VIRGINIA

DJ GRANT F-111-R-9, PROJECT I

LARGE IMPOUNDMENT INVESTIGATIONS: LAKE ANNA

April 1, 2000 to March 31, 2001

KEY FINDINGS

- Largemouth bass electrofishing catch rates for preferred (>380mm) and memorable (>510mm) size categories were significantly greater than average. In fact, these catch rates either set or tied modern records. Fingerling catch rates during the past three years were unchanged, and long-term fingerling catch rate variability was low (CV=39%) suggesting consistent recruitment.
- Largemouth bass structural indices reached record highs for the second consecutive year (PSD=80, RSD-P=43, RSD-M=7) indicating a population primarily composed of large individuals.
- Largemouth bass (n=326) up to 13 years (otolith age) were sampled over the past three years, and total annual mortality (catch curve) was 28%. While low, this rate is higher than previous estimates (based on a single year's data). It is believed that 28% is more accurate, but cohort analysis will be included next year.
- The largemouth bass growth curve improved each year from 1998-2000, but increases in total length were significant only for age 4 fish (bass within the slot). Males were significantly smaller than females for all ages over 2 when sample sizes permitted comparisons.
- Gill net catch rate of walleye was the highest (1.6/NN) since new netting protocols were established in 1997. Two strong year classes were evident (1999 Duke's Creek and 2000 Christopher Run stockings), and efforts to spatially expand the walleye population by rotating stocking sites appeared to be successful.
- Gill net catch rate of gizzard shad (27.1/NN) was significantly greater than average, and a strong 2000 year class was present resulting in a bimodal length distribution and a low (211 mm) mean size. Gill nets were compared to night electrofishing for forage assessment and were found to give acceptable (unbiased) estimates of size structure and had lower associated sampling variability.
- Acceptable striped bass habitat (water temperatures < 26C and dissolved oxygen > 2 mg/l) did not exist at several sites sampled in July and August.
- Gill net catch rate of striped bass (4.8/NN) was the highest since 1997 but was consistent with historical data. Strong 1998 and 1999 year classes documented during F-111-R-8 were still present with the former poised to move into the legal (>508 mm) size category. Recruitment of the 1998 year class (stocked at 50/ha) was better than previously believed, but catch rates for this year class were not significantly greater through time than for comparable year classes stocked at 25/ha.
- Gill net catch rate of black crappie (5.5/NN) was significantly lower than in previous years.

Compiled by John Odenkirk, Fisheries Biologist, Fredericksburg RO

VIRGINIA

DJ GRANT F-111-R-10, PROJECT I

LARGE IMPOUNDMENT INVESTIGATIONS: LAKE ANNA

April 1, 2001 to March 31, 2002

KEY FINDINGS

- Largemouth bass electrofishing catch rates for stock (>200mm), quality (>300mm) and preferred (>380mm) size categories were all significantly greater than average. In fact, these catch rates set modern records. Fingerling catch rates during the past four years were unchanged, and long-term fingerling catch rate variability was low (CV=36%) suggesting consistent recruitment.
- Largemouth bass structural indices were near record highs (PSD=75, RSD-P=42, RSD-M=4) indicating a population primarily composed of large individuals.
- Largemouth bass (n=467) up to 13 years (otolith age) were sampled over the past four years, and total annual mortality (catch curve) was 29%. While low, this rate was higher than previous estimates (based on smaller data sets) and probably more accurate. This mortality rate was equivalent to estimates of instantaneous natural mortality suggesting that fishing mortality was insignificant.
- Length at age of largemouth bass fluctuated between years but was significantly different only for age 2 and 4 fish (both declined compared to 2000). However, average growth was still more rapid than in other large Virginia impoundments (e.g., Smith Mountain Lake). Young bass grew more rapidly in the lower reservoir, while fish over age 2 grew faster in upper and middle lake sites. Males were significantly smaller than females for all ages over 2 when sample sizes permitted comparisons.
- Gill net catch rate of walleye was average (1.0/NN) since new netting protocols were established in 1997 but was lower than in 2000. Most walleye (95%) were collected in the upper lake despite two recent years of lower lake stockings. Thus, efforts to spatially expand the walleye population by rotating stocking sites now seem dubious. Stocking will be at 62/ha in 2002.
- Gill net catch rate of gizzard shad (21.0/NN) was slightly lower than in 2000 but was above average. Age 0 shad were less abundant than in 2000 resulting in a bimodal length distribution with a higher (248 mm) mean size. However, abundance of shad greater than 200 mm was very similar between years; and recent samples indicated higher shad biomass than in 1997-1999. Gill nets were compared to night electrofishing for forage assessment in 2000 and were found to give acceptable (unbiased) estimates of size structure and had lower associated sampling variability.
- Gill net catch rate of striped bass (3.5/NN) was slightly below average but was consistent with historical data. The excellent 1998 year class documented during F-111-R-8-9 was still present and will fully recruit to the fishery (>508 mm) in 2002. Recruitment of this year class (stocked at 50/ha) was better than previously believed. The 1997 year class (stocked at 25/ha) was also well represented in 2001 and should provide quality angling for several years. There was no relationship between stocking rate and catch of age 0 or age 1 fish, but catch of age 2 fish was positively related to initial stocking rate (more data are needed to improve this model). Two estimates of total annual mortality (age 0-4 of 1997 cohort and age 0-2 of 1999 cohort) were very close (36% and 35%). Stocking will be at 50/ha in 2002.
- Gill net catch rate of black crappie (8.2/NN) increased since 2000 but was still below average.

Compiled by John Odenkirk, Fisheries Biologist, Fredericksburg RO

VIRGINIA DEPARTMENT OF GAME & INLAND FISHERIES
LARGE IMPOUNDMENT
MANAGEMENT REPORT

Lake:	Anna	**Survey Year:**	1998
Location:	Louisa County	**Region:**	5
Prepared by:	John Odenkirk		

Management History: Lake Anna is a 3,886 hectare impoundment owned by the Virginia Power Company. The lake spans Louisa, Spotsylvania and Orange counties and serves as cooling water for the two-unit North Anna Nuclear Power Station. Fish stocking began in 1972 with introductions of largemouth bass, bluegill, redear sunfish and channel catfish. Subsequent stockings of redear, channel catfish, walleye, striped bass and largemouth bass (both Florida and northern strains) were made. Threadfin shad and blueback herring were successfully introduced in the 1980s. Striped bass and walleye have generally been stocked annually. A 305-381 mm slot length limit was established to restructure the largemouth bass population in 1985. Prior to that time, a 305-mm minimum size limit was in effect. A 508-mm minimum length limit regulates striped bass harvest.

Anglers and pleasure boaters heavily use the reservoir. A 1993 daytime creel survey (F-111-R-2) indicated that fishing pressure was approximately 73 hours/hectare. Preferred species included largemouth bass (72%), striped bass (14%), crappie (7%) and catfish (4%). Striped bass effort was likely higher than estimated due to unsampled winter months when participation in this fishery was high. Dominant species harvested by number were crappie (54%) and channel catfish (26%), while dominant species harvested by weight were channel catfish (36%), crappie (26%) and striped bass (21%). Largemouth bass anglers released 97% of all bass caught.

The aquatic weed *Hydrilla verticillata* became established in Lake Anna during the late 1980s, and abundance increased rapidly--from 39 hectares in 1990 to 337 hectares in 1994. Sterile (triploid) grass carp (n=6185) were stocked into Virginia Power's Waste Heat Treatment Facility (WHTF) in 1994 to control *Hydrilla*. The WHTF is separated from Lake Anna by three dikes, and thermal effluent enters the lake via gravity flow under the third dike. All grass carp stocked in the WHTF were marked with coded wire micro tags. No grass carp were stocked in Lake Anna.

Rotenone sampling at Lake Anna was conducted about every three years to generate species composition and biomass estimates. These data were used to evaluate forage (gizzard shad, threadfin shad, and blueback herring) abundance for stocked predators. Due to extremely high variances in biomass estimates, heavy shoreline development (with the potential for public relations problems) and intensive manpower requirements, rotenone use at Lake Anna was discontinued after 1995 (F-111-R-4 recommendation). Increased gill netting was determined to be a possible replacement for community structure and forage evaluation.

Impoundment Management Objective: To maintain the present fishery with particular emphasis on providing quality largemouth and striped bass fisheries within the capacity of available habitat. Largemouth bass spring electrofishing mean catch rates of 30/hour (quality) and 15/hour (preferred) are desirable based on historical data, and PSD and RSD-P should be at least 60 and 30. Criteria for striped bass recruitment will be developed in the next segment following the collection of additional data from new gear (see next section).

