable size until their 4th year.

Pocomoke River largemouth bass population assessment (Kruse 1988) points were size structure 26, abundance 21, recruitment 17 and overall 64. These numbers represent increased recruitment over 1991.

<u>Potomac River</u>

The 1,055 largemouth bass collected from the Potomac River by electrofishing (CPUE 34.32) during 1992 had a mean length of 293 mm and mean weight 587 g (Table 26). PSD (64%) and fish condition indices including K_{TL} (1.4), W_r (100%), and the length-weight relationship were within or near normal ranges. Electrofishing CPUE for YOY bass was 6.06. Thirty-one electrofishing samples were collected at the stations shown in Table 1.

Haul seine CPUE (0.29) in 1992 was similar to the 1989 rate (0.27) and electrofishing CPUE for YOY bass was also similar to the 1990 rate (5.0) indicating continued excellent recruitment.

The growth rate for Potomac River largemouth bass compared favorably with other Maryland tidal water bass (Table 11).

Four smallmouth bass (three adults, one YOY) were collected from the Potomac by electrofishing during 1992. The back-calculated growth rate for these fish is shown in Table 25 and appears to be slower than growth for Potomac River largemouth bass.

The 782 largemouth bass collected by electrofishing (CPUE 29.22) during 1993 ranged in length from 60 mm to 532 mm and had a mean length of 291 mm and mean weight 541 g (Table 26). PSD (74%) and fish condition indices calculated including K_{TL} (1.4), and the length-weight relationship were within or near normal ranges. Relative weight (W_R) by inch group for fish during the fall sample period was near or above the normal range (95% to 100%) indicating that bass have adequate prey. Electrofishing CPUE for YOY bass was 8.6. Twenty-seven electrofishing samples were collected at the stations shown in Table 1. CPUE (29.22) was similar to rates in 1988 (30.83), 1989 (29.9), and 1992 (34.32). High water salinity prevented electrofishing the River downstream from Nanjemoy Creek during 1993.

Haul seine CPUE (0.2) during 1993 was similar to the 1992 rate (0.29) and electrofishing CPUE for YOY bass was also similar to the 1990 rate (5.0) indicating continued excellent reproduction.

The growth rate for Potomac River largemouth bass compared favorably with other Maryland tidal water bass (Table 12).

Potomac River largemouth bass population assessment (Kruse 1988) points for 1993 were size structure 32, abundance 40, recruitment 12, and overall 84. These values indicate that the Potomac River has an outstanding largemouth bass fishery. Values in 1992 were size structure 36, abundance 36, recruitment 18, and overall 90. The value for recruitment changed from excellent during 1992 to good in 1993.

Three smallmouth bass were collected from the Potomac by electrofishing during 1993.

Potomac River electrofishing during 1994 collected 489 tidal water largemouth bass ranging in length from 70 mm to 515 mm. Electrofishing samples were collected at ten stations during August and October (Table 3). Mean electrofishing CPUE was 49.7 and (YOY) CPUE was 3.9. Overall CPUE for 1994 is not comparable to CPUE reported for previous years which included both spring and fall electrofishing samples. YOY CPUE values may be comparable since juvenile bass are seldom caught by electrofishing during the spring. Bass reproduction during 1994 may have been adversely affected by weather conditions throughout the spawning season.

The Potomac River PSD value confidence interval ($P(0.69<0.72<0.76)=0.90$) was near the normal range.

Potomac River largemouth bass 1994 population assessment (Kruse 1988) points were size structure 31, abundance 36, recruitment 17 and overall 84. The overall value is similar to the 1993 value and represents an excellent fishery.

Mattawoman Creek

A bass population estimate was conducted 27 September through 30 September 1993 for Mattawoman Creek using a modified Schnable mark and recapture method. The same section of Mattawoman Creek was sampled during the 1993 bass population estimate that was sampled in 1989 and included the 413 ha of tidal waters located downstream from the MD Route 225 bridge and upstream from the Smallwood State Park boat ramp.

The Mattawoman Creek bass population study area was electrofished four times and 2,406 bass were caught. The mean length for bass collected was 285 mm (range 68 mm to 540 mm). The population estimate was 11,823 bass and density was 28.6 bass/ha (Table 37). Water chemical samples collected at six sites included water temperature, pH, alkalinity, total hardness, nitrogen (nitrate and nitrite as N), ortho phosphate, and turbidity (Table 38). Alkalinity (63 ppm), pH (7.8), and nitrite (0 mg/l) were all within ranges favorable for the growth and development of largemouth bass. River water tended to be hard averaging 159 mg/l as $CaCo_3$. At all sample stations ortho phosphate and N levels were within the problem range for Maryland Coastal Plain waters. Water in Mattawoman Creek tended to be turbid, the average seechi depth was 0.64 m.

Emergent aquatic vegetation was abundant in Mattawoman Creek and consisted primarily of water lilies. Submerged aquatic vegetation occurred in small patches which included wild celery, hydrilla, milfoil, and coontail.

Severn River

Salinity levels exceeded the electrofishing unit operating range throughout the Severn River and no samples were collected. Two haul seine samples were conducted but no bass were found.

Stillpond Creek, Churn Creek, Worton Creek, Fairlee Creek

Forty-seven largemouth bass ranging in length from 120 mm to 470 mm and in weight from 36 g to 1,816 g were collected from Worton, Fairlee, Churn and Stillpond Creeks by electrofishing during 1994. The mean length of these fish was 286 mm and their mean weight was 447 g (Table 26). Electrofishing samples were collected at four stations during April through September (Table 3). YOY CPUE was 1.4. No YOY bass were found in Worton or Fairlee Creeks.

Haul seine data showed that bass had reproduced in Stillpond Creek. A total of 68 YOY largemouth bass were caught by haul seining for a mean CPUE of 6.18 (Table 2). No YOY bass were caught by haul seining in Churn Creek, Worton Creek, or Fairlee Creek.

The Worton, Fairlee, Churn and Stillpond Creek PSD value confidence interval ($P(0.35<0.48<0.6)=0.90$) was near the normal range. The bass condition index (K_{TL}= 1.5) was in the normal range and W_R by inch group for fish during the fall sample period was also near the normal range indicating that bass have adequate prey. Back-calculated length at each annulus for bass from the Creeks is shown in Table 19. In comparison to other rivers where fish reached harvestable size (305 mm) during their 2nd year bass in the Creeks did not attain harvestable size until their 3rd year.

Worton, Fairlee, Churn and Stillpond Creek largemouth bass population assessment (Kruse 1988) points were size structure 10, abundance 12, recruitment 15, and overall 37.

Transquaking River

Thirty-one largemouth bass were collected by electrofishing during 1991. Mean total length of these fish was 352 mm and their mean weight was 867 g (Table 26). Four electrofishing samples were collected at the two stations from April to October (Table 1). Mean electrofishing CPUE was 7.75, YOY largemouth bass CPUE was 0.5 (Table 3).

Electrofishing and haul seine samples showed that bass had reproduced in the Transquaking River during 1991, 95 YOY largemouth bass were caught (CPUE 13.6).

The Transquaking River bass PSD value confidence interval ($P(0.75<0.86<0.97)=0.90$) exceeded the normal range for productive largemouth bass populations and indicated limited reproductive success during previous years. The condition index (K_{TL}=1.5) was within the normal range and mean W_r (101%) exceeded the normal range indicating that bass have adequate prey. The growth rate for Transquaking River tidal water bass compared favorably to rates for bass from other Chesapeake Bay tidal rivers (Table 4).

Upper Chesapeake Bay

The 528 largemouth bass collected from the upper Chesapeake Bay by electrofishing (CPUE 10.8) during 1991 had a mean length of 289 mm and mean weight of 527 g (Table 26). PSD (63%) and fish condition indices including K_{TL} (1.4), W_r (99%), and the length-weight relationship were within or near normal ranges. Electrofishing CPUE for YOY bass was 2.28. Electrofishing samples were collected at the 28 stations shown in Table 1. Each station was sampled at least once between 2 April and 11 October.

The growth rate for upper Chesapeake Bay largemouth bass during 1991 was similar to bass growth in other tidal rivers (Table 21).

Haul seining during 1991 collected 193 YOY largemouth bass, and fingerling bass were collected from each of the upper bay tributaries (Table 2).

Northeast River

Fish cover in the Northeast River during 1992 consisted primarily of pilings, deteriorated piers, bulkheads, undercut banks, emergent vegetation in the tidal marshes, and fallen trees which remained partially submerged at low tide. Watermilfoil (Myriophyllum) was the only SAV found. Watermilfoil was located near Charlestown and consisted of patches estimated to cover approximately 8 ha. Once established a productive aquatic vegetation community would provide food, cover, and spawning habitat for bass, and improve water quality by filtering sediments and excessive nutrients from the River.

Water chemical samples were collected at five sites (Table 36). Data recorded included DO, ph, alkalinity, total hardness, conductivity, and salinity. DO (range 9.6 to 10.0 mg/l), ph (6.8 to 9.3), and alkalinity (51.3 ppm) were all within ranges favorable for the growth and development of largemouth bass. River water tended to be hard averaging 120 mg/l as $CaCO_3$.

A bass population estimate was conducted during 13 October through 16 October 1992. The 472 ha study area was electrofished four times. Total electrofishing effort was 34,026 seconds and 507 bass were caught. Mean electrofishing CPUE was 13.4, CPUE for bass not previously collected during this study was 12.1. Bass mean length was 320 mm (range 85 mm to 546 mm). The PSD value (63%) was within the normal range. Fifty-one YOY bass were collected and data from these fish were included in the population estimate. Two smallmouth bass were collected.

The largemouth bass population estimate of 1,744 fish was derived using the modified Schnabel method (Table 35). Population density was 3.69 bass per ha. Largemouth bass were not evenly distributed throughout the study area. Fish tended to concentrate at locations where cover was present and numbers were sparse in open waters where the stream bottom was heavily silted.

Wicomico River

Wicomico River electrofishing during 1991 collected 258 largemouth bass. Mean total length was 357 mm and mean weight was 812 g. Ten electrofishing samples (CPUE 25.8) were made at the six stations shown in Table 1. YOY largemouth bass CPUE was 1.9.

The electrofishing YOY CPUE and haul seine data showed that bass had reproduced in the Wicomico River. Thirty-nine YOY largemouth bass were caught by haul seining (CPUE 2.4). The Wicomico River PSD value (88%) exceeded the normal range, indicating limited reproductive success. Bass condition factors (K_{TL}=1.5, W_r=98%) were within normal ranges indicating that prey was abundant. The growth rate for Wicomico River tidal water bass is shown in Table 20 and compared favorably with rates from other tidal rivers.

Smallmouth Bass

Smallmouth bass were collected from the Susquehanna, Northeast, and Elk Rivers during 1991. YOY smallmouth bass were found only in the Susquehanna River. Data collected throughout the upper bay was combined to calculate the smallmouth bass growth rate shown in Table 23.

Data for 51 smallmouth bass was obtained from the Conowingo Dam Fish Lift during 5 May through 4 June 1994. These fish ranged in length from 235 mm to 520 mm and in weight from 160 g to 1,880 g. PSD (86%) exceeded the normal range, the condition factor (K_{TL}=1.2) and W_r per inch group values were below the normal ranges, likely a consequence of obtaining samples during the bass spawning season. The growth rate calculated for 40 of the smallmouth bass collected from the fish lift is shown in Table 24.

An initial stocking of 5,000 smallmouth bass fingerlings was conducted on 20 June 1991 in the Chester River at Millington as part of Project F-53-D. Three smallmouth were recaptured during two haul seines at the Millington and Chester River road crossings during August. These fish appeared to be healthy and robust. Seven YOY smallmouth bass were caught by seining near Millington during 1993. These fish were from the approximately 6,000 smallmouth YOY stocked during June of that year.

Approximately 85,000 smallmouth bass were stocked in the Chester from 1991 through 1995 (Table 28). One smallmouth (length 305 mm) from the 1991 stocking was caught by an angler during 1993 in Unicorn Branch. Commercial fishermen using fyke nets reported catching smallmouth bass from the River during 1993 and 1994. No smallmouth bass have been collected during Chester River electrofishing surveys. However, anglers frequently caught smallmouth bass from the River near Millington during 1994 and 1995. Scales were taken from 7 of these fish during 1994 for aging. Mean lengths for age 0 fish were 76 mm, age 1 fish 143 mm, age 2 fish 296 mm, and age 3 fish 358 mm.

No YOY smallmouth bass were found in 7 haul seine samples conducted during May 1995 prior to stocking fingerlings in the Chester River near Millington.

DISCUSSION

Maryland has approximately 87,000 ha of tidal waters which have the potential to support largemouth bass populations. During recent years these resources have benefitted from management that targeted adverse impacts from deteriorating aquatic habitat and increased fishery exploitation. From 1991 through 1995, management to restore tidal water sport fisheries included stocking 711,300 largemouth bass fingerlings and 138,900 smallmouth bass fingerlings (Tables 27, 28). Salinity barriers separate Chesapeake Bay largemouth bass fisheries into distinct communities. Population dynamics vary from river to river due to local ecological relationships and different exploitation patterns. Consequently, sustaining high quality bass sport fisheries will entail separate research and management for individual communities.

Resource investment requirements have made the estimation of population density by mark and recapture methods unfeasible for all of Maryland's tidal water bass fisheries. Estimation of population density by catch per effort is less time-consuming and less expensive than mark-recapture methods (Coble 1992). I have found a combination of mark-recapture and catch per effort to be practical and effective for estimating bass population density in Maryland tidal waters. Correlation was significant (r=0.827) for autumn CPE and seven population density estimates (Table 41). Based on CPE the estimated largemouth bass population for Maryland's 87,060 hectares of tidal water fisheries is 520,325. Comparing this figure to population levels calculated using the same procedure for 1990 shows a 43% increase. Bass population density calculated from CPE for individual tidal water fisheries is shown in Table 42. Potomac River largemouth bass population levels increased 49% over the same period and upper Chesapeake Bay increased 24%. The Potomac River population estimate (255,964) is lower than the 1994 creel survey estimate

(P(336,452<372,558<408,663)=0.95) whereas the upper Bay (76,426) and Choptank River (23,833) population estimates for bass >305 mm correspond with the creel survey estimates (1992 upper Bay 78,568, 1993 Choptank River 21,224).

Fedler (1989) found that Maryland anglers spend $38 million each year in pursuit of tidal water largemouth bass. At the present standing bass population level each Maryland tidal water largemouth bass has an approximate sport fishery value of $73.

Blackwater River

During the last half century thousands of hectares of freshwater marsh at Blackwater have changed to vast ponds of brackish water (Pendleton and Stevenson 1983). The Blackwater River largemouth bass fishery has deteriorated as a result of the increased water salinity and other ecological changes that have taken place. Anglers first reported declining largemouth bass numbers in the River during the 1980's. Maryland DNR electrofishing surveys have since found very few largemouth bass in the River. Haul seine samples showed that the small bass population resulted from reproductive failure which was brought on by high water salinity during the spawning season. Poor water quality and low DO during summer months has also slowed bass growth rates.

Rising sea level, more than 2.5 cm per ten years, has been drowning Blackwater River freshwater marshlands and destroying the aquatic vegetation that provided habitat for largemouth bass. The brackish water is toxic to freshwater marsh vegetation and it erodes the marsh peat soils. Marsh loss may be linked to peat degradation involving oxidation and diagenesis of organic materials by the presence of sulfates from tidal exchanges (Stevenson et al. 1985). Where lily pads, cattails and three-square grass have died, rancid decomposition gases now bubble up through open water. Some of the Blackwater's problems may be due to global warming or even plate tectonics. Actions such as canal construction, road construction, and the introduction of exotic animals (nutria) may have also influenced and accelerated marsh loss. These anthropogenic actions may provide the basis for management to preserve existing marsh or to restore freshwater communities over large areas of the River.

Around 1850 a canal was constructed on the Parsons Creek tributary to the Little Choptank River. Many years later a mosquito control ditch was constructed on Piney Gut, a Slaughter Creek tributary. Gradually saltwater flow through the canal and ditch eroded peat soils. Marshlands now provide a direct link for saltwater intrusion from the Little Choptank onto the Blackwater. Saltwater flow across Blackwater headwaters and its encroachment from downstream, due to sea level rise, constrict the River's freshwater communities between two lethal wedges.

Shorters Wharf Road was constructed across Blackwater in a manner that inhibits natural marsh building processes. The roadway directs both downstream river flow and tidal flow through a channel beneath one road bridge thereby limiting sediment deposition across the marsh (Pendleton and Stevenson 1983). More suspended solids are transported away than are deposited on the marsh. Flooding occurs when marsh building does not keep pace with rising sea level. Marsh inundation is magnified as the flooding forms ponds on the marsh, winds sweep across the ponds to erode mats of vegetation from the marsh, and the ponds enlarge into lakes.

Another problem is many nutrias live at Blackwater. These exotic animals graze on three-square vegetation and grub the marsh for plant rhizomes. The grubbing tends to form depressions where brackish water may accumulate to degrade peat solid and physically destroy the marsh (Carowan 1991).

Restoration of freshwater salinity regimes is necessary to preserve and reestablish the River's largemouth bass fishery. The Maryland Department of Natural Resources, The U.S. Fish and Wildlife Service, The U.S. Corps of Engineers, and National Marine Fisheries are evaluating proposals to limit saltwater flow from the Little Choptank onto the Blackwater, manage sediment transport at Shorters Wharf, and encourage the harvest of nutria. Maryland Freshwater Fisheries has implemented largemouth bass fingerling stocking to sustain the Blackwater River sport fishery during the interim. This stocking has had mixed success; survival rates have been low for stocked bass fingerlings, however, stocked fish now comprise approximately 40% of the harvestable size bass in the River.

Since 1989, more than 64,700 fingerling bass have been stocked in the River to take the place of natural reproduction. Stocked fish are effectively serving to sustain the River's sport fishery. It is anticipated that the Blackwater River will require long-term largemouth bass stocking to maintain a put and take bass sport fishery until habitat restoration measures can be initiated.

Back River

Largemouth bass were found in the Back River near Cox Neck and Muddy Gut during 1994. Water quality in the River has been poor, from one meter below the water surface to the stream bottom DO was less than 1 ppm during June 1988, and at that time no largemouth bass were found in the River by either electrofishing or haul seining. Bass inhabitation of the River during 1994 indicates improvement of water quality through watershed conservation programs. Largemouth bass fingerlings were stocked in Back River during 1995 in an attempt to reestablish a sport fishery.

Bear Creek near the Back River was surveyed for potential black bass habitat prior to the 1995 bass spawning season. The Creek has very little freshwater inflow and near its headwaters at Wise Avenue and Inverton Park water salinity exceeded 8 ppt. Water salinity exceeding 3 ppt prevents bass from reproducing in the Creek and water salinity levels fatal to bass (> 12 ppt) are plausible during summer months. As a result of these conditions the Creek lacks potential as a productive bass sport fishery and should not be stocked with fingerling bass.

Chester River

A combination of fishery and watershed management activities have improved the Chester River tidal water black bass fishery. Few bass were found in the Chester River during 1988 and their reproduction in tidal waters was virtually nil. At that time forage fish were abundant, leading to the conclusion that potential existed for the habitat to support a larger bass population. Fingerling stocking had been initiated during 1980 to substitute for reproduction and increase the bass population. New SAV stands were found during 1989 and the new SAV was accompanied by successful tidal water bass reproduction which continued in 1990. SAV stands declined during 1993.

Continued improvement for the Chester River largemouth bass fishery will depend on restoration of degraded aquatic habitat and carrying on fingerling stocking. The Chester River has large areas of mud flats that lack emergent vegetation and due to poor water quality SAV is sparse. Low DO levels found in the River upstream from Crumpton during the summer also impede bass production. Drought on the watershed during 1995 exacerbated poor DO levels and contributed to the encroachment of brackish water onto the freshwater habitat of largemouth bass. This combination resulted in anglers catching few bass during 1995.

Freshwater Fisheries Division has coordinated projects with the Waterway Improvement Division to preserve bass habitat in the River. When it was necessary to remove hazards to navigation from the River, bass habitat was conserved by retaining trees which had fallen into the river outside of the navigational channel.

Chicamacomico River

The Chicamacomico River has a productive largemouth bass sport fishery where reproduction and population density have been stable since 1989.

Choptank River

Fingerling bass stocking has been used to augment sporadic bass reproduction in the Choptank River. No largemouth bass reproduction was found during surveys conducted in the 1980's. Bass reproduction was observed during 1990, was excellent in 1991, and nearly absent in 1994.

Choptank River SAV growth has been variable. Stands of millfoil increased near Greensboro and dense stands of mixed SAV developed in clear water near Hillsboro from 1991 through 1993. All of this vegetation disappeared in 1994 as waters became turbid and congested with filamentous algae.

The Choptank River 1994 bass population estimate including YOY was 2,113 (Table 39). The 1994 population estimate was similar to the overall 1990 population estimate of 2,335 fish. The number of large bass, age 1 and older, increased 35% from 1,412 fish in 1990 to 1,911 fish in 1994. Population density changed from 0.93 bass/ha to 0.85 bass/ha.

The modal length of bass shifted from 330 mm in 1990 to the 356 - 406 mm range in 1994. The 15 YOY bass collected represented poor reproduction in comparison to 1990 when 108 YOY were found. Limited reproduction was apparently influenced by weather throughout the 1994 bass spawning season which was extremely cold and rainy.

Magothy River

Salinity lower than 3 ppt, the upper limit for successful bass reproduction, was restricted to very small sections in the upper reaches of the Magothy River near nontidal waters. These sections lacked aquatic vegetation, had extensive deposits of silt, and held little promise for bass reproduction, however, several young bass were found in the River.

Manokin River

The Manokin River largemouth bass fishery has improved greatly since the 1980's with more fish for anglers to catch and new SAV stands. Bass stocking has contributed to this improvement. Stocking was initiated for the River with micro-tagged fingerlings in 1989. In 1992 38% of the age 3 bass caught from the River had tags indicating that these fish had been stocked. Successful largemouth bass reproduction found in 1992 and new SAV stands provide the ingredients needed for continued improvement of the River's bass fishery.

Freshwater Fisheries Division has coordinated projects with the Waterway Improvement Division to preserve bass habitat in the

Manokin River. When it was necessary to remove hazards to navigation from the River, bass habitat was conserved by retaining trees which had fallen into the river outside of the navigational channel.

Marley Creek

Salinity lower than 3 ppt, the upper limit for successful bass reproduction, was restricted to very small sections in the upper reaches of Marley Creek near nontidal waters and no YOY bass were found. New SAV stands and the electrofishing capture of largemouth bass, during 1992, were evidence that Marley Creek bass habitat has improved since 1988 when dead fish littered the Creek's beaches. Fingerling bass stocking was implemented to exploit the environmental recovery. Soon after fish were stocked anglers started to report catching bass from the Creek. The sport fishery may be sustained on a put and take basis since largemouth bass reproductive potential is limited in the Creek.

Drought on the Marley Creek watershed during 1995 exacerbated DO condition and contributed to the encroachment of brackish water onto the freshwater habitat of largemouth bass. This combination resulted in anglers catching few bass during 1995.

Middle River

Tidal waters of the Middle River provide a good largemouth bass sport fishery where fingerling largemouth bass stocking is used to supplement for a lack of natural reproduction. Largemouth bass are unable to reproduce each year in the Middle River due to high water salinity that occurs some years during the spawning season.

Largemouth bass range varies substantially both annually and seasonally as a result of changing patterns of water salinity. Anglers caught numerous bass at the mouth of the River during 1994 when salinity levels were low throughout much of the year. During 1995, salinity was high and anglers reported catching more bass near the upper reaches of tidal waters.

Nanticoke River

Successful bass spawning in Nanticoke River tidal waters occurs primarily in a 3.2 km section of Marshyhope Creek downstream from the Maryland Route 313 Bridge. The limited quantity of specialized spawning habitats available in the Nanticoke makes its fishery vulnerable to the effects of urbanization, agriculture, and increased fishing pressure. Preservation of the largemouth bass fishery will require management to protect the habitat found in this section of the

River and stabilization of the fishery may include enhancing the section upstream which has potential for bass reproduction.

Marshyhope Creek is narrow (approximately 59 m wide) near Federalsburg and as a result boat wakes tend to not dissipate before reaching the shoreline. Most bass spawn in shallow waters along the shoreline and their nests are highly susceptible to damage from wave action (Bulkley, 1975). A "minimum wake zone" regulation to protect and enhance tidal water largemouth bass spawning habitat was established for a 4.8 km section of Marshy Hope Creek adjacent to the MD Route 313 Bridge during the period from 1 March through 15 June annually. In a minimum wake zone a vessel may not be operated in excess of the slowest possible speed necessary to maintain steerage under prevailing wind and sea conditions. The location includes all tidal waters upstream from a private boat ramp at coordinates $38^{0}39.71$ N Lat. & $75^{0}47.88$ W Lon. to the dividing line between tidal and nontidal waters. The annual period for the regulation corresponds with the largemouth bass spawning season in tidal waters.

Bass reproduction has occurred downstream from Route 313 in spite of boat generated wave action, apparently because numerous trees have fallen into the stream where they provide protection for some nests. In contrast upstream from Route 313 few fallen trees are found and reproduction has been unsuccessful. Restricting boat wakes from both sections of Marshyhope Creek during the spawning season will help to promote successful bass reproduction at nest sites not protected by fallen trees and could benefit reproduction in the event that cover becomes less abundant.

Freshwater Fisheries Division has coordinated projects with the Waterway Improvement Division to preserve bass habitats in the River. When it was necessary to remove hazards to navigation from the River, bass habitat was conserved by retaining trees which had fallen into River outside of the navigational channel.

Patapsco River

The number of largemouth bass has increased in the Patapsco River since the mid-1980's. This increase can be attributed to improved water quality, as a result of watershed conservation, new fishing regulations, and largemouth bass stocking. Water salinity restricts the Patapsco River largemouth bass population to river tributaries and a small area of the river's main-stem primarily upstream from the Hanover Street Bridge. This small area of bass habitat is heavily fished by anglers on the stream banks harvesting bass. Resultant to harvest and slow growth for largemouth few large fish are found in the River. Intermittent low levels of DO have contributed to slow growth for largemouth bass in tidal waters of the Patapsco River. Numbers of large Patapsco River largemouth bass could be increased by additional harvest restrictions (Fig. 1).

