STATEWIDE ALLIGATOR SURVEYS

by

Allan R. Woodward and Clinton T. Moore

Final Report
Study Number: 7566
Study Period: 1 July 1989 - 30 June 1990

September 1990

Bureau of Wildlife Research
Florida Game and Fresh Water Fish Commission
620 South Meridian Street
Tallahassee, FL 32399-1600

STATEWIDE ALLIGATOR SURVEYS

ALLAN R. WOODWARD
Biological Scientist III, Florida Game and Fresh Water Fish Commission, Wildlife Research Laboratory, 4005 South Main Street, Gainesville, FL 32601

CLINTON T. MOORE
Biological Scientist IV, Florida Game and Fresh Water Fish Commission, Wildlife Research Laboratory, 4005 South Main Street, Gainesville, FL 32601

Abstract: Night-light alligator surveys of 59 Florida wetlands indicated that population densities of ≥1, ≥4, and ≥6 ft. American alligators (*Alligator mississippiensis*) increased by 4.2, 3.5, and 7.5% per year, respectively, during the period 1974-89 ($P < 0.05$). Population densities of ≥6 ft. alligators increased between 1974 and 1979, probably because of increased recruitment and decreased wariness resulting from protection. An increase was observed in ≥1 ft. alligators from 1980-89 but not in the larger size classes, suggesting increases of young alligators. This was likely the result of increases of adult alligators during the 1970's. Counts of ≥1, ≥4, and ≥6 ft. alligators were inversely correlated with water level ($P < 0.05$). Water level was used as a covariate in regression analyses. In 1989, mean water level-adjusted alligator population densities on 17 permanent areas monitored since 1983 were 17.49 and 7.74 alligators per mile for ≥1 and ≥4 ft. alligators, respectively. These densities were well above minimum thresholds of 7.9 and 3.7 alligators per mile established by the 1984 GFC strategic plan. Water level changes and time interval between counts affected the independence of replicate counts. Considering normal rainfall patterns in Florida, counts should be conducted seasonally 15-30 days apart when water temperatures are ≥28 C to improve the accuracy of the growth rate parameter variance estimates. This study demonstrated that night-light counts can be used effectively to monitor alligator population trends. If inferences are to be made about the Florida alligator population, sample areas need to be selected in a stratified random design based on habitat type and management regime.

INTRODUCTION

The American alligator population in Florida declined since the beginning of the 20th century due to wetlands drainage and commercial hunting for skins (Kellog 1929, Allen and Neill 1949, Kersey 1975, Hines 1979). This decline became most apparent during the period 1950-70 (Hines 1979). Although there was general agreement among state, federal, and private authorities that alligator populations were decreasing, this perception was based largely upon subjective observations. Prior to 1974, information regarding the population status of alligators in Florida was limited and confined to the Everglades (Hines et al. 1968, Schemnitz 1974). The ostensible recovery of the Florida alligator population during the early 1970's, following federal protection in 1970, could not be substantiated because no objective system of monitoring statewide trends was in place.

As nuisance alligator complaints and attacks on human beings increased in the early 1970's (Schemnitz 1974, Hines 1976, Hines and Woodward 1980), it became evident that management of the Florida alligator population, including a sound method of monitoring population trends, would be necessary. In 1971, Chabreck (1976) organized annual night-light alligator surveys throughout the alligator's range to monitor the response of the American alligator population to protection. However, in Florida, those surveys were mainly conducted on national wildlife refuges. In 1974, the Florida Game and Fresh Water Fish Commission (GFC) initiated night-light surveys on non-federally managed lands throughout Florida to obtain an index of alligator abundance (Hines 1979, Wood et al. 1985). Areas were added in subsequent years as additional funding and manpower were appropriated for alligator monitoring and management. This made trend analysis of pooled data from all areas difficult (Wood et al. 1985). In addition, Wood et al. (1985) found variation in counts to be high and recommended conducting multiple counts per year to increase the power of regression analyses and account for variation in counts attributable to factors other than population changes. Since 1983, the GFC has made a concerted effort to survey all areas at least twice per year. To stay within budgets, over half of the survey routes initiated during the 1970's had to be discontinued. This created further problems in trend analysis of the statewide population (Wood et al. 1985).

The objectives of this investigation were to estimate alligator population trends from permanent night-light survey routes established in 1983, to analyze pooled 1974-89 survey data for alligator population trends, and to evaluate survey procedures employed since 1983 with regard to the underlying assumptions of trend analysis. Specific GFC strategic objectives addressed in this study were (GFC Strategic Plan 1988):

(1) to maintain the distribution of American alligators in all 67 counties through 1992-93,
(2) to maintain representative populations of alligators at or above 7.9 total alligators per shoreline mile and at or above 3.7 ≥4 ft. alligators per mile, through 1992-93, and
(3) to prevent a long-term decline of alligator populations statewide.

We thank the many GFC personnel for conducting surveys prior to 1983 and, since 1982, the following GFC and Florida Cooperative Fish and Wildlife Research Unit personnel: C. L. Abercrombie, D. David, D. Dowling, G. Holder, L. Hord, M. L. Jennings, J. McDaniel, C. McKelvy, C. Orme, H. F. Percival, T. Regan, K. G. Rice, T. Stice, J. White, and N. Wiley. J. Hamblen provided computer programming and data management, and T. Steele typed the many and lengthy tables.

METHODS

During each year of the period 1974-89, night-light surveys were conducted on 7-59 areas throughout Florida (Appendix A, Fig. 1). In 1974, routes were arbitrarily selected by biologists from each of 5 GFC administrative regions. In subsequent years, new areas were selected based on anticipated harvests, involvement in research investigations, or chronic nuisance alligator problems. Over the years, some areas were discontinued because of logistical problems and personnel changes. Prior to 1983, routes were surveyed once a year. After 1982, the number of permanent routes was reduced to 17 (Fig. 1), and most areas were surveyed at least twice per year. This group of areas was used for trend analysis to address GFC strategic objectives. Following 1983, 6 experimental alligator hunting areas were added for trend analysis. From 1983 through 1985, replicate surveys were run on irregular time intervals, and some were conducted on consecutive days. Since 1986, we attempted to run replicate surveys within a period of 7-14 days to help achieve within-year independence of surveys (Harris 1986).

Route descriptions and distances of surveyed areas are presented in Appendix A. On any area, surveys were conducted at consistent speeds from year to year, over the same route, and usually during the same month. Surveys on all areas were conducted between 25 May and 25 October, depending on latitude, when water temperatures were generally above 28 C (Woodward and Marion 1978). Routes on each area were designed to transect habitat likely to support the greatest densities of alligators (Woodward and Marion 1978, O'Brien and Doerr 1986). An attempt was made to maintain the same observer from year to year, but personnel changes sometimes prevented this. Survey crews used the same candlepower spotlight from year to year (Woodward and Marion 1978), and surveys on areas initiated after 1977 were conducted with a 200,000 c.p. spotlight.

When an alligator eye reflection was detected, the observer attempted to estimate total length (TL) of the alligator, using snout length judgements as an index of TL (Chabreck 1966). Observers were instructed to catch and measure several alligators early in the survey to calibrate the method. Sightings were recorded by 1 ft. (31 cm) TL increments when size judgements could be made. In this report, all alligator size classes will be reported in feet rather than meters. When precise size judgements could not be made, alligators were recorded in the general size categories 0-2 ft., 3-5 ft., and ≥6 ft. from 1977-1984, and 0-1 ft., 2-3 ft., 4-5 ft., and ≥ 6 ft. after 1984. In 1989, a ≥4 ft. category was added. Alligators that could not be confidently placed in a general size class were assigned a classification of unknown.

Survey crews were advised to avoid surveys during storms, high winds, or foggy conditions to minimize the effects of these variables on counts. Water temperature readings were recorded at the beginning of each survey from a representative location on the wetland. Water levels were obtained from U.S. Geological Survey gauge stations, where possible, or from gauges that could be monitored on a long-term basis (Appendix A).

Analyses

We analyzed densities (numbers of ≥1 ft., ≥4 ft., and

≥6 ft. alligators per shoreline mile) to estimate population growth trends for each area. The size classes analyzed in this study provide an indication of the population status of 3 important components of alligator populations: the overall population (≥1 ft.), the harvestable size class (≥4 ft.), and the reproductive size class (≥6 ft.). Alligators <1 ft. in TL were excluded because of high variation and lack of independence of sighting probabilities among siblings during the first year of life (Woodward and Marion 1978). We used absolute rather than relative densities, therefore, alligators classified in general size categories and as unknowns during counts were placed into the 3 main size classes for analysis. We assumed that unknowns from a particular count had the same size structure as known-size alligators from that same count and apportioned alligators into these categories accordingly. Alligators assigned to either of the pre-1985 0-2 or 3-5 ft. size classes, the post-1984 0-1 size class, or the 1989≥4 ft. size class were apportioned into the ≥1, ≥4, and ≥6 ft. size classes in a similar manner.

Population densities on each area were related to survey years through regression analysis. To statistically adjust density values and density trend estimates for visibility influence of water level, we included a centered water level covariate (water level minus long-term mean of water level) in all regression analyses.

We could not discern any sigmoidal growth patterns on individual areas when the highly variable adjusted densities were plotted against time. Therefore, regression models that fit annual changes in population density either linearly (as sums of water level, year, and error effects) or exponentially (as products of environmental effects) were no less adequate than more sophisticated nonlinear regression models. We also saw no tendency for variability in adjusted density to increase with density on individual areas. Thus, for any given wetland, an exponential model (i.e. a linear model of log-transformed density values) usually was no improvement over a linear model (of untransformed density values). However, the instantaneous growth rate parameter for the exponential model is expressed in per capita rather than absolute densities, facilitating trend comparisons among wetlands differing in average population density. Moreover, the instantaneous growth rate parameter may be easily converted to a finite rate of increase/decrease parameter (% per year). Therefore, we fit both linear and exponential growth models to survey data for each area. Linear model results were obtained to interpret the trend on a given wetland, while exponential model results were used in the calculation and comparison of statewide trend summaries.

Because lack of independence among surveys run within the same year for an area impacts the precision of the area trend estimates (Harris 1986), it was important to determine the influence of time and water level on the degree of independence between successive observations. We looked at the ratio of T_i to regression mean squared error (MSE), where:

$$\mathrm{MSE} = \frac{S(Y_i - \hat{Y}_i)^2}{\mathrm{edf}}$$

$$T_i = \frac{(Y_i - \hat{Y}_i)^2 + (Y_j - \hat{Y}_j)^2}{2}$$

Y_i is the observation, $\hat{Y}_i$ is its predicted value, edf is error degrees of freedom, and subscripts *i* and *j* denote successive within-year observations. MSE was obtained from the linear regression of either all data or data averaged by year on water level and year, whichever resulted in the larger MSE value. We also calculated the number of days separating the observations and the standardized difference in water levels (water level difference divided by historic water level S.D.). Because MSE and T_i were both averages of squared regression residuals, combinations of day and water level intervals associated with values of T_i/MSE > 1.0 were viewed as approximate minimum time intervals and water level differences between successive observations to approach independence. A smoothed contour plot of T_i/MSE versus values of day and water level values aided our interpretation of the relationship of these parameters.

Using all the data (and assuming within-year independence), regressions were run on 4 time intervals; 1974-89, 1974-79, 1980-89, and 1983-89 (17permanent areas only). Surveys without a water level record did not contribute to estimation of the regression line nor to calculation of adjusted densities. Regression estimates were available only for areas with

≥4 surveys with corresponding water level measurements.

The distributions of the instantaneous growth rates for the above time intervals were neither normal nor symmetric, so we tested equality of each median value with 0 using the sign test (Hollander and Wolfe 1973: 39, 54). The same test procedure was applied to the partial *r* value estimated for the water level effect.

For each of the ≥1 and ≥4 ft. size classes, 70% of the 1983 mean non-adjusted count value for 17 permanent areas established that year was set as a minimum acceptable threshold in a GFC strategic objective. Because all densities in this analysis were adjusted for water level, we also calculated 1983 minimum threshold mean adjusted densities, via the linear model, for purposes of comparison.

RESULTS

Independence of Replicate Counts

The T/MSE = 1.0 contour crossed the day interval axis at 40-60 days and the standardized water level difference axis between 1.0 and 3.0. This suggests that to achieve independent counts, surveys should be spaced at least 40 days apart under constant water level conditions or at any time interval with water level changes of over 1 standard deviation.

Water Level

Water level was inversely correlated ($P < 0.05$) with densities of ≥1 ft. alligators for all 4 time periods, ≥4 ft. alligators for all time periods except 1974-79, and ≥6 ft. alligators for the 1974-89 and 1980-89 time periods (Table 1). The strength of the relationship of water level to observed alligator densities (partial *r*) was not uniform among all areas (Tables 2, 3, and 4) and all size classes (Table 1). The median relationship between observed densities and water levels decreased in magnitude with increasing size class (Table 1).

1974-89 Trends

Significant ($P < 0.05$) increases in instantaneous growth were detected in all 3 size classes for the time period 1974-89, in the ≥6 ft. size class for the 1974-79 period, and in the ≥1 ft. size class for the 1980-89 period (Table 5). No other time-period/size-class combinations showed significant positive or negative trends. The finite annual rate of growth during the period 1974-89 was 4.2, 3.5, and 7.5% per year for the ≥1, ≥4, and ≥6 ft. size classes, respectively (Table 5). Table 6 summarizes the frequency of linear regression trend directions on individual areas for each time period. Areas with significant positive or negative trends during the 1974-89 time period are listed in Table 7. Linear regression statistics for 17 individual areas monitored since 1983 are presented in Tables 2, 3, and 4. Plots of adjusted densities of ≥1, ≥4, and ≥6 ft. alligators on areas surveyed since 1983 are presented in Appendix B.