Current Segment Activities: The lake was sampled by daytime spring electrofishing (5.8 hours at four sites) and fall/winter gill netting (34 net nights) in 1998. Spring electrofishing (9.6 hours at six sites) and gill netting (28 net nights) were also conducted in 1996, while electrofishing (3.4 hours), gill netting (34 net nights) and trap netting (12 net nights) were conducted in 1997.

Gill netting procedures changed in 1997. Prior to 1997, gear, effort, and strategies fluctuated - nets used were 30 x 2.4 m, and mesh sizes were usually 19,32 or 51-mm bar. Beginning in 1997, 61 x 2.4-m experimental eight-panel nets (10 - 51-mm bar mesh) were selected (Van Den Avyle 1995). Gill netting was conducted in the upper and lower portions of the lake with 28 net nights of experimental net effort annually - 14 in each portion. Sites were selected using a randomized block design. In addition, in 1998 and 1997, standard 51-mm nets (6 net nights annually) were used to supplement predator data and allow historical comparisons.

Electrofishing for largemouth bass was conducted in three areas of the reservoir: the upper, middle and lower portions. Efforts were made to sample every portion at least once annually. Upper lake sampling was conducted above "the splits" on both major tributary arms; middle lake sampling was conducted below the splits to the vicinity of the Route 208 bridge; and lower lake sampling was conducted near the dam and adjacent areas.

Stockings since the last management report include striped bass (38/ha in 1996, 25/ha in 1997 and 50/ha in 1998) and walleye (25/ha) in 1996. Current segment striped bass stockings were Chesapeake strain, while earlier stockings (except 1990) were Roanoke River strain - Chesapeake are considered more desirable, as Lake Anna is in this watershed. Striped bass were stocked in early June, and average weights were 0.26, 0.25 and 0.20 g in 1996 - 1998. Data were derived from hatchery gross weights, so statistical evaluation was not possible (no raw data). Striped bass stockings varied over the past decade (Table 1), but 25/ha were usually requested as a high priority with up to an additional 25/ha as a lower priority pending production.

Current Fishery Status:

Largemouth Bass

Largemouth bass mean electrofishing catch rates (CPUE) for most size groups increased since last segment (Table 2). For the period 1993-1998, CPUE of stock, quality, and preferred-size bass increased (Figure 1), while CPUE of memorable fish was stable, and CPUE of fingerlings decreased (size groups are after Anderson and Newmann 1996). A Kruskal-Wallis analysis of variance indicated that none of the changes in CPUE was significant; however, low sample size may have precluded the ability of the test to detect true differences (not all portions of the lake were sampled in all years). The increase in CPUE of quality-size fish was most noticeable, and without the "outlier" year of 1996, linear regression indicated the increase was indeed significant (R^2=0.96, P=0.004). Fingerling catch was the only trend component to decrease, but CPUE in 1998 was higher (8) than any year surveyed since 1993 (13). The decline in fingerling catch rate between 1993 and 1995 was detailed in the last report (F-111-R-4). Overall, total CPUE (fingerling + stock) remained remarkably consistent over the period and averaged 61 bass/hour. These data are commensurate with other large Virginia reservoirs (e.g., Smith Mountain Lake, 56 bass/hour, F-111-R-7; Kerr Reservoir, 55 bass/hour, F-111-R-6). Total CPUE was higher in the middle (89 bass/hour) and upper (72/hour) lake portions than in the lower (40/hour) portion. This was a routine trend.

Largemouth bass structural indices paralleled catch rates and suggested that population structure shifted upwards (towards larger individuals) recently (Figure 2). PSD in 1997 and 1998 (75 and 74) was nearly identical (as was RSD-P - 36 and 35) and also commensurate with other reservoirs (e.g., Smith Mountain Lake PSD and RSD-P of 69 and 32). Large individuals - especially within and just over the slot - dominated the 1997 and 1998 populations (Figure 3). Empirical data were evaluated to quantify the upward shift in structural indices, and ANOVA indicated that recruits collected in 1997 and 1998 were indeed larger than those sampled in 1996 (P<0.001). However, there was no detectable size difference between recruits collected in 1995 and 1997/1998. Thus, while it is possible that the population was unchanged since last segment, and 1996 data were merely subject to unknown variability; it seems more likely that the population fluctuated slightly and experienced an upward shift in size structure since 1996.

Scale and otolith pairs from a subsample of bass collected during electrofishing were used to evaluate growth and suitability of aging structures. During the first three electrofishing runs (one from each of the three portions of the lake), the first 30 bass were retained for removal of structures. This was the first time that otoliths were used to age largemouth bass in the District. Recent investigations (F-111-R-5) indicated that scales were underestimating the age structure of other District centrarchid populations.

The samples taken resulted in 85 readable pairs of which 54 showed agreement (64%). The remainder was nearly evenly split between 'scales overestimating age' (16%) and 'scales underestimating age' (20%). It was assumed that otolith ages were "true" ages. The most common variations were by one year - both for scales to underestimate (14%) and for scales to overestimate (11%). For young fish (1-3), there was no difference in average length at capture between otoliths and scales, but at older ages (4-7) variation occurred. However, this variation was offset by occurring in both directions (e.g., variation was not cumulative but fluctuated up and down effectively masking a structure bias when the sample was viewed as a whole, Figure 4). The largest disagreements were with larger fish and were always underestimates by scales - four years in one case. By using otoliths for evaluation, the maximum longevity of the sampled population increased from nine to 12 years.

Based on back-calculated lengths-at-annulus (the technique historically used), growth of young bass was good; however, previously documented slow growth of older bass (F-111-R-4) appeared to worsen (Figure 5). For example, age 2 bass averaged 259-mm total length (all sites combined) versus 235 mm District average or 245 mm in 1995 (Anna), but age 5 bass averaged only 395 mm compared to 418 mm (District) or 407 mm (Anna in 1995). However, growth was likely even slower, as scales may have overestimated some cases. For example, based on otoliths, an age 5 bass was only 388 mm in 1998. There was no significant difference in growth of bass from different portions of the lake, but analysis was hampered by low sample size. In previous years, bass grew slower in the lower lake, but it is likely that 1998 data would have revealed quicker growth of bass (especially younger fish) in this area had sample sizes been higher. Relative Weights

(Wr) were highest in upper lake bass (mean=99) and declined downlake. The lowest Wr values were from lower lake fish (mean=89). Overall, Wr of harvestable fish increased from 92 (1995) to 94 (1998) but was still lower than in other District waters (e.g., 102 at Lake Manassas). Stomachs taken from sacrificed fish were analyzed, and 77% were empty. Bass that had stomach contents ate fish (20%), crayfish (1%) and terrestrial insects (1%). Most fish were unidentifiable, but of known food items; bluegill, redear and white perch were consumed equally. No shad were found in bass stomachs, and it seems that seasonal habitat partitioning between shad and bass may be occurring. Bluegill abundance and size structure appeared adequate (e.g., 1998 mid-lake electrofishing CPUE-S was 142/hr, and PSD was 22), and the lack of submerged aquatic vegetation (SAV) should make them available to predators. Nonetheless, catch rates and structural indices indicated that bass size structure and abundance increased, and competition for available food resources likely intensified.

Total annual mortality was 0.22 (+/- 0.08, R^2=0.80) for bass age 2-12 based on a catch curve derived from otolith data (Table 3). Because fish over age 7 appeared sporadically, analysis was also performed on bass age 2-7 (age 1 fish were not adequately represented) with similar results (0.24 +/- 0.16, R^2=0.72). While these estimates assume constant recruitment (among other parameters), they are very low and support current and previous findings at Lake Anna (e.g., high bass abundance and structural indices, slow growth, low Wr, and low harvest). For comparison, Ebbers (1987) estimated total annual mortality of bass at 0.48 to 0.60 in a northern reservoir, while Dent (1986) calculated the total annual mortality of a Missouri bass population to be 0.45. Evidence suggests that bass at Lake Anna may be stockpiling and stunting albeit at a more desirable size than typically occurs. Current growth patterns require a bass about five years to grow out of the slot (381 mm) and ten years (at a conservative minimum) to reach citation length (559 mm). Based on growth curves, it's more likely that citation bass are at least 12 years old unless other factors are at work (e.g., cohort interactions, forage and growth variability).

The last report (F-111-R-4) suggested that 1994 might have produced a poor year class. However, recent findings indicate that, while not as successful as the 1993 cohort, the 1994 cohort was adequate. The weakest year class seems to have been 1995 (10% of sample). The record catch of fingerlings in 1993 seemed a reliable indicator of the strength of this year class (17% of sample in 1998), however year class strength seemed to have little impact on the adult population over time.