Anglers have stocked adult fish from the Potomac River in the Patapsco River. Potomac River bass are infested with bass tapeworms and stocking these fish could spread the disease.

Freshwater inflow to Maryland tidal waters was extremely high during 1994. Largemouth bass took advantage of low water salinity and expanded their range downstream in the Patapsco River during 1994 as was evident by anglers occasionally catching largemouth bass in the Baltimore Inner Harbor.

Patuxent River

Recruitment for Patuxent River black bass is low, few large bass are present, and abundance is low for fish of all sizes. Mean electrofishing CPUE 7.55, during 1993, was similar to 1986 CPUE 6.7 indicating that population density has changed little. The 1993 electrofishing YOY CPUE 0.64 was less than CPUE 3.18 during 1989 ($P = 0.05$). Stocking of largemouth bass and smallmouth bass was resumed for Patuxent River tidal waters during 1993 to augment natural reproduction.

Pocomoke River

Largemouth bass recruitment in the Pocomoke River each year has been good and the small fish have been in good condition. The River has few large bass (length > 381-mm). During the fall of 1991 large bass were in poor condition, although forage was abundant. The bass growth rate during 1993 in the Pocomoke River was slower than bass growth rates found in other Maryland tidal rivers. In comparison to other rivers where fish reached harvestable size (305 mm) during their 2nd year Pocomoke bass did not attain harvestable size until their 4th year. Slow growth rates and poor condition for large bass have been associated with low DO in the River's tidal waters during summer months.

Low DO (<3 ppm) occurs throughout July and August in the Pocomoke River near Snow Hill (Table 33, 34). Apparently influenced by tidal action DO was higher down river near Milburn Landing and Pocomoke City. Low DO coincided with bass fishing tournaments hours, typically 6:00 A.M. to 5:00 P.M. Bass in the boat live wells of anglers participating in bass fishing tournaments would be subjected to stressful and possibly fatal conditions when transported through low DO near Snow Hill. Fish released after fishing tournament weigh-ins at Shad Landing boat ramp or at the Snow Hill boat ramp during July and August are also placed in a stressful or possibly fatal environment. It is reasonable to assume that bass caught during July and August fishing tournaments experience a high rate of mortality and that the Pocomoke River bass population would benefit by precluding tournaments, except for immediate catch-and-release, on the River during this period.

Low abundance for Pocomoke River largemouth bass of catchable size indicates over-harvest. The number of large fish in the River could be increased by implementing a reduced creel limit for largemouth bass (Fig. 2).

Potomac River

The black bass fishery in Potomac River tidal waters continues to expand and the largemouth bass population is dynamic. A total of 1,055 largemouth bass ranging in length from 80 mm to 517 mm was collected from Potomac River tidal waters by electrofishing during 1992. Thirty-one electrofishing samples were conducted and bass catch-per-unit-effort (CPUE) (34.32), an indicator of population density, was similar to rates (30.83) in 1988 and (29.9) in 1989.

Reproduction has been substantial as indicated from PSD (64%) and numbers of stock and quality size fish are balanced. Condition indices calculated for largemouth bass including K_{TL} (1.4), W_R (100%), and the length-weight relationship (Log W = -6.2274+3.55 Log L, r=0.96) were within or near normal ranges. Sub-harvest size bass, 10" - 11" range, were abundant (n=196 fish) and as a result of having sufficient forage were in good condition (W_R 95%). Twelve inch bass were also abundant (n=118 fish) and in good condition W_R 94%.

Potomac River largemouth growth rates compared favorably with rates for other Maryland tidal water bass (Table 11).

Four smallmouth bass were collected from the Potomac by electrofishing during 1992 and one was a YOY.

Pomonkey Creek a tidal tributary to the Potomac River is narrow and boat wakes tend not to dissipate before reaching the shoreline. Most bass spawn in shallow waters near shorelines and their nests are highly susceptible to damage from wave action (Bulkley 1975). A "minimum wake zone" regulation to protect and enhance tidal water largemouth bass spawning habitats was established for a section of Pomonkey Creek during the period from 1 March through 15 June annually.

The annual State Qualifying Tournament is typical of Potomac River fishing tournaments during the bass spawning season. Based on information obtained at this tournament the number of male bass displaced from nests by Potomac River fishing tournaments has been greatly reduced as a result of the new 381-mm minimum length limit for black bass during the spawning season.

Participants in the 1989 Potomac River State Qualifying Tournament (May 19 and 20, pre-regulation) fished a total of 5,746 hours and checked in 1,787 bass. Evidently many of these bass had been nesting males because they had frayed or bloody fins and abraded snouts. Bass checked-in at tournaments during other times of the year do not exhibit these characteristics and I have observed bass guarding nests in hatchery ponds that had similar abrasions. Participants at the May 1990 State Qualifying tournament (post-regulation) fished 6,018 hours and checked in 708 bass. The tournament displaced nearly 60% fewer bass than in 1989.

Heidinger (1975) noted that removal of male bass from nests by angling results in complete mortality of eggs and larvae. Kramer and Smith (1962) found that within a few hours sunfish removed all eggs from unguarded nests and all fry had been removed within 2 days. In the Potomac River nest failure can also occur when the male bass is temporarily displaced from the nest to a fishing tournament check-in station. Commonly Potomac River fishing tournaments restrict fishing within 0.4 km of the check-in station and tournament fishermen transport bass in boat live wells distances as far as 40 km from capture sites to the check-in station. After release at the tournament check-in station a bass swimming at the maximum rate of 5 km/day (Siebold 1991) would require a minimum of 2 hours to return to its nest. Nests are vulnerable to predation during this time and can be prone to failure.

Potomac River fishing pressure has been high (20.5 angler hours/ha spring and summer 1990) and concentrated where habitat conditions favor largemouth bass (Fewlass 1991). The post-regulation reduction in number of bass caught during the spawning season by tournament fishermen indicates that the new regulation will also reduce the number of bass harvested by other anglers. Limiting harvest and preventing the temporary removal of male bass from nests by fishing tournaments can be expected to improve largemouth bass reproduction

The new harvest regulation appears to have exerted an effect ($P = 0.01$) on autumn electrofishing CPUE for age 0 largemouth bass. Post-regulation autumn electrofishing CPUE 13.67 in 1990, 12.60 in 1992, and 19.25 in 1993 was higher then pre-regulation CPUE 3.83 in 1984 and 2.50 in 1989. No relationship was evident between sites (Table 29). The CPUE change for age 0 bass after 1989 provided evidence that the new minimum length limit (381-mm) resulted in increased bass reproduction.

SAV is an important habitat component for largemouth bass in tidal water. SAV has been determined to be critical to the Chesapeake Bay's food chain serving as a food source and a nursery area (Batiuk 1992). The abrupt change in age 0 bass CPUE from 1989 to 1990 coincided with the new regulation. However, regression analysis indicated that age 0 bass CPUE did not respond to SAV growth patterns after 1990 (r^2 = 0.004). Age 0 bass CPUE and SAV tended to increase from 1984 through 1990, thereafter SAV declined as bass CPUE continued to increase (Table 31). SAV and age 0 bass associations have also varied in nontidal waters. Moxley and Langford (1982) noted that largemouth bass production in Florida lakes has been stimulated by the introduction of hydrilla (Hydrilla verticillata), Canfield and Hoyer (1992) found that Florida lakes with little vegetation have the potential for large year classes of age 0 largemouth bass, and Durocher et al. (1984) found there was no significant correlation between percent submerged vegetation coverage and the number of small bass.

The continued increase in age 0 largemouth bass CPUE after SAV began to decline indicated that affects on Potomac River bass reproduction from the new regulation were greater than those from SAV. Protection for nesting adult bass appears to have been more crucial to successful bass reproduction than SAV distribution.

The new harvest regulation appears to have exerted an effect (P = 0.0038) on autumn electrofishing CPUE for age 1 largemouth bass. Post-regulation autumn electrofishing CPUE 26.1 in 1992, 4.9 in 1993, and 18.2 in 1994 was higher then pre-regulation CPUE 5.3 in 1984, 7.4 in 1989, and 4.8 in 1990 (Table 32). No relationship was evident between sites (Table 30). The CPUE change for age 1 bass after 1990 provided evidence that the new minimum length limit (381-mm) resulted in increased bass recruitment.

Mattawoman Creek

The Mattawoman Creek bass population estimate for 1993 was 11,823 and included YOY (Table 37). This represents a 94% increase from 1989 when the population estimate was 6,105 fish. Population density has changed from 14.9 bass/ha to 28.7 bass/ha. Although Mattawoman Creek has a very productive bass fishery, present population levels are well below 1960 levels in the Northeast River which had 99 bass/ha (Elser 1960), indicating that the bass population has the potential for additional expansion.

The modal length for bass shifted from the 15 - 17 inch range in 1989 to the 13 - 14 inch range in 1993. This change appears to have resulted from increased bass reproduction following implementation of the 305 mm minimum length limit for black bass during the spawning season. The 775 YOY bass collected in 1993 represented nearly a fourfold increase over the number collected during 1989.

The distribution of hydrilla and milfoil has expanded in Mattawoman Creek since 1989 with milfoil becoming more abundant. Wild celery has increased upstream from Slavins Wharf and decreased downstream. An increase in water turbidity was noted over 1989 samples. During 1995 new stands of hydrilla were found throughout the Creek.

Severn River

The tidal portions of the Severn River have little potential to support a viable largemouth bass sport fishery. Salinity lower than 3 ppt, the upper limit for successful bass reproduction, is restricted to very small sections in the upper reaches of this river near nontidal waters.

Stillpond Creek, Churn Creek, Worton Creek, and Fairlee Creek

Recruitment has been good in Stillpond Creek, Churn Creek, Worton Creek, and Fairlee Creek but few large bass are present and abundance is low for fish of all sizes. Largemouth bass population density changed little in the Creek's during the period from 1988 (electrofishing CPUE 3.5) to 1994 (electrofishing CPUE 5.9).

Transquaking River

Largemouth bass electrofishing CPUE was 7.75 in the Transquaking River during 1991. Population density was very similar in the nearby Chicamacomico River (8.25). The high PSD (86%) showed that bass reproductive success had been limited in the Transquaking River during recent years. Management to reduce the flow of organic pollutants into Higgins Mill Pond (Md. Dept. of Environment pers. commun. 1990) upstream from Transquaking River tidal waters has benefitted the River's largemouth bass fishery. Prior to corrective management pollutants caused several fish die-offs in the impoundment.

Upper Chesapeake Bay

There were very few fingerling largemouth bass in the upper Bay before corrective management was initiated during 1980. Fewlass (1982) reported that largemouth bass reproduction in tidal waters of the upper Bay was virtually nonexistent, and the few fingerlings present were most likely migrants from nontidal waters. Both haul seine and electrofishing CPUE for YOY bass indicated that bass reproduction has tended to increase in the upper Chesapeake Bay since 1980 ($P = 0.05$) (haul seine: 1980 CPUE 0.01, 1991 CPUE 3.8) (electrofishing: 1980 CPUE 0.1, 1991 CPUE 2.28).

As a result of finding improved largemouth bass reproduction no fingerlings were stocked in the upper Bay during 1991, 1992, and 1993. Largemouth bass habitat improvement in the upper Bay was evident from new stands of SAV (1600 ha), especially on Susquehanna Flats where SAV had been absent during recent years. To take advantage of rapid habitat change stocking was resumed in 1994 (Table 27). Fingerling stocking can be a cost-effective method of speeding up the restoration of bass populations in recovering habitats and of maintaining a bass fishery in degraded habitats.

The growth rate for upper Chesapeake Bay largemouth bass was excellent during 1991 and growth rates were similar for largemouth bass in each of the upper Bay's tidal water tributaries (Table 22). There was no indication of competition among largemouth bass and striped bass in Northeast Creek where large number of both species were found occupying the same habitat. Fish of both species appeared to be well nourished and robust.

Northeast River

The 1992 Northeast River bass population of 1,744 fish was 32% higher than the 1,326 fish found during 1988. This was evidence of an improved fishery but population density 3.69 bass/ha remained well below 1960 levels when density was estimated at 99 bass/ha (Elser 1960). In the Potomac River changes in tidal water bass abundance have coincided with changing SAV abundance. Based on the observation that SAV abundance has changed little in the Northeast while increasing many folds in other upper Bay tributaries it is feasible that Northeast River bass population growth has not kept pace with populations in the other tributaries.

Fifty-one YOY bass were collected during 1992 indicating that recruitment has improved greatly since 1988 when only 18 YOY were found.

Wicomico River

Wicomico tidal waters near Salisbury support one of Maryland's best largemouth bass sport fisheries. Largemouth bass abundance as indicated by electrofishing CPUE (15.8 in 1985, 18.9 in 1987, 25.8 in 1991) has remained high. The largemouth bass population has been maintained by natural reproduction and recruitment from upstream impoundments. Electrofishing CPUE (1.9) for YOY largemouth bass in the Wicomico has been similar to the mean CPUE (2.47) for all Maryland tidal waters since 1990. PSD (88%) indicated that large fish composed a high percentage of the bass population.

Smallmouth Bass

Smallmouth bass habitat in Maryland tidal waters occurs primarily in upper tidal reaches of the Susquehanna, Potomac, Northeast, and Elk Rivers. Smallmouth bass reproduction was found only in the Susquehanna River during this investigation. Fishing tournaments and fish stocking are expanding the range of smallmouth bass in Maryland tidal waters. Live smallmouth bass are transported during Potomac River fishing tournaments from waters near Washington, D.C. downstream to Piscataway Creek and Mattawoman Creek where they are released. Smallmouth bass are also transported during upper Chesapeake Bay fishing tournaments from the Susquehanna River and Northeast River to Dundee Creek on the Gunpowder River. Approximately, 85,000 smallmouth bass were stocked in the Chester River, from 1991 through 1995, to restore smallmouth bass to the River where anglers have reported that smallmouth bass were abundant prior to the 1960's.

Back calculations from scales and fish lengths showed that tidal water smallmouth bass reached harvestable size during their 4th year. The growth rate calculated for 40 smallmouth bass taken from the Conowingo Dam Fish Lift was similar to that of other upper Bay smallmouth bass with fish reaching harvestable size during their 3rd and 4th years and it was also similar to the rate for Susquehanna River smallmouth bass collected below Conowingo pool by Pavol and Davis (1982) (Table 24). Smallmouth bass fingerlings stocked in the Chester River had excellent growth attaining 305 mm during their 2nd year and 358 mm in their 3rd year.

Fingerling stocking has established a productive put and take smallmouth bass fishery in the Chester River where anglers now catch numerous legal size fish.

Table 1. Locations of electrofishing stations for Maryland tidal water black bass.

Station	River	Location	Station	River	Location
1	Gunpowder	Dundee Creek	51	Chicamacomico	Downstream
2	Gunpowder	Bird River	52	Nanticoke	Federalsburg
3	Gunpowder	Bulkheads	53	Nanticoke	Below Rt 313
4	Bush	Winters Run	54	Nanticoke	Rt 14
5	Bush	James Run	55	Nanticoke	Sharptown
6	Bush	Church Creek	56	Nanticoke	Barren Creek
7	Susquehanna	Lapidum	57	Wicomico	Above Rt 50
8	Susquehanna	Spencer Island	58	Wicomico	Salisbury Ramp
9	Susquehanna	Garrett Island	59	Wicomico	Wharf
10	Susquehanna Flats	Battery	60	Wicomico	Oil Piers
11	Northeast	Charlestown	61	Wicomico	Tony Tank
12	Northeast	Arundel Co	62	Wicomico	Wicomico Creek
13	Northeast	Northeast Creek	63	Manokin	Princess Anne
14	Northeast	East Shore	64	Manokin	Kings Creek
15	Elk	Piney Creek	65	Pocomoke	Snow Hill
16	Elk	Little Elk	66	Pocomoke	Nassawango Creek
17	Elk	Big Elk	67	Pocomoke	Shad Landing
18	Elk	Frenchtown	68	Pocomoke	Pocomoke City
19	Elk	Herring Creek	69	Pocomoke	Near MD Vir. Line
20	Bohemia	Hack Point	70	Potomac	Port Tobacco
21	Bohemia	Scotchman Creek	71	Potomac	Nanjemoy Creek
22	Bohemia	Great Bohemia	72	Potomac	Mallows Bay
23	Bohemia	Little Bohemia Creek	73	Potomac	Mattawoman Creek, Navy
24	Sassafras	Turner Creek Mouth	74	Potomac	Mattawoman Creek, Slavins
25	Sassafras	Turner Creek	75	Potomac	Pomonkey Creek
26	Sassafras	Duffy Creek	76	Potomac	Piscataway Creek
27	Sassafras	Mill Creek	77	Potomac	Swan Creek
28	Sassafras	Fox Hole Landing	78	Potomac	Smoots Bay
29	Still Pond Creek	Landing	79	Patuxent	Hunting Creek
30	Still Pond Creek	Mouth	80	Patuxent	Spice Creek
31	Worton Creek	Worton Creek	81	Patuxent	Lyons Creek
32	Fairlee Creek	Fairlee Creek	82	Patuxent	Mattaponi Creek
33	Chester	Lankford Creek	83	Patuxent	Western Br
34	Chester	Morgan Creek	84	Patuxent	Rt 4
35	Chester	Below 301	85	Patapsco	Patapsco River
36	Chester	Above 301	86	Patapsco	Gwynn Falls
37	Chester	Southeast Creek	87	Back	Muddy Gut
38	Choptank	Tuckahoe, Hillsboro	88	Back	Deep Creek
39	Choptank	Tuckahoe, Rt. 328	89	Middle	Dark Head
40	Choptank	Greensboro	90	Middle	Frog Mortar
41	Choptank	Denton	91	Potomac	Oxen Run
42	Choptank	Ganeys	92	Patuxent	Hall Creek
43	Choptank	Hunting Creek	93	Potomac	Mattawoman Creek mouth
44	Blackwater	Hunters Walk	94	Potomac	Broad Creek
45	Blackwater	Rt 335	95	Potomac	Marshall Hall
46	Blackwater	Little Blackwater	96	Potomac	Greenway Flats
47	Blackwater	Key Wallace	97	Potomac	Wilson Bridge
48	Transquaking	Drawbridge Rd	98	Potomac	Chicamuxent Creek
49	Transquaking	Downstream	99	Marley Creek	
50	Chicamacomico	New Bridge Rd	100	Magothy River	

Table 2 Haul seine collection of black bass from Maryland tidal waters 1991, 1992, 1993, and 1994

						Number of YOY bass in each length group							
River	Mo	Day	Yr	Station	Seine	Total	38mm	65mm	89mm	114mm	140mm	165mm	191mm
Blackwater	6	25	91	below 335	1	0							
Blackwater	6	25	91	below 335	2	0							
Blackwater	6	25	91	below 335	3	0							
Blackwater	6	25	91	below 335	4	0							
Blackwater	6	25	91	below 335	5	0							
Blackwater	6	25	91	below 335	6	0							
Blackwater Big	6	17	91	Big Ramp	1	0							
Blackwater Big	6	17	91	Big Ramp	2	1		1 Microtagged					
Blackwater Big	6	17	91	Lft Cove	1	2	1	1 Microtagged					
Blackwater Big	6	17	91	Lft Cove	1	1		1 Microtagged					
Blackwater Big	6	17	91	Lft Cove	1	2	2 Microtagged						
Blackwater Big	6	17	91	Lft Point	1	0							
Blackwater Big	6	17	91	Lft Point	1	2	1	1					
Blackwater Big	6	17	91	Rt Creek	1	0							
Blackwater Big	6	17	91	Rt Creek	2	1	1						
Blackwater Big	6	17	91	Rt Creek	3	1	1						
Blackwater Lit	6	19	91	Ramp	1	0							
Blackwater Lit	6	19	91	Ramp	2	0							
Blackwater Lit	6	19	91	upstream	1	0							
Blackwater Lit	6	19	91	upstream	1	0							
Blackwater Lit	6	19	91	upstream	2	0							
Blackwater Lit	6	19	91	upstream	3	0							
Blackwater Lit	6	19	91	upstream	4	0							
Blackwater Lit	6	19	91	upstream	5	0							
Blackwater Lit	6	19	91	upstream	6	0							
Blackwater Lit	6	19	91	upstream	7	1		1					
Blackwater Lit	6	19	91	upstream	8	0							
Blackwater Lit	6	19	91	upstream	9	0							
Blackwater Lit	6	19	91	upstream	10	0							
Blackwater Lit	6	19	91	upstream	11	2	1	1					
Choptank	6	8	91	Denton Cove	1	16	12	2	2				
Choptank	7	8	91	Greensboro	1	4		2	2				
Choptank	7	8	91	Passapae Ldg	1	2		1	1				
Choptank	7	8	91	Passapae Ldg	2	2		2					
Choptank	7	8	91	Denton Ramp	1	1			1				
Choptank	7	8	91	Denton Ramp	2	0							
Choptank	7	8	91	Martinack	1	1			1				
Choptank	7	8	91	Martinack	2	0							
Choptank	7	8	91	Williston	1	0							
Choptank	7	8	91	Williston	2	0							
Choptank	7	8	91	Ganeys	1	0							
Choptank	7	8	91	Rt 328 Ramp	1	1			1				
Choptank	7	8	91	Reeses Ldg	1	0							
Choptank	7	8	91	Reeses Ldg	2	0							
Choptank	7	8	91	Ldg	1	0							
Choptank	7	8	91	Hillsboro	1	5			5				
Choptank	7	8	91	Stoney Point	1	0							
Choptank	7	12	91	Mullet Br Road	1	0	Had been stocked						
Choptank	7	12	91	Kingston Road	1	0	Had been stocked						
Choptank	7	12	91	Kingston Road	1	0	Had been stocked						
Nanticoke	6	20	91	Below 313 14	1	0							
Nanticoke	6	20	91	Bridge 16	1	0							
Nanticoke	6	20	91	Del Line 13	1	0							
Nanticoke	6	20	91	Idlewilde	1	1	1						
Nanticoke	6	20	91	Marhope 15	1	0							
Nanticoke	6	19	91	Sewage 4	1	0							
Nanticoke	6	20	91	Sharp Ramp 12	1	0							
Nanticoke	6	20	91	Sharp Ramp 12	2	0							
Nanticoke	6	19	91	Town Ramp 3	1	4	2	2					
Nanticoke	6	19	91	Twon Ramp 3	2	1		1					
Nanticoke	6	19	91	VFW Ramp 1	1	15	10	5					
Nanticoke	6	19	91	VFW Ramp 1	2	28	18	10					
Nanticoke	6	19	91	2	1	1		1					
Nanticoke	6	19	91	5	1	1	1						
Nanticoke	6	19	91	6	1	0							

Table 2 Cont. Haul seine collection of black bass from Maryland tidal waters 1991, 1992, 1993, and 1994

						Number of YOY bass in each length group							
River	Mo	Day	Yr	Station	Seine	Total	38mm	65mm	89mm	114mm	140mm	165mm	191mm
Nanticoke	6	19	91	6	2	0							
Nanticoke	6	19	91	7	1	0							
Nanticoke	6	19	91	8	1	1	1						
Nanticoke	6	19	91	9	1	0							
Nanticoke	6	20	91	17	1	0							
Nanticoke	6	20	91	18	1	1	1						
Pocomoke	6	14	91	Bridge	1	60	30	30					
Pocomoke	6	17	91	Milburn Ldg.	1	2	1	1					
Pocomoke	6	17	91	Milburn Ramp	1	2	1	1					
Pocomoke	6	14	91	Nass Midway	1	20	18	2					
Pocomoke	6	14	91	Nassawango	1	4	4						
Pocomoke	6	14	91	Nassawango br	1	5	2	3					
Pocomoke	6	17	91	Poco City	1	0							
Pocomoke	6	17	91	power line	1	0							
Pocomoke	6	14	91	Ramp	1	12	5	7					
Pocomoke	6	17	91	Ramp	1	1	1						
Pocomoke	6	17	91	River	1	0							
Pocomoke	6	14	91	River	1	14	14						
Pocomoke	6	14	91	River	1	1	1						
Pocomoke	6	14	91	River	1	1	1						
Pocomoke	6	14	91	Shad Run Ramp	1	9	4	5					
Pocomoke	6	14	91	Shad Run Wall	1	30	30						
Pocomoke	6	14	91	Snow Hill	1	18	8	10					
Pocomoke	6	14	91	Upstream Shad Ru	1	11	9	2					
Transquaking	6	21	91	Airey Ramp	1	50		50					
Transquaking	6	21	91	Airey Ramp	2	40		40					
Transquaking	6	21	91	Site 2	1	0							
Transquaking	6	21	91	Site 3	1	3	2	1					
Transquaking	6	21	91	Site 4	1	1		1					
Transquaking	6	21	91	Site 4	2	0							
Transquaking	6	21	91	Site 5	1	1	1						
UpBay	6	11	91	Elk Park Ramp	1	0							
UpBay	6	14	91	Furn Bay	1	3		3					
UpBay	6	11	91	Hance Pt	1	0							
UpBay	6	11	91	Logan Ramp	1	1	1						
UpBay	6	11	91	Logan Ramp	2	2	2						
UpBay	6	14	91	Mill Creek	1	0							
UpBay	6	14	91	Mill Creek	2	3	3						
UpBay	6	14	91	Susq Flats	1	0							
UpBay	6	14	91	Susq Flats	2	0							
UpBay	6	14	91	Susq Flats	3	0							
UpBay	6	14	91	Susq Flats	4	0							
UpBay	6	11	91	Tydings	1	1	40						
UpBay	6	11	91	Tydings	2	2	1	1					
UpBay	6	11	91	1	1	0							
UpBay	6	11	91	2	1	17	10	7					
UpBay	6	11	91	2	2	27	7	20					
UpBay	6	11	91	3	1	3		3					
UpBay	6	11	91	4	1	6	1	5					
UpBay	6	11	91	4	2	7	2	5					
UpBay	6	11	91	5	1	35	35						
UpBay	6	11	91	6	1	0							
UpBay	6	11	91	7	1	3	2	1					
UpBay	6	11	91	8	1	1		1					
UpBay	6	11	91	8	2	4		4					
UpBay	6	11	91	9	1	1		1					
UpBay	6	11	91	10	1	3	2			1			
UpBay	6	11	91	11	1	0							
UpBay	6	11	91	12	1	0							
UpBay	6	11	91	12	2	2		2					
UpBay	6	11	91	13	1	0							
UpBay	6	11	91	13	1	1	1						
UpBay	6	11	91	14	1	2	2						
UpBay	6	11	91	15	1	0							
UpBay	6	11	91	15	2	0							
UpBay	6	11	91	16	1	0							