Pooled slopes of ≥1 and ≥4 ft. alligator population trends on 17 permanent areas showed no discernible trend during the period 1983-89 (Table 5). The finite annual rate of growth during this period was 5.3, 4.8, and 1.9% for the ≥1, ≥4, and ≥6 ft. size classes, respectively (Table 5). Mean adjusted densities of alligators have exceeded the 1984 GFC strategic plan minimum thresholds of 7.9 total alligators and 3.7 ≥4 ft. alligators observed per mile (Fig. 2). Mean densities also exceeded minimum estimated thresholds adjusted for the effects of water level (10.2 ≥1 ft. and 4.6 ≥4 ft. alligators per mile).

DISCUSSION

Densities of ≥1, ≥4, and ≥6 ft. alligators on wetlands distributed throughout the state increased significantly during the period 1974-89, based on night-light surveys. A significant positive trend was detected in the ≥6 ft. size class from 1974-1979. We believe that this reflects increased recruitment of alligators into the ≥6 ft. size range coupled with decreased wariness resulting from protection received during the early 1970's. Increases in the ≥1 and ≥4 ft. size classes over the 15-year period and the continued increase of ≥1 ft. alligators during the 1980's probably represent productivity from the expanding adult size class during the 1970's. High variability in slopes among individual study areas precluded our detecting trends during the 1980's for the ≥4 and ≥6 ft. size classes and during the 1970's for the ≥1 and ≥4 ft. size classes. Areas incorporated in the analysis included 9 areas where ≥4 ft. alligators were hunted during the 1980's and 5 areas where early age-class alligators were removed for ranching purposes. These harvests probably contributed to a reduced rate of increase or greater variability in regression slopes during the 1980's.

Water level was inversely correlated with observed densities and accounted for a substantial amount of variation in counts on most areas as Woodward and Marion (1978) and Wood et al. (1985) noted. Use of water level as a covariate in regression analyses helped isolate the effects of year on counts and effectively softened the fluctuations in counts.

Pooled trends for the 1983-89 set of surveys showed no definite trend although increases in mean densities appeared large. Mean densities from the 17 permanent areas were well above both minimum non-adjusted thresholds and minimum thresholds adjusted for water level effects. This, coupled with a positive pooled slope from individual regressions, leads us to the conclusion that populations of Florida alligators have been stable to increasing over the past 6 years.

We believe the 3 size classes that we selected for analysis provided the best basis for making judgements about alligator population status. As recommended by Woodward and Marion (1978) we excluded <1 ft. alligators from our analysis because of high variability in counts. Therefore, we feel that the ≥1 ft. size class provided the best index of the overall alligator population. By regulation, only ≥4 ft. alligators can be taken during alligator hunts and nuisance alligator harvests in Florida (Hines and Woodward 1980, Woodward et al. 1987). Therefore, any impact of those management regimes would be reflected in that size class. Monitoring of the ≥6 ft. size class provided an index of the reproductive population because the onset of reproductive maturity occurs at 6 ft. TL (Joanen and McNease 1989, Woodward unpubl. data).

Sampling Assumptions

The above conclusions are dependent on several sampling assumptions: (1) survey locations provided a representative sampling of the Florida alligator population; (2) allocation of unknown size alligators into general size classes reflected the actual size distribution of unknowns; and (3) TL judgements from year to year were accurate.

Representative selection of survey locations.---In this study, survey locations were not randomly selected, nor were they stratified by habitat type, which may influence growth rate. Rather, areas were selected based on accessibility and, since 1980, potential for harvest. Therefore, human perturbation of those populations was more likely. This may have resulted in growth rates to be biased low relative to the overall Florida alligator population. Conversely, areas selected for harvest usually had high nesting densities, indicating high productivity, and probably represented areas with the highest intrinsic growth rates. Despite the above biases, we believe that the sample of areas surveyed provided a reasonable representation of the Florida alligator population and could be used as a reliable index. However, stratified random sampling of all habitat types would provide the least biased representation of Florida alligator populations (O'Brien and Doerr 1986).

Size allocations of unknowns.---What does one do with the unknown-size alligators when conducting analysis of absolute densities of different size classes? If total population is unknown, or if size composition of unknowns varies year to year, then trend analysis by size class would be biased if unknowns are omitted from the analysis. Large alligators tend to be more wary and prefer deeper water than smaller ones. Most unknowns were observed in habitat that was used by all size classes. It is likely that proportionate allocation biased estimates toward smaller alligators. However, we felt that as long as we applied this same methodology every year, inferences about trends would be minimally effected.

Total length judgements.---Changes in observers and changes in the TL size judgements of observers over years could have influenced the size distribution of counts. We believe that requiring observers to catch and measure several alligators following size judgements helped calibrate their estimates and minimized long-term biases. The biggest apparent problem was inconsistency among observers in placing deep-water observations of alligator eye reflections into size classes. Alligators, especially larger (≥4 ft.) individuals, become more wary with increasing boat and light disturbances (Woodward 1978). Therefore, on hunted areas, larger alligators tend to submerge before allowing observers to approach close enough to obtain a confident size estimate. These animals were commonly sighted in the deeper water habitat of larger alligators, and observers were instructed to assign general size categories to alligators seen in these areas based on the predominant size classes observed. We are confident that this procedure was correct in most cases and introduced less bias than assigning these animals to a general unknown category, especially under harvest regimes where larger alligators have become increasingly wary.

Assumptions of Trend Analyses

Harris (1986) listed 4 important assumptions that need to be met when conducting trend analysis: (1) the population increases or decreases exponentially (the proportional change in population size is constant); (2) counts are lognormally distributed; (3) counts are independent; and (4) the mean percentage of the population counted is constant at all population levels. Violation of any of these assumptions can lead to bias in the trend estimates, erroneous conclusions concerning significance of trends, or both. The following are our assessments of our success at meeting and impacts of failing to meet these assumptions for determining trends on individual areas:

Exponential population growth.---Exponential growth is a suitable growth form for many animal populations well below carrying capacity because the model will never predict a population size below zero, as can be the case with linear growth. For populations observed over short periods of time relative to the life span of the animal, linear growth is not unreasonable. However, neither growth form is suitable for populations observed near carrying capacity as both models can predict sustained population growth above that level. When counts of individual areas were plotted against time, we saw no clear advantage in one growth form over the other. As populations are monitored longer and more counts are collected, we would expect count variability to decrease. These additional data may render the linear and perhaps the exponential models as unsatisfactory models of alligator population growth.

Lognormal distribution.---The assumption of a lognormal distribution of errors goes hand-in-hand with the assumption of exponential growth. Errors due to unobservable effects multiply, rather than add together, under this assumption. We saw no consistent tendency for errors to increase in magnitude with either time or density, so, for interpreting trend on individual wetlands, we assumed normally distributed errors. As before, with more data, this assumption may prove untenable.

Independence of counts.---Regression analysis requires that each observation or, in this case, count, be independent. In alligator populations a random "mixing" of the population between counts generally would insure this condition. Insufficient mixing of the population increases the chances that variation among counts under similar conditions will be less than the overall variance for the population monitored over a variety of conditions. This phenomenon could bias variance estimates of growth parameters in either direction and lead to erroneous significance conclusions of trend. Insufficient mixing may be an important consideration, as adult alligators have a tendency to be territorial (Joanen and McNease 1970, 1972; Thompson and Gidden 1972; Goodwin and Marion 1979) and juvenile alligators remain in the vicinity of their nest site for several years (Deitz 1979). Movements may only occur during major environmental or seasonal changes (Woodward and Marion 1978), during breeding season (Joanen and McNease 1970, 1972; Goodwin and Marion 1979), when alligators attain certain sizes (McNease and Joanen 1974, Deitz 1979), when densities become excessive, or after water level changes (McNease and Joanen 1974). We postulated that time interval between counts and water level changes were factors that could induce mixing of alligator populations. The 7-14 day period recommended in 1986 appears to be too brief unless major water level fluctuations occur in between. Test conclusions for individual areas may have been biased because of the insufficient time between surveys during replicate surveys from 1983 through 1985.

Equal sightability at different population densities. ---When counts are used as an index of population abundance, unequal sightability at varying population densities can bias the trend estimate in either direction (Harris 1986). When counts are used to directly measure population abundance, as we have done, violation of this assumption can bias density estimates as well. As population densities of some species change, so does the sightability of animals, presumably because population pressures elicit changes in habitat use by animals (Harris 1986). This phenomenon may occur with alligators but would be very difficult to detect and measure. Therefore, we assumed equal sightability in the absence of indications to the contrary.

MANAGEMENT RECOMMENDATIONS

Night-light counts can be effectively used to monitor alligator population trends for individual areas and groups of areas. If inferences are to be made about trends in the statewide alligator population, then a stratified random sampling approach to selecting survey areas needs to be taken (O'Brien and Doerr 1986). We recommend stratification by habitat type and management regime so that effects of these parameters can be estimated.

Observers should be encouraged to place most alligators into size categories and to do this consistently from year to year. Certain characteristics, such as habitat type, water swirls, mud trails, wakes, and, occasionally, intensity of the eye reflection, can provide valuable clues to the size of an alligator. Placing "eye-shines" into the unknown category will leave allocation to a random computing mechanism that does not have the advantage of knowing the circumstances under which the alligator was observed.

Increasing the number of counts per year as recommended by Wood et al. (1985) effectively reduces the number of years necessary to detect population trends within a given area (Harris 1986). Multiple counts also help explain sources of variation in counts. However, additional surveys cost more and, without additional funding, would require reduction of the number of areas surveyed. Another major problem encountered with increasing the number of replicate counts is ensuring that they are independent. Based on data from this analysis, we recommend the interval between replicate counts be lengthened to increase the probability of population mixing. This period should be within the warm water (≥28 C) time frame (Murphy 1977, Woodward and Marion 1978) and should not span the period during the onset of nesting when breeding alligators are leaving the open waters for more secluded areas (Woodward and Marion 1978). This makes selecting a time frame for replicate counts very difficult. We recommend surveying alligators during late summer (20 July - 1 September) when water temperatures are high (≥28 C) and movements related to breeding and overwintering behavior are minimum. Water levels in Florida tend to rise substantially during this period so that the interval between counts can be less than 40 days. Given normal water level fluctuations in Florida, an interval of 15-30 days should allow sufficient opportunity for mixing. These restrictions may limit the number of independent surveys that can be conducted in a given year. We do not recommend conducting counts for trend analysis prior to water temperatures reaching 28 C because of the expected additional variation in counts. The effects of water temperature on counts may be dependent on the size structure of the population, and multiple counts (probably >3) will be needed to determine the amount of variability accounted for by water temperature changes. If counts are to be made in the spring, they should be conducted prior to 10 June to avoid decreasing sightability with the cessation of mating and onset of nesting activities (Woodward and Marion 1978, Woodward et al. 1989). In this study, 2 surveys per year provided sufficient counts to detect biologically significant trends over a 5-year period. Therefore, we recommend conducting 2 independent counts per year for long-term monitoring.

Non-transformed count data from individual areas can be analyzed using linear regression to determine trends, although suitability of these models should be confirmed as more data are collected. In any case, we recommend the use of the exponential model for summarization of trends from a sample of areas and the use of water level as a covariate in regression analyses. Absolute densities rather than proportion composition should be used to analyze trends of different size classes. Unknown size alligators can be used in the analysis if they are apportioned into size classes in a consistent manner over years. We recommend apportioning unknowns based on the size structure of known-size alligators.

LITERATURE CITED

Allen, E. R., and W. T. Neill. 1949. Increasing abundance of the alligator in the eastern portion of its range. Herpetologica 5:109-112.

Chabreck, R. H. 1966. Methods of determining the size and composition of alligator populations in Louisiana. Proc. Annu. Conf. Southeast. Game and Fish Comm. 20:105-112.

-----. 1976. Cooperative surveys of population trends in the American alligator, 1971-75. Third working meeting of the Crocodile Specialist Group, SSC/IUCN, Maningrida, Northern Territory, Australia. 8pp. (Mimeo.).

Deitz, D. C. 1979. Behavioral ecology of young American alligators. Ph.D. Dissertation, Univ. of Florida, Gainesville. 151pp.

Goodwin, T. M., and W. R. Marion. 1979. Seasonal activity ranges and habitat preferences of adult alligators in a north-central Florida lake. J. Herpetology 13:157-164.

Harris, R. B. 1986. Reliability of trend lines obtained from variable counts. J. Wildl. Manage. 50:165-171.

Hines, T. C. 1976. Alligator attacks on humans in Florida. Proc. Annu. Conf. Southeast. Assoc. Game and Fish Comm. 30:358-361.

-----. 1979. The past and present status of the alligator in Florida. Proc. Annu. Conf. Southeast. Assoc. Fish and Wildl. Agencies 33:224-232.

-----, and A. R. Woodward. 1980. Nuisance alligator control in Florida. Wildl. Soc. Bull. 8:234-241.

-----, M. J. Fogarty, and L. C. Chappell. 1968. Alligator research in Florida: a progress report. Proc. Annu. Conf. Southeast. Assoc. Game and Fish Comm. 22:166-180.

Hollander, M. and D. A. Wolfe. 1973. Nonparametric statistical methods. John Wiley and Sons, New York, N.Y. 503pp.

Kellog, R. 1929. The habits and economic importance of alligators. U.S. Dept. of Agric. Tech. Bull. No. 147. Washington, D.C. 36pp.

Kersey, H. A. 1975. Pelts, plumes, and hides. Univ. Presses of Florida, Gainesville, Florida. 158pp.

Joanen, T. and L. McNease. 1970. A telemetric study of nesting female alligators on Rockefeller Refuge, Louisiana. Proc. Annu. Conf. Southeast. Assoc. Game and Fish Comm. 24:175-193.

-----, and -----. 1972. A telemetric study of adult male alligators on Rockefeller Refuge, Louisiana. Proc. Annu. Conf. Southeast. Assoc. Game and Fish Comm. 26:252-275.

-----, and -----. 1989. Ecology and physiology of nesting and early development of the American alligator. Amer. Zool. 29:987-998.

McNease, L. and T. Joanen. 1974. A study of immature alligators on Rockefeller Refuge, Louisiana. Proc. Annu. Conf. Southeast. Assoc. Game and Fish Comm. 28:482-500.