Striped Bass

Striped bass were sampled with gill nets, and otoliths were removed from all specimens for age estimation. It was assumed that experimental nets gave unbiased population samples of fish under age 4, and standard nets selected for fish age 1-3. Eighty-five fish were caught with experimental nets, while 55 were collected with standard nets in 1998. Catch rate (CPUE or number of fish per net, per night) was higher for standard nets (9.2) than for experimental nets (3.0) despite the experimental net's longer size. A similar relationship was observed in 1997 when standard nets caught 34 fish (CPUE=5.7), and experimental nets caught 122 fish (CPUE=4.4, Table 4). In contrast, standard nets caught more fish in 1998 than in 1997 (CPUE increased from 5.7 to 9.2). This followed a trend detailed in the last report, and CPUE in standard nets increased every year since 1994. This suggested that abundance of recruits increased, but annual effort was as low as six net nights.

The largest disparity between striped bass catch in 1997 and 1998 was the high catch of age 0 fish in 1997 (Figure 6). Historical data were insufficient to evaluate the strength of this year class, but the 1997 cohort seemed very strong (76 fish or 62% of the sample). Young-of-year (YOY) comprised only 33% (n=28) of 1998's sample, but the strong 1997 year class was still dominant as age 1 fish (n=42 or 49%) (Figure 7). This occurred despite heavier fingerling stocking in 1998 (50/ha). Striped bass were stocked at 25/ha in 1997 and 38/ha in 1996. Hatchery data indicated that fingerlings were smaller in 1998 than in the previous two years, thus it is possible that this year class survived at a lower rate. However, if survival was lower, growth was not, as the mean length of age 0 fish varied by only 3 mm between the two years (Figure 8). YOY fish were much smaller in 1996 when fry were stocked supplementary.

YOY fish were more abundant overall in 1997 (t-test, P=0.083) and were more abundant in the lower lake in 1998 (P=0.013). However; caution should be observed when reviewing these data, as sampling precision of gill nets was marginal (e.g., untransformed CV estimates for YOY ranged from 0.64 to 1.40 with a median value of 1.13). The YOY index (total YOY caught in experimental nets/net nights) was 2.7 in 1997 and 1.5 in 1998.

Striped bass growth patterns were variable. Age 1 fish were larger in 1998 (mean TL=408 mm) than in 1997 (387 mm, t-test, P<0.001), but age 2 striped bass were larger in 1997 (518 mm) than in 1998 (471 mm, P<0.001). These trends were likely related to stocking size, as the small age 1 fish in 1997 and age 2 fish in 1998 were the 1996 year class - a product of fry supplement stocking and the smallest fall age

0 mean total length fish (163 mm). Generally, young fish grew quickly, as it took about 30 months to reach harvestable (508-mm) size.

Mortality estimates were derived from catch curves using otolith-aged fish caught in experimental nets. These estimates are tentative, for stocking policies violated the assumption of equal recruitment. However, as a rough guide (especially if recruitment is density independent as has been demonstrated in other Virginia waters), they offer a starting point. Total annual mortality was 50% (R^2=0.87, P=0.006) for ages 0-3 in 1997. Efforts to obtain a significant relationship excluding the 1996 cohort were unsuccessful. Mortality was 43% (R^2=0.85, P=0.076) for ages 1-3 in 1998. Collection of an unbiased sample of otoliths for a third consecutive year will allow for cohort mortality estimates that should be more accurate.

Walleye

Walleye were sampled with gill nets, and otoliths were removed from all specimens for age estimation. It was assumed that experimental nets gave unbiased population samples, while standard nets selected for fish over age 0. Eleven fish were caught with experimental nets, and 11 were taken with standard nets in 1998. This was similar to 1997 when 16 were taken with experimental nets, and 10 were captured with standard nets. CPUE in standard nets was 1.7 in 1997 and 1.8 in 1998. These catch rates are the highest reported and suggest that walleye abundance is increasing at Lake Anna. However, effort with standard nets was minimal, and experimental nets may have monitored the population better. All but one of the walleye caught in experimental nets during both years (n=27) was caught in the upper lake indicating that, at least during late fall, walleye abundance was spatially disproportionate.

Walleye initially grew rapidly at Lake Anna attaining 490 mm after only three growing seasons (Figure 9). However, after reaching about 500 mm, growth declined and increased very slowly thereafter. The most recent stocking (1996) was well represented in 1998 as age 2 fish (64% of sample).

Lake Anna is included in a statewide walleye research project and will be intensively sampled during 1999. Fish will be tagged for an exploitation study, and others will be monitored with telemetry gear. A separate report (F-117) will detail these investigations.

Black Crappie

Black crappie were evaluated with experimental gill nets in 1997 and 1998 and with trap nets in 1997. Otoliths were removed from a subsample of fish from trap nets. Crappie were the most abundant fish in gill nets in 1997 and the second most abundant in 1998 (Table 5). It was assumed that experimental gill nets sampled to the entire population without bias, and trap nets selected for larger individuals. Although gill net effort was equal, most crappie (92%) were caught in the upper lake where sampling precision was good (e.g. CV=0.38-0.48 in 1997-1998). Mean CPUE declined by 37% - from 59 in 1997 to 37 in 1998 (P=0.07).

Black crappie size structure, based on gill nets, was excellent in 1997 (PSD=69, RSD-P=15) but declined in 1998 (PSD=48, RSD-P=10, Table 6). CPUE of quality fish declined by 50%. The 1998 decline in RSD-P following the strong 1997 catch of 22-24 cm-group fish suggests that mortality is high (Figures 10, 11). Crappie growth, based on otoliths, was good, but length overlap (range) was high (Table 7). For example, age 4 fish averaged 265mm at Lake Anna compared to 252mm in other district waters (small impoundment mean) based on otoliths. Trap nets selected for slightly larger crappie (mean tl=226 mm) than gill nets (218 mm) in 1997.

Catfish

Catfish populations were evaluated with experimental gill nets in 1997 an 1998. The four species caught (in declining abundance) were channel catfish, white catfish, yellow bullhead and blue catfish. Although channel and white catfish catch varied in magnitude between years (Table 5), proportions remained constant with channel catfish leading by 20% each year. Catch of both species increased by over 140% between 1997 and 1998, but it is doubtful that these increases reflected population changes. Rather, increased catch in 1998 was more likely due to abiotic factors including a drought and record low pool elevations at Lake Anna during the latter half of 1998. Mean total length of channel catfish increased slightly (356 mm in 1997 to 385 mm in 1998) while mean length of white catfish decreased (284 mm to 257 mm). Yellow bullheads were taken in low numbers (about nine per year), and one blue catfish was caught each year (a 265 mm specimen in 1997, and a 330 mm individual in 1998). The origin of blue catfish is unknown, as no stocking records exist for this species in Lake Anna; however, blue catfish were stocked in the Lake Anna watershed (Lake Orange) during the 1980s.

Gizzard Shad

Much of Lake Anna's forage biomass is composed of gizzard shad, although blueback herring have never been adequately assessed, and threadfin shad abundance is cyclic. Estimates of gizzard shad biomass from rotenone samples ranged from 120 to 346 kg/ha within the past decade, while gill net CPUE in standard nets varied from 3.8 to 6.4. CPUE of shad in standard nets in 1997 and 1998 was commensurate but declined (6.0 and 3.3). It is unlikely that standard nets, with expended effort, were capable of detecting changes in shad abundance.

Conversely, catch increased in experimental nets - from 239 (1997) to 331 (1998). CPUE was 8.5 and 11.8. Experimental nets gave better but marginal sampling precision, as untransformed CV estimates ranged from 0.58 to 1.13.

The structure of the gizzard shad population changed between 1997 and 1998. Several cohorts were evident in 1997 (Figure 12), and length frequency peaks occurred at 19 and 28 cm. Few individuals under 17 cm were sampled. However, in 1998 (Figure 13), many shad between 11 and 14 cm were collected, while the larger peak increased to 29 cm. This species of forage was virtually absent from the 16-21 cm groups. It is unknown what factor(s) are responsible for these changes, but variable shad recruitment and/or foraging by predators likely played a role.

Gizzard shad were the most frequently caught fish in experimental gill nets in 1998 (they ranked second in 1997, Table 5). Most shad were caught in the upper lake (71 % in 1997 and 76% in 1998).

Hydrilla/Grass Carp

Eight grass carp were captured in Lake Anna since the last segment (Table 8). Fifty percent tested positive for coded wire tags (CWT) indicating that they belonged to Virginia Power's 1994 stocking in the WHTF. This suggests that a portion of the carp migrated under Dike 3 into Lake Anna. In fact, it is likely that most of the carp collected - tagged and untagged - were products of the 1994 stocking, as sampling in the WHTF indicated about 50% of CWT grass carp had lost their tags.

Sampling effort fluctuated over time while CPUE remained fairly constant (0.3-0.5/hr). Average length increased each year to an all-time high of 803 mm in 1998.

Grass carp stocking coincided with a hydrilla decline (Figure 14). However, 1995 was widely recognized as producing unfavorable growing conditions for SAV. Hydrilla increased in abundance in 1996 and declined each year thereafter.