Table 2 Cont. Haul seine collection of black bass from Maryland tidal waters 1991, 1992, 1993, and 1994

						Number of YOY bass in each length group							
River	Mo	Day	Yr	Station	Seine	Total	38mm	65mm	89mm	114mm	140mm	165mm	191mm
UpBay	6	11	91	16	2	1		1					
UpBay	6	11	91	17	1	1	1						
UpBay	6	11	91	17	2	0							
UpBay	6	11	91	17	3	0							
UpBay	6	11	91	18	1	1		1					
UpBay	6	10	91	19	1	6	3	3					
UpBay	6	10	91	20	1	0							
UpBay	6	10	91	21	1	0							
UpBay	6	10	91	21	2	0							
UpBay	6	11	91	22	1	0							
UpBay	6	10	91	23	1	4	3	1					
UpBay	6	10	91	23	2	1		1					
UpBay	6	10	91	24	1	34	25	9					
UpBay	6	11	91	25	1	20	15	5					
UpBay	6	11	91	26	1	0							
UpBay	6	11	91	27	1	0							
Wicomico	6	20	91	Allens	1	3	2	1					
Wicomico	6	20	91	Bouy 47	1	0							
Wicomico	6	20	91	Bouy 47	2	0							
Wicomico	6	20	91	Bouy 57	1	0							
Wicomico	6	20	91	Bouy 57	2	0							
Wicomico	6	20	91	Salisbury	1	3	3						
Wicomico	6	20	91	Ship	1	1	1						
Wicomico	6	20	91	Ship	2	0							
Wicomico	6	20	91	Ship Build	1	1		1					
Wicomico	6	20	91	Ship Build	1	0							
Wicomico	6	20	91	Tany Cr	1	1	1						
Wicomico	6	20	91	Tany Cr mth	1	1			1				
Wicomico	6	20	91	Tany Cr mth	2	0							
Wicomico	6	20	91	Wico Ramp	1	12	6	6					
Wicomico	6	20	91	Wico Ramp	2	8	3	5					
Wicomico	6	20	91	Wico Ramp	3	9	4	5					
Blackwater big	7	2	92	ramp	1	1	1		micro tagged				
Blackwater big	7	2	92	upstream	1	1		1					
Blackwater big	7	2	92	upstream	2	0							
Blackwater big	7	2	92	upstream	3	0							
Blackwater big	7	2	92	upstream	4	0							
Blackwater big	7	2	92	button cr	1	1		1					
Blackwater big	7	2	92	button cr	2	0							
Blackwater big	7	2	92	upstream	1	0							
Blackwater big	7	2	92	upstream	2	0							
Blackwater big	7	2	92	upstream	3	0							
Blackwater big	7	2	92	near walk	1	0							
Blackwater big	7	2	92	335	1	0							
Blackwater lil	7	7	92	ramp	1	0							
Blackwater lil	7	7	92	ramp	2	0							
Blackwater lil	7	7	92	upstream	1	0							
Blackwater lil	7	7	92	upstream	2	0							
Blackwater lil	7	7	92	left house	1	0							
Blackwater lil	7	7	92	1st cr	1	0							
Blackwater lil	7	7	92	1st cr	2	0							
Blackwater lil	7	7	92	2nd cr	1	0							
Blackwater lil	7	7	92	2nd cr	2	0							
Chicamacomico	6	30	92	ramp	1	6	5	1					
Chicamacomico	6	30	92	ramp	2	2	2						
Chicamacomico	6	30	92	downstream	1	1	1						
Chicamacomico	6	30	92	downstream	2	0							
Chicamacomico	6	30	92	downstream	3	1	1						
Chicamacomico	6	30	92	downstream	4	0							
Chicamacomico	6	30	92	bridge	1	0							
Chicamacomico	6	30	92	bridge	2	0							
Nanticoke	6	25	92	vfw	1	30	30						
Nanticoke	6	25	92	vfw	2	1	1						
Nanticoke	6	25	92	lagoon	1	10		10					
Nanticoke	6	25	92	lagoon	2	75	40	30					
Nanticoke	6	25	92	downstream	1	0							

Table 2 Cont. Haul seine collection of black bass from Maryland tidal waters 1991, 1992, 1993, and 1994

River	Mo	Day	Yr	Station	Seine	Number of YOY bass in each length group Total	38mm	65mm	89mm	114mm	140mm	165mm	191mm
Nanticoke	6	25	92	downstream	2	0							
Nanticoke	6	25	92	downstream	3	0							
Nanticoke	6	25	92	downstream	4	0							
Nanticoke	6	25	92	downstream	5	0							
Nanticoke	6	25	92	downstream	6	0							
Nanticoke	6	25	92	downstream	7	1	1						
Nanticoke	6	25	92	downstream	8	0							
Nanticoke	6	25	92	downstream	9	0							
Nanticoke	6	25	92	downstream	10	0							
Nanticoke	6	25	92	bridge	1	0							
Nanticoke	6	25	92	bridge	2	0							
Nanticoke	6	25	92	downstream	1	1	1						
Nanticoke	6	25	92	downstream	2	1	1						
Nanticoke	6	25	92	downstream	3	0							
Nanticoke	6	25	92	bridge	1	0							
Nanticoke	6	25	92	bridge	2	0							
Nanticoke	6	25	92	downstream	1	0							
Nanticoke	6	25	92	downstream	2	0							
Nanticoke	6	25	92	downstream	3	0							
Nanticoke	6	25	92	ramp	1	0							
Nanticoke	6	25	92	ramp	2	0							
Nanticoke	6	25	92	ramp	3	0							
Nanticoke	6	25	92	above 313	1	0							
Nanticoke	6	25	92	above 313	2	0							
Nanticoke	6	25	92	above 313	3	0							
Nanticoke	6	25	92	RR bridge	1	0							
Nanticoke	6	25	92	RR bridge	2	0							
Nanticoke	6	25	92	cement bridge	1	0							
Nanticoke	6	25	92	cement bridge	2	0							
Nanticoke	6	25	92	upstream	1	0							
Nanticoke	6	25	92	upstream	2	0							
Nanticoke	6	25	92	upstream	3	0							
Nanticoke	6	25	92	upstream	4	0							
Nanticoke	6	25	92	vienna Ramp	1	0		Salinity 2.5					
Nanticoke	6	25	92	vienna ramp	2	0							
Nanticoke	6	25	92	Rewastico ramp	1	0							
Nanticoke	6	25	92	Rewastico ramp	2	0							
Nanticoke	6	25	92	Rewastico	1	0							
Nanticoke	6	25	92	Rewastico	2	0							
Blackwater	7	15	92	Below 355	1	0							
Blackwater	7	15	92	Below 355	2	0							
Blackwater	7	15	92	Below 355	3	0							
Blackwater	7	15	92	Below 355	4	0							
Blackwater	7	15	92	Below 355	5	0							
Blackwater	7	15	92	Below 355	6	0							
Blackwater	7	15	92	Below 355	7	0							
Blackwater	7	15	92	Below 355	8	0							
Manokin	7	9	92	Taylor Br	1	0							
Manokin	7	9	92	Kings Cr	1	0							
Manokin	7	9	92	Pr Anne	1	0							
Marley Creek	8	9	92		1	0							
Marley Creek	8	9	92		2	0							
Marley Creek	8	9	92		3	0							
Marley Creek	8	9	92		4	0							
Magothy River	8	12	92		1	3			3				
Magothy River	8	12	92		2	0							
Magothy River	8	12	92		3	0							
Magothy River	8	12	92		4	0							
Magothy River	8	12	92		5	0							
Magothy River	8	12	92		6	0							
Magothy River	8	12	92		7	0							
Magothy River	8	12	92		8	0							
Magothy River	8	12	92		9	0							
Severn River	8	9	92		1	0							
Severn River	8	9	92		2	0							
Potomac	8	4	92	Mallows Bay	1	2			2				

Table 2 Cont. Haul seine collection of black bass from Maryland tidal waters 1991, 1992, 1993, and 1994

							Number of YOY bass in each length group						
River	Mo	Day	Yr	Station	Seine	Total	38mm	65mm	89mm	114mm	140mm	165mm	191mm
Potomac	8	4	92	Mattawoman	1	6			6				
Potomac	8	4	92	Mattawoman	2	2			1	1			
Potomac	8	4	92	Mattawoman	3	0							
Potomac	8	4	92	Mattawoman	4	0							
Potomac	8	4	92	Mattawoman	5	1		1					
Potomac	8	4	92	Mattawoman	6	0							
Potomac	7	15	92	Pomonkey	1	0							
Potomac	7	15	92	Pomonkey	2	0							
Potomac	7	15	92	Pomonkey	3	1	1						
Potomac	7	15	92	Pomonkey	4	1	1						
Potomac	7	14	92	Piscataway	1	0							
Potomac	7	14	92	Piscataway	2	0							
Potomac	7	14	92	Piscataway	3	0							
Potomac	7	14	92	Piscataway	4	0							
Potomac	7	14	92	Piscataway	5	0							
Potomac	7	14	92	Piscataway	6	0							
Potomac	7	14	92	Piscataway	7	0							
Potomac	7	14	92	Piscataway	8	0							
Potomac	7	14	92	Piscataway	9	0							
Potomac	7	14	92	Piscataway	10	0							
Potomac	7	28	92	Swan Creek	1	0							
Potomac	7	28	92	Swan Creek	2	0							
Potomac	7	28	92	Swan Creek	3	0							
Potomac	7	28	92	Swan Creek	4	0							
Potomac	7	28	92	Swan Creek	5	0							
Potomac	7	28	92	Swan Creek	6	0							
Potomac	7	28	92	Smoots Bay	1	0							
Potomac	7	28	92	Smoots Bay	2	0							
Potomac	7	28	92	Smoots Bay	3	0							
Potomac	7	28	92	Smoots Bay	4	0							
Potomac	7	28	92	Smoots Bay	5	0							
Potomac	7	28	92	Smoots Bay	6	0							
Potomac	7	28	92	Oxon Creek	1	1			1				
Potomac	7	28	92	Oxon Creek	2	0							
Potomac	7	28	92	Oxon Creek	3	0							
Potomac	7	28	92	Broad Creek	1	0							
Potomac	7	28	92	Broad Creek	2	0							
Potomac	7	28	92	Broad Creek	3	0							
Potomac	7	14	92	Marshall Hall	1	0							
Potomac	7	14	92	Marshall Hall	2	0							
Potomac	7	14	92	Marshall Hall	3	0							
Potomac	7	14	92	Marshall Hall	4	0							
Potomac	7	14	92	Marshall Hall	5	0							
Potomac	7	14	92	Greenway Flats	1	0							
Potomac	7	14	92	Greenway Flats	2	0							
Potomac	8	4	92	Chicamuxent	1	0							
Potomac	8	4	92	Chicamuxent	2	0							
Chester	6	29	93	Crumpton ramp	1	0							
Chester	6	29	93	Crumpton ramp	2	0							
Chester	6	29	93	Downstream bridge	1	0							
Chester	6	29	93	Downstream	1	0							
Chester	6	29	93	Sears Pd outlet	1	1		1					
Chester	6	29	93	Downstream Cove	1	0							
Chester	6	29	93	Buckingham	1	0							
Chester	6	29	93	Morgan 290 Br	1	0							
Chester	6	29	93	Morgan Rock Pile	1	0							
Chester	6	29	93	Morgan Pipe	1	0							
Chester	6	29	93	Morgan Pipe	2	0							
Chester	6	29	93	Rileys neck	1	0							
Chester	6	29	93	Rileys neck	2	0							
Chester	6	29	93	Morgan Pipe	1	0							
Chester	6	29	93	213 Bridge	1	0							
Chester	6	29	93	East 213 Br	1	0		milfoil					
Chester	6	29	93	East 213 Br	2	1	1						
Chester	6	29	93	Lyons Cr	1	0							
Chester	6	29	93	Crumpton	1	0							

Table 2 Cont. Haul seine collection of black bass from Maryland tidal waters 1991, 1992, 1993, and 1994

River	Mo	Day	Yr	Station	Seine	Number of YOY bass in each length group Total	38mm	65mm	89mm	114mm	140mm	165mm	191mm
Chester	6	29	93	Lyons Cr	1	1	1						
Chester	6	29	93	Shad landing	1	0							
Chester	6	29	93	Unicorn Branch	1	0		milfoil					
Chester	6	29	93	301 Bridge	1	0							
Chester	6	29	93	Dirt Ramp SMB	1	1		1					
Chester	6	29	93	Dirt Ramp SMB	2	1		1					
Chester	6	29	93	Dirt Ramp	3	0							
Chester	6	29	93	Joes Pond	1	0							
Chester	6	29	93	Joes Pond SMB	2	1		1					
Chester	6	29	93	313 Bridge SMB	1	2		2					
Chester	6	29	93	313 Bridge SMB	2	2		2					
Chester	6	29	93	Above RR	1	0							
Chester	6	29	93	1/4 mile up RR	1	0							
Chester	6	29	93	1/4 mile up RR	2	0							
Chester	6	29	93	RR	1	0							
Pocomoke	6	6	93	Snow Hill Ramp	1	0							
Pocomoke	6	6	93	Snow Hill Ramp	2	0							
Pocomoke	6	6	93	West Shore	1	0							
Pocomoke	6	6	93	West Shore	2	0							
Pocomoke	6	6	93	West Shore	3	0							
Pocomoke	6	6	93	Nassawgo Br	1	0							
Pocomoke	6	6	93	Nassawgo Br	2	0							
Pocomoke	6	6	93	River Ramp	1	0							
Pocomoke	6	6	93	Ramp	1	0							
Pocomoke	6	6	93	Shad Landing	1	1	1						
Pocomoke	6	6	93	Shad Landing	2	0							
Pocomoke	6	6	93	Pocomoke City Ra	1	0							
Pocomoke	6	30	93	Snow Hill Ramp	1	2	2						
Pocomoke	6	30	93	Snow Hill Ramp	2	3	3						
Pocomoke	6	30	93	2nd Ramp	1	7	7		2 microtagged				
Pocomoke	6	30	93	Nassawango Rd	1	2	2						
Pocomoke	6	30	93	Shad Ramp	1	3	3						
Pocomoke	6	30	93	Pocomoke Cove	1	1	1						
Pocomoke	6	30	93	Pocomoke Ramp	1	2	2						
Pocomoke	7	7	93	Poco 2nd Ramp	1	0							
Pocomoke	7	7	93	Poco 2nd Ramp	1	1		1					
Pocomoke	7	7	93	Sand Pit	1	0							
Pocomoke	7	7	93	Sand Pit	2	0							
Pocomoke	7	7	93	Sand Pit	3	0							
Pocomoke	7	7	93	Sand Pit	4	1		1					
Pocomoke	7	7	93	Sand Pit	5	0							
Pocomoke	7	7	93	Sand Pit	6	1		1					
Pocomoke	7	7	93	Sand Pit	7	0							
Stillpond	6	30	94	Ramp	1	0							
Stillpond	6	30	94	Ramp	2	0							
Stillpond	6	30	94	Spillway	1	39	14	25					
Stillpond	6	30	94	Spillway	2	18	6	12					
Stillpond	6	30	94	West Shore	1	7		3	3	1			
Stillpond	6	30	94	Point	1	4	1	1	1	1			
Stillpond	6	30	94	First Cove	1	0							
Stillpond	6	30	94	Shoreline	1	0							
Stillpond	6	30	94	Shoreline	1	0							
Stillpond	6	30	94		1	0							
Stillpond	6	30	94		2	0							
Stillpond	6	30	94		3	0							
Stillpond	6	30	94		4	0							
Stillpond	6	30	94		5	0							
Stillpond	6	30	94		6	0							
Worton Creek	6	30	94		1	0							
Worton Creek	6	30	94		2	0							
Worton Creek	6	30	94		3	0							
Worton Creek	6	30	94		4	0							
Worton Creek	6	30	94		5	0							
Worton Creek	6	30	94		6	0							
Worton Creek	6	30	94		7	0							
Fairlee Creek	6	29	94		1	0							

Table 2 Cont. Haul seine collection of black bass from Maryland tidal waters 1991, 1992, 1993, and 1994

River	Mo	Day	Yr	Station	Seine	Number of YOY bass in each length group Total	38mm	65mm	89mm	114mm	140mm	165mm	191mm
Fairlee Creek	6	29	94		2	0							
Fairlee Creek	6	29	94		3	0							
Fairlee Creek	6	29	94		4	0							
Fairlee Creek	6	29	94		5	0							
Fairlee Creek	6	29	94		6	0							
Fairlee Creek	6	29	94		7	0							
Fairlee Creek	6	29	94		8	0							
Patapsco	8	1	94	1st cove	1	0							
Patapsco	8	1	94	1st cove	2	0							
Patapsco	8	1	94	1st cove	3	1		1					
Patapsco	8	1	94	1st cove	4	2		2					
Patapsco	8	1	94	1st cove	5	8		8					
Patapsco	8	1	94	upriver	1	0							
Patapsco	8	1	94	2nd cove	1	0							
Patapsco	8	1	94	2nd cove	2	1		1					
Patapsco	8	1	94	upriver	1	0							
Patapsco	8	1	94	upriver	2	2		2					
Back River	8	1	94	Cox Neck	1	0							
Back River	8	1	94	Ramp	2	0							
Back River	8	1	94	Upstream	1	0							
Back River	8	1	94	Above Rt 150	1	0							
Back River	8	1	94	Above Rt 150	2	0							
Back River	8	1	94	Downstream	1	0							
Back River	8	1	94	Deep Creek	1	0							
Back River	8	1	94	Deep Creek	2	0							
Back River	8	1	94	Deep Creek	3	0							
Back River	8	1	94	Deep Creek	4	0							
Back River	8	1	94	Deep Creek	5	0							
Back River	8	1	94	Deep Creek	6	0							
Back River	8	1	94	Muddy Gut	1	0							
Back River	8	1	94	Muddy Gut	2	0							
Back River	8	2	94	Stoney Point	1	0							
Middle River	8	2	94	Deep Creek	1	2		2					
Middle River	8	2	94	Deep Creek	2	0							
Middle River	8	2	94	Deep Creek	3	1		1					
Middle River	8	2	94	Deep Creek	4	2		2					
Middle River	8	2	94	Frog Mortar	1	0							
Middle River	8	2	94	Frog Mortar	2	0							
Middle River	8	2	94	Frog Mortar	3	0							
Middle River	8	2	94	Frog Mortar	4	1		1					
Churn Creek	8	3	94		1	0							
Churn Creek	8	3	94		2	0							
Churn Creek	8	3	94		3	0							
Churn Creek	8	3	94		4	0							
Churn Creek	8	3	94		5	0							
Churn Creek	8	3	94		6	0							
Churn Creek	8	3	94		7	0							

Table 3. Chesapeake Bay largemouth bass electrofishing collection data 1991, 1992, 1993, and 1994.

Location	Station	Date	No. of Bass	Mean CPUE
Back River	87	101194	1	CPUE 1.5
Back River	88	101194	2	YOY CPUE 0
Blackwater River	45	61292	1	
Blackwater River	44	61692	1	CPUE 5.29
Blackwater River	47	62392	1	Var. 44.571
Blackwater River	44	100592	14	
Blackwater River	45	100592	16	YOY CPUE 0.71
Blackwater River	47	102292	2	Var. 2.238
Blackwater River	46	102692	2	

Table 3. Cont. Chesapeake Bay largemouth bass electrofishing collection data 1991, 1992, 1993, and 1994.

Location	Station	Date	No. of Bass	Mean CPUE
Chester River	36	42893	7	CPUE
Chester River	37	43093	4	P(5.35<15.13<24.90)=0.95
Chester River	35	52693	16	
Chester River	34	52493	11	YOY CPUE
Chester River	33	60393	3	P(0<0.25<0.63)=0.95
Chester River	35	100793	36	
Chester River	36	100793	24	
Chester River	34	101393	20	
Chicamacomico River	50	72292	10	CPUE 8.25
Chicamacomico River	51	72292	3	Var. 14.917
Chicamacomico River	51	91892	12	YOY CPUE 1.25
Chicamacomico River	50	92192	8	Var. 1.583
Choptank River	38	50694	4	CPUE
Choptank River	39	51094	1	P(4.87<9.67<14.46)=0.95
Choptank River	40	50694	4	
Choptank River	41	50994	19	YOY CPUE
Choptank River	42	50994	4	P(0<.33<0.9)=0.95
Choptank River	43	51094	3	
Choptank River	38	91594	13	
Choptank River	39	91594	14	
Choptank River	40	92394	11	
Choptank River	41	92394	23	
Choptank River	42	92994	3	
Choptank River	43	90294	17	
Marley Creek	99	51392	2	CPUE= 2.0 YOY CPUE=0
Magothy River	100	51192		
Manokin River	63	102792	14	CPUE 26.5
Manokin River	64	102792	39	Var. 312.5
				YOY CPUE 4.5
				Var. 12.5
Nanticoke River	55	61492	10	
Nanticoke River	53	70192	12	CPUE 14.78
Nanticoke River	54	71492	13	Var. 49.194
Nanticoke River	52	71492	4	
Nanticoke River	53	92292	20	YOY CPUE 2.33
Nanticoke River	52	100192	8	Var. 5.5
Nanticoke River	55	93092	24	
Nanticoke River	54	92992	19	
Nanticoke River	56	100592	23	
Patapsco River	85	92094	37	CPUE 18.5
Patapsco River	86	100494	0	YOY CPUE 0
Patuxent River	79	102793	2	
Patuxent River	81	62593	0	
Patuxent River	81	100493	12	CPUE
Patuxent River	82	61093	8	P(1.4<7.6<13.7)=0.95
Patuxent River	82	100493	4	
Patuxent River	83	62493	0	YOY CPUE
Patuxent River	83	100593	28	P(0<1.73<4.46)=0.95
Patuxent River	84	62493	2	Micro & SMB & LMB
Patuxent River	84	100493	20	
Patuxent River	92	62993	3	YOY CPUE
Patuxent River	92	100693	4	P(0<0.64<2.19)=0.95
				Reproduction

Table 3. Cont. Chesapeake Bay largemouth bass electrofishing collection data 1991, 1992, 1993, and 1994.

Location	Station	Date	No. of Bass	Mean CPUE
Pocomoke River	65	52191	10	CPUE 19
Pocomoke River	65	92391	18	Var. 411.428
Pocomoke River	66	41191	9	YOY CPUE 3.89
Pocomoke River	66	100791	65	Var. 53.86
Pocomoke River	67	42091	30	
Pocomoke River	68	51491	8	
Pocomoke River	68	100891	5	
Pocomoke River	69	42391	7	
Pocomoke River	65	42194	8	CPUE
Pocomoke River	67	42194	2	P(5.76<12.1<18.44)=0.95
Pocomoke River	66	50294	7	
Pocomoke River	68	50394	12	YOY CPUE
Pocomoke River	69	50394	14	P(0.30<1.1<1.9)=0.95
Pocomoke River	68	93094	3	
Pocomoke River	69	93094	6	
Pocomoke River	65	101194	29	
Pocomoke River	66	100694	21	
Pocomoke River	67	100694	19	

Pocomoke River	65	60393	5	
Pocomoke River	66	60393	6	CPUE
Pocomoke River	67	60393	4	P(5.62<11.10<16.58)=0.95
Pocomoke River	68	60993	4	
Pocomoke River	69	60993	7	YOY CPUE
Pocomoke River	65	101493	19	P(0<3.10<6.65)=0.95
Pocomoke River	69	101593	6	
Pocomoke River	63	101893	19	
Pocomoke River	67	101893	21	
Pocomoke River	66	101893	20	

Fairlee Creek	32	50594	3	
Fairlee Creek	32	91494	5	CPUE
Stillpond Creek	29	42794	14	P(2.59<5.88<9.16)=0.95
Churn Creek	30	42994	2	
Churn Creek	30	81294	7	YOY CPUE
Stillpond Creek	29	90694	7	P(0<1.38<3.54)=0.95
Worton Creek	31	50594	6	
Worton Creek	31	91494	3	

Potomac River	98	61892	34	
Potomac River	98	110892	43	
Potomac River	97	61692	12	
Potomac River	97	101392	18	
Potomac River	96	70292	31	CPUE 34.32
Potomac River	96	102092	21	Var. 1081.294
Potomac River	95	70292	15	
Potomac River	95	101692	56	
Potomac River	94	61692	1	
Potomac River	94	101392	7	YOY CPUE 6.06
Potomac River	93	70292	7	Var. 183.796
Potomac River	93	102092	31	
Potomac River	91	100792	33	
Potomac River	78	61692	43	
Potomac River	78	101392	33	
Potomac River	77	63092	16	
Potomac River	77	101492	32	
Potomac River	76	63092	9	
Potomac River	76	92992	28	
Potomac River	75	62992	12	
Potomac River	75	102092	67	
Potomac River	74	61792	31	
Potomac River	74	110692	95	
Potomac River	73	61792	23	
Potomac River	73	110692	145	
Potomac River	72	62992	25	
Potomac River	72	102192	39	

Table 3. Cont. Chesapeake Bay largemouth bass electrofishing collection data 1991, 1992, 1993, and 1994.