Murphy, T. M. 1977. Distribution, movement, and population dynamics of the American alligator in a thermally altered reservoir. M.S. Thesis. Univ. of Georgia, Athens. 42pp.

O'Brien, T. G. and P. D. Doerr. 1986. Night count surveys for alligators in coastal counties of North Carolina. J. Herpetology 20:444-448.

Schemnitz, S. D. 1974. Populations of bear, panther, alligators and deer in the Florida Everglades. Florida Sci. 37:157-167.

Thompson, R. L., and C. S. Gidden. 1972. Territorial basking counts to estimate alligator populations. J. Wildl. Manage. 36:1081-1088.

Wood, J. M., A. R. Woodward, S. R. Humphrey, and T. C. Hines. 1985. Night counts as an index of American alligator population trends. Wildl. Soc. Bull. 13:262-273.

Woodward, A. R. 1978. An evaluation of factors affecting night-light counts of alligators. M. S. Thesis. Univ. of Florida, Gainesville. 47pp.

-----, and W. R. Marion. 1978. An evaluation of factors affecting night-light counts of alligators. Proc. Annu. Conf. Southeast. Assoc. Fish and Wildl. Agencies 32:291-302.

-----, D. N. David, and T. C. Hines. 1987. American alligator management in Florida. Pages 98-113 in R. R. Odom, K. A. Riddleberger, and S. C. Ozier eds., Proc. 3rd Annu. Southeast. Nongame and Endangered Wildl. Symp. Athens, Georgia.

-----, M. L. Jennings, H. F. Percival. 1989. Egg collecting and hatch rates of American alligator eggs in Florida. Wildl. Soc. Bull. 17:124-130.

Table 1. Median partial correlation coefficients (r) and sign test results for the multiplicative (exponential model) effect of water level on alligators observed during night-light surveys on Florida wetlands during 4 time intervals.

Survey period	Size class	n	B[a]	r	P
1974-89					
	≥ 1 ft	59	8	-0.513	< 0.001
	≥ 4 ft	59	12	-0.362	< 0.001
	≥ 6 ft	53	19	-0.174	0.053
1974-79					
	≥ 1 ft	21	2	-0.648	< 0.001
	≥ 4 ft	21	6	-0.354	0.078
	≥ 6 ft	17	10	0.057	0.629
1980-89					
	≥ 1 ft	25	6	-0.598	0.015
	≥ 4 ft	25	5	-0.334	0.004
	≥ 6 ft	25	7	-0.174	0.043
1983-89					
	≥ 1 ft	17	1	-0.479	< 0.001
	≥ 4 ft	17	3	-0.386	0.013
	≥ 6 ft	17	6	-0.219	0.332

[a] Number of positive correlation coefficients (sign test statistic, Hollander and Wolfe 1973).

Table 2. Mean densities of ≥ 31 cm (1 ft.) alligators and linear regression statistics for night-light alligator surveys conducted on 17 areas during the period 1983-89. Information is presented in descending order of finite rate of increase estimated from the exponential model.

				Linear regression results			
				Year effect		Water level effect	
Survey Area	Finite rate of increase (%/year)[a]	$\bar{x}$ density (count/mile)	n[b]	regression coefficient	P	r	Partial P
Cons. Area 3A (L-67)	48.4	10.5	14	4.28	0.007	-0.306	0.309
Deer Point Lake	18.8	7.6	13	0.71	0.049	-0.186	0.564
Lake Woodruff	18.6	16.4	14	2.50	0.002	-0.613	0.026
Lochloosa Lake	17.4	20.7	14	2.98	0.004	-0.676	0.011
Bear Creek	13.3	3.2	14	0.33	0.010	-0.258	0.394
Lake Panosoffkee	9.7	25.6	15	2.42	0.103	-0.662	0.010
Cons. Area 1 (L-39)	8.7	10.2	13	1.12	0.361	-0.156	0.627
Orange Lake	7.6	48.2	11	2.75	0.380	-0.406	0.245
Lake Jessup	5.3	27.4	14	1.41	0.050	-0.813	0.001
Lake Iamonia	2.4	10.9	15	0.18	0.400	-0.738	0.003
Newnans Lake	1.3	14.2	14	0.19	0.819	-0.312	0.300
Lake Griffin	0.7	39.0	13	0.41	0.781	-0.613	0.034
Myakka River	-4.3	16.7	10	-0.75	0.447	-0.603	0.086
Lake Miccosukee	-7.4	14.8	15	-1.00	0.204	-0.342	0.231
Lake Apopka	-10.2	8.0	14	-0.74	0.021	-0.508	0.076
Lake Arbuckle	-11.0	5.5	9	-0.51	0.086	-0.644	0.084
Cons. Area 2A (L-35B)	-15.8	3.4	14	-0.53	0.004	0.615	0.025

[a] [exp (instantaneous growth rate from exponential model) –1] 100%

[b] Number of independent surveys contributing to regression.

Table 3. Mean densities of ≥ 122 cm (4 ft.) alligators and linear regression statistics for night-light alligator surveys conducted on 17 areas during the period 1983-89. Information is presented in descending order of finite rate of increase estimated from the exponential model.

				Linear regression results			
				Year effect		Water level effect	
Survey Area	Finite rate of increase (%/year) [a]	$\bar{x}$ density (count/mile)	n [b]	regression coefficient	P	r	Partial P
Cons. Area 3A (L-67)	57.3	7.9	14	3.22	0.001	-0.292	0.332
Deer Point Lake	18.5	8.6	14	1.35	0.001	-0.505	0.079
Lake Woodruff	14.6	2.1	13	0.25	0.010	-0.561	0.058
Lochloosa Lake	12.7	8.9	13	1.41	0.212	-0.275	0.387
Bear Creek	11.9	6.0	14	0.54	0.018	-0.328	0.274
Lake Panosoffkee	10.3	8.6	14	0.80	0.119	0.306	0.309
Cons. Area 1 (L-39)	9.9	8.3	13	0.84	0.025	0.171	0.594
Orange Lake	7.1	1.4	14	0.11	0.063	-0.688	0.009
Lake Jessup	4.8	11.0	15	0.46	0.351	-0.506	0.065
Lake Iamonia	2.8	7.9	14	0.20	0.707	-0.620	0.024
Newnans Lake	-1.2	6.6	15	-0.08	0.777	-0.341	0.233
Lake Griffin	-2.9	16.7	11	-0.49	0.742	-0.431	0.214
Myakka River	-4.5	15.5	10	-0.72	0.412	-0.598	0.089
Lake Miccosukee	-5.4	4.7	14	-0.28	0.116	-0.312	0.299
Lake Apopka	-6.7	2.6	9	-0.15	0.215	-0.590	0.123
Lake Arbuckle	-6.0	6.0	15	-0.41	0.002	-0.798	0.001
Cons. Area 2A (L-35B)	-15.5	2.6	14	-0.40	0.006	0.736	0.004

[a] [exp (instantaneous growth rate from exponential model) –1] 100%

[b] Number of independent surveys contributing to regression.

Table 4. Mean densities of ≥ 183 cm (6 ft.) alligators and linear regression statistics for night-light alligator surveys conducted on 17 areas during the period 1983-89. Information is presented in descending order of finite rate of increase estimated from the exponential model.

				Linear regression results			
				Year effect		Water level effect	
Survey Area	Finite rate of increase (%/year)[a]	$\bar{x}$ density (count/ mile)	n[b]	regression coefficient	P	r	Partial P
Cons. Area 3A (L-67)	49.0	4.6	14	1.63	0.003	0.003	0.992
Deer Point Lake	16.4	4.5	14	0.64	0.000	0.018	0.954
Lake Woodruff	14.2	6.4	13	1.02	1.135	-0.397	0.202
Lochloosa Lake	13.3	4.6	14	0.55	0.074	0.737	0.004
Bear Creek	10.7	3.8	15	0.30	0.291	-0.016	0.955
Lake Panosoffkee	7.5	3.4	14	0.18	0.242	-0.056	0.855
Cons. Area 1 (L-39)	7.3	6.3	13	0.49	0.097	0.410	0.186
Orange Lake	3.3	0.6	14	0.04	0.414	-0.226	0.459
Lake Jessup	1.9	0.9	13	0.01	0.878	-0.316	0.316
Lake Iamonia	-5.2	13.5	10	-0.69	0.304	-0.642	0.062
Newnans Lake	-5.2	3.3	14	-0.16	0.322	-0.507	0.077
Lake Griffin	-5.2	1.8	9	-0.08	0.342	-0.714	0.047
Myakka River	-5.4	3.7	15	-0.21	0.026	-0.490	0.075
Lake Miccosukee	-5.4	4.0	15	-0.10	0.796	-0.131	0.654
Lake Apopka	-9.8	3.3	14	-0.26	0.174	-0.681	0.010
Lake Arbuckle	-12.2	9.0	11	-1.19	0.093	-0.599	0.068
Cons. Area 2A (L-35B)	-16.0	1.6	14	-0.27	0.007	0.781	0.002

[a] [exp (instantaneous growth rate from exponential model) –1] 100%

[b] Number of independent surveys contributing to regression.

Table 5. Median instantaneous growth rates (b, year $^{-1}$), sign test results, and finite rates of growth (G, %) for observed alligator densities on Florida wetlands during 4 time intervals.

Survey period	Size class	n	B[a]	b	P	G
1974-89						
	≥ 1 ft	59	38	0.041	0.036	4.2
	≥ 4 ft	59	38	0.035	0.036	3.5
	≥ 6 ft	53	38	0.072	0.002	7.5
1974-79						
	≥ 1 ft	21	11	0.027	1.000	2.8
	≥ 4 ft	21	10	-0.042	1.000	-4.1
	≥ 6 ft	17	13	0.121	0.049	12.9
1980-89						
	≥ 1 ft	25	18	0.053	0.043	5.4
	≥ 4 ft	25	14	0.008	0.690	0.8
	≥ 6 ft	25	13	0.010	1.000	1.0
1983-89						
	≥ 1 ft	17	12	0.052	0.143	5.3
	≥ 4 ft	17	10	0.047	0.629	4.8
	≥ 6 ft	17	9	0.019	1.000	1.9

[a] Number of positive correlation coefficients (sign test statistic, Hollander and Wolfe 1973).

Table 6. Summary of direction of estimated linear trends in densities of alligators observed during night-light surveys conducted on wetlands in Florida during four periods.

Period	n[a]	Size class	Increase[b]	No Change	Decrease
1974-89	59				
		≥ 1 ft	11	45	3
		≥ 4 ft	11	46	2
		≥ 6 ft	9	47	2
1974-79	21				
		≥ 1 ft	1	19	1
		≥ 4 ft	2	18	1
		≥ 6 ft	0	21	0
1980-89	25				
		≥ 1 ft	6	15	4
		≥ 4 ft	6	18	1
		≥ 6 ft	6	15	4
1983-89	17				
		≥ 1 ft	5	10	2
		≥ 4 ft	5	11	1
		≥ 6 ft	2	13	2

[a] Sample sizes may not match those reported in Table 5 for the exponential model as the inability of the log transformation to process survey counts of 0 caused samples to be discarded from that model.

[b] $\underline{P} < 0.05$; test result for year effect linear regression coefficient.

Table 7. Areas showing significant ($\underline{P} \geq 0.05$) linear trends in alligators observed during night-light surveys in Florida over the period 1974-89, listed in descending order of finite growth rate. Refer to Appendix A for survey periods for individual areas.

Trend	Size Class		
	≥1 ft	≥4 ft.	≥ 6 ft.
Increased	Lake Parker	Lake Parker	Fort Kissimmee
	Lake Tarpon	Lake Tarpon	Cons. Area 3A (L-67)
	Lochloosa Lake	Fort Kissimmee	Lake Parker
	Deer Point Lake	Cons. Area 3A (L-67)	Lake Miccosukee
	Lake Woodruff	Kissimmee R. (Pool C)	Lake Jessup
	Lake Jessup	Lake Jessup	Cons. Area 1 (L-39)
	Lake Panasoffkee	Lake Griffin (West)	Lake Griffin
	Cons. Area 3A (L-67)	Lake Panasoffkee	Lake Arbuckle
	Lake Miccosukee	Lake Woodruff	Lake Woodruff
	Lake Iamonia	Lake Griffin	
	Orange Lake	Lake Miccosukee	
Decreased	Rodman Reservoir	Rodman Reservoir	Rodman Reservoir
	Lake Apopka	Station Pond	Lake George
	Lake Trafford		