Management Needed:

(1) Stock Chesapeake Bay striped bass (if available - if not, Roanoke River stream will suffice) at 25/ha annually - an additional 25/ha (pending available surplus) should only be stocked biannually to aid in efforts to determine optimum stocking rates. Drop striped bass stocking rate to 12/ha in 2001 to evaluate recruitment at lower density.

(2) Evaluate summer striped bass habitat.

(3) Stock walleye at 12/ha annually or in accordance with the walleye study plans.

(4) Conduct annual largemouth bass spring electrofishing surveys at the three standard sites (upper, middle, and lower lake). Otoliths should be removed from bass for the next two years to develop cohort-based mortality estimates. If growth, mortality and Wr continue to be undesirable, it is likely that the slot length limit will be removed, as it is now serving no biological purpose. Electrofishing data should be recorded as 1000-second "runs" at each site for enhanced statistical evaluation.

(5) Continue fall/winter experimental gill netting with an elimination of standard mesh net use and an accompanying increase in experimental net nights (just a few extra experimental net nights will likely give acceptable CVs to evaluate population changes of several species).

(6) Conduct a creel survey in 2000. The next management report will be due in 2003.

Literature Cited:

Anderson, R.O., and R.M. Newmann. 1996. Length, weight and associated structural indices. Pages 447-482 in B.R. Murphy and D.W. Willis, editors. Fisheries techniques, 2nd edition. American Fisheries Society, Bethesda, Maryland.

Dent, R.J., Jr.. 1986. Methods and parameters used in evaluating bass length limits on Pomme de Terre Lake, Missouri. Pages 65-72 in G.E. Hall ans M.J. Van Den Avyle, editors. Reservoir fisheries management, strategies for the '80's. American Fisheries Society. Bethesda, Maryland.

Ebbers, M.A. 1987. Vital statistics of a largemouth bass population in Minnesota from electrofishing and angler-supplied data. NAJFM 7:252-259.

Van Den Avyle, M.J., G.R. Ploskey, and P.W. Bettoli. 1995. Evaluation of gill-net sampling for estimating abundance and length frequency of reservoir shad populations. NAJFM 15:898-917.

Table 1. Lake Anna striped bass stocking records 1990-1998.

	*1990	1991	1992	1993	1994	1995	*1996	*1997	*1998
Fry	500,000						38,540		
Fingerling	162,623	109,000	191,829	111,980	145,553	132,248	109,409	96,124	194,537
Phase II				59,938					
Total	692,623	109,000	191,829	171,918	145,553	132,248	147,949	96,124	194,537
# ha	178	28	49	44	37	34	38	25	50

*Chesapeake Bay strain (all others Roanoke River)

Table 2. Electrofishing catch per unit effort (CPUE) of various size groups of largemouth bass at Lake Anna, Virginia 1993-1998.

	Lower					Mid					Upper					Mean				
CPUE	93	95	96	97	98	93	95	96	97	98	93	95	96	97	98	93	95	96	97	98
Fingerling	22	3	10	2	9		5	6	7	7	4	4	4		8	13	4	7	5	8
Stock	54	39	33	38	31		68	76	70	82	54	59	25		64	54	55	45	54	59
Quality	19	17	19	24	22		41	44	57	56	43	51	20		49	31	36	28	41	42
Preferred	5	5	5	9	8		19	20	29	26	24	28	11		28	15	17	12	19	21
Memorable	0	1	0	2	1		2	0	3	1	4	2	0		4	2	2	0	3	2
Total (fingerling & stock)	76	42	43	40	40		73	82	77	89	58	63	29		72	67	59	52	59	67

Table 3. Cohort contribution, mean TL, and age at capture for largemouth bass based on otoliths, Lake Anna, 1998.

Age	0	1	2	3	4	5	6	7	8	9	10	11	12
n	0	9	23	9	13	15	10	4	1	0	2	0	1
x TL		196	275	320	345	388	417	483	476		480		419
cohort	'98	'97	'96	'95	'94	'93	'92	'91	'90	'89	'88	'87	'86

Table 4. Gill net catch of otolith-aged striped bass, Lake Anna.

Age	0	1	2	3	4	5	6	7	8	TOTAL
1998										
experimental	28	42	7	4	3	0	0	0	1	85
4″ standard	0	29	19	4	1	2	0	0	0	55
Total	28	71	26	8	4	2	0	0	1	*140*
1997										
experimental	76	30	11	3	0	2	0	0	0	122
4″ standard	0	18	10	4	0	2	0	0	0	34
Total	76	48	21	7	0	4	0	0	0	*156*

Table 5. Top ten species collected with experimental gill nets*, Lake Anna (% of total).

1997		
species	n	
Black crappie	422	36%
Gizzard shad	239	20%
Striped bass	122	10%
White perch	74	6%
Channel catfish	65	6%
White catfish	52	4%
Threadfin shad	46	4%
Largemouth bass	40	3%
Blueback herring	39	3%
Walleye	16	1%

1998		
species	n	
Gizzard shad	331	24%
Black crappie	313	23%
White perch	227	16%
Channel catfish	159	12%
White catfish	127	9%
Striped bass	85	6%
Largemouth bass	34	2%
Threadfin shad	28	2%
White sucker	21	2%
Redear sunfish	14	1%

*28 net nights annually

Table 6. Black crappie structural indices and catch rates at Lake Anna, fall 1997-1998.

Year	**1997**	**1997**	**1998**
Gear	trap	e. gill	e. gill
Effort (nn)	12	28	28
n	224	422	313
PSD	82	69	48
RSD-P	26	15	10
RSD-M	2	3	3
CPUE-F	0	<1	<1
CPUE-S	19	15	11
CPUE-Q	15	10	5
CPUE-P	5	2	1
CPUE-M	<1	<1	<1

Table 7. Mean TL and age at capture for black crappie based on otoliths, Lake Anna, 1997.

Age	0	1	2	3	4	5
n*		12	24	18	13	2
x TL		169	215	253	278	275
range		(131-200)	(184-284)	(218-299)	(206-315)	(251-298)

*non-random sample

Table 8. Mean TL, weight and collection data for grass carp sampled by electrofishing in Lake Anna, 1996-1998.

year	effort (hr)	CPUE (no./hr)	TL (mm)	wt (g)	CWT*	Location
1996	9.6	0.4	700	4199	y	208 Bridge
			790	6469	y	Sturgeon Creek
			820	8172	n	Dickerson's
			760	7264	n	Dickerson's
1997	3.4	0.3	800	6356	y	Dam
1998	5.8	0.5	846	n/a	y	Hairfield
			827	n/a	n	Hairfield
			735	4767	n	Valentines

