STUDY PERFORMANCE REPORT

State: Michigan **Project No.:** F-80-R-6

Study No.: 230714 **Title:** Managing Michigan lakes: evaluating effects of watersheds and habitat perturbation on lake resources.

Period Covered: October 1, 2004 to September 30, 2005

Study Objective:

1. To evaluate the ability of the Fisheries Division Status and Trends Program to actually detect changes in the status of Michigan lakes over time.
2. To investigate the effects of habitat perturbation on lake biota.
3. To conduct workshops designed to improve dialog within the Division regarding implementation of the Status and Trends program, and integration of the program with research and management efforts.

Summary: Statistical analysis of existing data sets (to evaluate statistical power to detect temporal trends) was updated to account for the statistical complexity of the situation. A weighted mixed model was used to examine regional (statewide) temporal trends in mean length at age, using both Michigan and Wisconsin data. Overall, 26 of 42 fish species x age class x state combinations were examined for temporal trends. Of these, only four demonstrated significant regional temporal trends, with one being positive over time and 3 being negative over time. A components of variance approach was also employed to partition the total variance in mean length at age into five components: (1) site-to-site (spatial) variation, (2) coherent (year-to-year) variation, (3) ephemeral temporal (site-by-year interaction) variation, (4) variation in site-specific trends, and (5) residual variation. The variance estimates were then used in power analyses to investigate the statistical power to detect trends in mean length at age. Datasets demonstrated different patterns in the partitioning of total variability in mean length at age, and these differences contributed to differences in the power to detect regional temporal trends. With regards to field sampling components of this project, our analysis of relationships among shoreline development, littoral habitat, and fish populations documented habitat effects of shoreline development at both the local (site) and lake levels. We did not detect large effects of shoreline development on fish growth rates, but we found that black bass nesting success declined nearly two-fold with increasing lake dwelling density. Efforts to transfer findings to the Division in the form of interactive workshops and to develop broader collaborations have continued.

Findings: Jobs 1, 2, 3, 5, and 7 were scheduled for 2004-05, and progress is reported below.

Job 1. Title: Analyze existing data sets.–Evaluation of the Status and Trends Program is composed of two steps: (i) conducting temporal trend analyses, looking at trends in mean length at age over time, and (ii) using results from (i) to conduct power analyses. To date, we have conducted temporal trend analyses, estimated components of variance in mean length at age, and developed a simulation model to estimate the statistical power to detect regional (statewide) trends. For this analysis, we analyzed historical datasets containing mean length at age data for seven warm and coolwater fish species for the states of Michigan and Wisconsin. Results from Job 1 have been prepared for submission to the Canadian Journal of Fisheries and Aquatic Sciences for

publication as “Regional trends in fish mean length at age: components of variance and power to detect trends”. A reprint will be provided with a future progress report.

Job 2. Title: Conduct fieldwork to investigate effects of habitat perturbation on lake biota.–In summers 2003 and 2004, 6-15 lakes in the Huron River watershed of Michigan were sampled in order to quantify the relationships among residential shoreline development, littoral and lakewide habitat features, fish growth rates (largemouth bass and bluegill), and reproductive success of black bass. We found that coarse woody material abundance strongly declines with residential development. Features of aquatic plant assemblages are also influenced by residential development, and interestingly, reproductive success of black bass nests declines almost two fold with increasing residential development. Results of Job 2 have been submitted for publication in *Ecosystems* as well as *Transactions of the American Fisheries Society*. Both articles are currently in review, and reprints will be provided with a future progress report.

Job 3. Title: Process field samples and analyze data.–Nearly 750 largemouth bass scale samples from 15 study lakes (representing a gradient of shoreline dwelling density) were processed between 2004 and 2005. Scale annuli were measured using Optimas 6.51 imaging software. Back-calculated total length at the start of each growth increment was then determined for each fish. Growth increments of largemouth bass and bluegill were regressed against lake dwelling density (Figs. 1-4). Zooplankton samples from each of the 15 study lakes were also analyzed for species composition, relative abundance, biomass, and size structure. Initial analyses have been conducted to determine if characteristics of zooplankton assemblages vary predictably along the shoreline development gradient

Job 5. Title: Conduct Division-wide workshops.–Planning for the workshops has progressed in collaboration with Todd Wills, MDNR. A collaborative manuscript was developed and has been accepted for publication in *Fisheries*; it addresses statistical approaches available to state agencies to help improve monitoring programs. A reprint will be provided with a future progress report. In addition, a multi-state research project was funded to investigate relationships between in-lake features and lake landscapes. The statistical models developed will be used to inform development of lake typologies and to improve lake assessment programs.