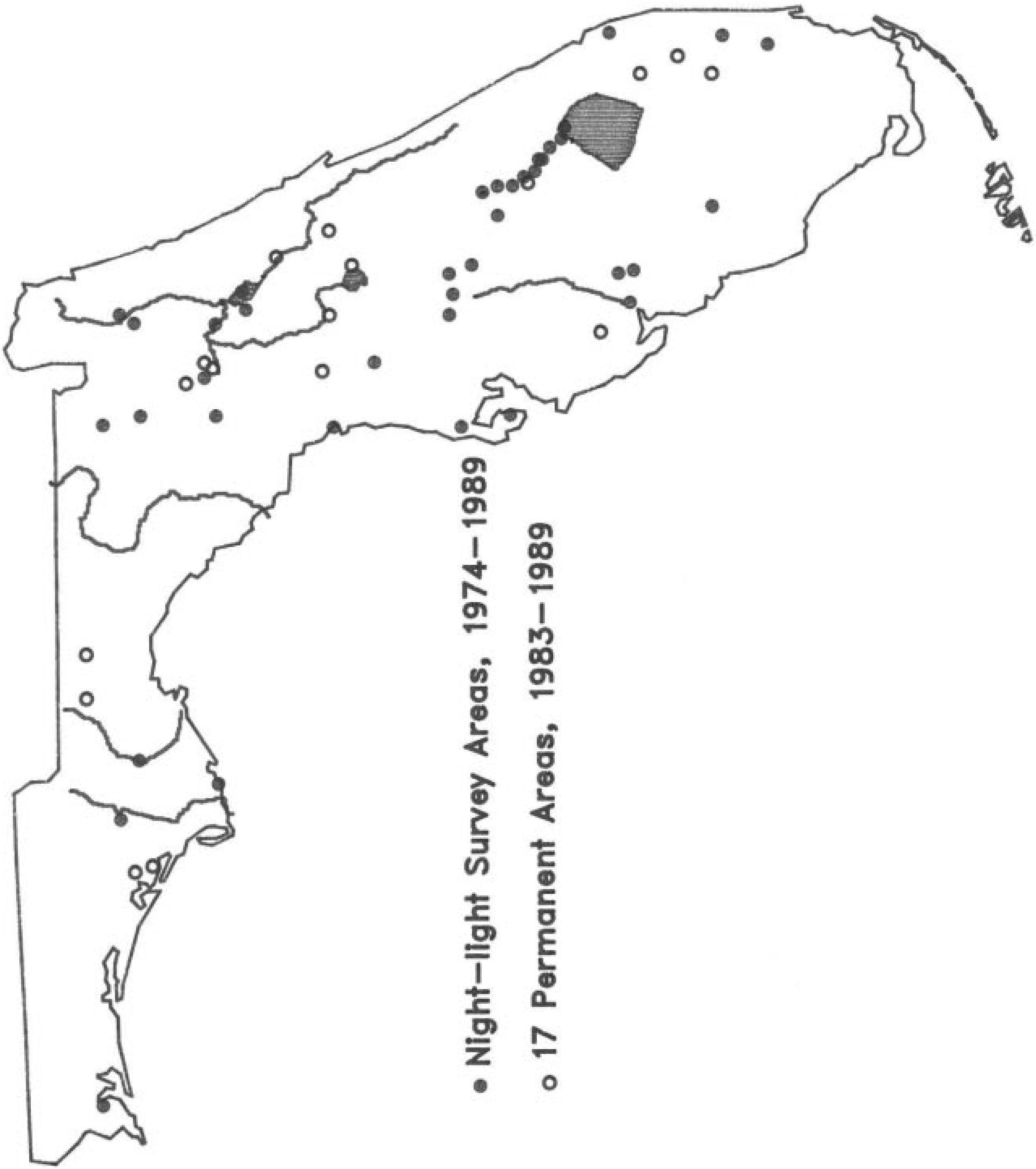


Figure 1. Locations of 59 night-light alligator survey routes conducted in Florida, 1974-89.

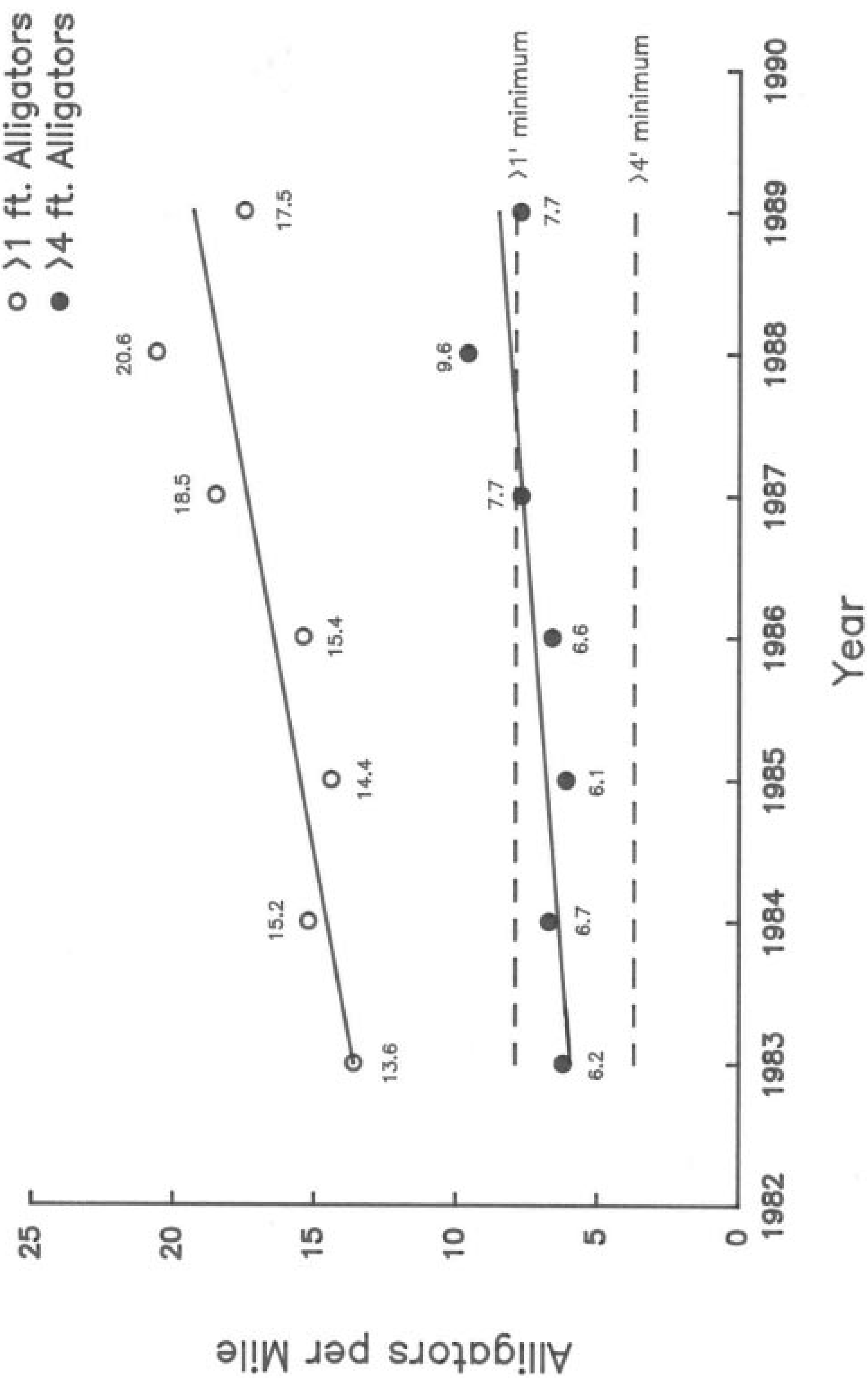


Figure 2. Mean water level-adjusted alligator densities per year observed during night-light counts conducted on 17 wetlands in Florida 1983-89. Water level adjustments based on linear regression model.

Appendix A. Descriptions for 59 night-light alligator survey routes on Florida wetlands, 1974-89.

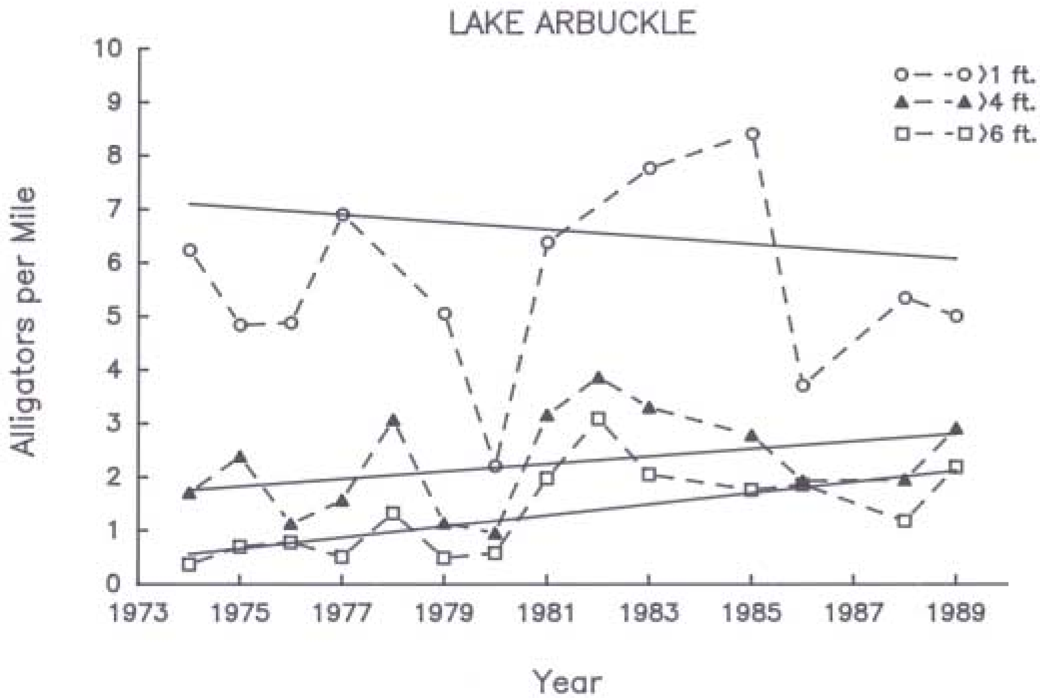
Area number	Area name	Route length (miles)	Brief description of route	Year-span of surveys
101	Port Charlotte	10.0	14 disjunct waterways in city	1974-80
102	Shell Creek	8.7	Shell Creek near Shell Creek campground	1976-82
104	Lake Tarpon	12.8	Perimeter of lake	1975-82
105	East Saddlecreek Park	4.7	Shoreline of E. Saddlecreek Park phosphate pit	1975-82
106	Lake Parker	9.7	Perimeter of lake	1975-83
107	Saddlecreek Park, N.W.	5.7	Perimeter of old phosphate pit	1975-82
108	Lake Arbuckle	11.8	Perimeter of lake	1974-89
109	South Withlacoochee R.	13.2	U.S. 98 bridge @ Rital north to Nobleton	1976-82
110	Lake Maggiore	3.4	Perimeter of lake	1976-82
113	Kissimmee River – Pool A	10.5	Shoreline of old river	1978-83
114	C-38 Canal – Pool A	11.0	Shoreline of canal	1978-83
115	Kissimmee River – Pool B	10.5	Shoreline of old river	1978-83
116	C-38 Canal – Pool B	12.6	Shoreline of canal	1978-83
117	Kissimmee River – Pool C	13.0	Shoreline of old river	1978-83
118	C-38 Canal - Pool C	8.8	Shoreline of canal	1978-83
119	Kissimmee River – Pool D	10.6	Shoreline of old river	1978-83
120	C-38 Canal – Pool D	9.5	Shoreline of canal	1978-83
121	Kissimmee Rier – Pool E	10.1	Shoreline of old river	1978-83
122	C-38 Canal – Pool E	7.7	Shoreline of canal	1978-83
123	Fort Kissimemee	8.6	North and south of Ft. Kissimmee	1974-81
124	Prairie Creek	9.0	Prairie Ck. north of Shell Creek	1976-82
131	Myakka River	13.8	River marsh and lake perimeter	1983-89
132	Lake Hancock	10.3	Perimeter of lake	1983-89
201	Julington Creek	10.0	Creek from St. Johns River east through creek	1974-82
202	Ocean Pond	6.0	Perimeter of pond	1974-82
203	Lake Palestine	5.4	Perimeter of lake	1974-82
206	Orange Lake	26.0	Perimeter of lake	1977-89
207	Station Pond	10.5	Perimeter of pond	1975-82
208	Lake Wauberg	2.2	Perimeter of lake	1974-82
210	Lochloosa Lake	16.0	Perimeter of lake	1977-89
211	Doctors Lake	13.8	Perimeter of lake	1977-84
213	Newnans Lake	13.3	Perimeter of lake	1976-89
301	Lake Miccosukee	12.8	Perimeter of lake through marsh	1975-89
302	Lake Iamonia	16.7	Perimeter of lake through marsh	1975-90
303	Wimico Waterway	12.6	Intracoastal from White City to Wimico	1975-82
304	Ochlockonee River	5.1	Long Pond to Jackson bluff	1978-82
305	Bear Creek	7.4	Bayhead to McAllaster Landing	1974-89
306	Chipola River	12.3	S.R. 20 south to Scott's Ferry	1076-82
307	Escambia River	13.8	Riverview to Chemstrand Rd.	1979-82
308	Deer Point Lake	14.3	Perimeter of lake to Bear Ck.	1982-89
401	Conservation Area 3A (L-67)	10.5	Holiday Park to Dade Co. line	1975-89
402	Conservation Area 2A (L-35B)	11.0	U.S. 27 east to Sawgrass Exwy.	1975-89
403	Miami Canal	15.9	U.S. 84 north to Palm Bch. Co. line	1974-82
404	C-18 Canal	6.9	I-95 south to PGA Blvd.	1975-82
405	L-8 Canal	12.8	L-7 Canal NW to Corbett boundary	1975-82
406	Conservation Area 1 (L-39)	13.1	L-39 from Sawgrass Exwy. to No. 6	1976-89
412	Lake Trafford	6.5	Perimeter of lake	1985-89
501	Lake Griffin (west)	11.1	Shoreline from Minute Maid to Bird Island	1974-78
502	North Withlacoochee River	8.7	Turner Fish Camp to S.R. 200	1975-82
503	Lake Panasoffkee	14.7	Perimeter of lake	1976-89
504	Lake Griffin (east)	9.6	Shoreline from Minute Maid to Haines Ck.	1976-78
505	Crystal River	7.0	Kings Bay to Shell Island	1977-82
519	Salt Springs	4.4	Salt Springs to Lake George	1981-89
522	Lake Woodruff	32.6	Spring Garden Lake & Lake Woodruff	1981-89
523	Lake Griffin	40.7	Perimeter of lake to SR 42	1979-89
524	Lske Apopka	34.4	Perimeter of lake	1979-89
525	Lake Jessup	30.7	Perimeter of lake to SR 46	1981-89
526	Lake George	52.8	Perimeter of lake to Georgetown	1984-89
527	Rodman Reservoir	49.0	Perimeter from Eureka Dam to Mill Dam	1985-89

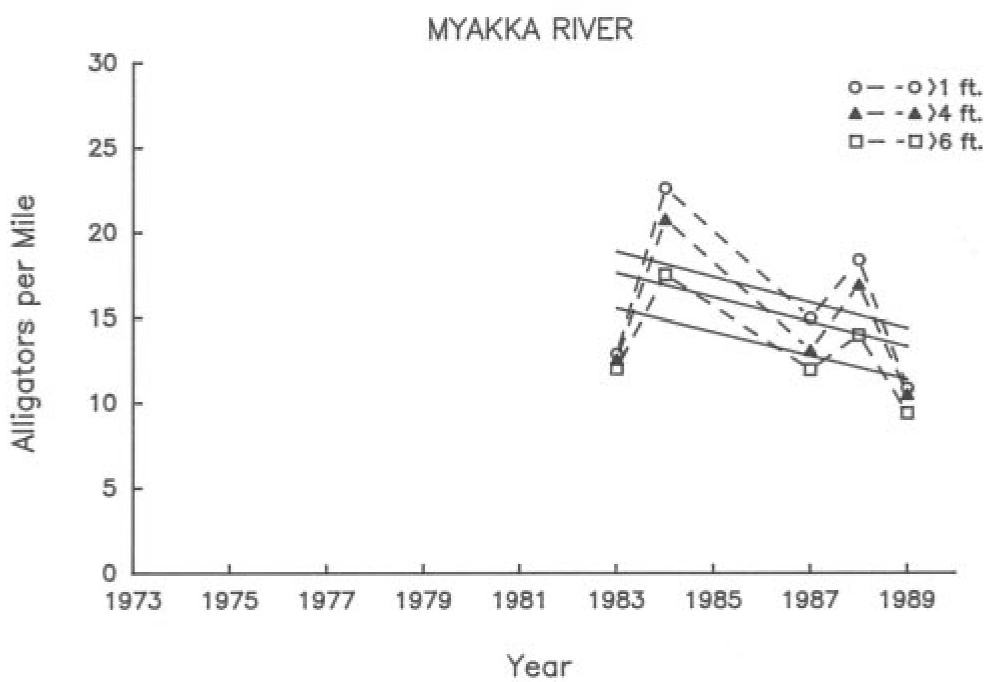
Appendix B. Descriptions of water gauge stations for alligator survey routes..