*coded wire tag present

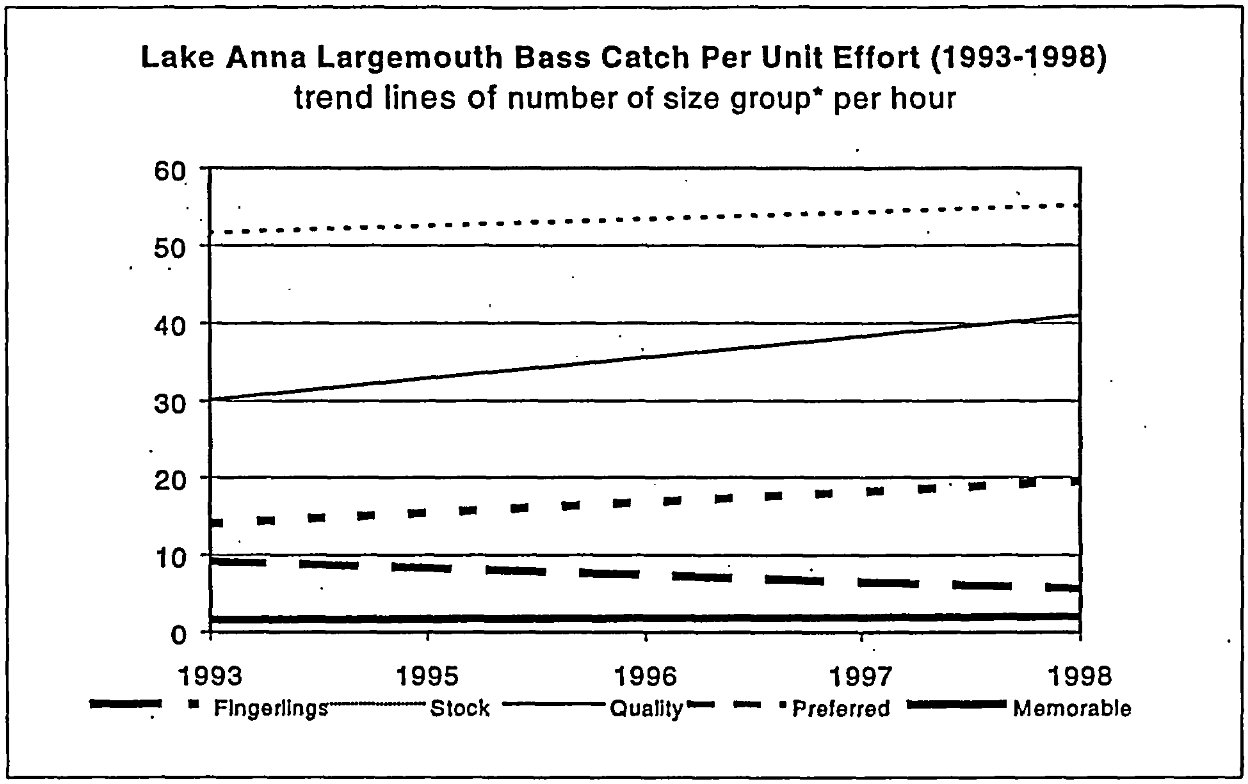
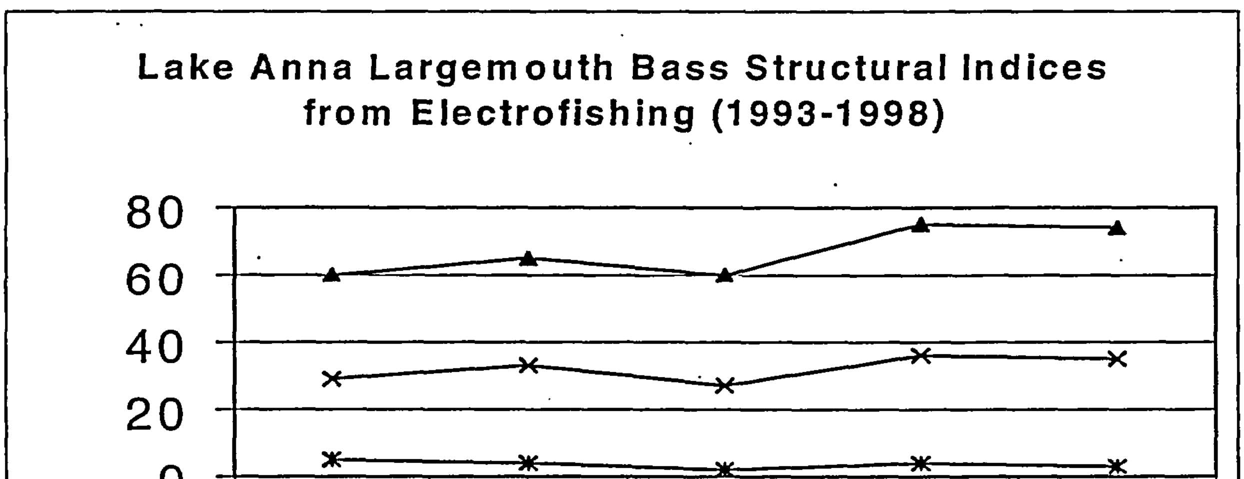


Figure 1.



	1993	1995	1996	1997	1998
PSD	60	65	60	75	74
RSD-P	29	33	27	36	35
RSD-M	5	4	2	4	3
Sites	2	3	6	2	4
n	180	297	441	198	381

Figure 2.

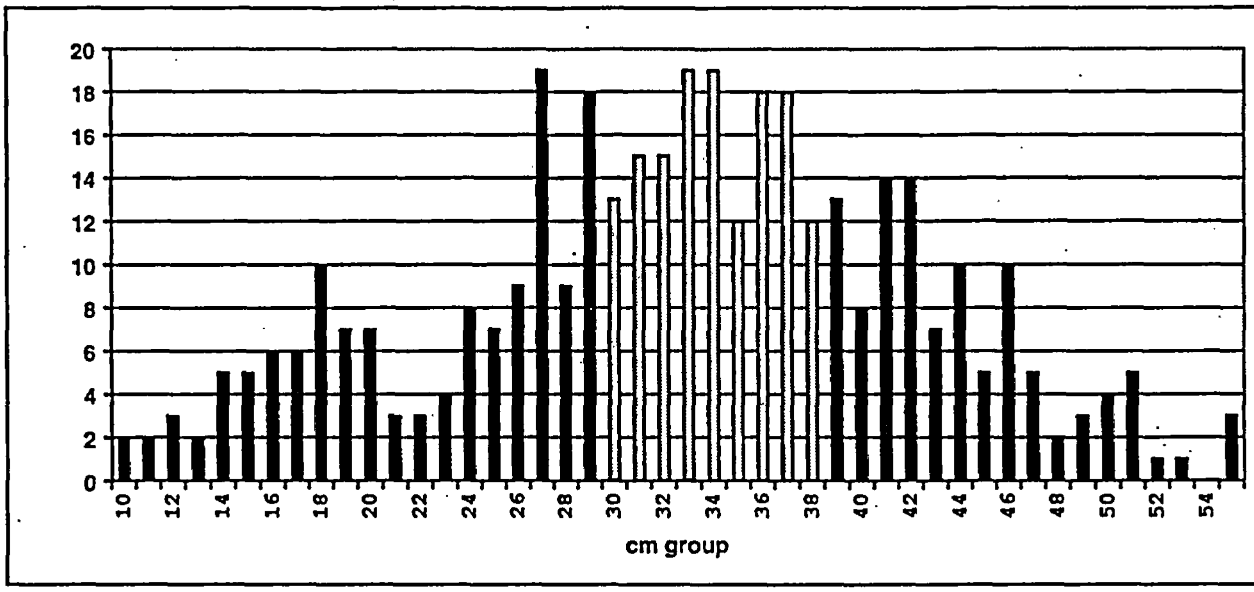
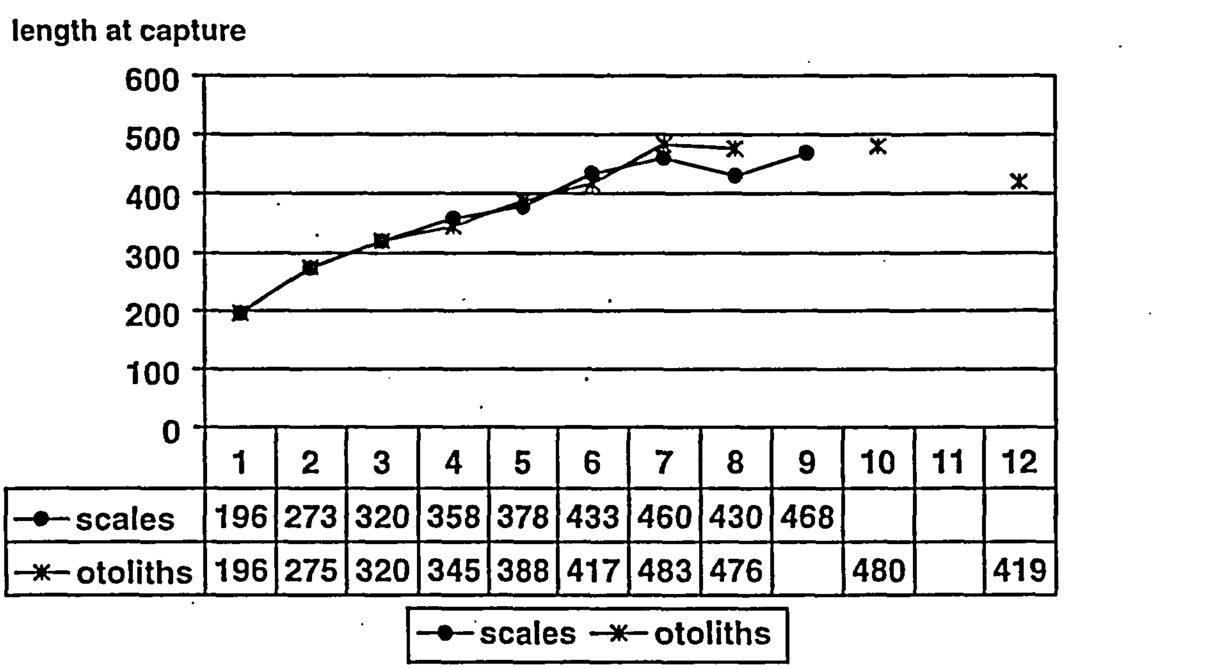
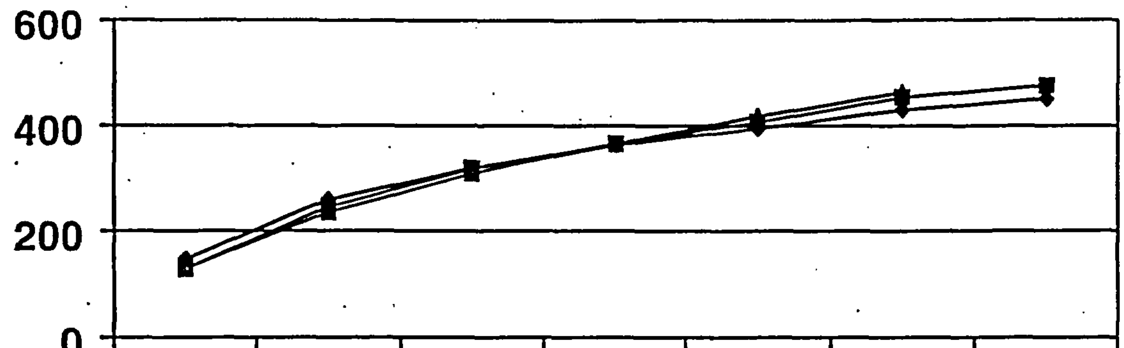


