**PA FISH AND BOAT COMMISSION**

**COMMENTS AND RECOMMENDATIONS**

December 2015

**WATER:** Hills Creek Lake (404A)

**EXAMINED:** May 2015

**BY:** Robert Wnuk, Aaron Frey, and Brandi Eberlin

Bureau Director Action: Date:

Division Chief Action: Date:

WW Unit Leader Action: Date:

CW Unit Leader Action: Date:

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**AREA COMMENTS:**

The Area 4 Fisheries Management Office conducted a general inventory of Hills Creek Lake in the spring of 2015. The fishery was in very good condition. Total population densities were average but the densities of larger individuals were above average. Changes in the fishery over time were almost all positive and fish population metrics indicated that Commonwealth Inland Waters Regulations were sufficient to protect and manage the fishery.

**AREA RECOMMENDATIONS:**

* Continue management under Commonwealth Inland Waters Regulations
* Re-survey in 2025

**This work made possible by funding from the Sport Fish Restoration Act Project F-57-R Fisheries Management.**

# Pennsylvania Fish & Boat Commission

**Bureau of Fisheries**

**Division of Fisheries Management**

Hills Creek Lake (404A)

# Fisheries Management Report

Prepared by:

Robert Wnuk and Aaron Frey

Date Sampled: May 2015 Date Prepared:December 2015

# Introduction

There is a substantial fishery resource in Pennsylvania's impoundments and natural lakes. To realize the potential of this resource the Pennsylvania Fish and Boat Commission (PFBC) has established a policy of lake examination. The primary objectives of the examination are to document fish populations and to collect social, physical, and chemical data that influence fish population structure and angler use and harvest. Establishing relationships among these parameters is essential for the development of sound fisheries management plans.

Hills Creek Lake is a 55.0 ha (135.9 ac) impoundment entirely within the confines of Hills Creek State Park. The lake is located 8.9 km (5.5 mi) East of Mansfield in Charleston Township, Tioga County. Daniels and Moase (1982) and Moase (1988, 1994) provide further details of the study area and lake hydrography.

The PFBC last conducted a general inventory at Hills Creek Lake in 1994 (Moase 1994). Since that time, however, there have been several species-specific efforts. Hills Creek Lake served as a control water for the statewide Panfish Enhancement Regulation evaluation. The Panfish Enhancement effort included an angler creel and opinion survey in 1998 (Moase et al. 1999); 40-set trap net surveys in 2003, 2005, and 2007 (Kristine et al. 2009); and an angler opinion survey in 2008 (Weigel et al. 2009). Additionally, Wnuk and Frey (2011) surveyed Walleye *Sander vitreus* at Hills Creek Lake as part of the statewide Walleye plan (PFBC Division of Fisheries Management 2011).

The PFBC terminated Muskellunge *Esox masquinongy* stocking at Hills Creek Lake following the Panfish Enhancement work and terminated Walleye stocking following the 2011 evaluation. Muskellunge provided a desirable fishery in the early years of the program but survival of stocked fingerlings declined as the Largemouth Bass *Micropterus salmoides* population grew. Walleye never met catch per unit effort (CPUE) guidelines and creel surveys demonstrated that few anglers targeted or caught this species. Currently, Hills Creek Lake is managed under Commonwealth Inland Waters Regulations with no stocking.

The Area 4 Fisheries Management office conducted a general inventory of Hills Creek Lake in May 2015. The objectives were: 1) determine the overall quality of fish populations; 2) measure changes in fish populations through time; and 3) determine if Commonwealth Inland Waters Regulations were sufficient to protect and manage the fishery.

# Methods

All procedures of the examination followed Hoopes (1989). We used Pennsylvania style trap nets (Table 1) to target most species. Site selection for trap nets was random within suitable habitat (Figure 1). Trap netting occurred from May 12 through 15, 2015. Water temperature during the trap netting effort ranged from 17.8 to 19.5oC and averaged 18.7oC. We fished 9 trap nets for a total of 212.2 hours.

Night electrofishing on the evening of May 19, 2015, targeted Largemouth Bass. Site selection for night electrofishing was random within suitable habitat. We electrofished 6 sites for approximately 10 minutes each. We did short runs to increase the total number of sites and so improve statistical reliability. Total electrofishing time was 1.01 hours and total electrofishing distance was 2.11 km. This was sufficient to cover 45% of the shoreline. Water temperature during the night electrofishing effort was 23.3oC.