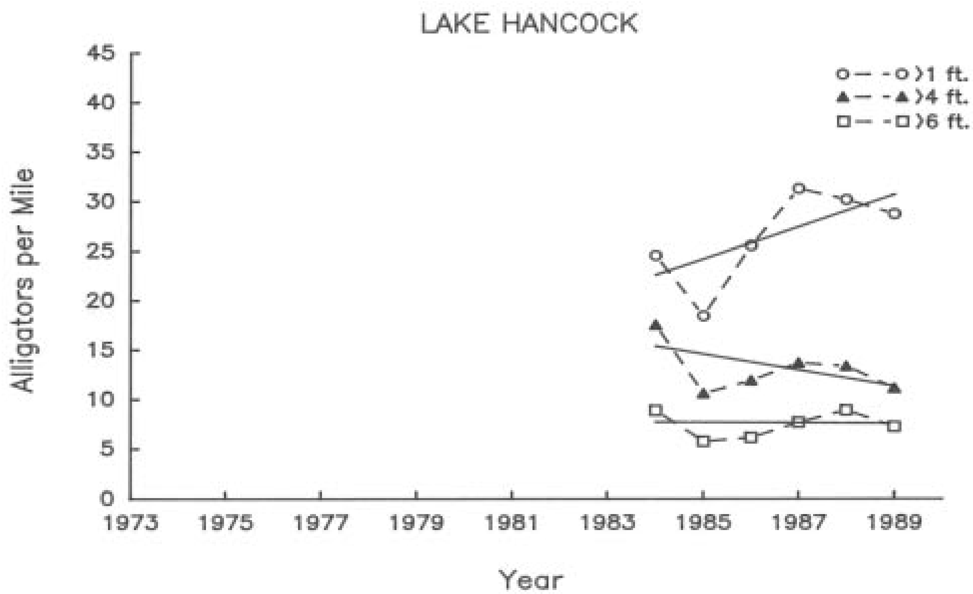
Area number	Area name	U.S.G.S. surface water gauge station No.	Location description
101	Port Charlotte	2298123	Prairie Ck. @ Fort Ogden
102	Shell Creek	2298123	Prairie Ck. @ Fort Ogden
104	Lake Tarpon	2307479	Lake Tarpon near Tarpon Springs
105	East Saddlecreek Park	SWFWMD [1]	N.W. Saddlecreek Park
106	Lake Parker	2294259	Lake Parker @ Lakeland
107	Saddlecreek Park, N.W.	SFWMD	N.W. Saddlecreek Park
108	Lake Arbuckle	2269600	Lake Arbuckle, south shore
109	South Withlacoochee R.	2312500	Withlacoochee River @ Croom
110	Lake Maggiore	2308000	Sawgrass Lake near Pinellas Park
113	Kissimmee River – Pool A	SWFWMD	---
114	C-38 Canal – Pool A	SWFWMD	---
115	Kissimmee River – Pool B	SWFWMD	---
116	C-38 Canal – Pool B	SWFWMD	---
117	Kissimmee River – Pool C	SWFWMD	---
118	C-38 Canal - Pool C	SWFWMD	---
119	Kissimmee River – Pool D	SWFWMD	---
120	C-38 Canal – Pool D	SWFWMD	---
121	Kissimmee Rier – Pool E	SWFWMD	---
122	C-38 Canal – Pool E	SWFWMD	---
123	Fort Kissimemee	2268904	Kissimmee River near Lake Wales
124	Prairie Creek	2298123	Prairie Ck. @ Fort Ogden
131	Myakka River	DNR [2]	Myakka River
132	Lake Hancock	SWFWMD	Lake Hancock
201	Julington Creek	2246500	St. Johns River @ Jacksonville
202	Ocean Pond	2228700	Ocean Pond near Olustee
203	Lake Palestine	2228700	Lake Palestine near Olustee
206	Orange Lake	2242450	Orange Lake @ Orange Lake
207	Station Pond	2240958	Lake Kanapaha @ Arrendondo
208	Lake Wauberg	2240958	Lake Kanapaha @ Arredondo
210	Lochloosa Lake	2242400	Lochloosa Lake @ Lochloosa
211	Doctors Lake	2246500	St. Johns River @ Jacksonville
213	Newnans Lake	2240900	Newnans Lake @ west shore
301	Lake Miccosukee	2326600	Lake Miccosukee @ west shore
302	Lake Iamonia	2328799	Lake Iamonia @ south side of structure
303	Wimico Waterway	-- [a]	--
304	Ochlockonee River	-- [a]	--
305	Bear Creek	2359660	Deer Point Lake north of dam
306	Chipola River	-- [a]	--
307	Escambia River	-- [a]	--
308	Deer Point Lake	2359660	Deer Point Lake north of dam
401	Conservation Area 3A (L-67)	2287400	Miami Canal at Broken Dam near Miami
402	Conservation Area 2A (L-35B)	2285000	N. New River Canal near Ft. Lauderdale
403	Miami Canal	2286700	Miami Canal near Lake Harbor
404	C-18 Canal	26521808	Canal C-18 near Jupiter
405	L-8 Canal	2278550	L-8 near Loxahatchee
406	Conservation Area 1 (L-39)	2278550	L-8 near Loxahatchee
412	Lake Trafford	2291200	Lake Trafford @ north side
501	Lake Griffin (west)	2238300	Lake Griffin @ west side
502	North Withlacoochee River	-- [a]	--
503	Lake Panasoffkee	2312698	Lake Panasoffkee @ west shore
504	Lake Griffin (east)	2238300	Lake Griffin @ west side
505	Crystal River	2310750	Crystal River near Crystal River
519	Salt Springs	2236210	Lake George @ Salt Springs
522	Lake Woodruff	2236000	St. Johns River near DeLand
523	Lake Griffin	2238300	Lake Griffin @ west side
524	Lske Apopka	2237600	Lake Apopka @ Winter Garden
525	Lake Jessup	2234499	Lake Monroe @ Sanford
526	Lake George	2236210	Lake George @ Salt Springs
527	Rodman Reservoir	2243958	Lake Oklawaha near Orange Springs

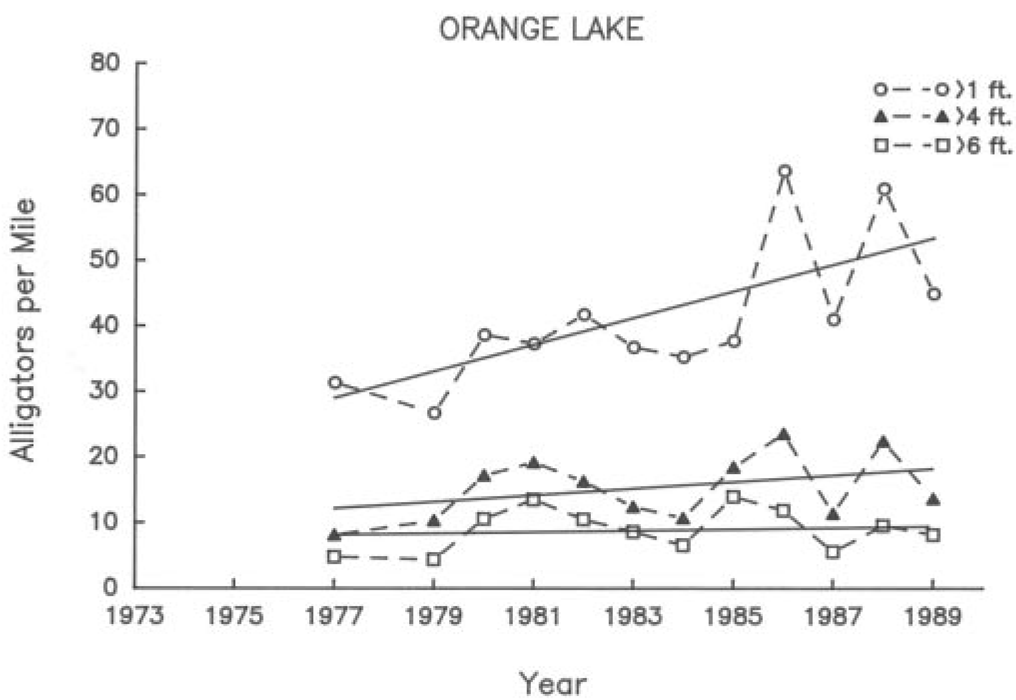
[1] South West Florida Water Management District gauge station
[2] Department of Natural Resources gauge at state park
[a] Unknown gauge station. Water level data transferred from Wood et al. (1985) analysis.

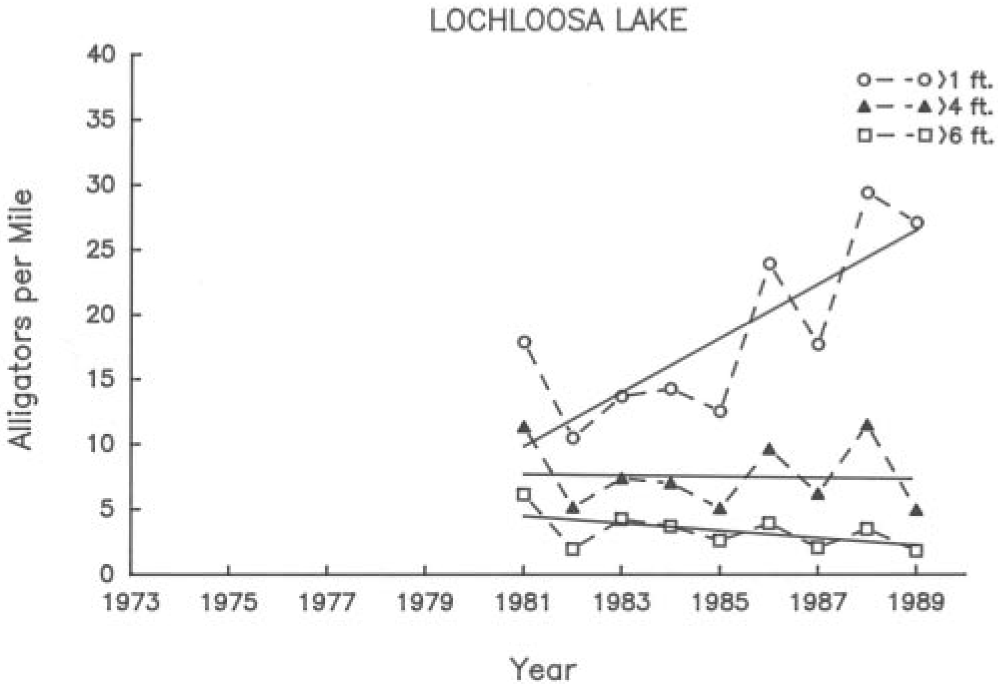
APPENDIX C: Plots of water level-adjusted densities of alligators observed during night-light counts on selected wetlands in Florida, 1974-89. Estimated trends and water level adjustments based on linear regression models.