Figure 3. Length frequency histogram of LMB sampled at Lake Anna by electrofishing, 1998 (n=381).
note: slot length limit fish highlighted



	1	2	3	4	5	6	7	8	9	10	11	12
scales	196	273	320	358	378	433	460	430	468			
otoliths	196	275	320	345	388	417	483	476		480		419

Figure 4. Lake Anna largemouth bass 1998 scale-otolith agreement.
n=86 for scales, n=87 for otoliths



	1	2	3	4	5	6	7
1998	147	259	319	363	395	430	451
1995	129	245	318	366	407	454	476
mean*	130	235	309	366	418	463	

Figure 5. Lake Anna largemouth bass back-calculated growth comparisons (scales).
* historical district average

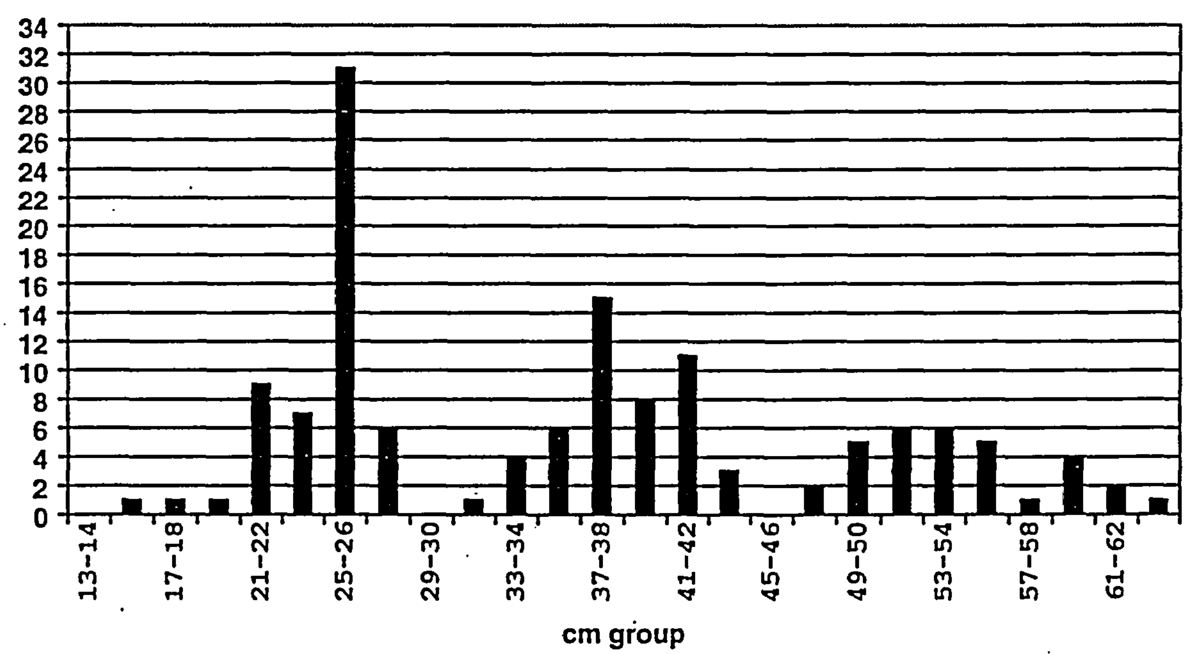


Figure 6. Length Frequency histogram of all striped bass caught in gill nets in 1997, Lake Anna (n=156)

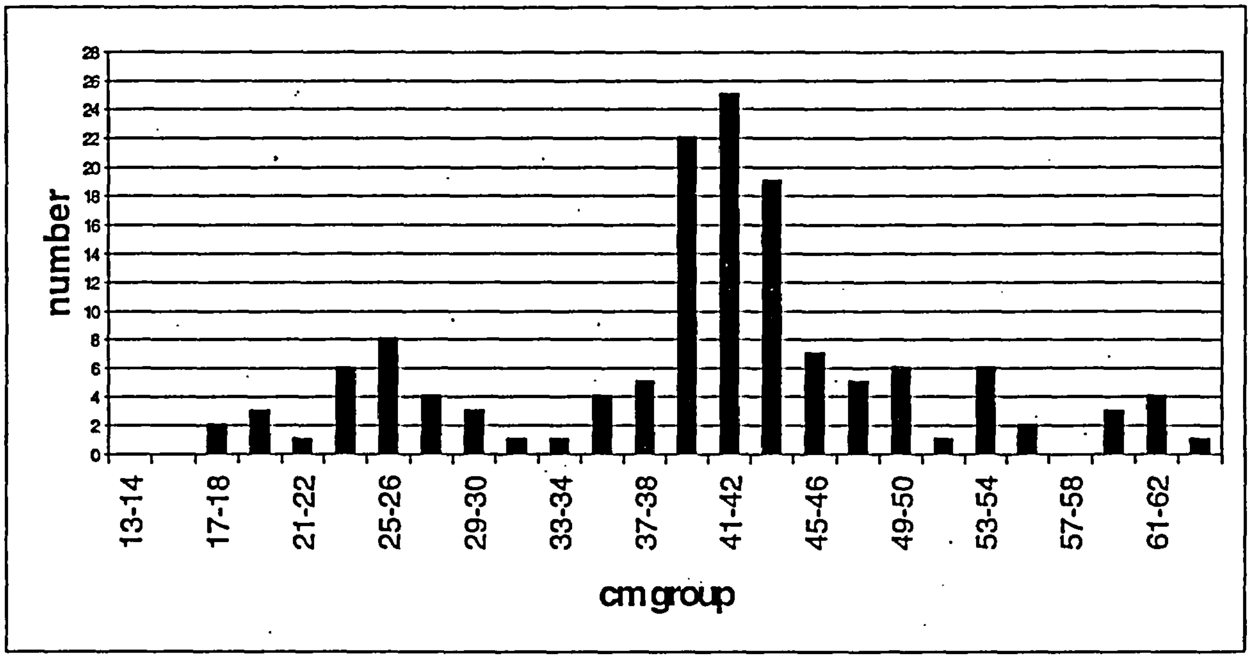


Figure 7. Length frequency histogram of all striped bass caught in gill nets in 1998, Lake Anna (n=140).

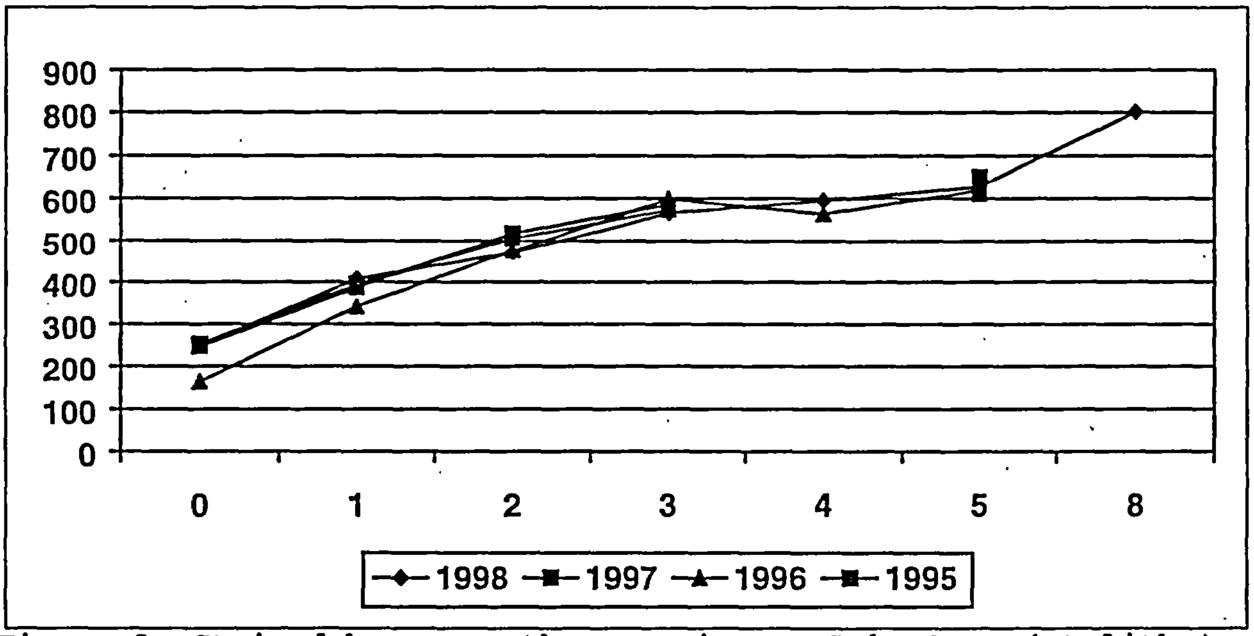


Figure 8. Striped bass growth comparisons, Lake Anna (otoliths).