Location	Station	Date	No. of Bass	Mean CPUE
Potomac River	71	70192	31	
Potomac River	71	93092	119	
Potomac River	70	71992	7	
Potomac River	70	102392	0	
Potomac River	71	72993	7	
Potomac River	71	102893	34	
Potomac River	72	72293	0	
Potomac River	73	61593	16	CPUE
Potomac River	73	102193	38	P(19.96<29.22<38.49)=0.95
Potomac River	74	71493	40	
Potomac River	74	102193	48	
Potomac River	75	70793	7	YOY CPUE 8.6
Potomac River	75	102693	62	P(3.29<8.63<13.97)=0.95
Potomac River	76	60793	22	
Potomac River	76	102093	53	
Potomac River	77	63093	13	
Potomac River	77	102093	34	
Potomac River	78	61493	81	
Potomac River	78	101993	45	
Potomac River	91	60993	6	
Potomac River	91	101893	40	
Potomac River	94	61493	13	
Potomac River	94	101893	20	
Potomac River	95	70793	9	
Potomac River	95	92693	65	
Potomac River	96	70793	4	
Potomac River	96	102693	59	
Potomac River	97	60993	2	
Potomac River	97	101993	10	
Potomac River	98	72293	30	
Potomac River	98	110493	14	
Potomac River	70	80894	3	
Potomac River	72	80894	25	CPUE
Potomac River	71	102494	39	P(25.29<49.7<74.1)=0.95
Potomac River	73	101894	126	
Potomac River	74	101894	70	YOY CPUE
Potomac River	75	101994	73	P(1.12<3.9<6.68)=0.95
Potomac River	76	101794	40	
Potomac River	77	101794	42	
Potomac River	78	101894	44	
Potomac River	91	101894	35	
Transquaking River	48	50291	2	CPUE 7.75
Transquaking River	48	91691	7	Var. 72.25
Transquaking River	49	42491	2	YOY CPUE 0.5
Transquaking River	49	91791	20	Var. 0.333
Upper Chesapeake Bay	20	61091	1	
Upper Chesapeake Bay	20	91191	1	
Upper Chesapeake Bay	21	61691	5	CPUE 10.18
Upper Chesapeake Bay	21	91191	3	Var. 111.548
Upper Chesapeake Bay	21	100391	12	
Upper Chesapeake Bay	22	61791	7	YOY CPUE 2.28
Upper Chesapeake Bay	22	91291	7	Var. 24.21
Upper Chesapeake Bay	23	61791	1	
Upper Chesapeake Bay	23	91091	1	
Upper Chesapeake Bay	4	52891	10	
Upper Chesapeake Bay	4	101191	41	
Upper Chesapeake Bay	5	53091	8	
Upper Chesapeake Bay	5	100991	32	
Upper Chesapeake Bay	6	71091	11	
Upper Chesapeake Bay	6	100991	34	
Upper Chesapeake Bay	15	60691	1	
Upper Chesapeake Bay	16	53191	5	

Table 3. Cont. Chesapeake Bay largemouth bass electrofishing collection data 1991, 1992, 1993, and 1994.

Location	Station	Date	No. of Bass	Mean CPUE
Upper Chesapeake Bay	16	100891	9	
Upper Chesapeake Bay	17	53191	10	
Upper Chesapeake Bay	17	100891	5	
Upper Chesapeake Bay	18	60391	4	
Upper Chesapeake Bay	18	100991	45	
Upper Chesapeake Bay	19	61391	1	
Upper Chesapeake Bay	1	40891	10	
Upper Chesapeake Bay	2	40291	1	
Upper Chesapeake Bay	2	101091	2	
Upper Chesapeake Bay	3	32591	24	
Upper Chesapeake Bay	3	101091	8	
Upper Chesapeake Bay	11	62591	5	
Upper Chesapeake Bay	11	100491	17	
Upper Chesapeake Bay	12	62591	6	
Upper Chesapeake Bay	12	93091	19	
Upper Chesapeake Bay	13	62091	4	
Upper Chesapeake Bay	13	91991	14	
Upper Chesapeake Bay	14	62091	8	
Upper Chesapeake Bay	14	93091	15	
Upper Chesapeake Bay	24	42491	10	
Upper Chesapeake Bay	25	42491	3	
Upper Chesapeake Bay	26	52291	14	
Upper Chesapeake Bay	26	90991	2	
Upper Chesapeake Bay	27	52891	6	
Upper Chesapeake Bay	27	90991	3	
Upper Chesapeake Bay	28	52391	10	
Upper Chesapeake Bay	28	100291	24	
Upper Chesapeake Bay	7	50291	6	
Upper Chesapeake Bay	7	100291	12	
Upper Chesapeake Bay	8	50291	2	
Upper Chesapeake Bay	8	100291	12	
Upper Chesapeake Bay	9	42591	3	
Upper Chesapeake Bay	9	100791	31	
Upper Chesapeake Bay	10	62691	3	
Upper Chesapeake Bay	10	100791	3	
Wicomico River	57	50191	62	
Wicomico River	57	93091	22	CPUE 25.8
Wicomico River	58	41891	46	Var. 327.733
Wicomico River	58	100991	32	YOY CPUE 1.9
Wicomico River	59	50891	4	Var. 4.77
Wicomico River	59	101091	28	
Wicomico River	60	42291	18	
Wicomico River	60	101891	23	
Wicomico River	61	52091	22	
Wicomico River	62	41691	1	

Table 4. Back calculated length (mm) for Transquaking River largemouth bass collected during 1991.

# Fish	Age	An1	An2	An3	An4	An5	An6	An7	An8	An9	An10
5	1	139									
6	2	153	284								
5	3	138	282	344							
2	4	117	258	348	392						
5	5	136	267	340	397	430					
2	6	134	255	312	369	419	435				
0	7	-	-	-	-	-	-	-			
3	8	133	204	266	333	376	414	438	457		
Total 28											
Mean Length		139	265	326	375	411	423	438	457		
Increment		139	126	61	49	36	12	15	19		

Table 5. Back calculated length (mm) for Blackwater River largemouth bass collected during 1992.

# Fish	Age	An1	An2	An3	An4	An5	An6	An7	An8	An9	An10
9	1	178									
10	2	140	247								
5	3	126	226	291							
2	4	146	224	308	344						
2	5	127	220	294	379	412					
Total 28											
Mean Length		150	236	296	362	412					
Increment		150	86	60	66	50					

Table 6. Back calculated length (mm) for Manokin River largemouth bass collected during 1992.

# Fish	Age	An1	An2	An3	An4	An5	An6	An7	An8	An9	An10
8	1	156									
14	2	165	289								
8	3	135	264	330							
5	4	144	259	332	362						
0	5	-	-	-	-	-					
2	6	144	282	344	378	419	437				
2	7	191	246	316	365	393	412	435			
0	8	-	-	-	-	-	-	-	-		
1	9	191	305	391	434	462	471	476	485	491	
Total 40											
Mean Length		155	275	334	373	417	434	449	485	491	
Increment		155	120	59	39	44	17	15	36	6	

Table 7. Chester River Largemouth Bass Growth 1993.
Back Calculated Length (mm) At Each Annulus

# Fish	Age	An1	An2	An3	An4	An5	An6	An7	An8	An9	An10
16	1	151									
23	2	152	280								
18	3	156	268	341							
21	4	150	250	316	359						
18	5	137	234	314	374	411					
5	6	136	260	339	375	406	428				
2	7	143	229	292	364	406	434	456			
0	8										
2	9	145	211	270	322	352	411	439	477	496	
Total 105											
Mean Length		148	257	322	365	405	426	447	477	496	

Table 8. Back calculated length (mm) for Chicamacomico River largemouth bass collected during 1992.

	# Fish	Age	An1	An2	An3	An4	An5	An6	An7	An8	An9	An10
	4	1	151									
	10	2	170	295								
	3	3	180	293	355							
	5	4	165	304	364	405						
	2	5	145	301	363	419	443					
	3	6	170	284	347	397	431	457				
Total	27											
Mean Length			166	296	357	405	436	457				
Increment			166	133	61	48	31	21				

Table 9. Choptank River Largemouth Bass Growth 1994.
Back Calculated Length At Each Annulus

# Fish	Age	An1	An2	An3	An4	An5	An6	An7	An8	An9	An10
15	1	191									
21	2	164	286								
12	3	159	262	324							
13	4	139	257	325	372						
4	5	110	228	303	368	410					
1	6	148	259	304	347	389	418				
1	7	153	228	272	317	376	406	421			
0	8										
1	9	114	168	226	337	385	417	433	433	481	
Total 68											
Mean Length		160	265	316	366	398	414	427	433	481	

Table 10. Patapsco River Largemouth Bass Growth 1994.
Back Calculated Length At Each Annulus

# Fish	Age	An1	An2	An3	An4	An5	An6	An7	An8	An9	An10
19	1	188									
6	2	138	260								
3	3	148	261	325							
2	4	150	246	310	373						
Total 30											
Mean Length		171	258	319	373						

Table 11. Back Calculated Length (mm) for Potomac River largemouth bass collected during 1992.

# Fish	Age	An1	An2	An3	An4	An5	An6	An7	An8	An9	An10
393	1	184									
172	2	172	297								
67	3	168	271	342							
96	4	166	268	336	397						
60	5	164	263	334	385	418					
29	6	160	252	334	389	427	454				
9	7	149	255	350	395	431	452	469			
5	8	179	264	352	397	437	464	486	500		
1	9	125	306	336	366	396	427	457	472	487	
Total 832											
Mean Length		175	278	338	392	422	454	474	495	487	
Increment		175	103	60	54	30	32	20	21		

Table 12. Potomac River Largemouth Bass Growth 1993, Back Calculated Length At Each Annulus.

# Fish	Age	An1	An2	An3	An4	An5	An6	An7	An8	An9	An10
43	1	155									
124	2	175	293								
59	3	148	264	341							
35	4	144	267	342	386						
26	5	167	280	346	391	418					
14	6	162	291	363	403	430	449				
4	7	161	290	360	389	429	451	470			
3	8	144	260	340	390	420	440	465	486		
4	9	150	259	334	400	448	464	478	493	505	
1	10	150	266	381	454	468	483	491	503	515	526
Total 313											
Mean Length		162	281	345	392	425	452	473	491	507	526

Table 13. Back Calculated Length (mm) for Nanticoke River largemouth bass collected during 1992.

	# Fish	Age	An1	An2	An3	An4	An5	An6	An7	An8	An9	An10
	32	1	178									
	33	2	159	281								
	14	3	152	274	349							
	9	4	148	250	328	374						
	5	5	147	241	329	382	417					
	5	6	145	251	338	388	418	441				
	0	7	-	-	-	-	-	-	-			
	1	8	123	257	316	376	391	435	450	465		
	0	9	-	-	-	-	-	-	-	-	-	
	1	10	123	213	361	421	451	480	495	510	525	534
Total	100											
Mean Length			161	269	339	381	418	446	473	488	525	534
Increment			161	108	70	42	37	28	27	15	37	9

Table 14. Back Calculated Length (mm) for Marley Creek largemouth bass collected during 1992.

	# Fish	Age	An1	An2	An3	An4	An5	An6	An7	An8	An9	An10
	0	1	---									
	2	2	121	194								
Total	2											
Mean Length			121	194								
Increment			121	73								

Table 15. Back calculated length (mm) at each annulus for Pocomoke River largemouth bass collected during 1991.

	# Fish	Age	An1	An2	An3	An4	An5	An6	An7	An8	An9	An10
	15	1	186									
	38	2	137	232								
	23	3	129	239	293							
	21	4	133	340	294	337						
	8	5	138	249	324	368	393					
	2	6	138	292	386	416	447	462				
	1	7	141	247	286	331	379	406	419			
	1	8	189	257	342	393	441	479	496	513		
Total	109											
Mean Length			142	261	302	351	405	452	457	513		
Increment			142	119	41	49	54	47	5	56		

Table 16. Pocomoke River Largemouth Bass Growth 1993, Back Calculated Length At Each Annulus.

# Fish	Age	An1	An2	An3	An4	An5	An6	An7	An8	An9	An10
12	1	117									
18	2	127	218								
6	3	117	217	284							
11	4	118	216	277	310						
6	5	108	171	243	298	339					
7	6	127	203	266	310	339	366				
4	7	106	181	265	313	351	376	394			
6	8	107	170	249	297	343	373	399	411		
Total 70											
Mean Length		118	203	266	306	342	371	397	411		

Table 17. Pocomoke River Largemouth Bass Growth 1994, Back Calculated Length At Each Annulus.

# Fish	Age	An1	An2	An3	An4	An5	An6	An7	An8	An9	An10
17	1	133									
15	2	147	252								
30	3	121	221	290							
18	4	117	224	297	335						
7	5	121	237	306	344	369					
4	6	103	191	268	315	362	388				
3	7	113	221	278	324	351	375	388			
0	8										
2	9	134	234	305	348	391	412	433	449	459	
Total 96											
Mean Length		126	228	292	335	367	389	406	449	459	

Table 18. Patuxent River Largemouth Bass Growth 1993, Back Calculated Length At Each Annulus.

# Fish	Age	An1	An2	An3	An4	An5	An6	An7	An8	An9	An10
21	1	140									
13	2	163	283								
11	3	145	272	338							
9	4	154	266	336	378						
3	5	166	248	336	384	403					
1	6	126	246	326	403	434	489				
0	7										
0	8										
1	9	127	219	324	404	435	460	472	484	490	
Total 59											
Mean Length		149	270	336	383	415	474	472	484	490	

Table 19. Worton, Stillpond & Fairlee Creeks Largemouth Bass Growth 1994.

# Fish	Age	An1	An2	An3	An4	An5	An6	An7	An8	An9	An10
		Back Calculated Length At Each Annulus									
12	1	173									
5	2	153	279								
3	3	181	258	297							
1	4	144	282	365	406						
4	5	132	236	329	377	423					
Total 25											
Mean Length		162	261	322	383	423					

Table 20. Back calculated length (mm) at each annulus for Wicomico River largemouth bass collected during 1991.

# Fish	Age	An1	An2	An3	An4	An5	An6	An7	An8	An9	An10
29	1	173									
49	2	170	302								
58	3	159	281	351							
45	4	154	264	333	375						
22	5	141	265	342	388	416					
9	6	145	260	364	407	430	443				
1	7	151	281	360	396	432	450	476			
1	8	189	266	317	382	420	446	477	497		
Total 214											
Mean Length		160	279	345	383	420	444	476	497		
Increment		160	119	66	38	37	24	32	21		

Table 21. Back calculated length (mm) at each annulus for upper Chesapeake Bay largemouth bass collected during 1991.

# Fish	Age	An1	An2	An3	An4	An5	An6	An7	An8	An9	An10
115	1	168									
67	2	160	283								
54	3	146	260	331							
37	4	149	254	321	371						
28	5	148	248	321	369	403					
14	6	142	247	320	367	406	435				
4	7	135	252	309	347	380	421	438			
1	8	154	273	378	431	445	471	484	497		
1	9	127	219	280	403	464	479	495	501	507	
Total 321											
Mean Length		157	263	325	370	404	437	455	499	507	
Increment		157	106	62	45	34	33	18	44	8	

Table 22. Back calculated length (mm) for largemouth bass from upper Chesapeake Bay tributaries during 1991.

River	# Fish	An1	An2	An3	An4	An5	An6	An7	An8	An9
Bush	84	154	255	319	364	394	428	460		
Bohemia	33	157	265	324	364	412	437			
Elk	59	161	259	323	376	416				
Gunpowder	35	169	276	316	354	386				
Northeast	74	150	269	326	368	385	405	429		
Sassafras	24	167	266	327	374	412	446	460	499	507
Susquehanna	30	138	262	345	378	403	417			

Table 23. Back calculated length (mm) at each annulus for upper Chesapeake Bay smallmouth bass during 1991.

	# Fish	Age	An1	An2	An3	An4	An5	An6	An7	An8	An9	An10
	3	1	219									
	1	2	144	226								
	1	3	119	206	262							
	1	4	118	228	283	338						
	1	5	121	207	264	393	422					
Total	7											
Mean Length			166	217	270	365	422					
Increment			166	51	53	95	57					

Table 24. Back calculated length (mm) at each annulus for Smallmouth Bass from the Susquehanna River Conowingo Dam Fish Lift during 1994.

	# Fish	Age	An1	An2	An3	An4	An5	An6	An7	An8	An9	An10
	3	1	161									
	8	2	154	242								
	9	3	145	236	310							
	8	4	158	242	308	357						
	2	5	108	231	294	372	423					
	6	6	132	219	291	350	397	421				
	2	7	152	233	278	368	413	431	458			
	1	8	122	211	299	387	476	485	493	414		
	1	9	142	216	304	338	405	473	480	493	507	
Total	40											
Mean Length			146	234	301	358	411	434	472	453	507	

Table 25. Back Calculated Length (mm) for Potomac River smallmouth bass collected during 1992.

	# Fish	Age	An1	An2	An3	An4	An5	An6	An7	An8	An9	An10
	3	1	125									
Total	3											
Mean Length			125									
Increment			125									

Table 26. Indices describing Maryland tidal water black bass populations 1991, 1992, 1993, and 1994.

RIVER	Year	No. Fish	Mean TL	Mean Weight	KTL	PSD	Log W = a + n Log L	M Mortality
Back	1994	3	258	268				
Blackwater	1992	36	286	442	1.5	P(0.52<0.67<0.81)=0.90	Log W = -5.1165+3.12 Log L	55%
Chester	1993	121	361	851	1.5	P(0.79<0.85<0.90)=0.90	Log W = -5.5858+3.30 Log L	29%
Chicamacomico	1992	33	333	675	1.3	P(0.67<0.79<0.92)=0.90	Log W = -5.4581+3.24 Log L	43%
Choptank	1994	117	332	669	1.5	P(0.73<0.79<0.86)=0.90	Log W = -5.2766+3.18 Log L	22%
Manokin	1992	53	314	635	1.6	P(0.77<0.86<0.95)=0.90	Log W = -5.2751+3.19 Log L	47%
Nanticoke	1992	133	302	531	1.5	P(0.56<0.63<0.71)=0.90	Log W = -5.1725+3.14 Log L	51%
Patapsco	1994	37	304	463	1.5	P(0.32<0.46<0.6)=0.90	Log W = -5.5490+3.29 Log L	58%
Patuxent	1993	83	284	510	1.4	P(0.53<0.63<0.74)=0.90	Log W = -6.2501+3.57 Log L	35%
Pocomoke	1991	152	273	398	1.4	P(0.57<0.64<0.71)=0.90	Log W = -4.6666+2.92 Log L	41%
Pocomoke	1993	111	251	407	1.4	P(0.59<0.68<0.78)=0.90	Log W = -5.0804+3.09 Log L	15%
Pocomoke	1994	122	299	470	1.5	P(0.61<0.69<0.76)=0.90	Log W = -5.1255+3.11 Log L	50%
Potomac	1992	1055	293	587	1.4	P(0.62<0.64<0.67)=0.90	Log W = -6.2274+3.55 Log L	40%
Potomac	1993	782	291	541	1.4	P(0.71<0.74<0.77)=0.90	Log W = -6.1079+3.50 Log L	24%
Potomac	1994	489				P(0.69<0.72,0.76)=0.90		
Worton, Fairlee & Stillpond	1994	47	286	447	1.5	P(0.35<0.48<0.6)=0.90	Log W = -4.5490+2.89 Log L	50%
Transquaking	1991	30	358	867	1.5	P(0.75<0.86<0.97)=0.90	Log W = -4.8317+3.01 Log L	26%
Upper Bay	1991	528	289	527	1.4	P(0.60<0.63<0.67)=0.90	Log W = -5.4495+3.24 Log L	38%
Wicomico	1991	258	357	812	1.5	P(0.84<0.88<0.91)=0.90	Log W = -5.1029+3.11 Log L	10%

Table 27. Largemouth bass stocked in Maryland tidal waters as part of Sport Fish Restoration Project F-53-D

Year	River	Site Stocked	No. Bass		Source
1991	Blackwater	Md 335	13502		Unicorn
1991	Blackwater	Md 335	6425		Lewistown
1991	Blackwater	Little Blackwater	1151		Lewistown
1991	Choptank	Tuckahoe	11107		Unicorn
1991	Choptank	King Creek	16145		Unicorn
1992	Blackwater	Md 335	9862		Unicorn
1992	Marley Creek		17882		Unicorn
1992	Patuxent	Hunting Creek	191		Cedarville
1992	Choptank	Tuckahoe	3793		Unicorn
1992	Choptank	King Creek	200		Unicorn
1993	Chester River	Rileys	750		Lewistown
1993	Patuxent	Waysons C	6485	mt	Manning
1993	Cabin John Creek		17000		Unicorn
1993	Patuxent	Jacksons	1000	mt	Manning
1993	Pocomoke River		5294	mt	Lewistown
1993	Patuxent	Mataponi	1000	mt	Manning
1993	Pocomoke River		5248	mt	Manning
1993	Blackwater River		5283	mt	Unicorn
1993	Chester River	Unicorn	94		Unicorn
1993	Worton Creek		436		Unicorn
1994	Patuxent River	Waysons	10000		Manning
1994	Patuxent River	Governors Br	11000		Manning
1994	Patuxent River	Hall Creek	10000		Manning
1994	Patuxent River	Western Br	6000		Manning
1994	Pocomoke River		22400		Unicorn
1994	Transquaking River		18000		Unicorn
1994	Susquehanna River		18000		Unicorn
1994	Gunpowder River		27000		Unicorn
1994	Big Blackwater River		45000		Unicorn
1994	Chester River		58500		Unicorn
1994	Marley Creek		19800		Unicorn
1994	Sassafras River		22500		Unicorn
1994	Elk River		23000		Unicorn
1994	Northeast River		20200		Unicorn
1995	Gunpowder River		23700		
1995	Back River		20600		
1995	Middle River		23000		
1995	Patapsco River		20300		
1995	Patuxent River		50000		
1995	Chester River		50450		
1995	Choptank River		69700		
1995	Wicomico River		1400		
1995	Worton Creek		7100		
1995	Northeast River		10800		

(mt) microtagged

Table 28 Smallmouth bass stocked in Maryland tidal waters 1991 through 1995 as part of Sport Fish Restoration Project F-13-D

Year	River	Site Stocked	No. Bass	Source
1991	Chester	Millington	5000	Lewistown
1992	Chester	Millington	22000	Lewistown
1993	Chester	Millington	6000	Lewistown
1993	Patuxent	4-H	1411	Manning
1994	Chester	Millington	20000	Manning
1994	Patuxent	4-H	7000	Manning
1994	Patuxent	Governors Br	11000	Manning
1994	Patuxent	Waysons	1000	Manning
1994	Patuxent	Western Br	3000	Manning
1995	Chester	Millington	32000	Manning
1995	Patuxent		30500	

Table 29. Analysis of variance for repeated-measures data testing for differences in age-0 largemouth bass CPUE by electrofishing in the Potomac River due to new fishing regulation and site.

Source	df	F-value	P
Site	9	0.92	0.4805
Regulation	1	5.89	0.0117
Regulation*Site	9	0.59	0.7235

Table 30. Analysis of variance for repeated-measures data testing for differences in age-1 largemouth bass CPUE by electrofishing in the Potomac River.

Source	df	F-value	P
Site	9	1.97	0.0721
Regulation	1	11.09	0.0038
Regulation*Site	9	1.32	0.2614

Table 31. Age-0 largemouth bass collected by electrofishing the Potomac River during 15 minute sample periods and submerged aquatic vegetation (SAV) distribution.

Year	Regulation	Number of Samples	Bass $\bar{x}$ CPUE	Number of Samples	$\bar{x}$ SAV Frequency
1984	Pre	6	3.8	6	0.4
1989	Pre	10	3.2	8	0.8
1990	Post	9	13.7	8	1.2
1992	Post	10	12.6	8	0.7
1993	Post	8	19.3	8	0.3

Table 32. Age-1 largemouth bass collected by electrofishing the Potomac River during 15 minute sample periods.

Year	Regulation	Number of Samples	Bass Mean CPUE
1984	Pre	6	5.3
1989	Pre	10	7.4
1990	Pre	10	4.8
1992	Post	9	26.1
1993	Post	7	4.9
1994	Post	9	18.2

Table 33. Pocomoke River hourly average dissolved oxygen concentration (DO) for the Nassawango Creek & Snow Hill area, 6 AM through 5 PM.

Time	February DO ppm	April DO ppm	May DO ppm	June DO ppm	July DO ppm	August DO ppm	September DO ppm
600	10.40	7.68	5.84	3.64	3.07	2.68	3.62
700	10.27	7.70	5.70	3.46	2.93	2.62	3.56
800	10.06	7.65	5.70	3.39	2.89	2.63	3.47
900	10.03	7.75	5.65	3.45	2.86	2.58	3.53
1000	10.02	7.69	5.58	3.45	2.85	2.51	3.28
1100	10.19	7.63	5.62	3.35	2.97	2.50	3.34
1200	10.20	7.63	5.59	3.34	3.07	2.55	3.52
1300	10.17	7.64	5.65	3.48	2.97	2.60	3.46
1400	10.08	7.73	5.56	3.46	2.96	2.68	3.51
1500	10.27	7.79	5.69	3.57	3.21	2.73	3.58
1600	10.19	7.79	5.74	3.60	3.09	2.78	3.57
1700	10.48	7.94	5.77	3.64	3.37	2.84	3.45

Table 34. Pocomoke River hourly average dissolved oxygen concentration (DO) for the Pocomoke City area, 6 AM through 5 PM.

Time	July DO ppm	August Do ppm
600	3.25	4.90
700	3.14	4.53
800	3.09	4.88
900	3.11	4.61
1000	3.02	4.52
1100	3.04	4.34
1200	3.12	4.55
1300	3.13	4.55
1400	3.15	4.81
1500	3.28	4.97
1600	3.26	5.38
1700	3.32	5.30

Table 35. Largemouth bass population estimate Northeast River October 1992.

Date	Number Caught C	Recaptures R	Number Marked Less Removals	Estimate N	95% Confidence Interval Low	High
10/13	123	0	123			
10/14	151	13	138			
10/15	131	20	111			
10/16	102	18				
	Total	51		1744	1276	2282

Table 36. Northeast River water quality data for October 1992.