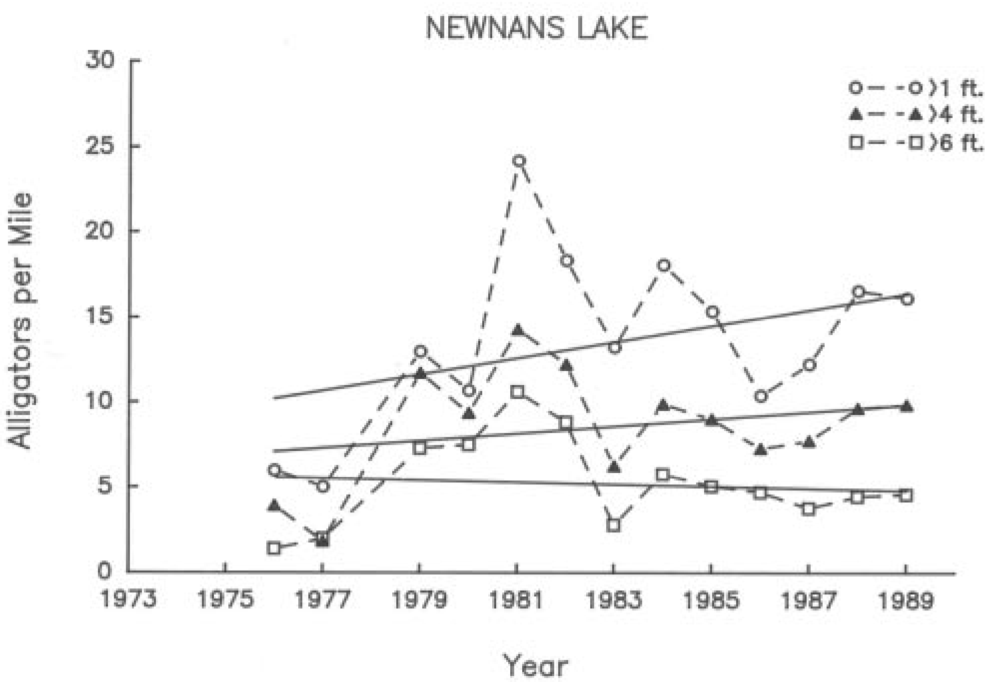

LAKE ARBUCKLE
Alligators per Mile
Year
>1 ft.
>4 ft.
>6 ft.
0
1
2
3
4
5
6
7
8
9
10
1973
1975
1977
1979
1981
1983
1985
1987
1989

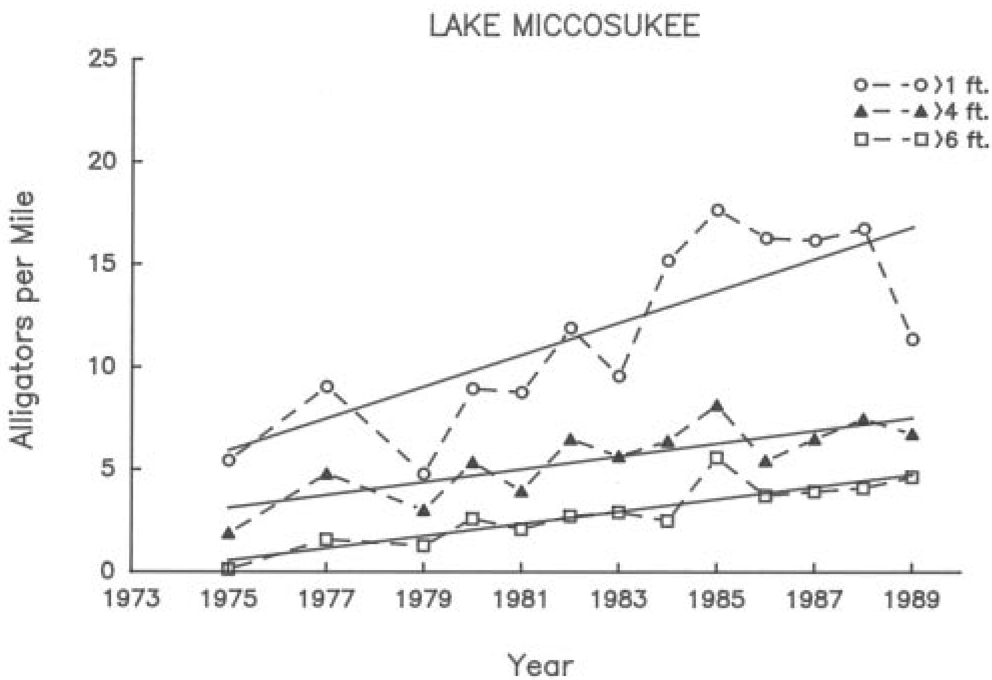

MYAKKA RIVER
Alligators per Mile
Year
>1 ft.
>4 ft.
>6 ft.
0
5
10
15
20
25
30
1973
1975
1977
1979
1981
1983
1985
1987
1989

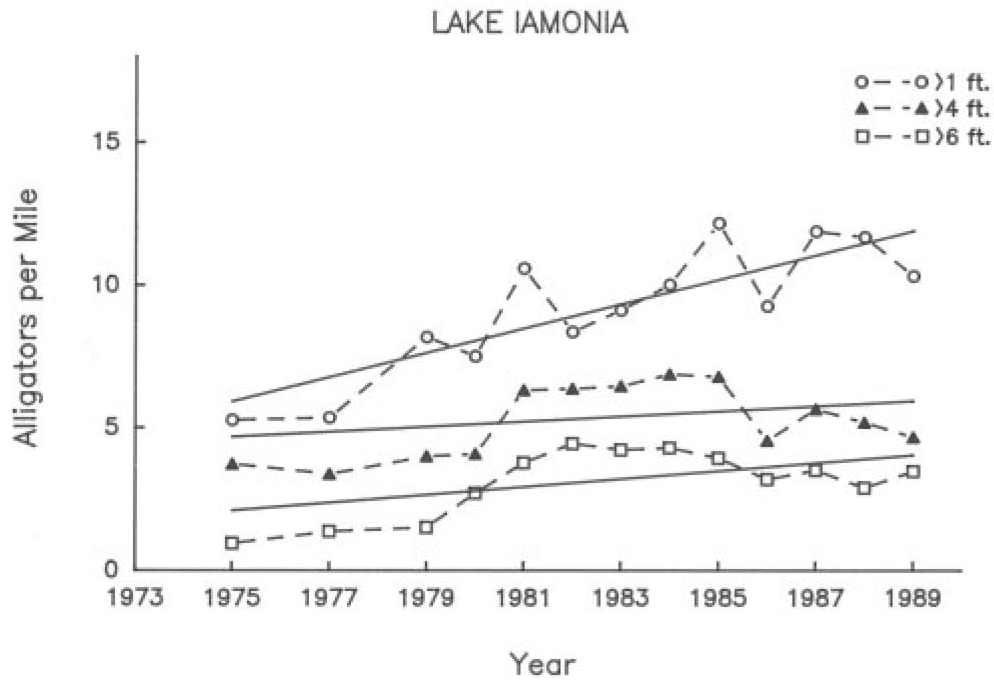

LAKE HANCOCK
o- -o >1 ft.
▲- -▲ >4 ft.
□- -□ >6 ft.
Alligators per Mile
0
5
10
15
20
25
30
35
40
45
1973
1975
1977
1979
1981
1983
1985
1987
1989
Year

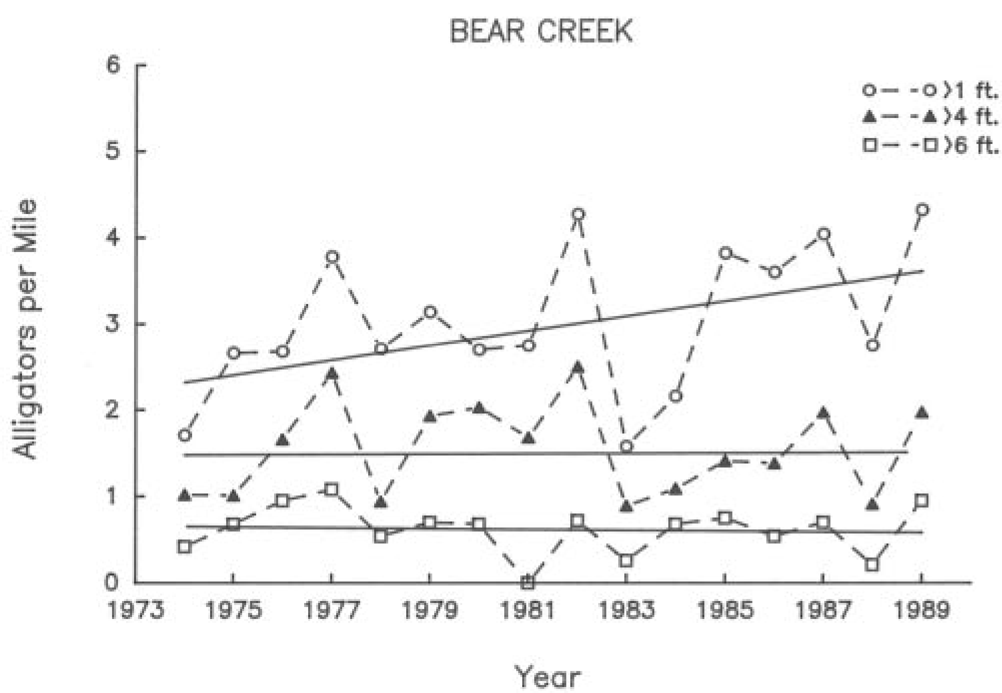

ORANGE LAKE
o- -o >1 ft.
▲- -▲ >4 ft.
□- -□ >6 ft.
Alligators per Mile
0
10
20
30
40
50
60
70
80
1973
1975
1977
1979
1981
1983
1985
1987
1989
Year

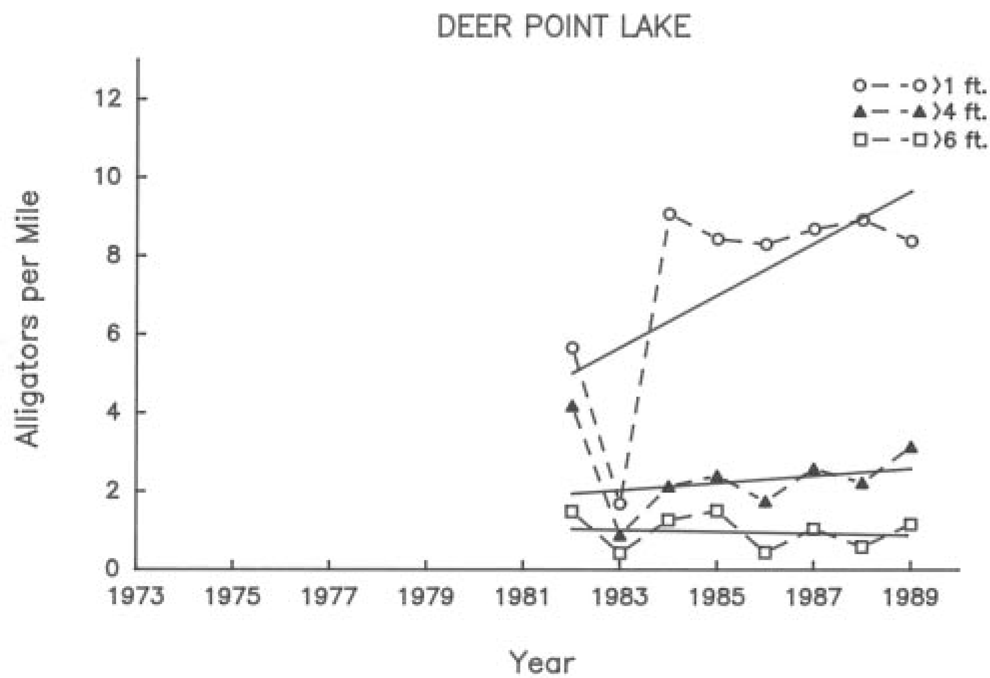

LOCHLOOSA LAKE
o- -o >1 ft.
▲- -▲ >4 ft.
□- -□ >6 ft.
Alligators per Mile
40
35
30
25
20
15
10
5
0
1973
1975
1977
1979
1981
1983
1985
1987
1989
Year

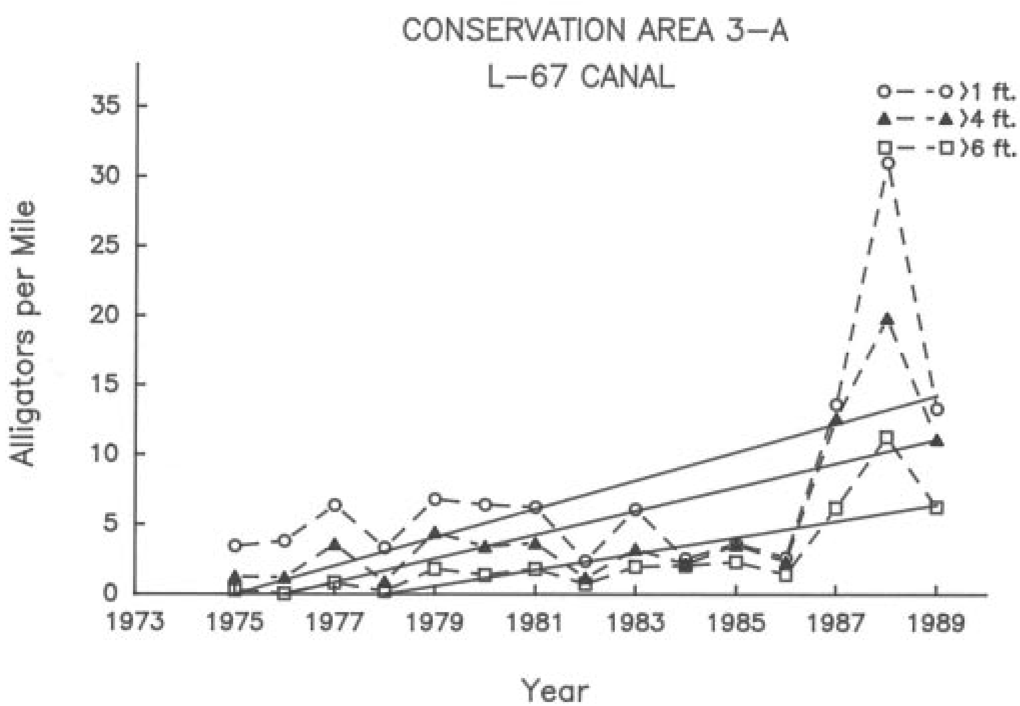

NEWNANS LAKE
o- -o >1 ft.
▲- -▲ >4 ft.
□- -□ >6 ft.
Alligators per Mile
30
25
20
15
10
5
0
1973
1975
1977
1979
1981
1983
1985
1987
1989
Year