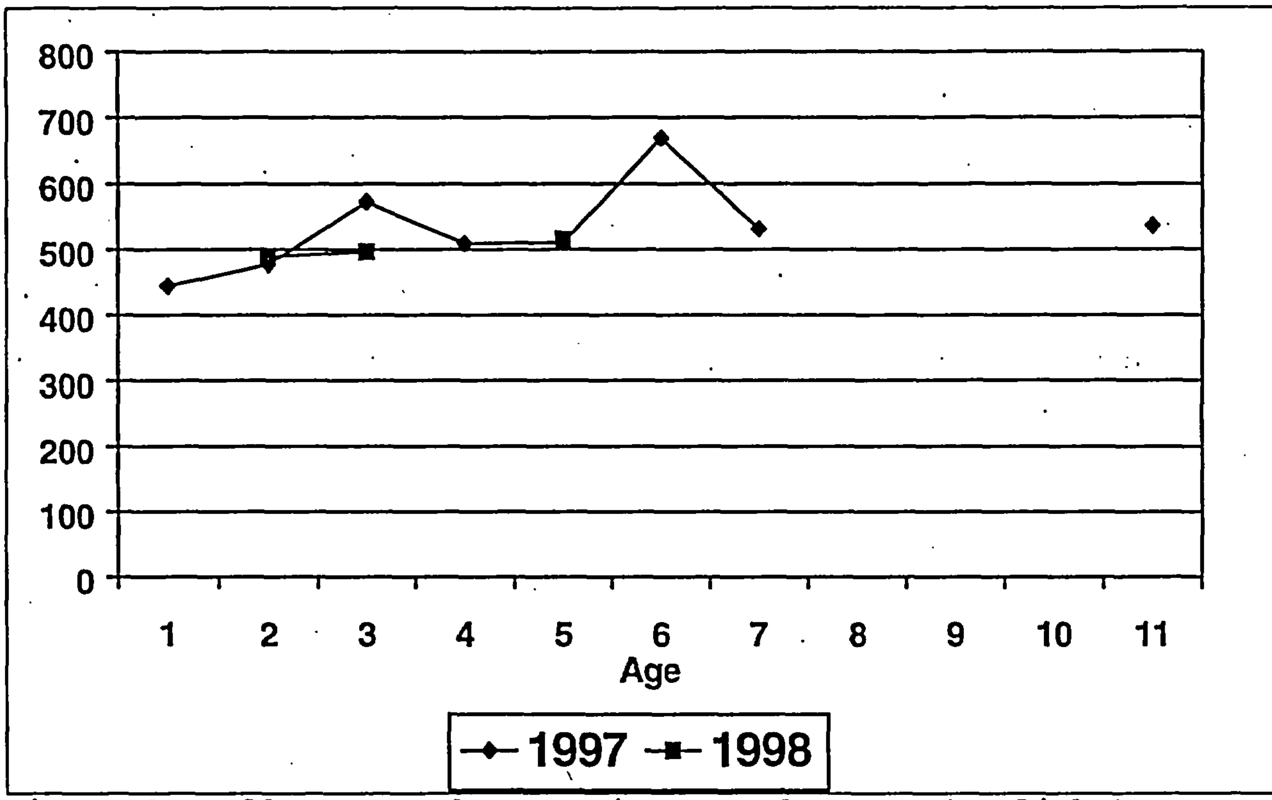


Figure 9. Walleye growth comparisons, Lake Anna (otoliths).
note: specimens collected in fall, thus two growing seasons have elapsed (ages actually 1+, 2+, ...)

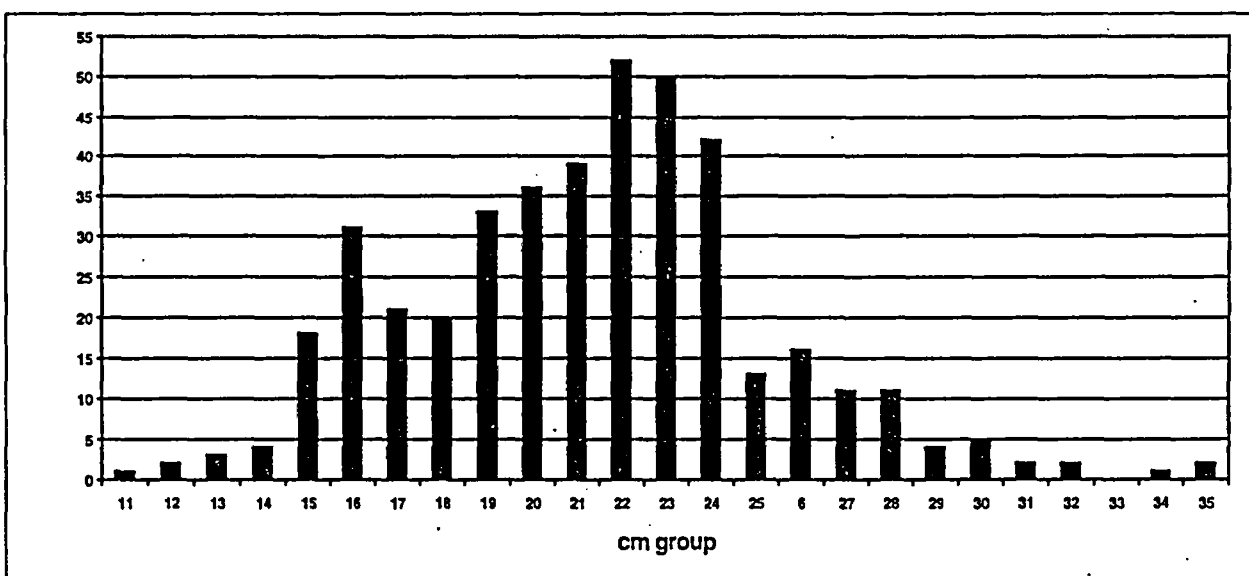


Figure 10. Length frequency histogram of black crappie sampled at Lake Anna by experimental gill nets, 1997.

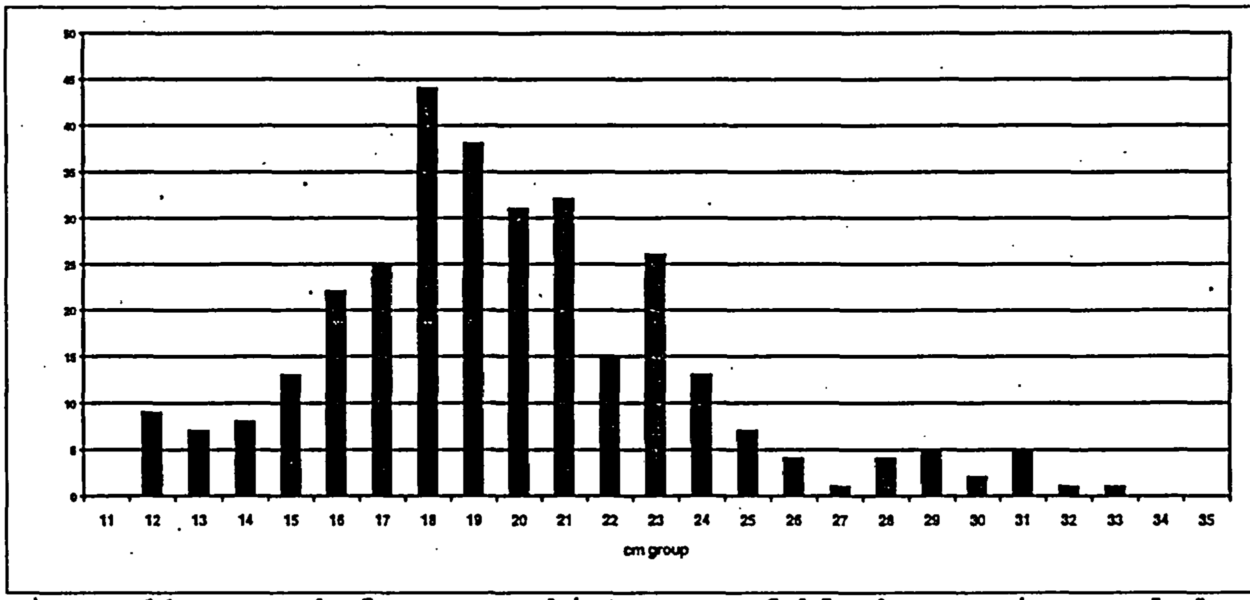


Figure 11. Length frequency histogram of black crappie sampled at Lake Anna by experimental gill nets, 1998.