Job 7. Title: Prepare annual reports and manuscripts.–This annual report was completed as scheduled. In addition to several manuscripts currently in review or preparation, the following master’s thesis was completed and includes findings for this study:

Jubar, A.K. 2004. Quantifying effects of residential lakeshore development on littoral fishes and habitat: toward a framework for lake ecosystem conservation. Master’s thesis. Department of Fisheries and Wildlife, Michigan State University, East Lansing.

Prepared by: M. Bremigan, P. Soranno, T. Wagner, and A. Jubar
Date: September 30, 2005

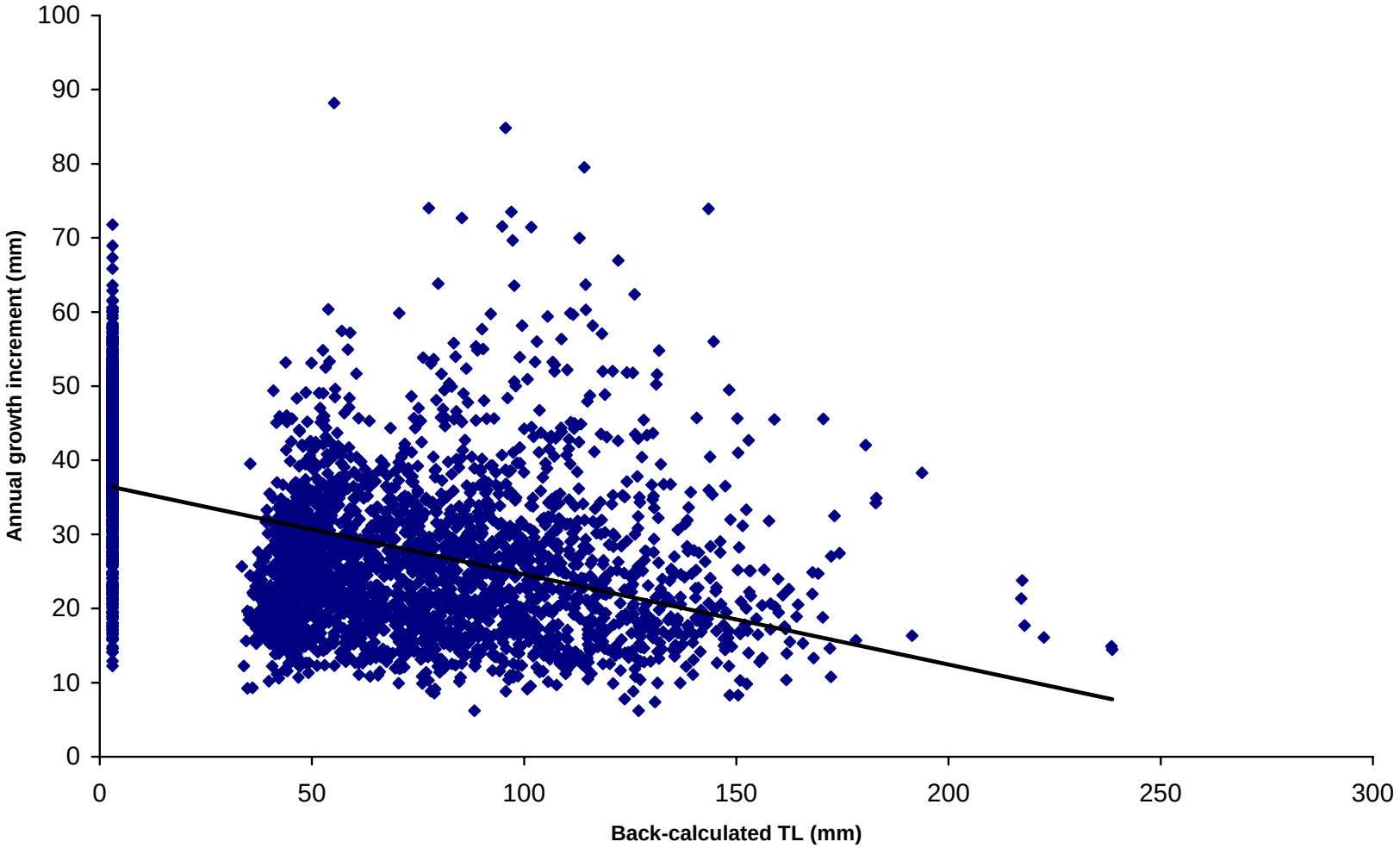

Figure 1.–Annual growth increment (mm) relative to fish size (back-calculated total length, mm) of bluegill collected in 2003 and 2004 in the 15 study lakes. Data points on far left indicate size at hatching.