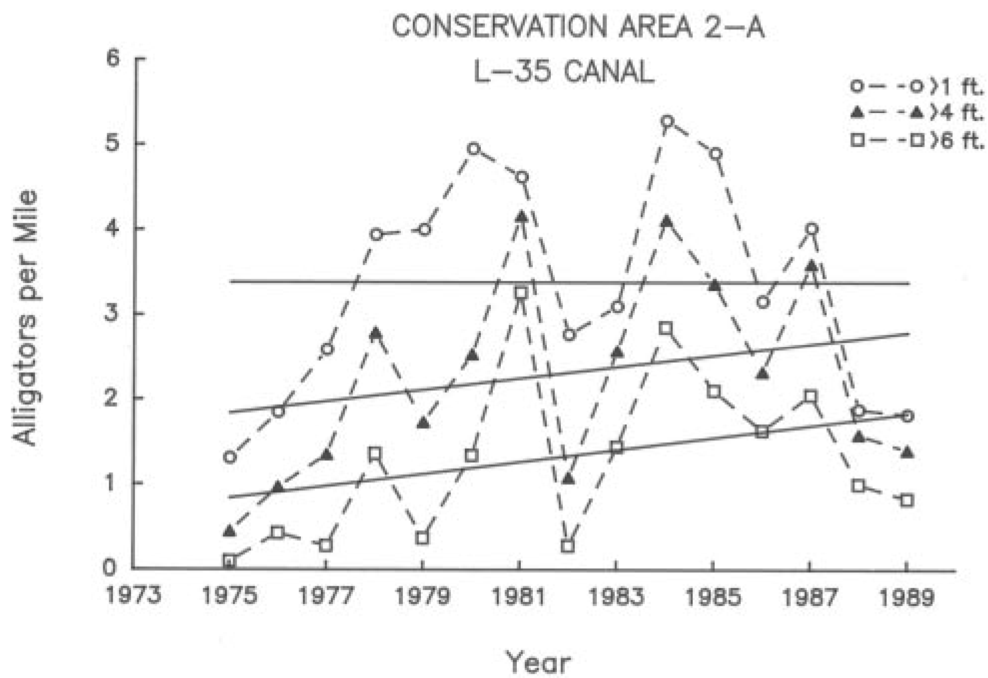

LAKE MICCOSUKEE
Alligators per Mile
Year
o- -o >1 ft.
▲- -▲ >4 ft.
□- -□ >6 ft.
0
5
10
15
20
25
1973
1975
1977
1979
1981
1983
1985
1987
1989

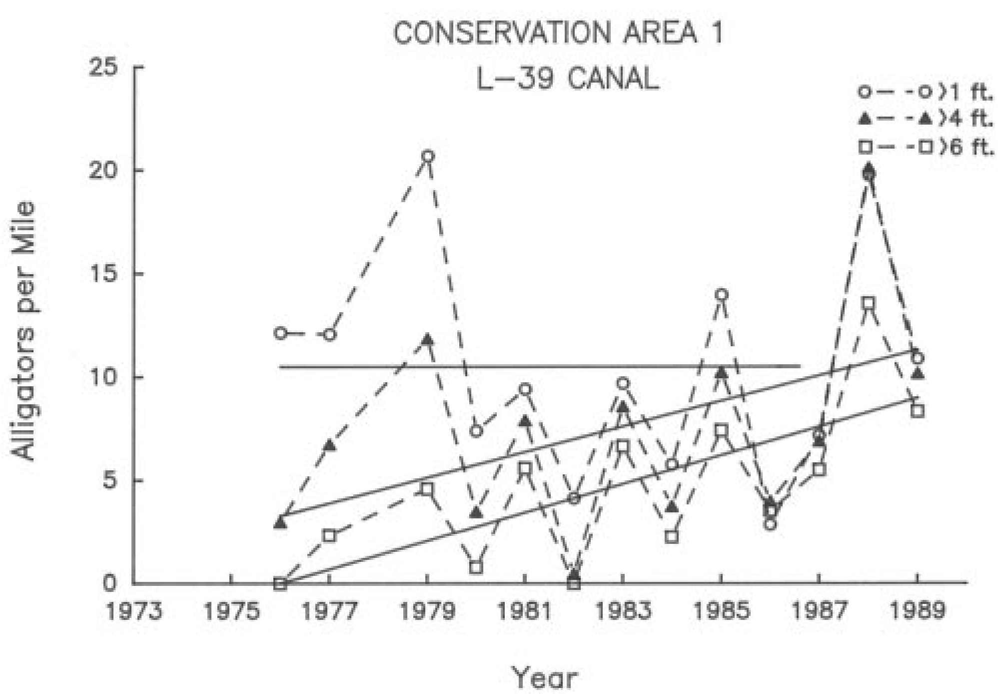

LAKE IAMONIA
o— -o >1 ft.
▲— -▲ >4 ft.
□— -□ >6 ft.
Alligators per Mile
0
5
10
15
1973
1975
1977
1979
1981
1983
1985
1987
1989
Year

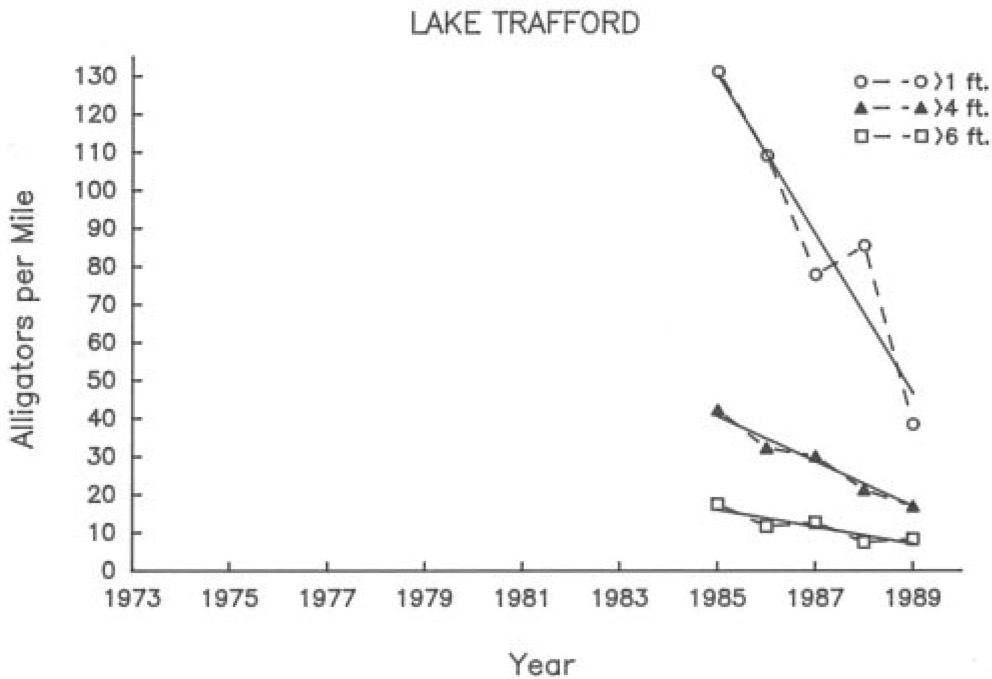

BEAR CREEK
o— -o >1 ft.
▲— -▲ >4 ft.
□— -□ >6 ft.
Alligators per Mile
0
1
2
3
4
5
6
1973
1975
1977
1979
1981
1983
1985
1987
1989
Year

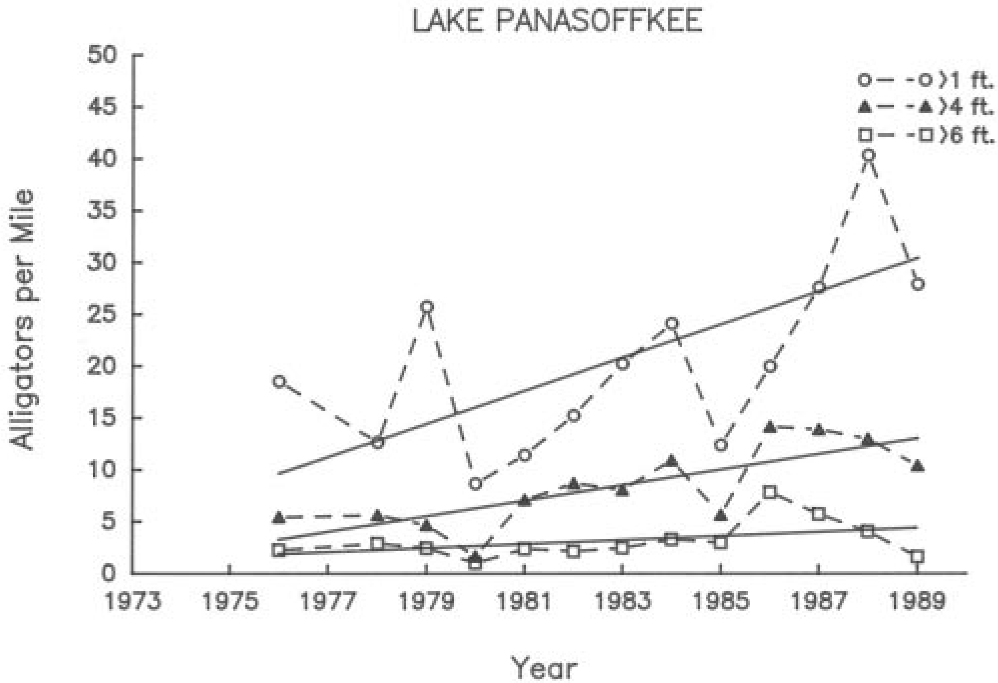

DEER POINT LAKE
o- -o >1 ft.
▲- -▲ >4 ft.
□- -□ >6 ft.
Alligators per Mile
0
2
4
6
8
10
12
1973
1975
1977
1979
1981
1983
1985
1987
1989
Year

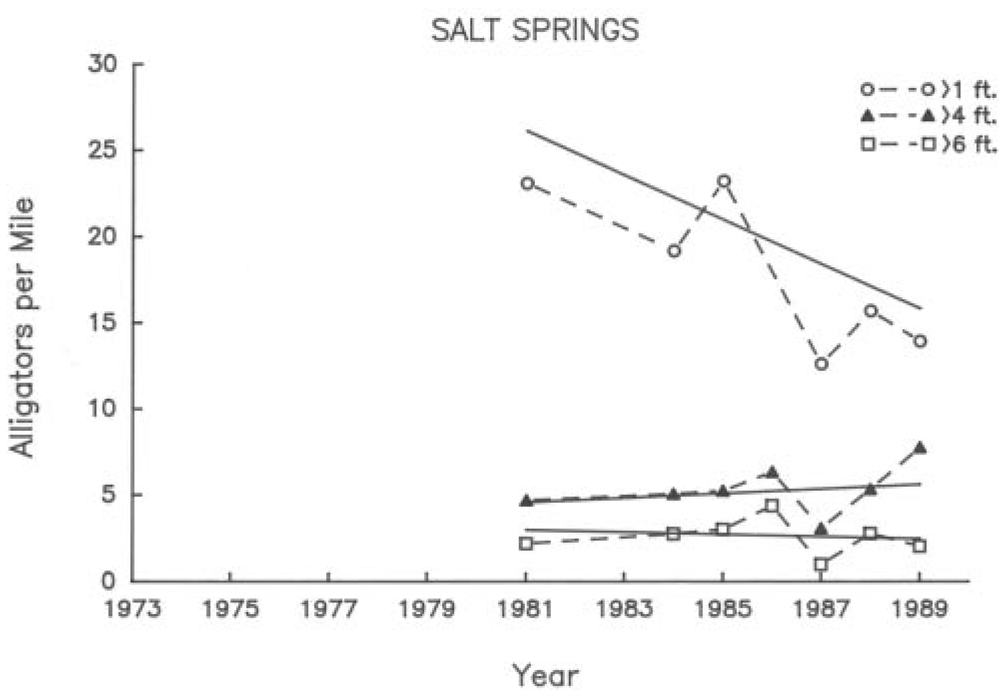

CONSERVATION AREA 3-A
L-67 CANAL
o- -o >1 ft.
▲- -▲ >4 ft.
□- -□ >6 ft.
Alligators per Mile
0
5
10
15
20
25
30
35
1973
1975
1977
1979
1981
1983
1985
1987
1989
Year

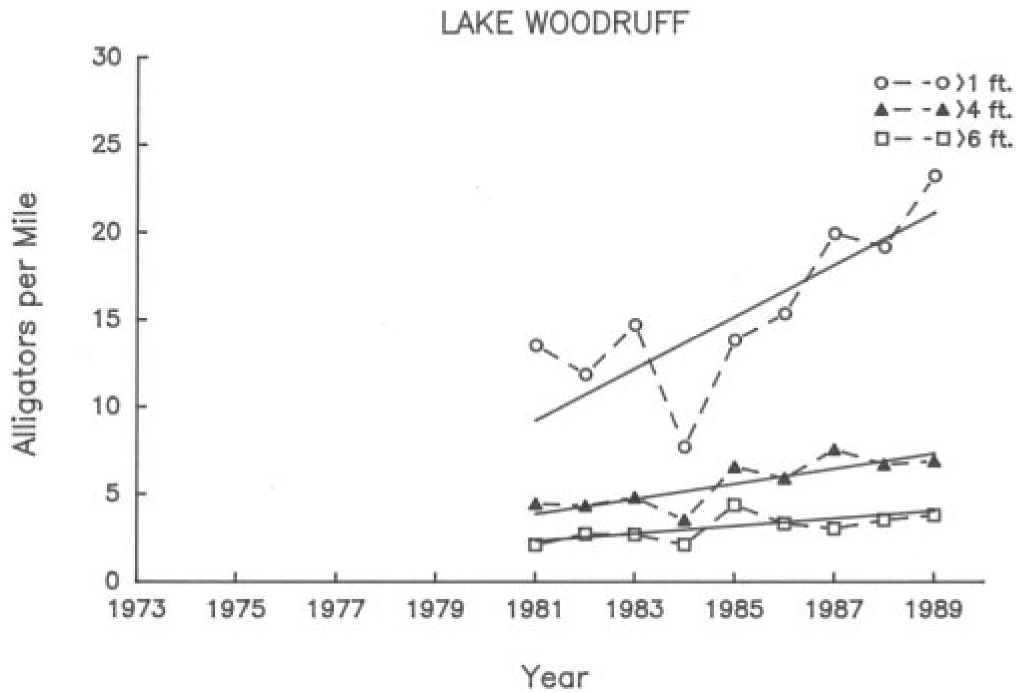

CONSERVATION AREA 2-A
L-35 CANAL
>1 ft.
>4 ft.
>6 ft.
Alligators per Mile
0
1
2
3
4
5
6
1973
1975
1977
1979
1981
1983
1985
1987
1989
Year