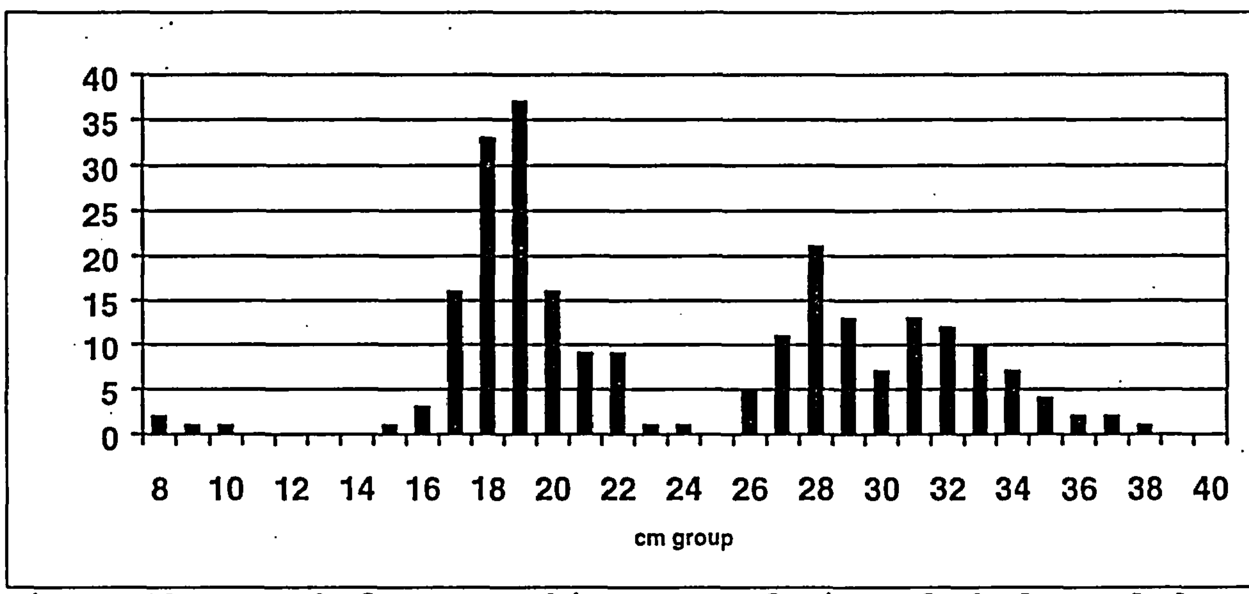


Figure 12. Length frequency histogram of gizzard shad sampled at Lake Anna by experimental gill nets, 1997.

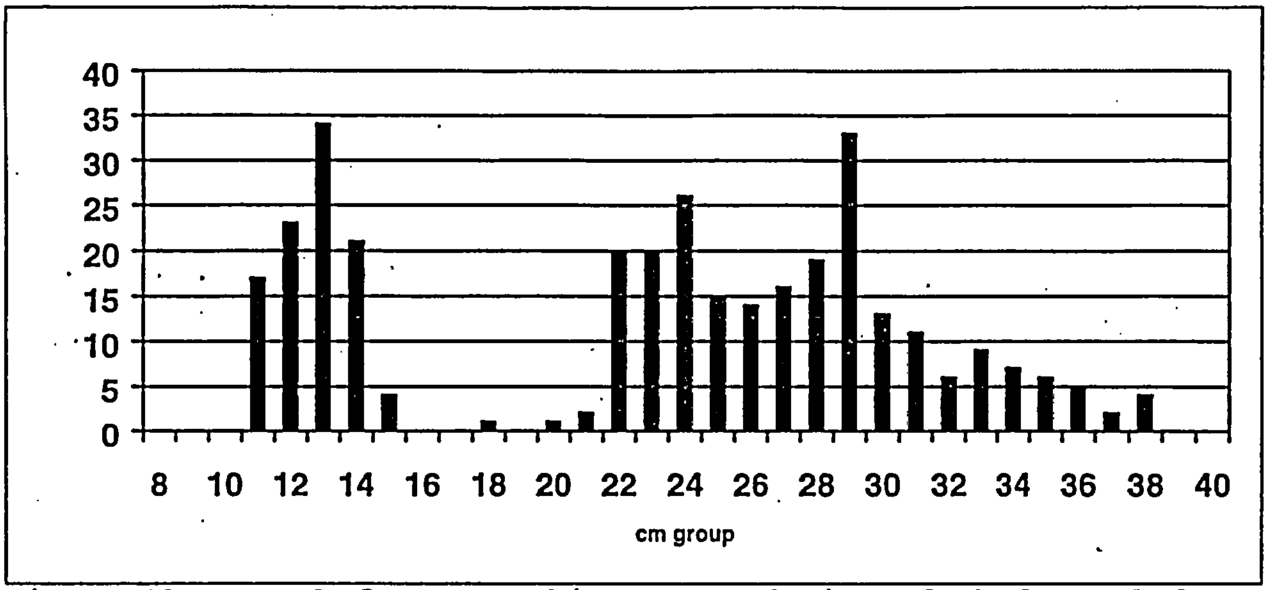


Figure 13. Length frequency histogram of gizzard shad sampled at Lake Anna by experimental gill nets, 1998.

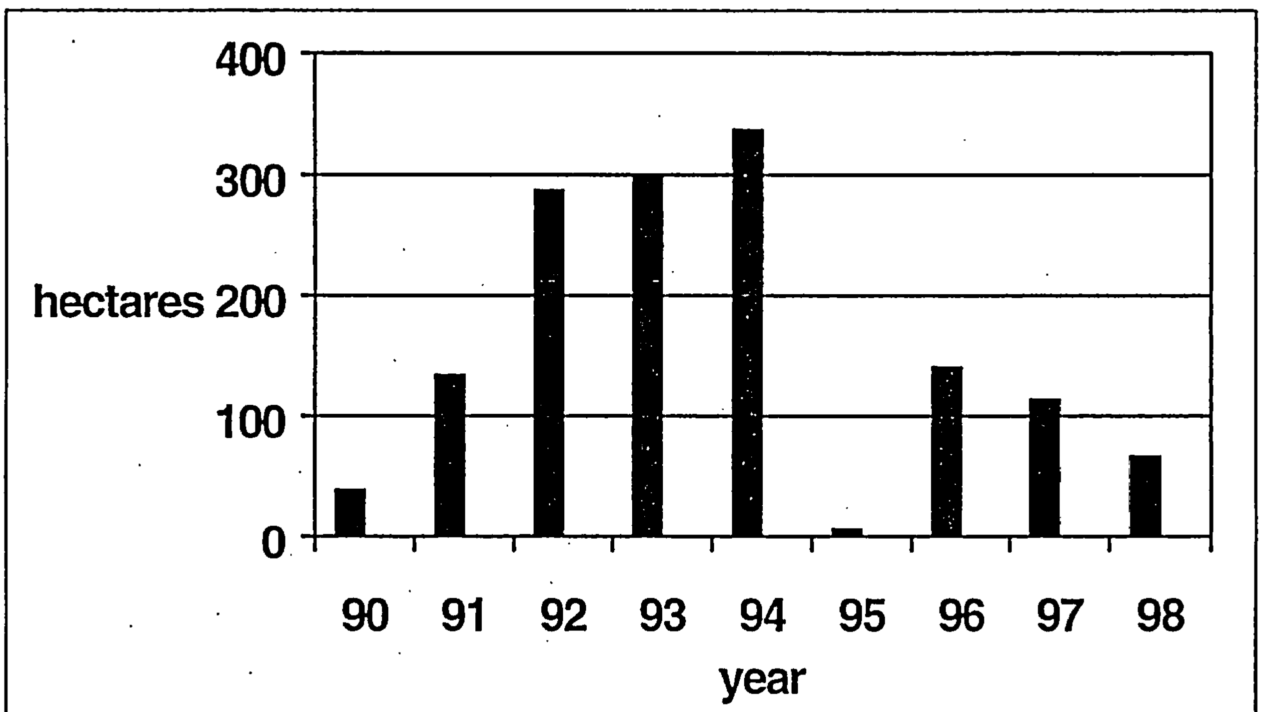


Figure 14. Hydrilla coverage of Lake Anna.