We measured all of the fish we captured to the nearest 25 mm length group. We collected maximum total lengths, weights, and scales from a stratified sub-sample (10 per 25 mm length group) of Black Crappie *Pomoxis nigromaculatus*, Bluegill *Lepomis macrochirus*, and Largemouth Bass. Weights were determined with an ADAM electronic scale (Model LBK12a, 6,000 g) calibrated with Fisher calibration weights.

To determine the overall quality of fish populations we compared 2015 CPUE values from Hills Creek Lake to statewide averages. These comparisons used a Bayesian implementation of a mixed effects model (Wagner et al. 2006). Tyler Wagner from the Pennsylvania State University created the model code. Results were considered significant if the confidence limits for the difference between lake specific and statewide mean CPUE values did not include 0.

To detect changes in fish populations through time we compared CPUE values, percent-frequency distributions, and growth rates from 2015 to the previous examination. The previous examination was 1994 for Largemouth Bass and 2007 for all other species. CPUE comparisons used Mann-Whitney U tests (Zar 1984), percent-frequency distribution comparisons used Kolmogorov-Smirnov two-sample tests (Neumann and Allen 2007), and growth rate comparisons used analysis of covariance (ANACOVA; Isley and Grabowski 2007). The key variable in the ANACOVA was the interaction between year and mean length at age. Back-calculated lengths at age followed the Frazier corrected Lee method (Carlander 1981) with standard intercept values (Carlander 1982).

To determine if Commonwealth Inland Waters Regulations were sufficient to protect and manage the fishery, we used the above information in combination with standard population metrics. Standard population metrics were proportional stock density (PSD), relative stock density (RSD), relative weight (Wr), and total annual mortality. Most of these calculations followed Anderson and Neumann (1996) but total annual mortality calculations followed the catch curve methods of Miranda and Bettoli (2007).

All statistical tests were performed in R version 3.0.0 (R Core Team 2013) with an alpha level of 0.05. In addition, the mixed effects model used program JAGS (Plummer 2003) and growth rate comparisons used R packages car (Fox and Weisberg 2011) and FSA (Ogle 2011).

# Results

All gears combined captured 661 fish of 11 different species (Table 2). Bluegill was the most numerous species, accounting for 51.0% of the total catch. The next most numerous species were Pumpkinseed *Lepomis gibbosus* (16.1%), Black Crappie (8.0%), and Largemouth Bass (7.7%). No other species accounted for more than 7.0% of the total catch. All species collected in 2015 had been found in previous work.

*Overall Quality of Fish Populations*

Total fish population densities at Hills Creek Lake were generally average when compared to statewide values (Table 3). The exceptions were Brown Bullhead *Ameiurus nebulosus*, Pumpkinseed, and Yellow Perch *Perca flavescens*. Total CPUE values for Brown Bullhead and Yellow Perch were significantly lower than statewide means, while total CPUE of Pumpkinseed was significantly higher.

Densities of large fish at Hills Creek Lake were generally better than statewide values. CPUE of large Bluegill, Largemouth Bass, Pumpkinseed, and Yellow Bullhead *Ameiurus natalis* were significantly greater than statewide averages. In contrast, CPUE of large Brown Bullhead was significantly lower than the statewide average.

*Changes in Fish Populations Through Time*

We observed several changes in fish population densities between 2015 and the previous survey (Table 4). Most changes were positive. Total CPUE of Black Crappie, Bluegill, Pumpkinseed, and Yellow Bullhead were all significantly greater in 2015 than in 2007. CPUE values for large individuals of these four species were also significantly greater this year. The only negative density change we observed was a significant decline in total Largemouth Bass CPUE between 2015 and 1994.

Percent-frequency distributions of Largemouth Bass, Yellow Perch, Brown Bullhead, and Yellow Bullhead were stable through time. In contrast, percent-frequency distributions of Black Crappie, Bluegill, Pumpkinseed, and Golden Shiner *Notemigonus crysoleucas* were significantly different (Figures 2 – 9). Where significant differences occurred, the changes were always positive with a greater percentage of larger fish available in 2015.

We collected enough Largemouth Bass, Black Crappie, and Bluegill for age and growth analyses. Growth of these species at Hills Creek Lake usually exceeded statewide averages after age 2 (Figures 10 – 12). When compared to previous work at Hills Creek Lake, Bluegill growth rate was significantly faster in 2015 but there were no significant differences in growth rates of Largemouth Bass and Black Crappie.