Sample Station	1	2	3	4	5	Mean
Temperature °C	17	17	17	17	13	16.2
DO ppm	9.6	10	9.8	10.2	9.6	9.8
Ph	8.7	9.3	9.0	9.2	6.8	8.6
Alkalinity (mg/l)	51.3	51.3	51.3	51.3	51.3	51.3
Hardness (mg/l)	119	137	137	137	68	120
Conductivity (micromhos/cm)	450	500	550	550	140	438
Salinity (ppt)	0.5	0.5	0.1	0.5	0	0.3

Table 37. Largemouth bass population estimate Mattawoman Creek September 1993.

Date	Number Caught C	Recaptures R	Number Marked Less Removals	Estimate N	95% Confidence Interval Low	High
9/27	227	0	226			
9/28	797	9	788			
9/29	762	71	691			
9/30	620	89				
Total		169		11823	10058	13728

Table 38. Mattawoman Creek water quality data for September 1993.

Sample Station	1	2	3	4	5	6	Mean
Temperature °C	21	18	21	21	21	21.5	20.6
DO ppm	8.8	7.4	8.0	8.4	8.4	8.6	8.3
Ph	8.0	6.5	7.2	7.8	8.7	8.6	7.8
Alkalinity (mg/l)	68.4	85.5	68.5	68.4	17.1	68.4	62.7
Hardness (mg/l)	188	205	188	188	34	154	180
Secchi Depth (m)	.68	.28	.64	.61	.66	.94	.64
Ortho Phosphate	.7	.6	1.1	.6	.7	.5	.7
Nitrate	5	5	5	6	4	5	5
Nitrite	0	0	0	0	0	0	0

Table 39. Largemouth bass population estimate Choptank River September 1994.

Date	Number Caught C	Recaptures R	Number Marked Less Removals	Estimate N	95% Confidence Interval Low	High
9/23	34	0	31			
9/26	124	2	122			
9/27	71	7	64			
9/28	127	10				
Total		19		2113	1316	3478

Table 40. Choptank River water quality data for September 1994.

Station	1	2	3	4	5	6	7	8	9	10	11	12	Mean
Temperature °C	14	13	14	14	12	13	16	15	16	15	15	13	14.2
DO ppm	6.6	5.8	6.0	6.4	10.4	6.8	6.6	6.6	10.2	7.8	8.2	8.8	7.5
Ph	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0
Alkalinity (mg/l)	68.4	51.3	51.3	68.4	51.3	68.4	51.3	51.3	68.4	34.2	51.3	51.3	48.8
Hardness (mg/l)	68	51	51	68	68	68	51	68	68	51	68	68	62.3
Secchi Depth (m)	2.1	2.1	1.2	.9	.3	.6	.6	.6	.3	.3	.6	.6	0.9
Ortho Phosphate	.75	2.5	0	.9	.3	.2	.1	.5	.9	1.0	1.3	.7	0.8
Nitrate	9	11	12	10	15	14	17	17	15	20	13	12	13.8
Nitrite	0	0	0	0	0	0	0	0	0	0	0	0	0

Table 41. Tidal water largemouth bass catch per effort, largemouth bass population density estimated by mark and recapture for regression analysis.

Year	River	Catch per effort (fish/h)	Estimated density (fish/hectare)
1988	Northeast	87	2.81
1989	Potomac	234	12.06
1990	Choptank	24	3.4
1992	Northeast	65	2.7
1993	Potomac	392	28.27
1994	Choptank	68	3.25
1994	Patuxent	96	10.8

Table 42. Tidal water largemouth bass population density based on autumn catch per effort from the equation $\log^{10}D=0.841549\ \log^{10}CPE - 0.88805$.

River	Area hectare	CPE (fish/h)	Estimated Density (fish/hectare)	Estimated number of bass
Pocomoke	1654	68	4.51	7459
Manokin	243	10.6	0.94	229
Wicomico	1170	101.6	6.32	7397
Nanticoke	3792	75.2	4.91	18612
Chicamacomico	852	40	2.89	2459
Choptank	6414	54	3.71	23822
Wye	363	4	0.42	151
Transquaking	444	54	3.71	1648
Blackwater	2344	34	2.52	5899
Middle	1575	60	4.06	6392
Patapsco	4113	74	4.84	19916
Magothy	444	4	0.42	184
(Stillpond	1396	22	1.74	2435
Worton Fairlee Churn)				
Marley Creek	405	4	0.42	168
South	162	4	0.42	67
Patuxent	3269	43.7	3.11	10160
Back	1372	6	0.58	802
Severn	240	4	0.42	100
Chester	4453	106.7	6.59	29339
Miles	190	4	0.42	79
Upper Bay	31000	60.7	4.10	127043
Potomac	21166	219.6	12.09	255964
			Total	520325

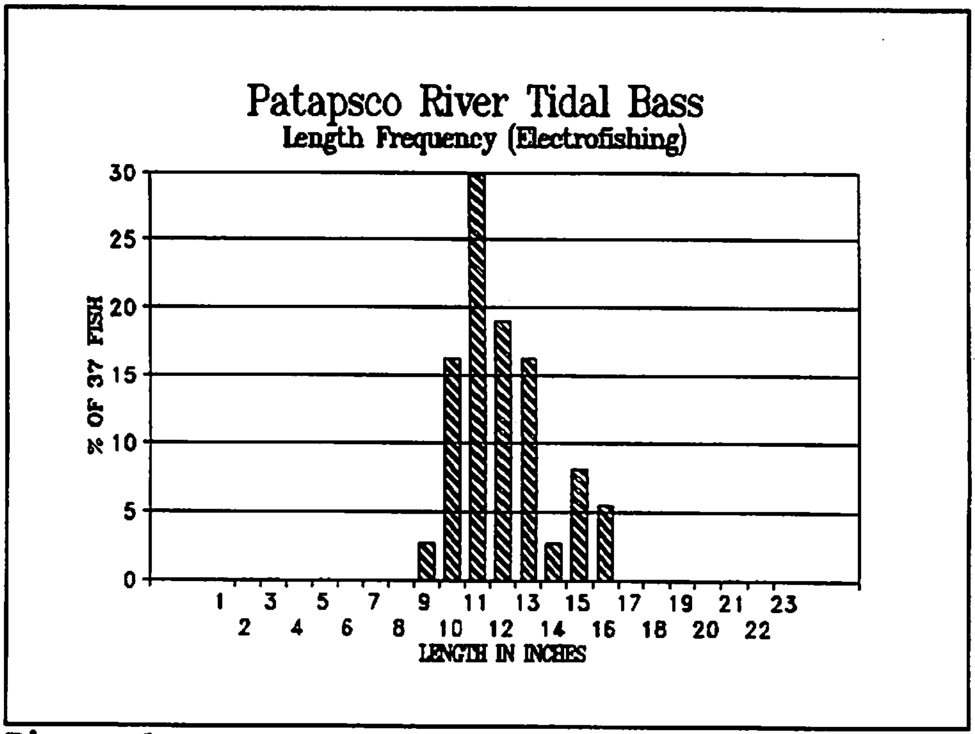

Figure 1

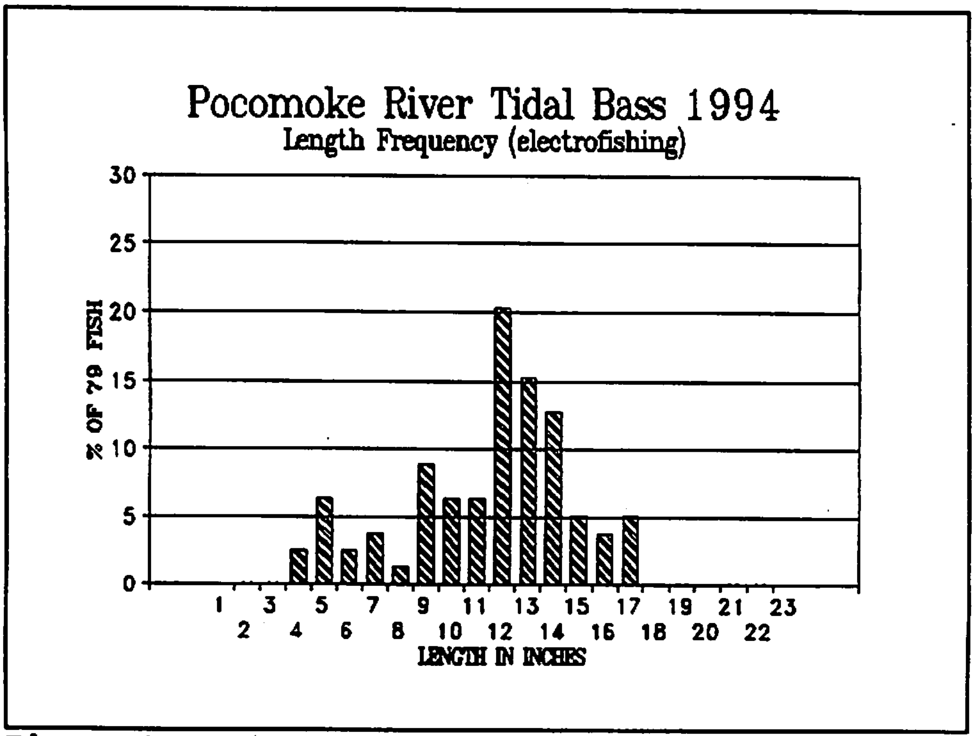

Figure 2

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Freshwater Fishery Management And Maryland Sportfishing Tournaments

By Leon Fewlass

INTRODUCTION

Traditional fishery management and data collection methods are based on fish harvest and do not readily apply to tournaments which are based on catch-and-release. Assessing tournament impacts and developing appropriate management represents a new challenge for fishery scientists. Potential effects that have been identified for investigation during this study include tournament bass mortality rates, fish displacement, competition for fishery access, fish handling techniques, fish concentration at release stations, and fish population dynamics. From study findings Maryland has implemented innovative tournament fishery management including protecting black bass during their spawning season and recommending improved fish handling techniques.

Increased fishing pressure and higher numbers of bass fishing tournaments along with a change from fish harvest to catch-and-release have necessitated the employment of new tagging systems for generating comprehensive fish movement pattern data. Largemouth bass caught by anglers at Potomac River fishing tournaments were tagged with passive integrated transponders (PIT tags) during 1990 to study bass movement patterns, the effects of fish displacement, and fish recapture rates. Advantages of the PIT tag system include each fish having a unique identification number, tagging is permanent, and fish mortality as a result of the tagging process is low.

METHODS

Catch-per-unit-effort (CPUE) data and size ranges for fish caught at both tidal and nontidal water black bass fishing tournaments were collected each year from 1991 through 1995. Fishing tournament organizers were requested to submit tournament schedules and summaries of their catch records to the Freshwater Fisheries Division. Schedules were also obtained from the managers of marinas where preregistration for tournaments was required. A clerk from Freshwater Fisheries Division attended weekend tournaments to obtain catch data. Information recorded at each tournament included tournament identification, location, date, hours fished, number and species of fish harvested, number and species of fish caught and released, number of anglers, lengths of fish caught, and fishing conditions.

Tournament CPUE represents catch per hour and is calculated by the formula: $CPUE = n / f \times h$ where n = number of fish caught, f = number of anglers, and h = mean number of hours fished. Estimated number of fish caught annually during tournaments was calculated by multiplying mean number of fish caught in tournaments by the number of weekend days in a fishing season and adding the observed number of fish caught during weekday tournaments. Data collected was separated into categories for 12 inch (350mm) fish and 15 inch (381mm) fish as a result of the 15 inch minimum creel regulation (from March 1 through June 15) implemented in 1990.

The Potomac River black bass fishery encompasses an area in excess of 16,000 ha where salinity of the tidal waters is less than 5 ppt during the spring of the year. Included are waters extending from 0.8 km north of Chain Bridge downstream to the US Route 301 Bridge and tributary headwaters downriver from the Route 301 Bridge. PIT tag data was collected in Maryland and Virginia (in cooperation with the Virginia Commission of Game and Fish).

A PIT tag consists of a microchip and an electromagnetic coil contained in a 21 mm x 19 mm capsule. Each tag has a unique 10 digit identification code which is decoded by passing a hand-held detector near the fish.

PIT tags were implanted into abdomens of largemouth bass caught by anglers at 8 fishing tournaments originating from Mattawoman Creek during 1990. Forty-four largemouth bass were also tagged and placed in ponds at Manning and Unicorn Hatcheries to determine tag retention and fish condition following tagging.

Once tagged the fish were measured, scanned with a PIT tag detector to record the identification number, and then released into the river near the Smallwood Sate Park tournament check-in station. Fisheries personnel were stationed at the release area on tournament day and the following day to record numbers of bass caught by people fishing either from boats or the shoreline. Data was collected for studying PIT tagged bass movement patterns and recapture rates by scanning fish from Potomac River electrofishing surveys, at access point creel surveys during 1990, and at fishing tournaments during 1990, 1991, 1992, and 1993. Bass survival rates (S) for successive years of recapture (R_1, R_2) were calculated by the formula $S=R_2/R_1$ from Ricker (1975). Recaptured bass were released at the Mattawoman Creek tournament check-in station, except for 28 fish which were released in Nanjemoy Creek, Maryland, and Gunston Cove, Virginia.

Bass were collected for tagging at amateur or professional tournaments. After tournament weigh-in bass were placed (< 1 lb. fish/gal H_2O) in insulated tanks containing water, supersaturated with oxygen and having 2.5 ppt salinity, for transport to the tagging station. The tagging station was located where fish caught during tournaments would normally be released. Scanning was performed to identify previously tagged fish, new specimens were tagged, fish were measured (total length mm), and all fish were released into the river. Following tournaments fishing activity was monitored, to determine whether or not concentrations of fish at the release site were highly vulnerable to angling.

Data was collected for studying PIT tagged bass movement patterns and recapture rates by scanning fish at Potomac River electrofishing surveys, at access point creel surveys, and at fishing tournaments. The estimated number of PIT tagged bass harvested by anglers during 1990 was derived through an access point creel survey.

A database has been established for Maryland freshwater fishing tournaments that will be used for formulating fishery management decisions. The database includes the number of tournament fishermen, number of fish caught, catch rates, fish movement patterns, fish size ranges, and other details relating to tournament activities.

RESULTS AND DISCUSSION

Freshwater Fisheries Division personnel collected data from 366 bass fishing tournaments from 1990 through 1995 (Table 1). The estimated number of bass fishing tournaments held annually in Maryland was 716. Twenty-five of these tournaments had more than 100 participants. Bass fishing organizations from other states annually conducted 175 tournaments, and the tidal Potomac River had 178 tournaments. Freshwater Fisheries personnel made 55 weekend day trips to Potomac River boat ramps to collect tournament data during March through November. No tournaments were found on 29% of these trips, although organizers had scheduled tournaments for several of the days. Smallwood Marina on the Potomac River had the greatest estimated number of tournaments 135 and appeared to have reached weekend tournament capacity. The only times of the year when weekend tournaments were not found at Smallwood Marina were early spring, mid summer, and late fall.

Tidal Potomac River bass numbers have increased 49% during the past five years and have contributed to higher catch rates by bass tournament anglers. The estimated number of bass caught has tripled while angler numbers have doubled. The trend has been for more anglers to catch even more bass. High catch rates for bass have attracted tournament and non-tournament anglers to the River despite crowded fishing conditions and crowded launching facilities. The River's dynamic aquatic vegetation community consisting predominantly of hydrilla, milfoil, and wild celery has been essential for development of the bass fishery.

Estimated numbers of bass caught during 1990 tidal Potomac tournaments (8061) and 1991 tidal Potomac tournaments (8159) were similar. The trend has been for tournament anglers to catch more fish, 12,799 during 1992, 12,759 in 1993, 21,360 in 1994, and 24,261 in 1995. The estimated number of anglers participating in Potomac River tidal water bass fishing tournaments has also increased from 5,168 in 1991 to 10,636 in 1995.

Black bass catch rates for tidal Potomac River fishing tournaments during 1991 ranged from a spring CPUE of 0.13 (15" minimum creel) to a summer-autumn CPUE of 0.26 (12" minimum creel). The combined CPUE of 0.20 in 1991 was similar to the combined CPUE of 0.16 in 1990, whereas the 12 inch minimum creel catch rate increased from 0.17 in 1990 to 0.26 in 1991. Increased catches were also noted at tournaments held by the Potomac Bassmasters of Virginia where average total weight of fish checked in by the top five boats was up from 80 lbs/month in 1990 to 109 lbs/month in 1991. Numbers of bass caught per hour during the spawning season were similar for 1991 (0.13) and 1992 (0.12). CPUE increased to 0.37 in 1992 after the spawning season. Tournament anglers also checked in much larger bass during 1992 than in 1991. Mean length (354 mm) for a sample of 400 bass at nine post spawning season tournaments in 1991 was significantly different ($P < 0.05$) from mean length (410 mm) for a sample of equal size from 12 tournaments in 1992. CPUE during the 1993 spawning season declined from 0.132/hour in 1991 to 0.11/hour in 1993. This decrease parallels a shift for modal bass length in the River from the 15 - 17 inch range in 1989 to the 13 - 14 inch range in 1993, a possible result of increased bass reproduction following implementation of the 15 inch minimum size limit during the spawning season. The population trend has also resulted in increased CPUE after the spawning season when 12 inch bass may be creeled. CPUE has tended to increase, varying from 0.17/hour in 1990 to 0.367 in 1992. The 1993 rate, 0.286/hour, was lower than the 1992 rate, however, confidence intervals overlapped. Mean length for a sample of 236 bass from tidal Potomac tournaments after the bass spawning season was 379 mm ($P(372<379<387)=0.95$). Although tournament participants could check-in fish 12 inches or longer the modal lengths for bass checked-in during tournaments were from 15 to 17 inches. This was a result of anglers having an abundance of bass to cull. CPUE during the spawning season increased to 0.243 bass/hour in 1995. CPUE after the spawning season has tended to vary from 0.17 bass/hour in 1990 to 0.37 bass/hour in 1992, 0.28 bass/hour in 1994 and 3.13 bass/hour in 1995.

The live release each year of approximately 20,000 tournament caught black bass at the Smallwood Sate Park Marina on the Potomac River has raised concern that bass overcrowd waters in Mattawoman Creek near the weigh-in station. Overcrowded bass should exhibit slow growth rates and be underweight. This has not been the case in Mattawoman Creek where the bass were plump and healthy during autumn. Relative weights for all inch groups of Mattawoman Creek bass were within or exceeded the normal range (95% to 100%)(Fig. 1). Mattawoman Creek bass growth has been excellent (Table 2), similar to growth throughout the Potomac River and exceeding the growth rate for Pocomoke River bass.

Waters at Smallwood Marina and Fort Washington Marina on the tidal Potomac River have excellent dissolved oxygen concentration (DO) for supporting bass released after tournaments. Figure 2 denotes a typical DO cycle for a 48-hour period in August. Dissolved oxygen concentration would be expected to be low during this time of year, however DO stayed well above 7 ppm, well above the bass stress level (3 ppm) and also above the minimum needed for productive bass fisheries (5 ppm).

Bass mortality above 20% has been found at some fishing tournaments in Maryland. Live well operation, weigh-in procedures and release procedures contribute to high mortality rates. Maryland Freshwater Fisheries Division has been working with tournament organizers to reduce fish mortality by improving fish handling during weigh-in. During 1995 the Division in cooperation with State Park personnel constructed a permanent weigh-in facility adjacent to the River at Smallwood Marina. Previously club tournaments often conducted their weigh-in at parking lots away from the water. This prolonged fish handling time and increased bass mortality. The new facility has three fish holding tanks that are filled with river water via an electric pump. During a tournament fresh river water is continuously circulated through the tanks. The weigh-in tanks are also equipped with an aeration system. Anglers are instructed to dip water from the tanks into their plastic fish holding bags while en route to the scales to increase oxygen levels. To reduce the number of anglers en route at one time from boats to the scales only 25 plastic bags are issued per tournament.

Potomac River tournament organizers have used a fish transport boat to return bass to tidal waters. The boat has four 125 gallon live wells equipped with recirculators and an air pump. Bass are placed in the live wells throughout the tournament. The first fish in the tanks remain on the boat for more than 90 minutes until they are released. Biologists measured DO in the tanks while 1,324 tournament caught bass were added to the tanks on September 15, 1994. Water temperature was 24.5 ^{0}C. As fish were placed in the tanks DO levels declined below 5 ppm in less than 10 minutes and to 3 ppm in 15 minutes (Fig. 3). Schramm and Heidinger (1988) state that for live fish release DO should be maintained in live-wells at concentrations $\geq$ 5 ppm. Dissolved oxygen increased slightly at 70 minutes when the boat operator added new water to the fish tanks. Failure of the air pump and recirculator to maintain essential DO indicated that the number of fish exceeded the boat capacity. Schramm and Heidinger (1988) recommend one gallon of water tank capacity for each pound of bass. During 1995 a permit was initiated for transporting live black bass ≥ 12 inches long and in excess of the individual creel limit in boats or trucks after bass fishing tournaments. Permit restrictions state that fish transport tanks may contain no more than one bass per gallon of water at water temperature ≤ 70 °F and no more than one pound of bass at water temperature > 70 °F. The restrictions are intended to improve the live release of largemouth bass.

A 3.7 m x 0.9 m x 1.8 m holding net having 3.8 cm mesh with an open top and a 0.6 m diameter outlet at one end was tested as a device for separating impaired or dead fish from healthy fish when bass were freed back into the River after several Smallwood Marina fishing tournaments. Bass were placed in the net following weigh-in. Conceivably, healthy bass would swim through the net end opening whereas the net would restrain impaired and dead fish. Dissolved oxygen levels remained stable within the net as fish were added. The net fulfilled expectations during months when temperatures were cool, April, May, and June, and tournaments had few fish mortalities. But during hot weather dozens of fish in poor condition and dead fish were trapped and the net became unmanageable.

Fishing tournament popularity has increased the demand for launching facilities. Tournament organizers may consider using facilities where habitat is marginal for bass survival once marinas within prime habitat reach capacity. To prevent fish mortality as a result of tournaments releasing bass in high water salinity, it is recommended that no bass fishing tournament release stations be allowed downstream from the summer 8 ppt salinity level. Largemouth bass cease feeding and eventually die at water salinity > 12 ppt (Meador & Kelso 1989). There has been no evidence that short term exposure to high water salinity adversely affects largemouth bass. Fish hatcheries often increase water salinity as a prophylactic measure when transporting largemouth bass. Bass mortality rates may not be affected by transporting bass in boat live wells through high salinity water. This type of transport may have other as yet undefined effects on bass fisheries.

Forty-four largemouth bass were tagged and placed in ponds at Manning and Unicorn Hatcheries to determine PIT tag retention and fish condition following tagging. Thirty days later the fish were removed from the ponds and scanned with a PIT tag detector. All of the fish were healthy and had retained their tags. Based on these findings tag retention was nearly 100% and fish mortality from the tagging process was considered to be insignificant.

During April through October 1990, 3361 black bass (=>305 mm) were PIT tagged at fishing tournaments and released in Mattawoman Creek, a Potomac River tidal tributary. By the end of October 114 fish were recaptured with one fish being recaptured twice. This fish was caught by a fisherman and checked in at the Mattawoman Creek creel survey station, and three days later it was caught near the creel survey station by electrofishing. No multiple recaptures of fish occurred at fishing tournaments in 1990. Seventy-one recaptures were by tournament participants, 17 by electrofishing, and 27 by anglers checked at creel surveys. Anglers harvested nine of the 27 PIT tagged bass they checked in during creel surveys.

Anglers recaptured 19 fish within one day after tagging and 18 more within two days. Thirty-six of the 98 fish recaptured by anglers during 1990 were caught within two days after tagging. Most bass were caught within a period from 3 to 14 days following tagging. No PIT tagged fish were checked in at creel survey stations on tournament day or the following day although 4 creel surveys were conducted during these periods. Two of these creel surveys were located at the site where tournament bass were released. Following a three-day tournament launched from Mattawoman Creek during October 1990 fisheries personnel checked bank-fishermen and boats landing at the release site for PIT tagged bass. No PIT tagged bass were caught by anglers fishing from the shoreline. Some anglers in boats were observed catching bass, these fish were not checked because the anglers did not land at the marina.

Tournament organizers designated a 37 ha section of Mattawoman Creek, extending from Rum Point to Grinders Wharf and surrounding the tournament fish release station, off-limits for tournament participants to catch bass. The minimum distance from the release station to the off-limits boundary was 0.4 km. Tournament fishermen caught 35 PIT tagged bass outside of this area within two days after tagging. Thirteen bass were collected by electrofishing within the off-limits area. Thirty-nine percent of the bass that were caught in this area 12 days following a tournament had been PIT tagged and 7% caught 20 days later also had been tagged. Twelve days following a tournament two PIT tagged bass were caught 4.3 km upstream from the restricted area. No tagged fish were among 10 bass collected by electrofishing near the release station 40 days after a tournament.

Within 48 hours following tagging four fish were checked-in at the Piscataway Creek tournament station, one was checked-in at the Piscataway Creek creel survey station, and one was caught by electrofishing Piscataway Creek. Apparently these six bass had been transported upstream 29 km miles to Piscataway Creek by fishermen.

Biologists attended 38 fishing tournaments between 23 March and 2 November 1991 to locate tagged bass. Fishermen checked-in 3,003 bass at these tournaments and 60 had PIT tags. Anglers reported the recapture sites for 10 fish. Three were recaptured 8 km down river from the release site in Chickamuxen Creek, three in Mattawoman Creek, two near Greenway Flats (19 km upstream from the release site), one in Pomonkey Creek (16 km upstream from the release site) and one in Chopawomsic Creek (11 km down river from the release site). One bass was recaptured twice in Mattawoman Creek during 1991. Five fish were recaptured in Mattawoman Creek within 0.8 km of the release site on March 26, 1991 by electrofishing. Two of the recaptures were checked-in and released at a tournament in Pohick Bay Virginia. The annual survival rate (1990-1991) for tagged bass was 55.1%.