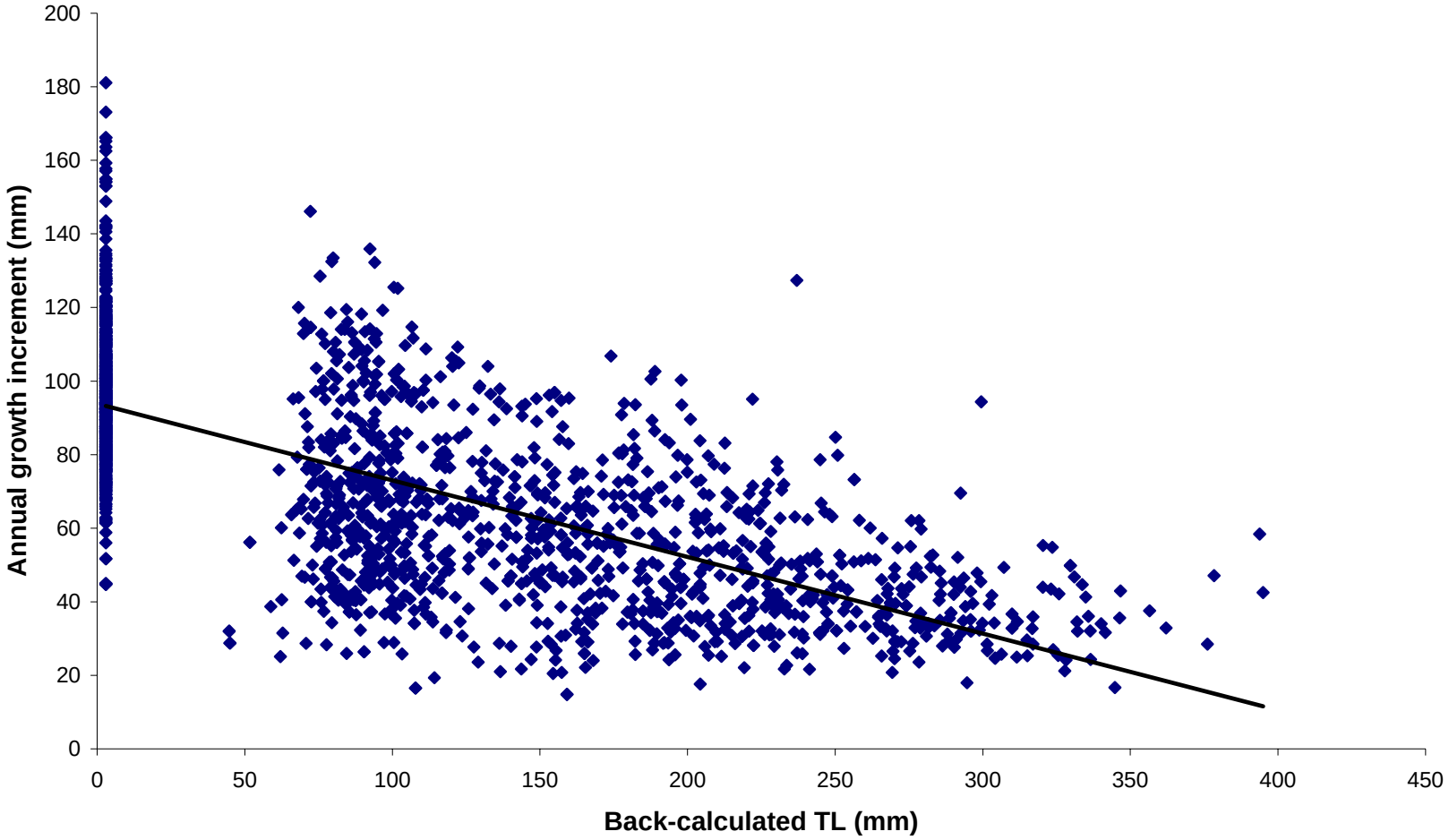

Figure 2.–Annual growth increment (mm) relative to fish size (back-calculated total length, mm) of largemouth bass collected in 2003 and 2004 in the 15 study lakes. Data points on far left indicate size at hatching.