*Standard Population Metrics*

Largemouth Bass PSD was 54 (Table 5), which was improved from a PSD of 38 in 1994. For all other species, PSD values were > 90 and exceeded those from the previous survey. Yellow Perch relative weight was 79 but relative weight exceeded 90 for all other species. Total annual mortality was 24.8% for Bluegill and 28.4% for Largemouth Bass. Both mortality values were substantially lower than during the previous survey.

**Discussion**

The fishery at Hills Creek Lake was in very good condition. For most species, total population density was average but the density of larger individuals was above average. The exceptions were Yellow Perch and Brown Bullhead. Lower density of Yellow Perch was probably related to the timing of the survey. We sampled after Yellow Perch had completed spawning and left shallow water habitats. The decline in Brown Bullhead density was compensated by an increase in Yellow Bullhead density.

Almost all of the changes we observed in fish populations through time were positive. Total annual mortality rates decreased and more big fish were available to anglers. Because total annual mortality rates were below 40%, CPUE values for larger individuals of most species were above average, and PSD values were high, we concluded that angler harvest was not having a negative impact on fish populations. Thus, Commonwealth Inland Waters Regulations were sufficient to protect and manage the fishery.

# Management Regulations

* Continue management under Commonwealth Inland Waters Regulations
* Re-survey in 2025

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**Table 1.** Description of fish sampling gear used during the 2015 Hills Creek Lake (404A, Tioga County, Pennsylvania) survey.

|  |  |
| --- | --- |
| Gear | Description |
|  |  |
| Trap Nets | Pennsylvania trap net; pot mesh 20 mm stretch measure; 30 m lead |
|  |  |
| Boat Electrofisher | 5.2 m flatbottom aluminum boat rigged with eight fixed droppers (four per side); 5000 Watt Honda generator (Model # EG 5000); Smith-Root variable voltage pulsator electroshocker (Type VIa) |

**Table 2.** Number of fish captured by all gears combined at Hills Creek Lake (404A, Tioga County, Pennsylvania) during the 2015 survey.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Common name | Scientific Name | Number Caught | Percent of Catch | Present  Historically |
|  |  |  |  |  |
| Black Crappie | *Pomoxis nigromaculatus* | 53 | 8.0 | Yes |
|  |  |  |  |  |
| Bluegill | *Lepomis macrochirus* | 337 | 51.0 | Yes |
|  |  |  |  |  |
| Brown Bullhead | *Ameiurus nebulosus* | 5 | 0.8 | Yes |
|  |  |  |  |  |
| Chain Pickerel | *Esox niger* | 1 | 0.2 | Yes |
|  |  |  |  |  |
| Golden Shiner | *Notemigonus crysoleucas* | 41 | 6.2 | Yes |
|  |  |  |  |  |
| Largemouth Bass | *Micropterus salmoides* | 51 | 7.7 | Yes |
|  |  |  |  |  |
| Muskellunge | *Esox masquinongy* | 1 | 0.2 | Yes |
|  |  |  |  |  |
| Pumpkinseed | *Lepomis gibbosus* | 107 | 16.1 | Yes |
|  |  |  |  |  |
| Walleye | *Sander vitreus* | 12 | 1.8 | Yes |
|  |  |  |  |  |
| Yellow Bullhead | *Ameiurus natalis* | 34 | 5.1 | Yes |
|  |  |  |  |  |
| Yellow Perch | *Perca flavescens* | 19 | 2.9 | Yes |
|  |  |  |  |  |
| **Totals:** |  | **661** | **100.0%** |  |

**Table 3.** Statistical comparisons of catch per hour values for selected species and length groups captured at Hills Creek Lake (404A, Tioga County, Pennsylvania) in 2015 with statewide means. Statistically significant differences (confidence limits do not include 0) are highlighted in yellow.