Biologists attended 42 bass fishing tournaments between 21 March and 31 October 1992 to locate tagged fish. Fishermen checked-in 5,861 bass at these tournaments and 45 had PIT tags. Fifteen tagged fish were released in Nanjemoy Creek and the remainder in Mattawoman Creek. Several tagged fish were reported by anglers as being caught in the hydrilla bed at the mouth of Mattawoman Creek (1.6 km downstream from the release site) and one was recaptured at the mouth of Chicamuxen Creek (6.4 km south of the tournament release site). Three PIT tagged fish were captured during electrofishing surveys. One tagged bass was captured at Greenway Flats (19 km upstream from the release site) during July. The second was found in Nanjemoy Creek (42 km downstream from the release site) in September, this fish had been released in Mattawoman Creek. The third fish was first caught during a May tournament and released at Fort Smallwood boat ramp. It was recaptured at Grinders Wharf during a November electrofishing survey.

The survival rate of the tagged bass between the 2nd and 3rd year after tagging was 75%. Through 1992 219 (6.5%) of the pit tagged fish had been recaptured.

Biologists attended 44 Potomac River bass fishing tournaments from 20 March through 30 October 1993 to locate tagged fish. Fishermen checked-in 8,935 bass at these tournaments and 9 had PIT tags. One recaptured bass had been caught by biologists electrofishing during 1992 at Grinders Wharf. All tagged fish were checked in at tournaments launched from Mattawoman Creek. Three tagged bass were found by biologists electrofishing Mattawoman Creek. Tagged bass were not found in electrofishing samples outside of Mattawoman Creek from Mallows Bay to Oxen Creek.

The survival rate of tagged bass between the 3rd and 4th years after tagging was 24%. Survival 1990 through 1993 was 35% based on the slope of the line plotted for logarithmic values of annual recaptures. Through 1993 231 (6.9%) of the pit tagged fish had been recaptured. Nine PIT tagged largemouth bass were found among 615 largemouth bass inland in private holding ponds.

The displacement of bass from their catch site to waters at a location where weigh-in programs are conducted is intrinsic to the catch-and-release concept practiced at many bass fishing tournaments. PIT tag bass study showed that displacement had little effect on the tidal Potomac River fishery. Within hours after being released PIT tagged bass resumed feeding and started to move away from the release area. This was apparent from the catch by tournament participants of 35 PIT tagged bass outside the off-limits area less than 48 hours after tagging. It was feasible that displacement could produce concentrations of bass highly susceptible to angling and subsequent harvest but this did not occur. Near the release site fish harvest by bank-fishermen was minimal for two days following tournaments and most PIT tagged bass were taken by boat-fishermen from tournaments launched at other boat ramps. These fish were relocated to waters where the tournaments originated. PIT tagged bass continued to emigrate from release station waters and their density declining from one-third of the electrofishing catch two weeks following a tournament to none by 40 days. Bass dispersion from release station waters was rapid and extensive. Two weeks following a tournament 6% of the fish collected 4 km upstream from the off-limits area were PIT tagged fish. Hocutt and Siebold (1990) found that in less than 30 days nearly 50% of the bass displaced within the Potomac River during a radio telemetry study returned to where they had been caught.

PIT tag returns at creel surveys also showed that harvest was minimal for tournament released bass. Only 7% of the 3,361 bass PIT tagged were harvested and among the 33 PIT tagged bass checked by the creel clerk none were caught on tournament day. No individual checked by a creel census clerk harvested more than one PIT tagged bass dispelling the theory that tournaments produced concentrations of bass which were highly vulnerable to angling.

Assuming that PIT tagged bass were a representative segment of the Potomac River bass population the 7% harvest was well below the optimal rate 40% for a productive sport fishery (Graham 1971) and constituted minimal fishery exploitation. This harvest appeared to be sustainable even though Graham's optimal range pertained to impoundment fisheries which may have higher bass recruitment rates than tidal water black bass fisheries.

Only 6.9% (231 fish) of the PIT tagged bass were recaptured during the four years of Potomac River tournaments attended by Fisheries personnel and only one fish was captured twice. It could be concluded from these findings that the Potomac River bass population was very large where the number of bass checked-in during tournaments represented a small segment of the population or that bass checked-in experienced a high mortality rate even though tournament participants practiced catch-and-release. Both conclusions are supported by findings from Potomac River tournament studies other than the PIT tag study. The best estimate for the size of the Potomac River bass population, based on mark-and-recapture and creel survey catch per unit effort, was 300,000 fish. During 1990 the number of bass checked-in during tournaments was equivalent to only 5.4% ($P(0.027<0.054<0.165)=0.95$) of the population providing support for the conclusion that only a small segment of the bass population was actually checked in during tournaments (Fig. 4). Fishermen practicing for future tournaments were observed releasing many other bass where they were caught. Conclusion number two was based on the premise that high bass mortality following tournaments would reduce the probability of multiple PIT tag recaptures. Bass mortality exceeded 19% following a 1989 Potomac River fishing tournament and 22 percent of the 62 largemouth bass and smallmouth bass caught during a June 1994 non-tidal Potomac River fishing tournament died prior to weigh-in providing evidence to support this conclusion. However tournament bass mortality was insignificant to maintenance of a productive fishery because 19% tournament bass mortality equated to only 1% of the tidal Potomac River black bass population.

Table 1. Summary of data from Maryland black bass sport fishing tournaments 1991-1995.

Waters	Number of Tournaments for Data Collection	Number of Bass Caught	Number of Anglers	CPUE Bass/ Hour
1991				
Tidal Potomac	35	5168	3003	0.198
(15" Minimum)	16	1824	1039	0.128
(12" Minimum)	19	3432	1964	0.251
Lakes	8	3344	527	0.123
Nontidal Rivers	4	1144	161	0.124
Tidal Rivers (excluding Potomac)	16	4488	1506	0.212
(15" Minimum)	4	1008	126	0.118
(12" Minimum)	12	3344	1380	0.254
1992				
Tidal Potomac	41	7616	5166	0.194
(15" Minimum)	30	3172	2332	0.124
(12" Minimum)	12	4032	2834	0.367
Lakes	12	2268	736	0.150
Nontidal Rivers	8	2184	581	0.142
Tidal Rivers (Excluding Potomac)	15	3264	1045	0.162
(15" Minimum)	4	520	54	0.067
(12" Minimum)	11	2436	991	0.196
1993				
Tidal Potomac	38	8840	4688	0.156
(15" Minimum)	28	3900	2870	0.110
(12" Minimum)	10	3696	1818	0.286
Lakes	2	588	34	0.233
Nontidal Rivers	6	1904	157	0.109
Tidal Rivers (Excluding Potomac)	26	5032	1842	0.181
(15" Minimum)	7	780	115	0.101
(12" Minimum)	19	3780	1727	0.217
1994				
Tidal Potomac	67	5538	10788	0.216
15" minimum	36	3145	4129	0.162
12" minimum	31	2393	6659	0.281
Upper Potomac	9	345	476	0.201
Upper Chesapeake Bay	18	886	1383	0.163
15" minimum	8	170	119	0.115
12" minimum	10	716	1264	0.196
Reservoirs	6	127	204	0.21
Trophy Lake (Leonards)	1	6	17	0.27
Tidal Chester 12"	1	7	11	0.175
Tidal Choptank 15"	1	5	14	0.295

Table 1. Cont. Summary of data from Maryland black bass sport fishing tournaments 1991-1995.

Waters	Number of Tournaments for Data Collection	Number of Bass Caught	Number of Anglers	CPUE Bass/ Hour
1995				
Tidal Potomac	98	16029	6958	0.287
15" minimum				0.243
12" minimum				0.313
Upper Potomac	6	300	278	0.131
Upper Chesapeake Bay	5	916	403	0.245
15" minimum	3	194	135	0.185
12" minimum	2	722	268	0.337
Tidal Chester 12"	1	20	8	0.294
Tidal Choptank 12"	1	20	12	0.196
Tidal Nanticoke 15"	1	29	11	0.330
Tidal Patuxent 12 "	1	10	19	0.066

Table 2. Growth of Mattawoman Creek largemouth bass compared to bass from other waters.

Location	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9
Mattawoman 1993	157	281	351	396	436	457	466	488	502
Pocomoke 1994	118	203	266	306	342	371	397	411	
Potomac 1993	162	281	345	392	425	452	473	491	507

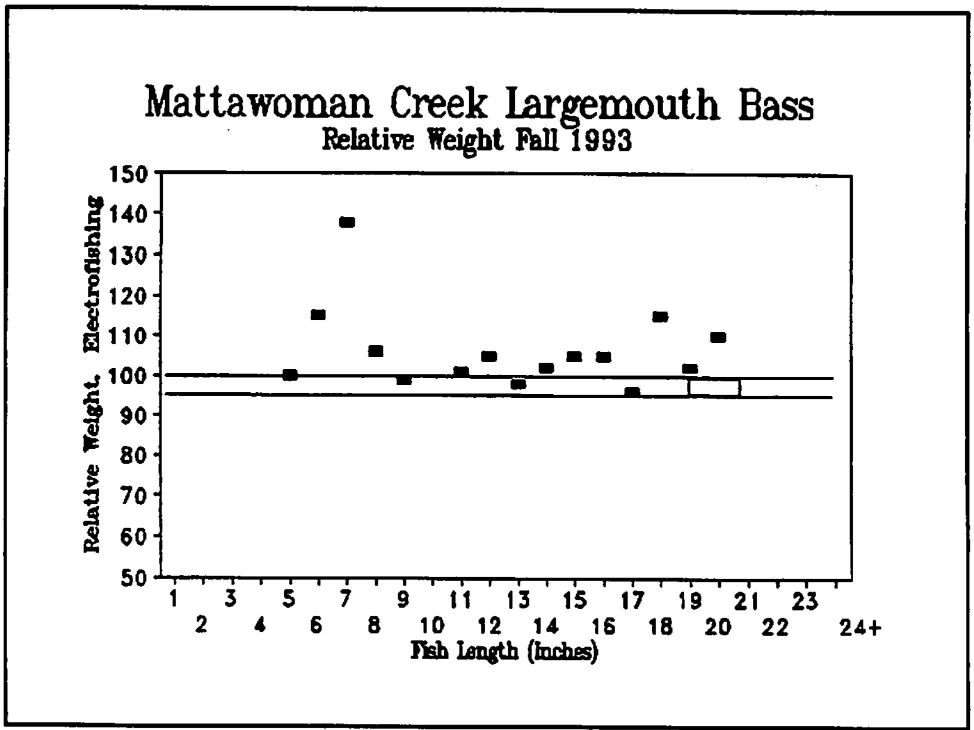

Figure 1

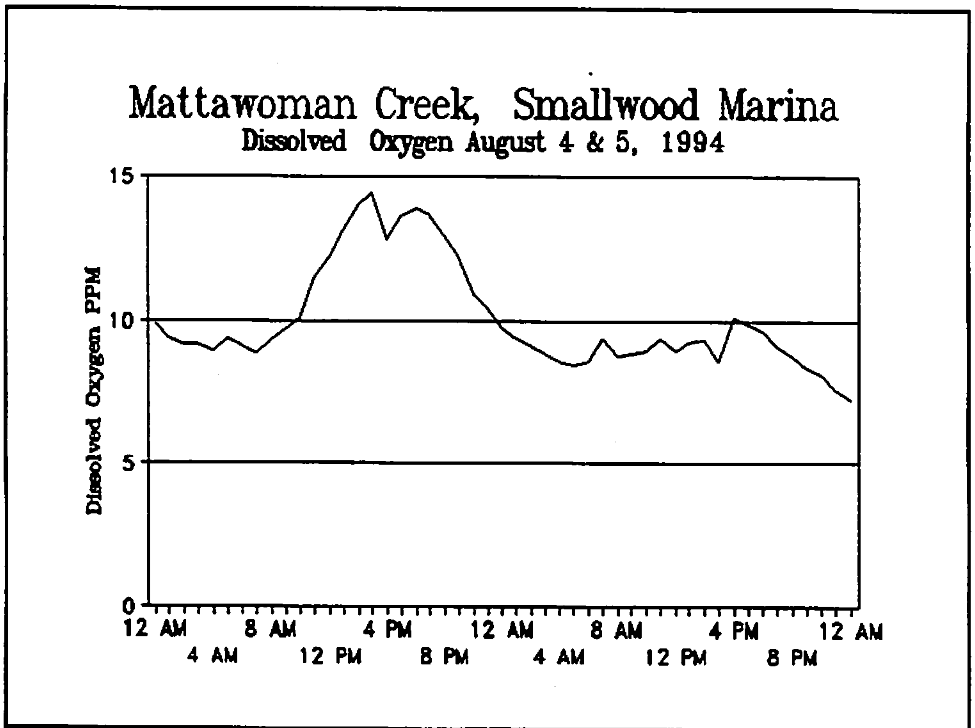

Figure 2

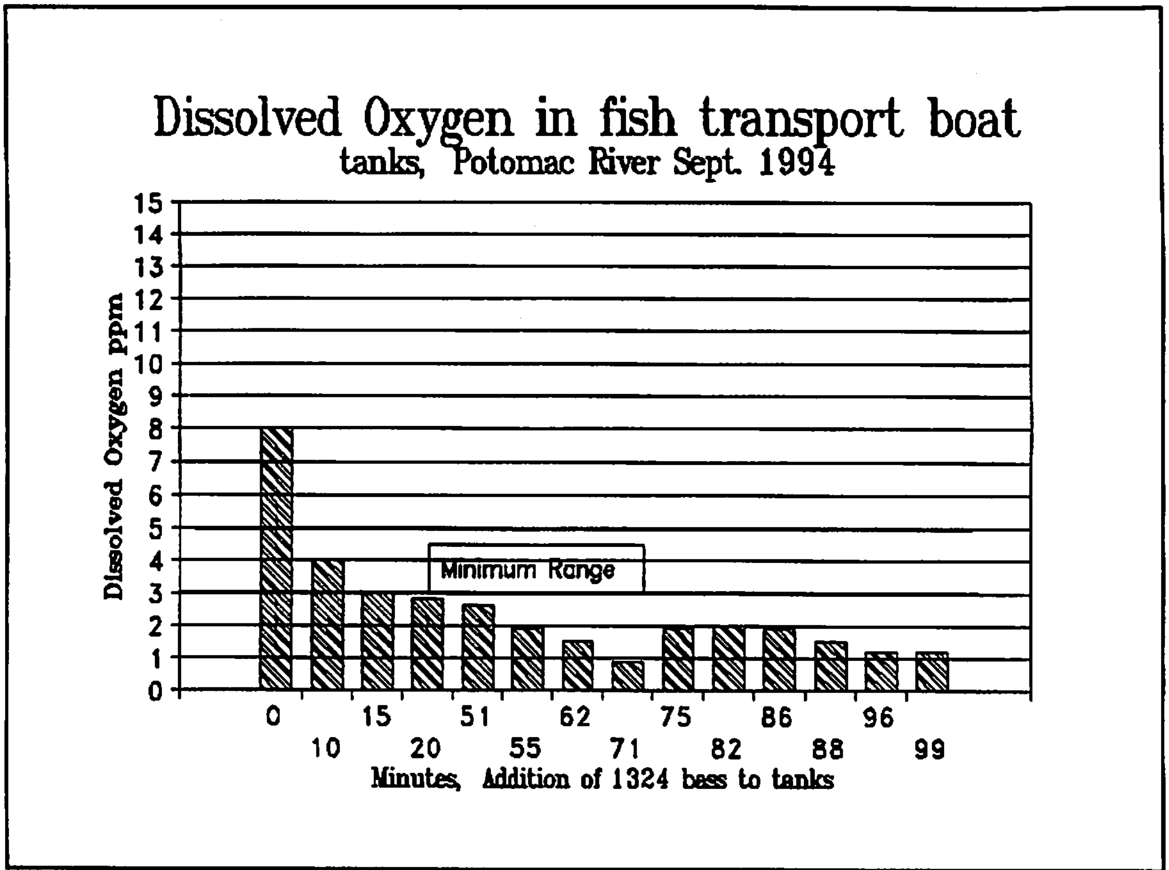
Dissolved Oxygen in fish transport boat
tanks, Potomac River Sept. 1994
Dissolved Oxygen ppm
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
0
Minimum Range
0
10
15
20
51
55
62
71
75
82
86
88
96
99
Minutes, Addition of 1324 bass to tanks

Figure 3

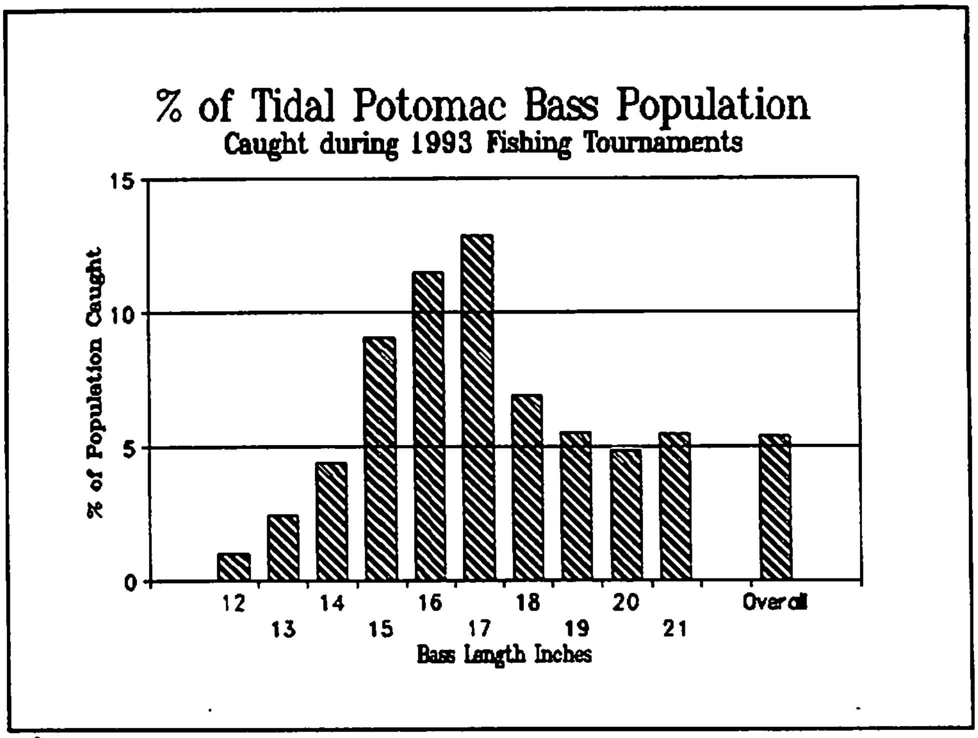

Figure 4

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Tidal Largemouth Bass Habitat Enhancement

By Carol Richardson-Heft
and
Leon Fewlass

INTRODUCTION

Efforts are underway to preserve and enhance largemouth bass habitats in Maryland's tidal waters. Habitat conservation is needed to insure the propagation of largemouth bass populations.

Largemouth bass reproduction in Maryland's segment of the Nanticoke River has been primarily in a 3.2 km section of Marshyhope Creek downstream from Federalsburg. Numerous large trees have fallen into the stream providing fish structure but trees are lacking immediately upstream where bass reproduction has been unsuccessful. Conceivably the submerged tree limbs protect bass nests by impeding stream and tidal water currents.

Wooden nesting boxes were placed in Marshyhope Creek where little spawning had been found to determine if largemouth bass reproduction could be enhanced. The boxes were designed to impede potentially damaging water currents. Concurrent to tests in Marshyhope Creek fish nesting boxes were also tested in a largemouth bass hatchery pond. All boxes were removed from the water after the bass spawning season.

Newly constructed piers are not suitable as quality habitat for largemouth bass. The use of preservative treated pilings impedes colonization on new piers by aquatic organisms which serve as part of the bass food chain. Triangles constructed from untreated slab wood were attached to the existing pilings on a pier in Watts Creek, a tributary of the Choptank River, to determine whether or not the structures could be used to provide cover for bass.

METHODS

Construction plans for fish nesting boxes were adapted from a design by Green et al. (1988). Modifications included altering structure dimensions and leaving the inside bottom of the box open. Installations having open bottoms retain natural stream substrate within the box for bass nesting and could promote submerged aquatic vegetation (SAV) development. Nesting boxes were built by members of the Delaware and Maryland Bass Federations.

Prior to the bass spawning season nesting boxes were placed in the upper portion of Marshyhope Creek where largemouth bass reproduction has been unsuccessful. Length, width, and height dimensions for boxes were 0.9 m x 0.6 m x 0.6 m and 0.9 m x 0.9 m x 0.6 m. Steel fence posts were used to secure boxes to the stream bottom. Floating warning buoys were attached to each installation.

Multi parameter water quality dataloggers (Hydrolab-DataSonde$_R$ 3) were placed at two locations in Marshyhope Creek. Water quality data was collected during 1992 and 1993. One datalogger was placed where successful largemouth bass reproduction had been recorded annually and one where reproduction had been unsuccessful.

Three oak slabs, each approximately 0.7 m long, were nailed together using galvanized nails to form a triangle. Twelve triangles were constructed during 1991 and attached below the low tide level to the existing pilings on a 58 m^2 pier in Watts Creek, a tidal tributary of the Choptank River. The triangles were submerged at low tides and were within the pier perimeter where they would not interfere with boat traffic. The structures were visually monitored annually.

RESULTS AND DISCUSSION

Two fish nesting boxes were placed in a largemouth bass hatchery pond at Maryland's Unicorn Lake Hatchery throughout the 1992 spawning season. Boxes were positioned diagonally in adjacent pond corners with the open side facing away from land. This arrangement allowed fish activity within boxes to be observed from the pond bank. One box was submerged entirely whereas approximately 30 cm of the other remained above water. Boxes were anchored by placing concrete blocks on side ledges.

Several largemouth bass reproduced in the hatchery pond containing the two nesting boxes. One nest inside the submerged box was the site for the production of several thousand young bass. An adult fish was first observed guarding this nest and later guarding fry inside and around the nesting box. The nesting box that remained partially exposed above water became an area of concentration for largemouth bass although no fish were observed spawning inside the box. Largemouth bass continued to spawn successfully and congregate at nesting boxes in the hatchery pond during 1993 and 1994.

Haul seining, during 1988 and 1991, revealed that the majority of Nanticoke River tidal water largemouth bass spawn within a 3.2 km section of Marshyhope Creek downstream from Federalsburg. Habitat conditions here were characterized by a solid stream bed, coves that retained water at low tides, pH levels within the range favorable for bass reproduction, emergent aquatic vegetation stands, and an abundance of trees that had fallen into the water where they functioned to protect bass nests from water currents. Upstream from this section for a distance of approximately 1.6 km to the confluence of tidal and nontidal waters limited bass reproduction was found. Here a sewage treatment plant discharged into the Creek, there were no aquatic vegetation stands, and few fallen trees were present which could protect bass nests.

The limited quantity of spawning habitats available in the Nanticoke make the fishery especially vulnerable to the effects of urbanization, agriculture, and increased fishing pressure. Preservation of the largemouth bass fishery will include management to protect the habitat found in the 3.2 km section of the river where reproduction takes place and continued efforts to enhance the upstream area which has potential for bass reproduction.

Two fish nesting boxes of different size were placed in Marshyhope Creek during 1992. Water levels varied with the tide inside the nesting boxes, several cm of water remained in boxes at low tides. A largemouth bass was observed on 4 May 1992 inside the smaller box. This fish appeared to be nesting as it chased herring from the box interior. Upstream from Federalsburg, where aquatic vegetation was absent during 1988 and 1991 dense stands of spiny naiad developed in 1992. SAV grew inside the box and did not undulate with water currents as did SAV outside the box providing evidence that the structure impeded water currents.

Substrate inside the larger box was scoured and no SAV growth developed indicating that this design may have increased water current velocity. No bass were observed using this nesting box. Use of the larger size box was discontinued after 1992.

YOY bass were collected by haul seine from Marshyhope Creek during 1992. YOY bass were found downstream from Federalsburg but none were caught where the nesting boxes were located.

Analysis of Hydrolab water quality data indicated that during the period of the spawning season sampled dissolved oxygen concentration (DO), pH, temperature, and salinity levels were favorable for bass reproduction in both stream segments. Dissolved oxygen concentration, frequently less than 3 mg/l during the July and August sample period, was atypical for waters having highly productive bass fisheries.

On 4 May 1993 four small nesting boxes were placed in Marshyhope Creek. An adult largemouth bass was observed on 15 May inside one of the nesting boxes. No SAV grew in the boxes during 1993. Spring 1993 rainfall was heavy increasing water turbidity and apparently reducing SAV growth. One YOY bass was observed inside a nesting box on 17 June and two were collected by haul seine from areas adjacent to the nesting boxes.

Water quality analysis of Hydrolab data found no major differences in water quality for the two areas sampled. Hydrolabs were retrieved in May 1993 due to high waters from heavy rainfall.

On 15 May 1994 twenty nesting boxes were placed in the upper portion of Marshyhope Creek where largemouth bass reproduction has been unsuccessful. The boxes were placed in three clusters. During 1994 no SAV grew inside or near the nesting boxes and no YOY bass were found inside or near the nesting boxes.

Nesting boxes did not appear to facilitate largemouth bass reproduction when placed in the tidal Marshyhope Creek where habitat conditions had prevented reproduction. This indicated the boxes could not be used effectively to expand the spawning area in the stream. Largemouth bass did spawn each year in boxes placed in the fish hatchery pond where existing habitat was suitable for bass spawning. Consequently nesting boxes may have the potential to augment largemouth bass reproduction in tidal streams where suitable habitat for bass spawning already exists.

The oak slab triangles appear to be an effective means of increasing largemouth bass cover in tidal waters. Triangle structure attachment was very stable, only one was lost from the pier pilings during 1991 through 1995. The untreated oak slabs also became encrusted with organic organisms which can benefit the bass food chain.

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Maryland Tidal Water Largemouth Bass Creel Census
by Alan Heft

ABSTRACT

Access point creel surveys were repeated on three Maryland tidal water fisheries, the upper Chesapeake Bay (1992), the Choptank River (1993), and the Potomac River (1994). The objectives for these surveys were similar to 1985-1990 surveys (Heft and Fewlass 1991): determine fishery quality, estimate angler use, evaluate angler preferences, assess the affects of fishery exploitation, and to expand the data base for future management use. Bass harvest estimates were generated for the Potomac River for the 15 inch minimum size season (1 March through 15 June) and 12 inch minimum size season (16 June to 1 March) to evaluate implementation, during 1990, of the 15 inch minimum size limit. Data was also collected regarding the prevalence of catch-and-release angling and bass fishing tournament participation.