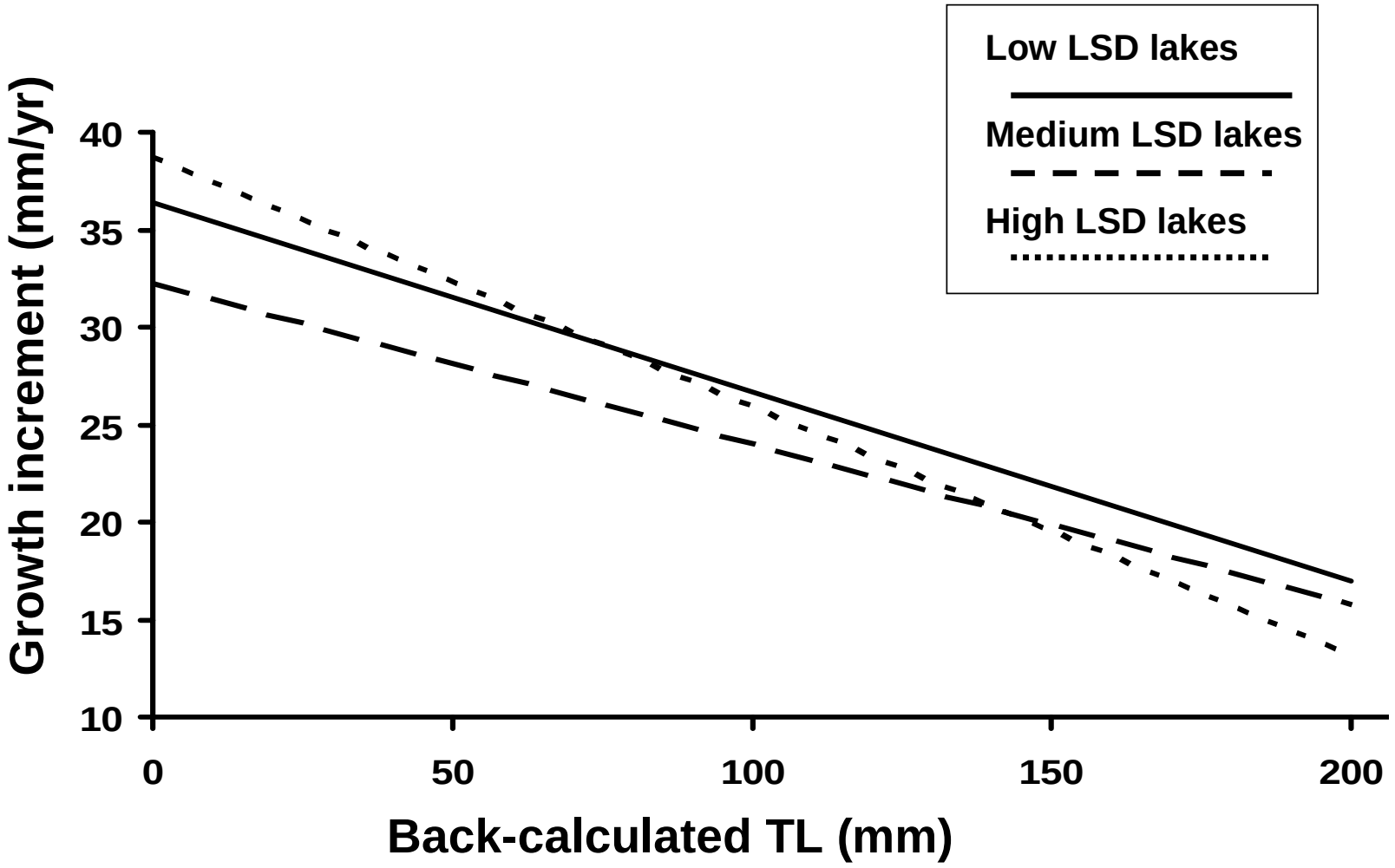

Figure 3.–Annual growth increment for bluegill (growth years 2001 and 2002) as a function of back-calculated total length. Low development lakes (<13 dwellings•km^{-1}) are represented by the solid line, medium development lakes (13-20 dwellings•km^{-1}) are represented by the wide-dashed line, and high development lakes (>20 dwellings•km^{-1}) are represented by the short-dashed line.