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  |  |  | Mean Catch per Hour Values  Log-transformed  Raw Values Modeled Values | | | | 95% Confidence  Limits for the |
| Species | Length  Group (mm) | Gear  Type | Hills Creek  Lake | Statewide  Mean | Hills Creek  Lake | Statewide  Mean | Difference  Between  Modeled Values |
|  |  |  |  |  |  |  |  |
| Black Crappie | Total Catch | PATN | 0.25 | 1.35 | -1.13 | -0.59 | -0.03 to 1.10 |
|  | > 225 mm | PATN | 0.19 | 0.18 | -1.40 | -1.63 | -0.57 to 0.11 |
|  |  |  |  |  |  |  |  |
| Bluegill | Total Catch | PATN | 1.58 | 1.58 | 0.17 | -0.04 | -0.72 to 0.29 |
|  | > 175 mm | PATN | 1.30 | 0.45 | -0.13 | -1.08 | -1.40 to -0.53 |
|  |  |  |  |  |  |  |  |
| Brown Bullhead | Total Catch | PATN | 0.02 | 0.86 | -1.98 | -0.92 | 0.52 to 1.59 |
|  | > 300 mm | PATN | 0.02 | 0.86 | -2.08 | -1.60 | 0.12 to 0.84 |
|  |  |  |  |  |  |  |  |
| Largemouth Bass | Total Catch | NEF | 50.59 | 69.80 | 3.75 | 3.61 | -0.93 to 0.63 |
|  | > 300 mm | NEF | 25.65 | 19.64 | 2.83 | 2.29 | -1.39 to 0.23 |
|  | > 375 mm | NEF | 8.94 | 5.56 | 1.77 | 0.78 | -1.92 to -0.06 |
|  |  |  |  |  |  |  |  |
| Pumpkinseed | Total Catch | PATN | 0.50 | 0.24 | -0.80 | -1.33 | -0.87 to -0.19 |
|  | > 175 mm | PATN | 0.35 | 0.06 | -1.08 | -1.97 | -1.10 to -0.68 |
|  |  |  |  |  |  |  |  |
| Yellow Bullhead | Total Catch | PATN | 0.16 | 0.09 | -1.79 | -1.84 | -0.30 to 0.20 |
|  | > 300 mm | PATN | 0.09 | 0.01 | -2.05 | -2.23 | -0.28 to -0.09 |
|  |  |  |  |  |  |  |  |
| Yellow Perch | Total Catch | PATN | 0.09 | 1.15 | -1.59 | -0.70 | 0.27 to 1.49 |
|  | > 225 mm | PATN | 0.07 | 0.20 | -1.87 | -1.66 | -0.15 to 0.56 |

NEF = Night Electrofishing; PATN = Pennsylvania Trap Net.

**Table 4.** Statistical comparisons of catch per unit effort values for selected species and length groups captured at Hills Creek Lake (404A, Tioga County, Pennsylvania) between 2015 and the previous survey. Statistically significant results (p < 0.05) are highlighted in yellow.

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  | Length | Gear | Catch per Hour | |  | Mann-Whitney U Test  2015 vs Previous Survey\* | |
| Species | Group | Type | 2015 | Previous Survey\* |  | W | p |
|  |  |  |  |  |  |  |  |
| Black Crappie | Total Catch | PATN | 0.25 | 0.11 |  | 262 | 0.01 |
|  | > 225 mm | PATN | 0.19 | 0.05 |  | 294 | < 0.01 |
|  |  |  |  |  |  |  |  |
| Bluegill | Total Catch | PATN | 1.58 | 0.83 |  | 248 | 0.04 |
|  | > 175 mm | PATN | 1.30 | 0.59 |  | 266 | 0.01 |
|  |  |  |  |  |  |  |  |
| Brown Bullhead | Total Catch | PATN | 0.02 | 0.04 |  | 144 | 0.35 |
|  | > 300 mm | PATN | 0.02 | 0.04 |  | 143 | 0.33 |
|  |  |  |  |  |  |  |  |
| Golden Shiner | Total Catch | PATN | 0.19 | 0.19 |  | 231 | 0.09 |
|  |  |  |  |  |  |  |  |
| Largemouth Bass | Total Catch | NEF | 50.59 | 108.14 |  | 5 | 0.04 |
|  | > 300 mm | NEF | 25.65 | 38.28 |  | 12 | 0.38 |
|  | > 375 mm | NEF | 8.94 | 16.11 |  | 6 | 0.06 |
|  |  |  |  |  |  |  |  |
| Pumpkinseed | Total Catch | PATN | 0.50 | 0.09 |  | 327 | < 0.01 |
|  | > 175 mm | PATN | 0.35 | 0.03 |  | 317 | < 0.01 |
|  |  |  |  |  |  |  |  |
| Yellow Bullhead | Total Catch | PATN | 0.16 | 0.01 |  | 327 | < 0.01 |
|  | > 300 mm | PATN | 0.09 | 0.00 |  | 317 | < 0.01 |
|  |  |  |  |  |  |  |  |
| Yellow Perch | Total Catch | PATN | 0.09 | 0.09 |  | 150 | 0.58 |
|  | > 225 mm | PATN | 0.07 | 0.05 |  | 172 | 0.98 |

NEF = Night Electrofishing; PATN = Pennsylvania Trap Net.