Catch rates (bass/angler-hour) of bass for species anglers and all anglers has increased for each fishery since the initial surveys and are equal to or exceed catch rates reported for high quality bass fisheries throughout North America. Largemouth bass (Micropterus salmoides) were the most sought after species in the upper Chesapeake Bay and the Potomac River, and the 2nd most sought after species in the Choptank River with the majority of bass anglers (81% to 90%) practicing catch-and-release.

Upper Chesapeake Bay waters support a high quality sportfishery for black bass and a variety of other fish species. Fishing pressure has increased six-fold in the upper Chesapeake Bay since 1987 but remains relatively light in comparison to other tidal waters. Black bass continue to be the most sought after fish, catch rates of bass are good for all anglers and excellent for species anglers.

The Choptank River sportfishery continues to be highly used, angling pressure per acre was greater than in the upper Bay or the Potomac River. Despite this heavy fishing pressure the Choptank River supports a high quality, diverse sportfishery. A considerable improvement in the quality of the largemouth bass sportfishery since the 1988 survey was observed, as evidenced by increases in the estimated bass population size (239%) and the bass catch rate (410%) by species anglers.

The Potomac River supports one of the best black bass sportfisheries in the United States. Black bass catch rates increased from 1990 rates and were much higher than the rates recorded in other Maryland tidal waters. The bass population has increased an estimated 57% since the 1990 survey. Even though

the bass population increased fishing pressure remained similar to the 1990 level, possibly due to the resource being near an angler use saturation point. Harvest of bass was 75% less than in 1990, an indication that the implementation of a 15 inch minimum size limit for bass during the spawning season was successful in its objective to reduce the number of male bass removed from their nests.

INTRODUCTION

Access point creel surveys were conducted for the upper Chesapeake Bay (1992), the Choptank River (1993), and the Potomac River (1994) as part of investigations of Largemouth bass populations inhabiting Maryland tidal waters. The objectives for these surveys were similar to those for surveys conducted from 1985-1990 (Heft and Fewlass 1991); determine fishery quality, estimate angler use, evaluate angler preferences, assess the effects of fishery exploitation, and to expand the data base for future management use. Bass harvest estimates were generated for the Potomac River for the 15 inch minimum size season (1 March through 15 June) and 12 inch minimum size season (16 June to 1 March) to evaluate implementation, during 1990, of the 15 inch minimum size limit. Data was also collected regarding the prevalence of catch-and-release angling and bass fishing tournament participation.

METHODS

Upper Chesapeake Bay

The upper Chesapeake Bay study area (approximately 27,125 ha) was the same as delineated in the 1986 survey (Heft and Fewlass 1991) inclusive of tidal waters of the Sassafras River (Eastern Shore) northward through the Gunpowder River (Western Shore). The survey design was changed from the 1986 study methods to follow methods and procedures for access point creel surveys as described by Coomer and Holder (1980), Fowler and Holder (1987), Borawa (1989), and CreeSys Fish Info System (Ontario Ministry of Natural Resources 1985).

The survey term, 6 May 1992 through 1 November 1992, was selected to sample the fishery during peak usage by anglers. The survey term was divided into two week survey periods normally consisting of ten weekdays and four weekend days. However when holidays occurred on weekdays they were considered weekend days. To account for the change in day-length during the various seasons the survey term was also divided into three seasons: spring (May 6-30), summer (June 1 - August 31), and fall (September 1 - November 1). Starting and ending times for the samples were changed for each season to insure maximum contact with anglers. All sample days were split into two 6 hour periods (early and late). Survey site locations were selected based upon their relative usage by anglers and conduciveness to this type of sampling. Because angler access to the fishery had changed since 1986, data was collected at nine access points, as compared to seven in the 1986 survey. In addition two of the survey sites were sub-divided making 12 sites. Each site was assigned a sampling probability based on observations of angler use and information from previous investigations. Survey sites and their sampling probabilities are listed in Table 1. Parameters were entered into the CreeSys program to generate the sampling calendar.

Creel clerks were instructed to interview angling parties passing through the access point and record their answers on Creel Interview Forms. When too many anglers were present to interview at one time the clerk interviewed as many as possible and recorded the number of other anglers that were not interviewed. Anglers were interviewed whether or not they had finished fishing for the day. The clerk asked each fishing party: fishing start time, if finished fishing, fishing stop time, number in party, number fishing, number of rods, respondents attitude toward the level of fishing pressure in the upper Bay (Light, Good, Heavy), whether they practice catch-and-release, state of residence, if they participate in bass fishing tournaments, if they are participating/practicing for a bass fishing tournament, what do they feel is the quality of the upper Bay sportfishery (Very poor, Poor, Fair, Good, Excellent), fish species sought, number creeled, and number released. The fish species that were recorded included largemouth bass, smallmouth bass (<u>Micropterus</u> <u>dolomieui</u>), catfish (<u>Ictalurus</u> spp.), sunfish (<u>Lepomis</u> spp.), crappie (<u>Pomoxis</u> spp.), yellow perch (<u>Perca flavescens</u>), striped bass (<u>Morone</u> <u>saxatilis</u>), and "Other" (any fish other than the previous choices). Data from the Creel Interview Forms was analyzed in house with the CreeSys program using a personal computer.

<u>Choptank River</u>

The 1993 Choptank River creel survey area was the same as delineated in the 1988 survey (Heft and Fewlass 1991), the 1,215 ha section of tidal river from the Maryland Route 321 bridge upstream to the non-tidal dividing lines at the town of Greensboro and the Tuckahoe Dam. The Choptank River survey term was 5 May 1993 through 2 November 1993. To account for the change in day-length during the various seasons the survey term was divided into three seasons: spring (May 5-30), summer (June 1 - August 31), and fall (September 1 - November 2).

Several Choptank River survey methods differed from those used for the upper Chesapeake Bay creel survey. Seven survey site locations were selected (Table 2). Smallmouth bass were deleted from the fish species list and pickerel (*Esox* spp.) were added. The estimated number of largemouth bass in the tidal Choptank River was determined from the catch equation, $Ct=Nt_0(1-e^{-M-qf})qf/M+qf$ (Calhoun 1966), where Ct=the estimated number of bass caught from the creel survey.

Potomac River

The Potomac River study area included all tidal waters of the main river (and its Maryland tributaries) from the U.S. Route 301 bridge upstream to the Maryland-Washington D.C. boundary, comprising approximately 12,145 ha. The Potomac River survey methods followed those used for the upper Bay and Choptank River surveys except for the following changes. The survey term was 1 May through 31 October, 1994, with six public access areas along the tidal Potomac River in Maryland selected as sample locations (Table 3): General Smallwood State Park, Fort Washington boat landing, Friendship Landing on Nanjemoy Creek, Marshall Hall boat landing, Rt. 301 boat landing, and Port Tobacco boat landing. Partway through the survey the Port Tobacco boat landing was closed for repairs and the remaining survey dates were transferred to the General Smallwood and Fort Washington sites. The fish species recorded included largemouth bass, catfish spp., sunfish spp., crappie spp., yellow perch, white perch (*Morone americana*), striped bass, chain pickerel (*Esox niger*), and "Other" (any fish other than the previous choices).

RESULTS

1992 Upper Chesapeake Bay Survey

Anglers fished 119,209 hours, caught and released 90,723 fish, and harvested 15,954 fish. Overall catch rate (fish harvested and catch-and-release) was 0.90 fish/ang-hr. Fish were harvested at the rate of 0.14 fish/ang-hr and caught and released at the rate of 0.76 fish/ang-hr. Fishing pressure was 1.8 ang-hrs/acre. Overall fish harvest and catch rates for all fish species were 0.25 fish/acre and 1.60 fish/acre, respectively. Catch rates, percent of total catch, and number of fish caught for each species by all anglers are listed in Table 4.

By species Other had the highest catch rate (0.364 fish/ang-hr) and composed 40.5% of the total number of fish caught. The majority of fish in the Other category were white perch but also included common carp (*Cyprinus carpio*), american eel (*Anguilla rostrata*), gizzard shad (*Dorosoma cepedianum*), walleye (*Stizostedium vitreum*), and white sucker (*Catostomus commersoni*). Largemouth bass had the next higher catch rate of 0.123 fish/ang-hr, comprising 13.7% of the total catch, followed by catfish (0.112 fish/ang-hr, 12.5%), sunfish (0.087 fish/ang-hr, 9.6%), yellow perch (0.081 fish/ang-hr, 9.0%), striped bass (0.075 fish/ang-hr, 8.3%), smallmouth bass (0.053 fish/ang-hr, 5.9%) and crappie (0.005 fish/ang-hr, 0.5%). Harvest rates, percent of total catch, and number of fish harvested for each species by all-anglers are listed in Table 5.

Other had the highest harvest rate (0.0709 fish/ang-hr) and accounted for 51.4% of the total number of fish harvested. The next higher harvest was catfish (0.0409 fish/ang-hr, 29.7%), followed by yellow perch (0.0128 fish/ang-hr, 9.3%), sunfish (0.00461 fish/ang-hr, 3.3%), crappie (0.00411 fish/ang-hr, 3.0%), largemouth bass (0.00369 fish/ang-hr, 2.7%), striped bass (0.000562 fish/ang-hr, 0.4%), and smallmouth bass (0.000268 fish/ang-hr, 0.2%).

Largemouth bass were the most sought after fish being pursued by 32.1% of the anglers. Catfish (19.3%) were the next sought after fish, followed by Other (19.0%), smallmouth bass (11.1%), sunfish (6.1%), yellow perch (5.8%), striped bass (5.5%), and crappie (1.0%) (Table 6).

Among species-anglers yellow perch fishermen had the highest catch rate (1.428 fish/ang-hr) and accounted for 68.8% of all yellow perch caught. Crappie anglers had the next catch rate (1.094 fish/ang-hr), accounting for 91.2% of all crappie caught, followed by Other anglers (0.819 fish/ang-hr, 49.4%), striped bass anglers (0.520 fish/ang-hr, 40.9%), largemouth bass anglers (0.433 fish/ang-hr, 97.8%), catfish anglers (0.429 fish/ang-hr, 59.8%), sunfish anglers (0.368 fish/ang-hr, 21.2%), and smallmouth bass anglers (0.310 fish/ang-hr, 94.1%). Catch rates, percent of total catch, and number of fish caught per species by species-anglers are listed in Table 7.

Harvest rates among species anglers were highest for crappie anglers who harvested 1.094 fish/ang-hr and accounted for 100% of all crappies harvested. Other anglers (0.298 fish/ang-hr, 92.4%) were next, followed by yellow perch anglers (0.283 fish/ang-hr, 85.9%), catfish anglers (0.212 fish/ang-hr, 81.0%), sunfish anglers (0.0306 fish/ang-hr, 33.1%), largemouth bass anglers (0.0123 fish/ang-hr, 92.5%), striped bass anglers (0.00699 fish/ang-hr, 73.1%), and smallmouth bass anglers (0.00166 fish/ang-hr, 100%). Harvest rates, percent of total catch, and number of fish harvested per species by species-anglers are listed in Table 8.

Catch and release angling was practiced by 84.0% of anglers. The majority of the anglers interviewed were Maryland residents (84.5%). Pennsylvania anglers were the next numerous (10.1%), followed by Delaware anglers (2.9%), and anglers from New Jersey (<1%), New York (<1%), Virginia (<1%), and Georgia (<1%). Most anglers (79.0%) did not participate in black bass fishing tournaments and only 9.5% were participating or practicing for a bass tournament when interviewed. Sportfishing pressure in the upper Bay was considered by anglers as Good (44.4%), Heavy (34.9%), and Light (20.7%). The majority of anglers felt that the quality of the upper Bay sportfishery was Good (54.0%), followed by Fair (25.5%), Excellent (10.5%), Poor (7.8%), and Very Poor (2.2%).

1993 Choptank River Survey

Anglers fished 37,348 hours (SE 3,907), caught and released 24,840 fish (SE 3,672), and harvested 3,953 fish (SE 1,083). Overall catch rate (fish harvested and catch-and-release) was 0.771 fish/ang-hr (SE 0.127). Fish were harvested at the rate of 0.106 fish/ang-hr (SE 0.029) and caught and released at the rate of 0.665 fish/ang-hr (SE 0.098). Fishing pressure was 12.4 ang-hrs/acre (SE 1.0). Overall fish harvest and catch rates (caught and released fish only) for all fish species were 1.3 fish/acre (SE 0.4) and 8.3 fish/acre (SE 1.6), respectively. The black bass population size was estimated to be 21,224 (range 17,708-24,740).

Catfish had the highest catch rate (0.342 fish/ang-hr) and composed 44.3% of the total number of fish caught. Sunfish had the next catch rate, 0.161 fish/ang-hr, composing 20.8% of the total catch, followed by largemouth bass (0.137 fish/ang-hr, 17.8%), white perch (0.079 fish/ang-hr, 10.2%), yellow perch (0.026 fish/ang-hr, 3.4%), crappie (0.014 fish/ang-hr, 1.9%), striped bass (0.006 fish/ang-hr, 0.7%), "Other" (0.006 fish/ang-hr, 0.7%), and pickerel (0.001 fish/ang-hr, 0.1%). "Other" fish species caught were common carp, american eel, and gizzard shad. Catch rates, percent of total catch, and number of fish harvested for each species by all-anglers are listed in Table 9.

Catfish had the highest harvest rate (0.076 fish/ang-hr) and accounted for 71.4% of the total number of fish harvested. The next harvested fish was sunfish (0.021 fish/ang-hr, 19.5%), followed by crappie (0.004 fish/ang-hr, 4.2%), white perch (0.002 fish/ang-hr, 2.3%), largemouth bass (0.001 fish/ang-hr, 1.6%), pickerel (0.001 fish/ang-hr, 1.0%), and yellow perch (<0.001 fish/ang-hr, <1.0%). Harvest rates, percent of total catch, and number of fish harvested for each species by all-anglers are listed in Table 10.

Catfish were the most sought after fish being pursued by 49.2% of the anglers. Largemouth Bass were the next sought after fish (33.4%), followed by sunfish (22.7%), white perch (17.2%), yellow perch (3.7%), crappie (3.1%), "Other" (1.4%), pickerel (0.6%), and striped bass (0.2%) (Table 11). Percentage is greater than 100 because some anglers pursued more than one species.

Among species-anglers catfish fishermen had the highest catch rate (0.675 fish/ang-hr) and accounted for 94.1% of all catfish caught. Sunfish anglers had the next catch rate (0.632 fish/ang-hr), accounting for 91.1% of all sunfish caught, followed by striped bass anglers (0.615 fish/ang-hr, 47.6%), white perch anglers (0.378 fish/ang-hr, 72.0%), largemouth bass anglers (0.365 fish/ang-hr, 99.8%), crappie anglers (0.313 fish/ang-hr, 89.3%), yellow perch anglers (0..200 fish/ang-hr, 37.1%), pickerel anglers (0.166 fish/ang-hr, 74.4%), and "other" anglers (0.092 fish/ang-hr, 21.4%). Catch rates, percent of total catch, and number of fish caught per species by species-anglers are listed in Table 12.

Harvest rates among species anglers were highest for pickerel anglers who harvested 0.166 fish/ang-hr and accounted for 100% of all pickerel harvested. Catfish anglers (0.155 fish/ang-hr, 97.7%) were next, followed by crappie anglers (0.107 fish/ang-hr, 100%), sunfish anglers (0.089 fish/ang-hr, 100%), white perch anglers (0.016 fish/ang-hr, 100%), and largemouth bass anglers (0.005 fish/ang-hr, 100%). Harvest rates, percent of total catch, and number of fish harvested per species by species-anglers are listed in Table 13.

Catch-and-release angling was practiced by 90.2% of anglers. The majority of the anglers interviewed were Maryland residents (80.5%). Delaware anglers were the next numerous (17.0%), followed by anglers from New Jersey (1.9%), Virginia (1.4%), Pennsylvania, Texas, North Carolina, Florida, Washington D.C., and Germany (all <1%). Most anglers (80.4%) did not participate in black bass fishing tournaments, but of the anglers interviewed who did 10.2% were at that time participating or practicing for a bass tournament. Sportfishing pressure in the Choptank River was considered by anglers as Good (59.6%), Light (34.1%), and Heavy (6.3%). The majority of anglers felt that the quality of the Choptank River sportfishery was Good (65.9%), followed by Fair (23.1%), Excellent (5.9%), Poor (4.7%), and Very Poor (0.4%).

<u>1994 Potomac River Survey</u>

The Potomac River creel survey found that anglers fished 184,044 (SE 13,685) hours, caught and released 124,254 fish, and harvested 27,279 fish. Combined catch rate (fish harvested and catch-and-release) was 0.823 fish/ang-hr. Fish were harvested at the rate of 0.148 fish/ang-hr and caught and released at the rate of 0.675 fish/ang-hr. Fishing pressure was estimated at 6.1 ang-hrs/acre. The black bass population was estimated at 372,558 (range 336,452 to 408,663).

Harvest and catch rates for all fish species were 0.909 fish/acre and 4.142 fish/acre, respectively. Mean weight of all harvested fish was 1.8 lbs/fish. By species striped bass had the highest mean harvested weight (5.1 lbs/fish), followed by catfish

(3.4 lbs/fish), other (2.2 lbs/fish), largemouth bass (1.9 lbs/fish), yellow perch (0.6 lbs/fish), crappie (0.4 lbs/fish), white perch (0.4 lbs/fish), and sunfish (0.3 lbs/fish). Mean weights of all harvested fish are listed in Table 14.

By species largemouth bass was the highest all-angler catch rate (0.383 fish/ang-hr) and composed 56.7% of the total number of fish caught. White perch had the next catch rate (0.168 fish/ang-hr), composing 24.8% of the total catch, followed by striped bass (0.047 fish/ang-hr, 6.9%), catfish (0.044 fish/ang-hr, 6.6%), yellow perch (0.021 fish/ang-hr, 3.1%), sunfish (0.007 fish/ang-hr, 1.0%), other (0.005 fish/ang-hr, 0.7%), and crappie (0.001 fish/ang-hr, 0.2%). Catch rates, percent of total catch, and number of fish caught for each species by all-anglers are listed in Table 15.

White perch had the highest harvest rate (0.105 fish/ang-hr) and accounted for 71.1% of the total number of fish harvested. The next harvested species was catfish (0.027 fish/ang-hr), composing 18.3% of the harvest, followed by largemouth bass (0.008 fish/ang-hr, 5.4%), other (0.004 fish/ang-hr, 2.4%), sunfish (0.002 fish/ang-hr, 1.4%), yellow perch (0.001 fish/ang-hr, 0.6%), striped bass (0.001 fish/ang-hr, 0.5%), and crappie (0.001 fish/ang-hr, 0.3%). Harvest rates, percent of total catch, numbers of fish harvested, and average weights for each species for all-anglers are listed in Table 14.

Largemouth bass were the most sought after fish, being pursued by 70.1% of anglers. Catfish (12.9%) were the next sought after fish, followed by white perch (7.7%), yellow perch (2.6%), striped bass (2.1%), sunfish (2.1%), other (1.8%), and crappie (0.6%) (Table 16).

Among species-anglers white perch anglers had the highest catch rate (1.318 fish/ang-hr) and accounted for 88.6% of all white perch caught. Largemouth bass anglers had the next catch rate (0.465 fish/ang-hr), accounting for 99.9% of all largemouth bass caught, followed by striped bass anglers (0.373 fish/ang-hr, 31.1%), crappie anglers (0.314 fish/ang-hr, 78.5%), sunfish anglers (0.282 fish/ang-hr, 77.8%), catfish anglers (0.232 fish/ang-hr, 84.1%), yellow perch anglers (0.231 fish/ang-hr, 29.6%), and other (0.105 fish/ang-hr, 91.8%). Catch rates, percent of total catch, and number of fish caught per species by species-anglers are listed in Table 17.

Harvest rates among species-anglers were also highest for white perch anglers who harvested 0.930 fish/ang-hr and accounted for 99.5% of the white perch harvest. Catfish anglers (0.167 fish/ang-hr, 98.5%) were next, followed by crappie anglers (0.163 fish/ang-hr, 100%), sunfish anglers (0.105 fish/ang-hr, 96.1%), other anglers (0.0815 fish/ang-hr, 100%), yellow perch

(0.00308 fish/ang-hr, 84.7%), striped bass (0.0157 fish/ang-hr, 91.1%), and largemouth bass (0.00966 fish/ang-hr, 100%). Harvest rates, percent of total harvest, and number of fish harvested per species by species-anglers are listed in Table 18.

Largemouth bass catch and harvest rates for the 15 inch minimum size limit period (March 1 - June 15) and the 12 inch minimum size limit period (June 16 - February 28) were estimated (Table 19). For the 15 inch minimum size period largemouth bass were caught by all-anglers at the rate of 0.445 fish/ang-hr and harvested at the rate of 0.0119 fish/ang-hr. Species-anglers catch (0.521 fish/ang-hr) and harvest (0.0140 fish/ang-hr) rates for this period were slightly higher. For the 12 inch minimum size period the catch rate for all-anglers was 0.400 fish/ang-hr and the harvest rate was 0.00834 fish/ang-hr. Species-anglers catch (0.489 fish/ang-hr) and harvest (0.0102 fish/ang-hr) rates were comparable with rates for species-anglers from the 15 inch minimum size period.

Largemouth bass catch rates were calculated for each month of the survey (Table 20). For all-anglers the highest catch rate occurred in October (0.494 fish/ang-hr), followed by June (0.466 fish/ang-hr), August (0.380 fish/ang-hr), September (0.380 fish/ang-hr), July (0.364 fish/ang-hr), and May (0.340 fish/ang-hr). Species-anglers catch rates for each month were considerably higher than those for all-anglers. September (0.555 fish/ang-hr) had the highest catch rate, followed by June (0.539 fish/ang-hr), August (0.530 fish/ang-hr), October (0.521 fish/ang-hr), July (0.424 fish/ang-hr), and May (0.419 fish/ang-hr).

Monthly harvest rates of largemouth bass are listed in Table 21. Harvest rates for both species-anglers and all-anglers were highest in October (0.0150 fish/ang-hr, 0.160 fish/ang-hr) and May (0.0130 fish/ang-hr, 0.0160 fish/ang-hr). The lowest harvest rate occurred in September for both species-anglers (0.0003 fish/ang-hr) and all-anglers (0.0004 fish/ang-hr).

Catch-and-release angling was practiced by 80.6% of anglers. The majority of the anglers interviewed were Maryland residents (86.5%), the non-resident anglers (13.5%) were from 19 states (Pennsylvania, Virginia, New Jersey, North Carolina, Delaware, South Carolina, Washington D.C., New York, Ohio, Louisiana, Tennessee, Kentucky, West Virginia, New Hampshire, Florida, Arkansas, Oklahoma, Indiana, and Mississippi). Most anglers practice catch-and-release (80.6%) and consider themselves bass anglers (82.6%), and of these bass anglers 44.2% participate in bass fishing tournaments. Sportfishing pressure in the Potomac River was considered by anglers as Heavy (45.8%), Good (44.5%), and Light (10.1%), and the quality of the sportfishery as Good (52.2%), Excellent (32.1%), Fair (13.9%), Poor (1.7%), and Very Poor (0.1%).

DISCUSSION

1992 Upper Chesapeake Bay Survey

The most significant finding from the 1992 upper Chesapeake Bay creel survey has been an almost six-fold increase in fishing pressure, 1.8 ang-hrs/acre, as compared to 0.31 ang-hrs/acre in 1987 (Heft and Fewlass 1991). Although this is a large increase fishing pressure in the upper Bay is still relatively light in comparison to other Maryland tidal river sportfisheries (Table 22). An increase in non-resident anglers from 1.0% in 1987 to 15.5% in 1992 accompanied fishing pressure increase. The catch rate by all anglers was good (0.90 fish/ang-hr) when compared to catch rates from other Maryland tidal waters and the 1987 upper Bay survey (Table 22). The highly successful BASS Masters Classic championship fishing tournament in August of 1991 held on the upper Bay publicized the improved sportfishing available in the area and likely contributed to the increased fishing pressure.

Black bass were the most sought after sportfish in both the 1987 and 1992 surveys but the percentage of anglers pursuing black bass decreased in 1992 to 43.2% as compared to 79.0% in 1987. The overall catch rate for black bass in 1992 (0.176 fish/ang-hr) was almost twice that found in 1987 (0.090 fish/ang-hr) and is indicative of a good quality fishery. The largemouth bass catch rate by species anglers (0.433 fish/ang-hr), who are usually more proficient at catching their targeted species (Reiman 1987) than other anglers, was excellent and is comparable to the bass catch rate in the Potomac River. The decrease in the percentage of anglers pursuing bass was likely due to both the influx of more anglers and an increased interest in the numerous other sportfish species available in the upper Bay. This was reflected in the increased overall catch rates for sunfish, catfish, and yellow perch for the 1992 survey as compared to the rates from the 1987 survey.

The improved, more positive attitude by which anglers view the upper Bay sportfishery was apparent during this survey. The majority of anglers interviewed in 1992 responded that the quality of fishing in the upper Bay was "Good" or "Excellent" (54% and 11% respectively) as compared to the 1987 survey when 18% responded "Good" and <1% "Excellent". The majority of respondents in 1987 felt that fishing was either "Fair" or "Poor" (51% and 28% respectively). The increase in non-residents fishing the upper Bay area, as described earlier, was also indicative of the improving quality and reputation of the fishery. Elser (1960) found during a 1958 creel survey of the Northeast River, a microcosm of the upper Bay fishery, that 75% of all anglers were non-residents. The 1987 survey, completed just as the fishery was beginning a recovery from the declines of the two preceding decades, showed that only 1% of anglers were non-residents. The return to the upper Bay of non-resident anglers from neighboring states including Pennsylvania, Delaware, New Jersey, New York, and Virginia highlights the reputation for quality angling that this fishery is developing.

Based on this survey the upper Bay is providing a quality sportfishing resource for freshwater sportfish species, and in particular a lightly used, high quality black bass sportfishery. Black bass continue to be the most sought after fish species with anglers also now exploiting the previously less utilized panfish and catfish resources. Catch-and-release is practiced by most anglers (84.0%) with the majority of harvested fish being white perch or catfish. Harvest rates of black bass were so low as to have little or no impact on the continued expansion of the fishery.