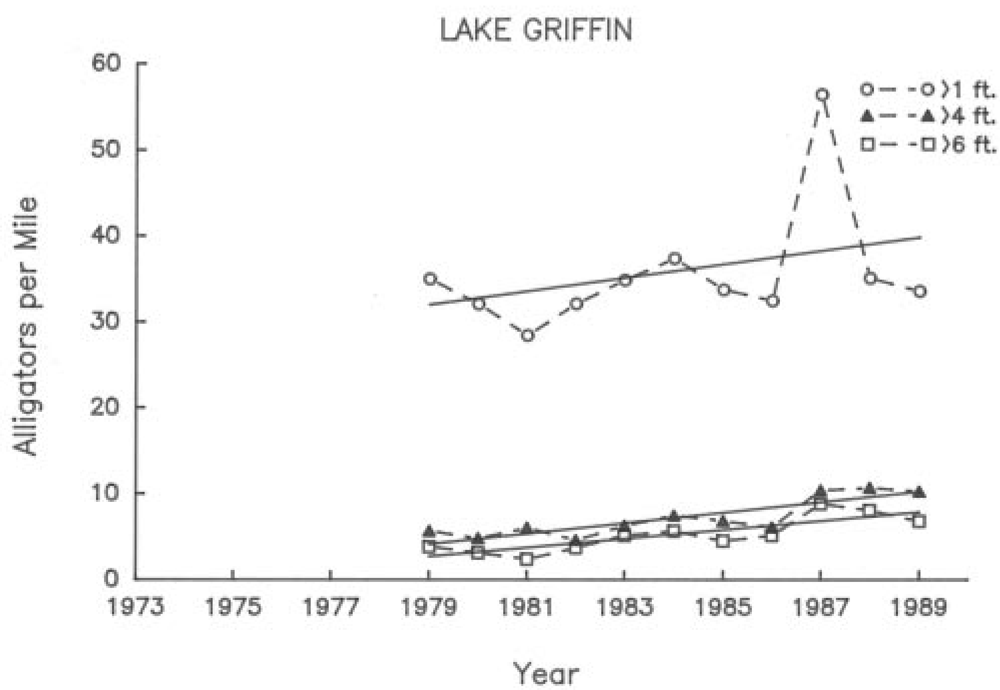

CONSERVATION AREA 1
L-39 CANAL
>1 ft.
>4 ft.
>6 ft.
Alligators per Mile
0
5
10
15
20
25
1973
1975
1977
1979
1981
1983
1985
1987
1989
Year

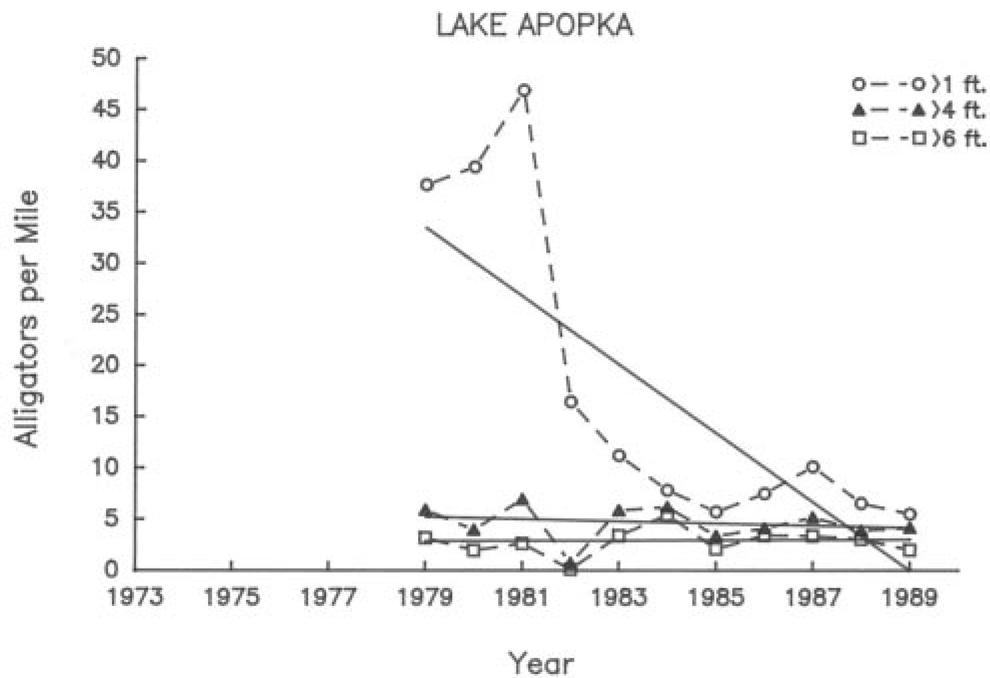

LAKE TRAFFORD
Alligators per Mile
130
120
110
100
90
80
70
60
50
40
30
20
10
0
1973
1975
1977
1979
1981
1983
1985
1987
1989
Year
>1 ft.
>4 ft.
>6 ft.

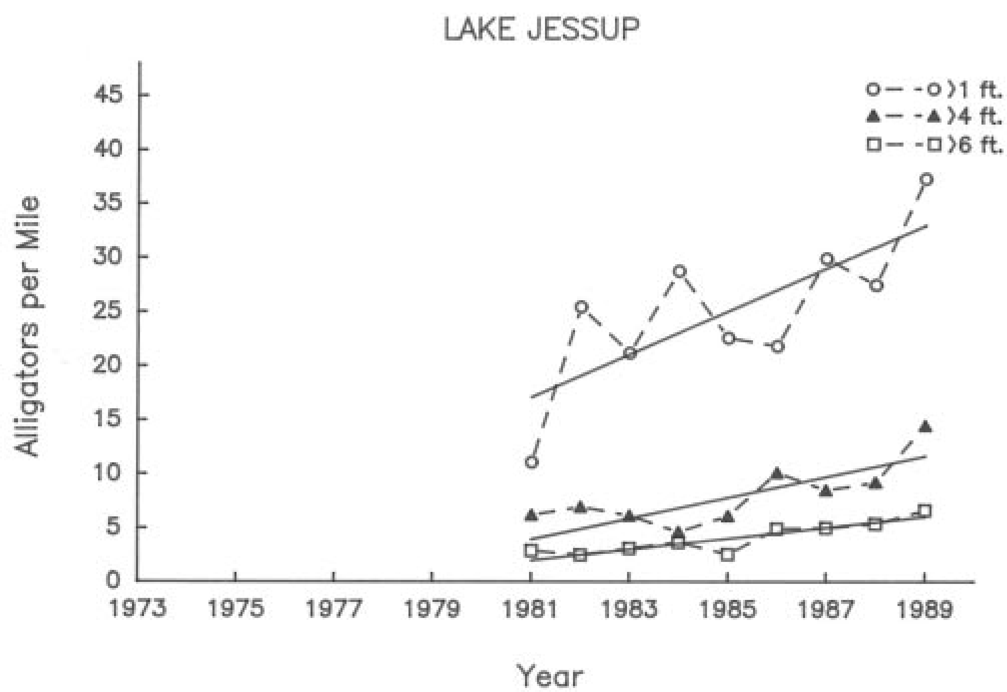

LAKE PANASOFFKEE
50
45
40
35
30
25
20
15
10
5
0
Alligators per Mile
o- -o >1 ft.
▲- -▲ >4 ft.
□- -□ >6 ft.
1973
1975
1977
1979
1981
1983
1985
1987
1989
Year

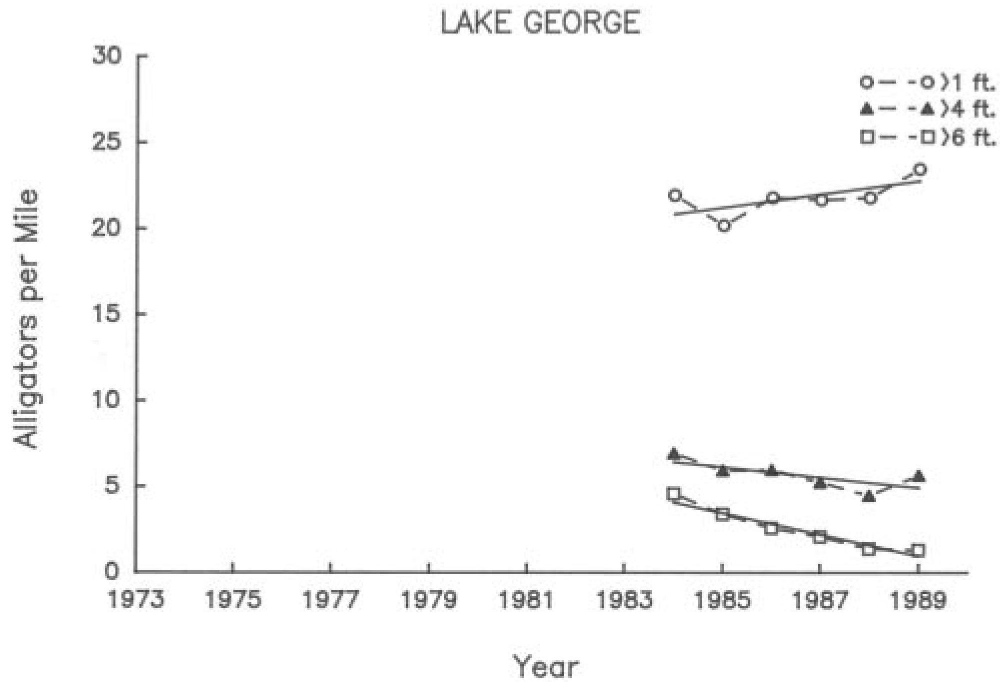

SALT SPRINGS
30
25
20
15
10
5
0
Alligators per Mile
o- -o >1 ft.
▲- -▲ >4 ft.
□- -□ >6 ft.
1973
1975
1977
1979
1981
1983
1985
1987
1989
Year

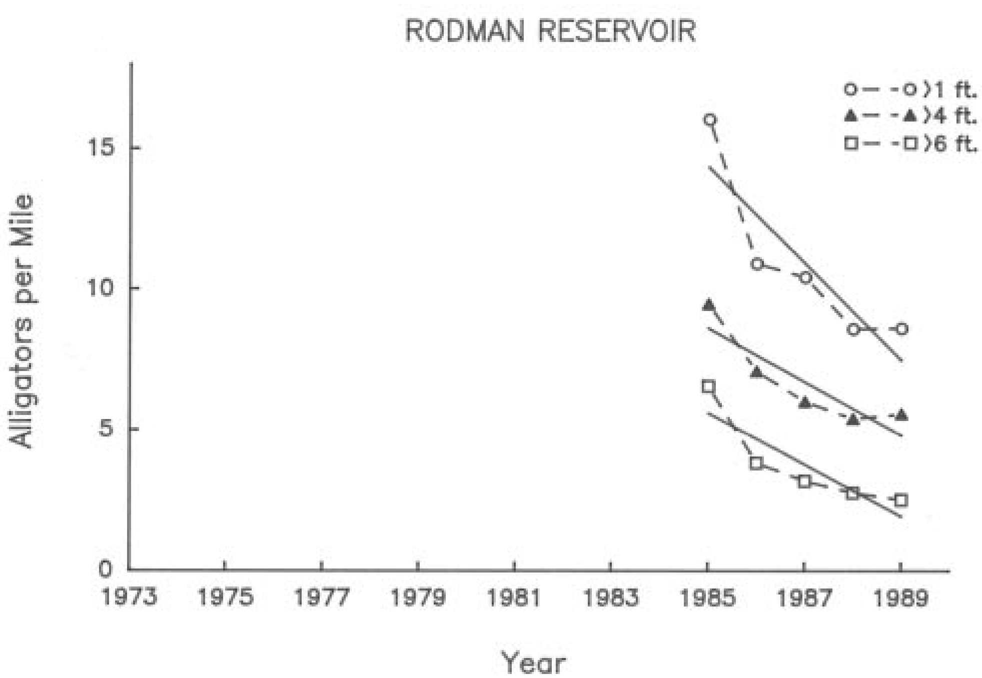

LAKE WOODRUFF
Alligators per Mile
30
25
20
15
10
5
0
1973
1975
1977
1979
1981
1983
1985
1987
1989
Year
>1 ft.
>4 ft.
>6 ft.


LAKE GRIFFIN
Alligators per Mile
60
50
40
30
20
10
0
1973
1975
1977
1979
1981
1983
1985
1987
1989
Year
>1 ft.
>4 ft.
>6 ft.


LAKE APOPKA
Alligators per Mile
50
45
40
35
30
25
20
15
10
5
0
1973
1975
1977
1979
1981
1983
1985
1987
1989
Year
o— -o >1 ft.
▲— -▲ >4 ft.
□— -□ >6 ft.


LAKE JESSUP
Alligators per Mile
45
40
35
30
25
20
15
10
5
0
1973
1975
1977
1979
1981
1983
1985
1987
1989
Year
o— -o >1 ft.
▲— -▲ >4 ft.
□— -□ >6 ft.


LAKE GEORGE
o- -o >1 ft.
▲- -▲ >4 ft.
□- -□ >6 ft.
Alligators per Mile
30
25
20
15
10
5
0
1973
1975
1977
1979
1981
1983
1985
1987
1989
Year


RODMAN RESERVOIR
o- -o >1 ft.
▲- -▲ >4 ft.
□- -□ >6 ft.
Alligators per Mile
15
10
5
0
1973
1975
1977
1979
1981
1983
1985
1987
1989
Year