\*Previous survey was 1994 for Largemouth Bass and 2007 for all other species.

**Table 5.** Standard population metrics for selected fish species captured at Hills Creek Lake (404A, Tioga County, Pennsylvania) in 2015 and the previous survey\*.

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Species | Year | PSD | RSD | RSD Length  (mm) | Relative  Weight | Minimum Length for Relative Weight (mm) | Total  Annual  Mortality | Age Groups  For Total  Annual  Mortality |
|  |  |  |  |  |  |  |  |  |
| Black Crappie | 2015 | 92 | 15 | 250 | 93 | 100 | NS | NS |
|  | 2007 | 87 | 22 | 250 | 95 | 100 | 16.5% | 4 – 7 |
|  |  |  |  |  |  |  |  |  |
| Bluegill | 2015 | 98 | 38 | 200 | 96 | 80 | 24.8% | 5 - 8 |
|  | 2007 | 82 | 55 | 200 | 94 | 80 | 77.9% | 6 – 9 |
|  |  |  |  |  |  |  |  |  |
| Brown Bullhead | 2015 | NA | NA | 300 | NA | NA | NA | NA |
|  | 2007 | 100 | 97 | 300 | NA | NA | NA | NA |
|  |  |  |  |  |  |  |  |  |
| Largemouth Bass | 2015 | 54 | 19 | 375 | 94 | 150 | 28.4% | 2 - 5 |
|  | 1994 | 38 | 16 | 375 | 94 | 150 | 47.7% | 2 – 7 |
|  |  |  |  |  |  |  |  |  |
| Pumpkinseed | 2015 | 97 | 1 | 200 | NS | 50 | NS | NS |
|  | 2007 | 50 | 8 | 200 | 95 | 50 | 45.5% | 5 – 8 |
|  |  |  |  |  |  |  |  |  |
| Yellow Bullhead | 2015 | 100 | 59 | 300 | NA | NA | NA | NA |
|  | 2007 | NA | NA | 300 | NA | NA | NA | NA |
|  |  |  |  |  |  |  |  |  |
| Yellow Perch | 2015 | 90 | 50 | 250 | NS | 100 | NS | NA |
|  | 2007 | 67 | 44 | 250 | 79 | 100 | 10.0% | 3 – 8 |

NA = Not available; NS = Data not suitable for calculations.

\*Previous survey was 1994 for Largemouth Bass and 2007 for all other species.

State Park Property

Night Electrofishing Site

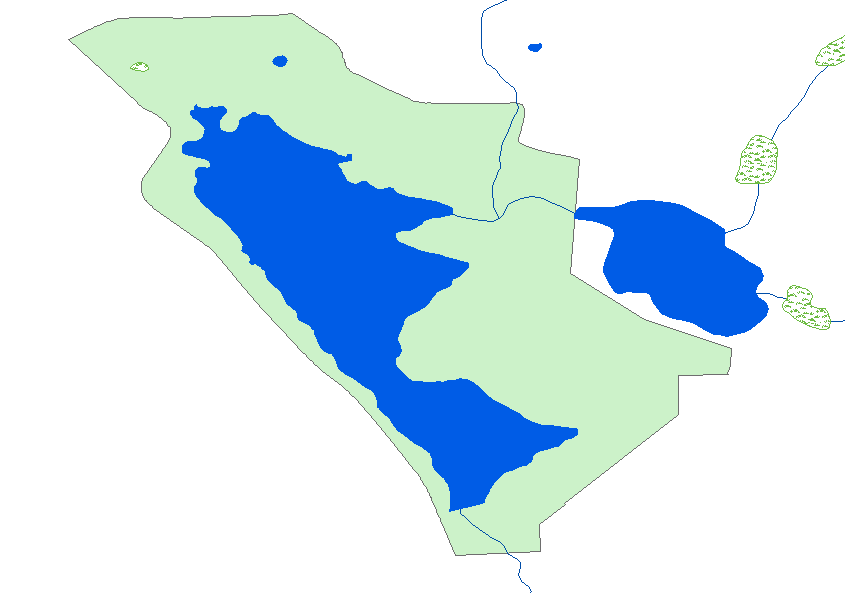
Wetlands

Trap Net Site

**Tauscher**

**Pond**

**Hills Creek Lake**

****

**NORTH**

Scale:

1 cm = 129 m

**Figure 1.** Location of 2015 sampling sites at Hills Creek Lake (404A, Tioga County, Pennsylvania).

**Figure 2.** Percent frequency distributions of Largemouth Bass captured by night electrofishing and trap nets at Hills Creek Lake (404A, Tioga County, Pennsylvania) in 2015 and 1994.

Two Sample Kolmogorov-Smirnov Test:

D = 0.33, p < 0.01

Result: 2015 Significantly Greater

**Figure 3.** Percent frequency distributions of Black Crappie captured by trap nets at Hills Creek Lake (404A, Tioga County, Pennsylvania) in 2015 and 2007.

**Figure 4.** Percent frequency distributions of Bluegill captured by trap nets at Hills Creek Lake (404A, Tioga County, Pennsylvania) in 2015 and 2007.

Two Sample Kolmogorov-Smirnov Test:

D = 0.17, p = 0.01

Result: 2015 Significantly Greater

Two Sample Kolmogorov-Smirnov Test:

D = 0.48, p < 0.01

Result: 2015 Significantly Greater

**Figure 5.** Percent frequency distributions of Pumpkinseed captured by trap nets at Hills Creek Lake (404A, Tioga County, Pennsylvania) in 2015 and 2007.

Two Sample Kolmogorov-Smirnov Test:

D = 0.29, p = 0.14

Result: No Significant Difference

**Figure 6.** Percent frequency distributions of Yellow Perch captured by trap nets at Hills Creek Lake (404A, Tioga County, Pennsylvania) in 2015 and 2007.

Two Sample Kolmogorov-Smirnov Test:

D = 0.57, p = 0.12

Result: No Significant Difference

**Figure 7.** Percent frequency distributions of Brown Bullhead captured by trap nets at Hills Creek Lake (404A, Tioga County, Pennsylvania) in 2015 and 2007.

Two Sample Kolmogorov-Smirnov Test:

D = 0.26, p = 0.92

Result: No Significant Difference

**Figure 8.** Percent frequency distributions of Yellow Bullhead captured by trap nets at Hills Creek Lake (404A, Tioga County, Pennsylvania) in 2015 and 2007.

Two Sample Kolmogorov-Smirnov Test:

D = 0.70, p < 0.01

Result: 2015 Significantly Greater

**Figure 9.** Percent frequency distributions of Golden Shiner captured by trap nets at Hills Creek Lake (404A, Tioga County, Pennsylvania) in 2015 and 2007.

Analysis of Covariance test of the assumption of equal slopes between 1994 and 2007 Largemouth Bass growth data:

**F** **P**

YEAR:INC 2.0104 0.1568

YEAR:INC2 0.2836 0.5946

Result: No Significant Difference

**Figure 10.** Back-calculated lengths at age of Largemouth Bass captured at Hills Creek Lake (404A, Tioga County, Pennsylvania) in 2015 and 1994 compared to statewide averages.

Analysis of Covariance test of the assumption of equal slopes between 2015 and 2007 Black Crappie growth data:

**F** **P**

YEAR:INC 0.9187 0.3386

YEAR:INC2 0.1685 0.1685

Result: No Significant Difference

**Figure 11.** Back-calculated lengths at age of Black Crappie captured at Hills Creek Lake (404A, Tioga County, Pennsylvania) in 2015 and 2007 compared to statewide averages.

Analysis of Covariance test of the assumption of equal slopes between 2015 and 2007 Bluegill growth data:

**F** **P**

YEAR:INC 8.8857 0.003024

YEAR:INC2 25.2654 7.12e-07

Result: 2015 Significantly Greater

**Figure 12.** Back-calculated lengths at age of Bluegill captured at Hills Creek Lake (404A, Tioga County, Pennsylvania) in 2015 and 2007 compared to statewide averages.

DISTRIBUTION

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