1993 Choptank River Survey

The Choptank River sportfishery is being highly used by anglers. Fishing effort (12.4 ang-hrs/acre) has increased as compared to the 1988 (Heft and Fewlass 1991) survey (10.0 ang-hrs/acre) and is higher than for other surveyed Maryland tidal-freshwater sportfisheries listed in Table 22. Number of fish caught and catch rates (all anglers and species anglers) were lower overall and for all species except black bass than in 1988 (Tables 23, 24). In particular striped bass, yellow perch and white perch catches were 95%, 81%, and 37% lower, respectively. Numbers of catfish and sunfish, the 1st (49.2%) and 3rd (22.7%) most sought after species, caught and harvested were similar to those found in 1988, but estimated catch and harvest rates were lower due to more angler effort expended. However the overall catch (0.771 fish/ang-hr) and harvest (0.106 fish/ang-hr) rates for the Choptank River sportfishery remain high and are indicative of an excellent quality sportfishery (Table 25). The seasonal availability and vulnerability of white perch, yellow perch, and striped bass to angling is often dependent on spring weather and other environmental conditions. All three species spawn in the spring and early spawning runs may have reduced the numbers of fish available to anglers during the creel survey period.

Largemouth bass were the 2nd most sought after fish (33.4%). Even though angler effort for bass was 31% less than found in 1988 (Table 23) the number of bass caught increased from 1,606 (SE 316) in 1988 to 5,113 (SE 847) in 1993. Bass catch rates by all anglers (0.137) and species anglers (0.365) were excellent and compare favorably to catch rates found during 1990 and 1994 Potomac River creel surveys and the 1992 upper Chesapeake Bay creel survey (Table 26), areas that support high quality black bass sportfisheries. Only 63 bass were harvested (0.001 fish/ang-hr) and this low harvest is attributable to the finding that 90% of all Choptank anglers practice catch-and-release angling. Since the 1988 survey the black bass population has increased 239% from an estimated 6,258 (SE 1,231) bass to 21,224 (SE 3,516) bass.

A major shift in the way that anglers view the quality of the Choptank River sportfishery has occurred since the 1988 creel survey when most anglers described the quality as either "Fair" (36%) or "Poor" (33%). A majority of anglers now describe the quality of the Choptank River sportfishery as "Good" (65.9%) or "Excellent" (5.9%). Although the sportfishery received the highest angling effort per acre of the three waters surveyed most anglers described the fishing pressure on the Choptank as "Good" (59.6%) or "Light" (34.1%). The Choptank River sportfishery was used mainly by anglers from Maryland (80.5%) and Delaware (17.0%), as in 1988, and continues to provide an important regional recreational resource.

The Choptank River sportfishery is highly utilized and provides excellent sportfishing opportunities for various gamefish species. Black bass angling has improved significantly since the 1988 survey and bass angling success rates are now comparable to those found for the nationally recognized Potomac River bass sportfishery (Heft and Fewlass 1991, Fewlass 1994). Angling quality should continue to improve as the black bass population expands and watershed management efforts improve spawning and habitat conditions for the white perch, yellow perch, and striped bass populations.

1994 Potomac River Survey

Freshwater Fisheries Division personnel interviewed 903 anglers during the 1994 tidal water Potomac River creel survey. The Potomac River continued to support one of the best tidal largemouth bass sportfisheries in Maryland. Largemouth bass angling success rates by all-anglers and species-anglers were 18% and 24% higher than in 1990 (Heft and Fewlass 1991) and were higher than rates from other Maryland and national tidal largemouth bass fisheries (Table 26). The fishery has been recognized by various local and national publications and bass fishing organizations as being one of the finest largemouth bass fisheries in the United States, attracting many professional and amateur bass angling tournaments and non-resident anglers (13.5% of all anglers in 1994). Angler opinion of the quality of the fishery was very positive, as evidenced by 84.3% of anglers interviewed responding that quality was either "Excellent" or "Good".

The tidal Potomac River continues to support excellent sportfisheries for fish species other than largemouth bass. Species anglers accounted for the majority of the catch and harvest for a particular species, with the exception of yellow perch. The majority of yellow perch caught and harvested were as incidental catches, likely by largemouth bass anglers. Fishing effort directed towards catfish increased slightly from the 1990 survey although the number of fish caught and harvested declined (Tables 29, 30). However angler success rates remained high and the average size of harvested catfish (3.4 lbs/fish) was excellent. White perch continued to be the most harvested fish and a large increase was observed in fishing effort (25%) and angler success rates since 1990.

Monthly catch rates for largemouth bass mirrored the trend observed in 1990 with the highest rates in spring (May, June) and fall (September, October) months (Table 20). Anglers specifically fishing for bass had the highest catch rate, both in 1990 and 1994, during September.

Unlike 1990 when harvest was higher during the 12 inch minimum size period the 1994 harvest rate of largemouth bass was higher during the 15 inch minimum size period (1 March - 15 June) (Table 19). This change does not impede the objective of reducing bass harvest during this period as overall 75% less bass were harvested than in 1990, and along with the high incidence of catch-and-release practiced by Potomac bass anglers supported the assumption that much of the bass harvest was a result of anglers keeping large bass as "trophies". During spring, the 15 inch minimum size period, the larger female bass are more easily caught than at other times of the year. Overall angler harvest of bass remained very low, less than 1.0% of the estimated largemouth bass population.

Angling effort was similar to that found in 1990 (Table 27), with the majority of effort in both surveys (1990-71%, 1994-70%) directed towards largemouth bass. The largemouth bass population, estimated from creel surveys, has increased 57% since 1990 (Heft and Fewlass 1991) and as expected with this increase catch rates have also risen (Table 28). However angler effort has not noticeably increased (Table 27), possibly because angling pressure is near a saturation point. This saturation point may be due in part to concentration of the majority of the bass population into sections of the river having prime bass habitat. Anglers congregate in these sections, which causes problems such as heavy boat traffic and sporadic antagonistic encounters of resource users. Some anglers have reported that due to crowding they no longer fish the Potomac River. Forty-six percent of Potomac River anglers considered fishing pressure to be "Heavy". Crowding also occurs at boat launching ramps which are typically at capacity for the majority of days during the peak bass angling season.

Based on angler success rates the Potomac River continues to provide one of the best largemouth bass fisheries in the United States.

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Table 1. 1992 Upper Chesapeake Bay access point creel survey sampling sites and probability of angler use for each site.

Site	Probability
Dundee Creek Marina	0.15
Tydings Park	0.15
Lapidum	0.15
Flying Point	0.10
Sassafras River	
Turner's Creek	0.06
Duffy Creek	0.06
Susquehanna River	
Conowingo dam	0.03
Port Deposit	0.03
Power Co. Ramp	0.03
Elk Neck	0.10
Route 213	0.07
Northeast Marina	0.04

Table 2. 1993 Choptank River access point creel survey sampling sites and probability of angler use for each site.

Site	Probability
Denton	0.20
Martinak	0.20
Ganey's Wharf	0.15
Greensboro	0.15
Tuckahoe	0.125
Hillsboro	0.125
Rt. 328	0.05

Table 3. 1994 Potomac river access point creel survey sampling sites and probability of angler use for each site.

Site	Probability
Mattawoman creek	0.45
Fort Washington	0.32
Nanjemoy creek	0.06
Port Tobacco creek	0.06
Marshall Hall	0.06
Rt. 301	0.05

Table 4. Estimated number of fish caught, catch rate (fish/ang-hr), and percent of total catch by species for all anglers for the 1992 Upper Chesapeake Bay creel survey.

Fish Species	Estimated no. of fish caught	SE	Catch rate (fish/ang-hr)	Overall catch %
Other	43431	13077	0.364	40.5
Largemouth bass	14655	2299	0.123	13.7
Catfish spp	13375	2595	0.112	12.5
Sunfish spp	10317	4561	0.087	9.6
Yellow perch	9630	3812	0.081	9.0
Striped bass	8923	2149	0.075	8.3
Smallmouth bass	6346	3305	0.053	5.9
Crappie spp	537	308	0.005	0.5

Table 5. Estimated number of fish harvested, harvest rate (fish/ang-hr), and percent of total fish harvested by species for all anglers for the 1992 Upper Chesapeake Bay creel survey.

Fish Species	Estimated no. of fish harvested	SE	Harvest rate (fish/ang-hr)	Overall catch %
Other	8455	2756	0.0709	51.4
Catfish spp	4881	825	0.0409	29.7
Yellow perch	1530	789	0.0128	9.3
Sunfish spp	549	228	0.00461	3.3
Crappie spp	490	306	0.00411	3.0
Largemouth bass	440	153	0.00369	2.7
Striped bass	67	46	0.000562	0.4
Smallmouth bass	32	17	0.000268	0.2

Table 6. Percentage of anglers fishing for a specific sportfish species for the 1992 Upper Chesapeake Bay creel survey.

Fish Species	% of Anglers fishing for this species
Largemouth bass	32.1
Catfish	19.3
Other	19.0
Smallmouth bass	11.1
Sunfish	6.1
Yellow perch	5.8
Striped bass	5.5
Crappie	1.0

Table 7. Estimated number of fish caught, catch rate (fish/ang-hr), and percent of total catch of that species for species-anglers for the 1992 Upper Chesapeake Bay creel survey.

Fish Species	Estimated no. of fish caught	SE	Catch rate (fish/ang-hr)	Overall catch %
Yellow perch	6621	3197	1.428	68.8
Crappie spp	490	306	1.094	91.2
Other	21460	7207	0.819	49.4
Striped bass	3648	1370	0.520	40.9
Largemouth bass	14338	2256	0.433	97.8
Catfish spp	7994	1462	0.429	59.8
Sunfish spp	2189	530	0.368	21.2
Smallmouth bass	5972	3296	0.310	94.1

Table 8. Estimated number of fish harvested, harvest rate (fish/ang-hr), and percent of total fish harvested of that species for species-anglers for the 1992 Upper Chesapeake Bay creel survey.

Fish Species	Estimated no. of fish harvested	SE	Harvest rate (fish/ang-hr)	Overall catch %
Crappie spp	490	306	1.094	100.0
Other	7812	2777	0.298	92.4
Yellow perch	1314	775	0.283	85.9
Catfish spp	3955	696	0.212	81.0
Sunfish spp	182	91	0.0306	33.1
Largemouth bass	407	145	0.0123	92.5
Striped bass	49	45	0.00699	73.1
Smallmouth bass	32	17	0.00166	100.0

Table 9. Estimated number of fish caught, catch rate (fish/ang-hr), and percent of total catch by species for all anglers for the 1993 Choptank river creel survey.

Fish Species	Estimated no. of fish caught	SE	Catch rate (fish/ang-hr)	Overall catch %
Catfish	12760	1532	0.342	44.3
Sunfish sp.	6007	1117	0.161	20.8
Largemouth bass	5113	847	0.137	17.8
White perch	2933	512	0.079	10.2
Yellow perch	983	330	0.026	3.4
Crappie sp.	540	201	0.014	1.9
Striped bass	212	121	0.006	0.7
Other	206	70	0.006	0.7
Pickerel sp.	39	25	0.001	0.1

Table 10. Estimated number of fish harvested, harvest rate (fish/ang-hr), and percent of total fish harvested by species for all anglers for the 1993 Choptank river creel survey.

Fish Species	Estimated no. of fish harvested	SE	Harvest rate (fish/ang-hr)	Overall catch %
Catfish	2829	516	0.076	71.6
Sunfish sp.	769	289	0.021	19.5
Crappie sp.	165	149	0.004	4.2
White perch	89	49	0.002	2.3
Largemouth bass	63	50	0.001	1.6
Pickerel sp.	29	24	0.001	1.0
Yellow perch	9	6	-	-

Table 11. Percentage of anglers fishing for a specific sportfish species for the 1993 Choptank river creel survey.

Fish Species	% of Anglers fishing for this species
Catfish	49.2
Largemouth bass	33.4
Sunfish	22.7
White perch	17.2
Yellow perch	3.7
Crappie	3.1
"other"	1.4
Pickerel	0.6
Striped bass	0.2

*Total percentage >100% because some anglers pursued more than one fish species

Table 12. Estimated number of fish caught, catch rate (fish/ang-hr), and percent of total catch of that species for species-anglers for the 1993 Choptank river creel survey.

Fish Species	Estimated no. of fish caught	SE	Catch rate (fish/ang-hr)	Overall catch %
Catfish	12014	1310	0.675	94.1
Sunfish sp.	5530	1098	0.632	92.1
Striped bass	101	93	0.615	47.6
White perch	2111	367	0.378	72.0
Largemouth bass	5104	845	0.365	99.8
Crappie sp.	482	198	0.313	89.3
Yellow perch	365	163	0.200	37.1
Pickerel	29	24	0.166	74.4
Other	44	21	0.092	21.4

Table 13. Estimated number of fish harvested, harvest rate (fish/ang-hr), and percent of total fish harvested of that species for species-anglers for the 1993 Choptank river creel survey.

Fish Species	Estimated no. of fish harvested	SE	Harvest rate (fish/ang-hr)	Overall catch %
Pickerel sp.	29	24	0.166	100
Catfish	2764	480	0.155	97.7
Crappie	165	149	0.107	100
Sunfish sp.	769	289	0.089	100
White perch	89	49	0.016	100
Largemouth bass	63	50	0.005	100

Table 14. Estimated number of fish harvested, harvest rate (fish/ang-hr), percent of total harvest, and average weight (lbs) of harvested fish by fish species for all-anglers, 1994 Potomac river creel survey.

Fish species	Estimated no. of fish harvested	SE	Harvest rate (fish/ ang-hr)	Overall harvest %	Average weight
White perch	19402	9751	0.105	71.1	0.04 lbs
Catfish spp	4988	778	0.027	18.3	3.4 lbs
Black bass	1463	285	0.008	5.4	1.9 lbs
Other	695	291	0.004	2.4	2.2 lbs
Sunfish spp	381	158	0.002	1.4	0.3 lbs
Yellow perch	177	81	0.001	0.6	0.6 lbs
Striped bass	124	71	0.001	0.5	5.1 lbs
Crappie spp	85	56	0.001	0.3	0.4 lbs

Table 15. Estimated number of fish caught, catch rate (fish/ang-hr), and percent of total catch by fish species of harvested fish for all-anglers, 1994 Potomac river creel survey.

Fish species	Estimated no. of fish caught	SE	Catch rate (fish/ ang-hr)	Overall catch %
Black bass	70435	6826	0.383	56.7
White perch	30860	10199	0.168	24.8
Striped bass	8625	2708	0.047	6.9
Catfish spp	8141	964	0.044	6.6
Yellow perch	3797	771	0.021	3.1
Sunfish spp	1262	368	0.007	1.0
Other	925	395	0.005	0.7
Crappie spp	209	136	0.001	0.2

Table 16. Percentage of anglers fishing for a specific species, 1994 Potomac river creel survey.

Fish species	% of anglers fishing for
Black bass	70.1
Catfish spp	12.9
White perch	7.7
Yellow perch	2.6
Striped bass	2.1
Sunfish spp	2.1
Other	1.8
Crappie spp	0.6

Table 17. Estimated number of fish caught, catch rate (fish/ang-hr), and percent of total catch by fish species for species-anglers, 1994 Potomac river creel survey.

Fish species	Estimated no. of fish caught	SE	Catch rate (fish/ ang-hr)	Overall catch %
White perch	27351	10211	1.318	88.6
Black bass	70428	6826	0.465	99.9
Striped bass	2684	995	0.047	6.9
Crappie spp	164	115	0.314	78.5
Sunfish spp	982	343	0.282	77.8
Catfish spp	6844	892	0.232	84.1
Yellow perch	1125	440	0.231	29.6
Other	849	396	0.105	91.9

Table 18. Estimated number of fish harvested, harvest rate (fish/ang-hr), and percent of total harvest by fish species for species-anglers, 1994 Potomac river creel survey.

Fish species	Estimated no. of fish harvested	SE	Harvest rate (fish/ ang-hr)	Overall harvest %
White perch	19305	9752	0.930	99.5
Catfish spp	4912	776	0.167	98.5
Crappie spp	85	56	0.163	100.0
Sunfish spp	366	158	0.105	96.1
Other	659	291	0.082	100.0
Yellow perch	150	79	0.031	84.7
Striped bass	113	73	~~0.016~~	91.1
Black bass	1463	285	0.010	100.0

Table 19. All-anglers and species-anglers black bass catch and harvest rates (fish/ang-hr) from the 1990 and 1994 Potomac river creel surveys for the 15 inch minimum size period (1 March - June 15) and the 12 inch minimum size period (16 June - 28 February).

	15 inch minimum (1 March - 15 June)		12 inch minimum (16 June - 28 February)	
	1990	1994	1990	1994
Catch				
All anglers	0.341	0.445	0.255	0.400
Species anglers	0.360	0.521	0.349	0.489
Harvest				
All anglers	0.0087	0.119	0.023	0.0083
Species anglers	0.0092	0.014	0.031	0.0102

Table 20. All-anglers and species-anglers largemouth bass catch rates (fish/ang-hr) for each month of the 1990 and 1994 Potomac River creel surveys.

		May	June	July	August	September	October
Catch							
All-anglers-	1990	0.314	0.298	0.301	0.237	0.432	0.169
	1994	0.340	0.466	0.364	0.380	0.380	0.494
Species-anglers-	1990	0.397	0.310	0.318	0.329	0.576	0.339
	1994	0.419	0.539	0.424	0.530	0.555	0.521

Table 21. All-anglers and species-anglers largemouth bass harvest rates (fish/ang-hr) for each month of the 1990 and 1994 Potomac River creel surveys.

		May	June	July	August	September	October
Harvest							
All-anglers-	1990	0.036	0.008	0.013	0	0.006	0.047
	1994	0.013	0.010	0.012	0.008	0.001	0.015
Species anglers-	1990	0.046	0.007	0.014	0	0.009	0.095
	1994	0.016	0.011	0.014	0.011	0.001	0.016

Table 22. All-anglers overall (all fish species) catch and harvest rates (fish/ang-hr) and fishing effort (ang-hrs/acre) from creel surveys conducted on Maryland tidal water sportfisheries.

River	Fishing effort (ang-hrs/acre)	Harvest rate (fish/ang-hr)	Catch rate (fish/ang-hr)
Magothy R. - 1957	9.87	1.8	3.3
Northeast R. -1958	7.29	0.29	0.65
Upper Chesapeake Bay - 1987	0.31	0.33	----
Upper Chesapeake Bay - 1992	1.8	0.14	0.90
Choptank R. - 1988	10.0	0.19	1.36
Choptank R. - 1993	12.4	0.106	0.771
Potomac R. - 1990	8.3	0.11	0.41
Potomac R. - 1994	6.1	0.15	0.68

Table 23. Comparison of angler harvest and catch rates for all-anglers, 1988 and 1993 Choptank river creel surveys.

Fish species	Year	Fishing Effort (ang-hrs)	Harvest (fish/ ang-hr)	Caught (fish/ ang-hr)
Largemouth bass	-1988	30173	0.014	0.053
	1993	37348	0.001	0.137
Catfish	-1988	30173	0.16	0.47
	1993	37348	0.076	0.342
Sunfish	-1988	30173	0.011	0.317
	1993	37348	0.021	0.161
Crappie	-1988	30173	0.001	0.032
	1993	37348	0.004	0.014
White perch	-1989	30173	0.001	0.154
	1998	37348	0.002	0.079
Yellow perch	-1988	30173	0.003	0.167
	1993	37348	<0.001	0.026
Pickerel	-1988	30173	<0.001	0.002
	1993	37348	0.001	0.001
Striped bass	-1988	30173	-	0.161
	1993	37348	-	0.006
Other	-1988	30173	-	-
	1993	37348	-	0.006
Totals	-1988	30173	0.19	1.36
	1993	37348	0.106	0.771

Table 24. Comparison of angler harvest and catch rates for species anglers, 1988 and 1993 Choptank river creel surveys.

Fish species	Year	Fishing Effort (ang-hrs)	Harvest (fish/ ang-hr)	Caught (fish/ ang-hr)
Largemouth bass	-1988	20295	0.020	0.078
	1993	13983	0.005	0.365
Catfish	-1988	8563	0.54	0.88
	1993	17799	0.155	0.675
Sunfish	-1988	117	-	5.501
	1993	8750	0.089	0.632
Crappie	-1988	-	-	-
	1993	1540	0.107	0.313
White perch	-1988	126	-	1.709
	1993	5585	0.016	0.378
Yellow perch	-1988	-	-	-
	1993	1825	-	0.200
Pickerel	-1988	-	-	-
	1993	175	0.166	0.166
Striped bass	-1988	-	-	-
	1993	164	-	0.615
Other	-1988	-	-	-
	1993	478	-	0.092

Table 25. Comparison of angler effort, overall fish catch and harvest rates, fishing pressure, and fish caught and harvest and catch per acre for the 1988 and 1993 Choptank river creel surveys.

Year	Fishing Effort (ang-hrs)	Harvest (fish/ ang-hr)	Caught (fish/ ang-hr)	Fishing pressure (ang-hrs/ acre)	Harvest (fish/ acre)	Caught (fish/ acre)
1988	30,173	0.19	1.36	10.0	1.9	13.7
1993	37,348	0.106	0.771	12.4	1.3	8.3

Table 26. Reported overall catch and harvest rates and relative fishery quality for various tidal black bass sportfisheries located throughout North America compared with the overall catch and harvest rates (all-anglers) from the upper Chesapeake Bay (1987 & 1992), Choptank River (1998 & 1993), and Potomac River (1990 & 1994) creel surveys.

Location	Harvest rate (fish/ang-hr)	Catch rate (fish/ang-hr)	Reported fishery quality
St. Mary's River, Georgia, tidal, 1987 (Fowler and Holder 1987)	0.04	----	Average
Altamaha River, Georgia, tidal, 1983 (Hottell et al. 1983)	0.03	----	Average
Ocmulgee River, Georgia, tidal, 1980 (Coomer and Holder 1980)	0.055	----	Good
Back Bay, Virginia, tidal, 1950-1951 (Rosebery 1952)	0.29	----	Excellent
Northeast River, Maryland, tidal, 1958 (Elser 1958)	0.06	0.10	----
Upper Chesapeake Bay, Md., tidal, 1987 (Heft and Fewlass 1991)	0.09	----	Poor
Upper Chesapeake Bay, Md., tidal, 1992 (Heft 1992)	0.004	0.178	Excellent
Choptank River, Md., tidal, 1988 (Heft and Fewlass 1991)	0.014	0.053	Poor
Choptank River, Md., tidal, 1993 (Heft 1993)	0.001	0.137	Excellent
Potomac River, Md., tidal, 1990 (Heft and Fewlass 1991)	0.023	0.280	Excellent
Potomac River, Md., tidal, 1994 (Heft 1994)	0.008	0.383	Excellent

Table 27. Comparison of angler effort, overall (all fish species) fish catch and harvest rates, fishing pressure, and fish harvest and catch per acre for the 1990 and 1994 Potomac river creel surveys.

Year	Fishing Effort (ang-hrs)	Harvest (fish/ ang-hr)	Caught (fish/ ang-hr)	Fishing pressure (ang-hrs/ acre)	Harvest (fish/ acre)	Caught (fish/ acre)
1990	249,446	0.11	0.30	8.3	1.0	2.5
1994	184,044	0.15	0.68	6.1	0.9	4.1

Table 28. 1990 and 1994 Potomac river largemouth bass population estimates calculated from the catch-equation (Calhoun 1966) utilizing creel survey data.

Year	Population estimate
1990	158,609 < 139,477 < 177,471)
1994	372,558 < 336,453 < 408,663)

Table 29. Comparison of all-anglers harvest and catch rates and numbers of fish harvested and caught for all fish species, 1990 and 1994 Potomac river creel surveys.

Fish species		Fishing Effort (ang-hrs)	Number of fish harvested	Harvest (fish/ ang-hr)	Number of fish caught	Caught (fish/ ang-hr)
Largemouth bass	-1990	249446	5851	0.023	69788	0.280
	1994	184044	1463	0.008	70435	0.383
Catfish	-1990	249446	6581	0.026	11983	0.048
	1994	184044	4988	0.027	8141	0.044
Sunfish	-1990	249446	739	0.003	1062	0.004
	1994	184044	381	0.002	1262	0.007
Crappie	-1990	249446	1099	0.004	1120	0.004
	1994	184044	85	0.001	209	0.001
White perch	-1990	249446	12989	0.051	15139	0.061
	1994	184044	19402	0.105	30860	0.168
Yellow perch	-1990	249446	255	0.001	796	0.003
	1994	184044	177	0.001	3797	0.021
Striped bass	-1990	249446	1147	0.005	2733	0.011
	1994	184044	124	0.001	8625	0.047
"other"	-1990	249446	-	-	-	-
	1994	184044	659	0.004	925	0.005

Table 30. Comparison of species-anglers harvest and catch rates and numbers of fish harvested and caught for all fish species, 1990 and 1994 Potomac river creel surveys.

Fish species		Fishing Effort (ang-hrs)	Number of fish harvested	Harvest (fish/ ang-hr)	Number of fish caught	Caught (fish/ ang-hr)
Largemouth bass	-1990	190422	5765	0.030	69702	0.366
	1994	151458	1463	0.010	70428	0.465
Catfish	-1990	20954	5238	0.250	9597	0.458
	1994	29500	4912	0.167	6844	0.232
Sunfish	-1990	2031	739	0.364	1018	0.501
	1994	3482	366	0.105	982	0.282
Crappie	-1990	140	0	-	20	0.060
	1994	522	85	0.163	164	0.314
White perch	-1990	15478	11925	0.770	12986	0.840
	1994	20752	19305	0.930	27351	1.318
Yellow perch	-1990	-	-	-	-	-
	1994	4870	150	0.031	1125	0.231
Striped bass	-1990	33548	1147	0.034	2080	0.062
	1994	7196	113	0.016	2684	0.373
"other"	-1990	-	-	-	-	-
	1994	8086	659	0.815	849	0.105