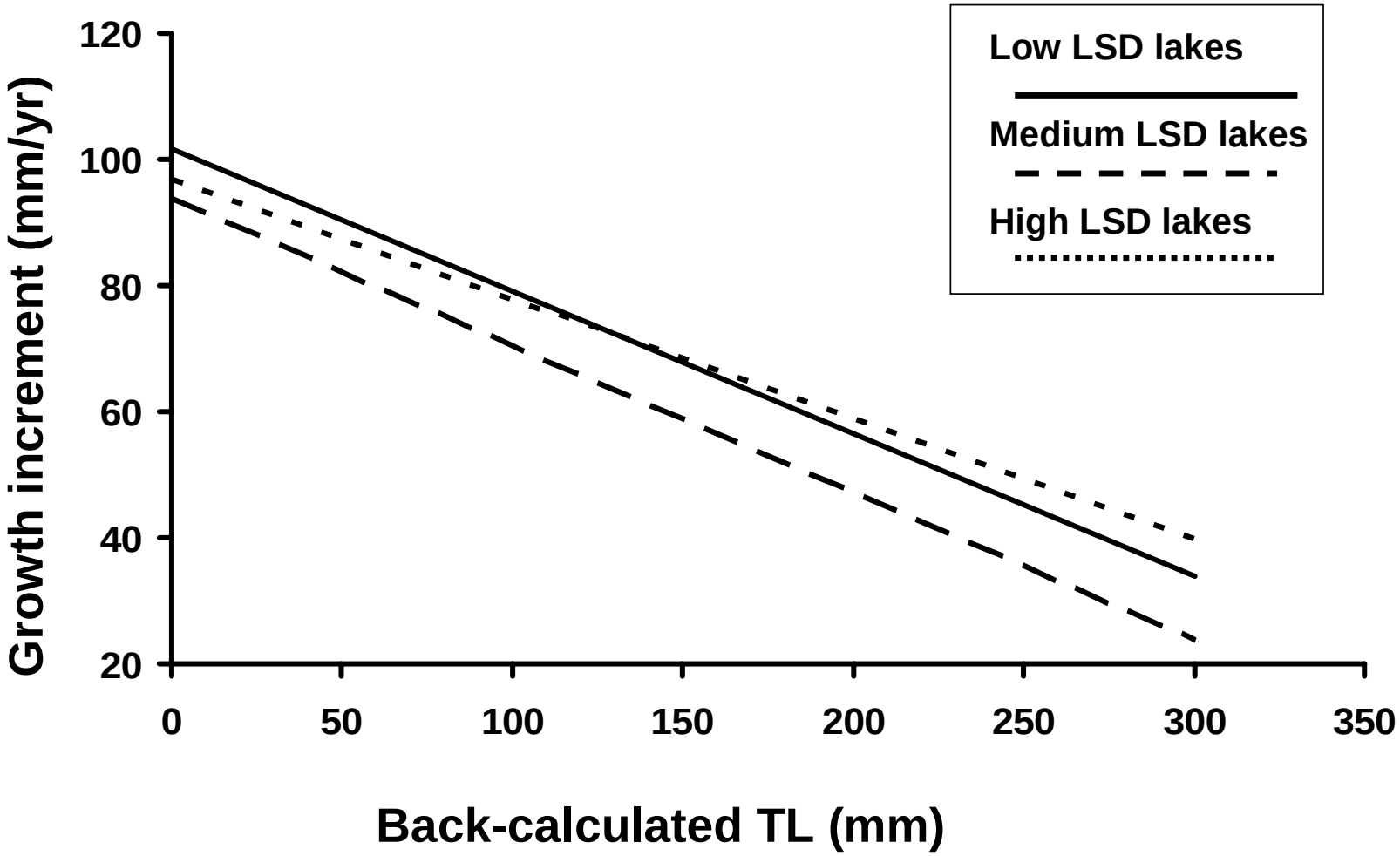

Figure 4.–Annual growth increment for largemouth bass (growth years 1998 and 2001) as a function of back-calculated total length. Low development lakes (<13 dwellings•km^{-1}) are represented by the solid line, medium development lakes (13-20 dwellings•km^{-1}) are represented by the wide-dashed line, and high development lakes (>20 dwellings•km^{-1}) are represented by the short-dashed line.