# AN EVALUATION OF FACTORS AFFECTING NIGHT-LIGHT COUNTS OF ALLIGATORS [a]

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*Abstract*: Sixty-eight night surveys of American alligators (*Alligator mississippiensis*) were conducted from 17 June 1976 to 12 July 1977 on a large cypress-fringed lake in north-central Florida. Multiple regression analyses of the effects of 11 environmental variables (water temperature, air temperature, wind speed, wave height, cloud cover, water level, moonlight, precipitation, 24-hour precipitation, 24-hour maximum temperature, and 24-hour minimum temperature) on surveys with a white light ($n = 44$) indicated that counts were positively correlated with water temperature and negatively associated with water level. Water temperature was the most important variable in cool weather (1 October - 1 May) and accounted for 85% of the variation in counts ($n = 22$) during those months. Water level was the most important variable in warm weather (1 May - 1 October) and accounted for 53% of the variation during those months. Monthly changes in size composition and distribution of the alligator population are described and their relationships to night-light counts are discussed. No significant differences were detected in the effectiveness of airboats relative to outboard motorboats or red light relative to white light in counting or approaching alligators. Light intensity had a significant effect on both counts ($P < 0.02$) and on approachability ($P < 0.05$). Guidelines are established for conducting future night-light surveys for population trends.

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The Florida alligator population has apparently fluctuated considerably over the past 2 decades. The population was reduced to what appeared to be a critical level in the mid-1960's (Craighead 1968, King 1972, Schemnitz 1972, Thompson and Gidden 1972). This motivated the U.S. Fish and Wildlife Service to classify it as endangered in 1966 (Bureau of Sport Fisheries and Wildlife 1966). Alligators were afforded additional federal protection with the Amendment to the Lacy Act in 1969 and populations began on what seemed to be a rapid recovery. Prior to 1971, however, no empirical data were available to support these apparent trends.

In 1971, the Alligator Recovery Team attempted to monitor alligator population trends by setting up a series of night-light transects in 7 of the 10 states within the alligator's range. Counts along transects in Florida reflected a decrease from 12.6 alligators per km in 1971 to 9.1 alligators per km in 1975 (Chabreck 1976). These data did not support the alleged increases over this time interval. However, Chabreck (1976) noted that additional transects were included in the survey results on successive years, making trend comparisons invalid. He also reported that rainfall at the time of the survey, bright moonlight, excessive noise created by the survey craft (particular airboats), habitat changes, and time of year particularly seemed to affect night counts with a net result of increasing variability and introducing error into year to year comparisons.

In 1974, the Florida Game and Fresh Water Fish Commission began comparing an independent series of transects from year to year. The same transects were compared on a year-to-year basis and showed an increase in alligators counted from 8.0 per km in 1974 to 20.9 per km in 1977; this supported the apparent positive trend of the Florida population. However, Hines (1976 pers. comm.) indicated that varied environmental conditions and

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survey techniques caused problems similar to those encountered by Chabreck (1976). In 1976, Florida petitioned to have the alligator's status changed for management purposes from endangered to threatened. It was apparent at that time that data on population trends were weak and more precise methods were needed to evaluate the population status of Florida alligators.

To date, there have been few quantified studies to help explain variability in night counts. Murphy (1977) found a high linear correlation ($r = 0.94$) between water temperature and night counts at an atomic reactor cooling reservoir in South Carolina. However, prior to that study, standards for optimum methods, procedures and weather conditions for conducting night alligator counts were based primarily on guidelines suggested by Chabreck (1966). The guidelines stated that counts should be made in late April or early May, during the dark of the moon, and on a still night with wind velocity less than 13 km/hr. In 1971, the Alligator Recovery Team revised some of the guidelines and added others. The updated recommendations included conducting counts from May to October, when air temperature is above 21 C, and initiating the survey approximately 1 hour after sunset (Chabreck 1976).

Due to seasonal and yearly fluctuations in water levels and changing vegetational characteristics of Florida wetlands, airboats are sometimes more suitable than outboard motorboats for conducting night alligator surveys. Consequently, these 2 craft types have been used interchangeably. There is clearly a difference between the level and type of noise produced by these 2 boat types. However, the relative impact of these disturbances on alligator counts is unknown.

Alligator hunters have insisted that the use of red lights increases the ability to approach alligators. Two possible factors can be responsible for this alleged behavior by alligators; they cannot perceive red light and are less disturbed when approached, or they can detect red light but are not disturbed as much due to the color of the light. The potential advantages of this survey method were apparent, but untested.

In view of the importance of night counts as a basis for documenting population trends of alligators, and the inherent variability in present methods and procedures, we undertook this study with the following objectives:

(1) To quantify the effects of various environmental variables on total alligators counted.

(2) To evaluate the effects of size composition and spatial distribution of an alligator population on counts.

(3) To evaluate the relative effectiveness of airboats compared to motorboats in counting and approaching alligators.

(4) To assess the relative effectiveness of red versus white lights in counting and approaching alligators.

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## MATERIALS AND METHODS

The study was conducted on Newnan's Lake, approximately 6 km east of Gainesville, Alachua Co., Florida (Fig. 1). This lake is typical of large cypress-fringed lakes in north-central Florida. Open water surface area of the lake encompasses approximately 2430 ha with approximately 21 km of shoreline. Cypress (*Taxodium distichum*) fringe extends over nearly 75% of the lake perimeter spreading into a wooded swamp on the northern and eastern sides. The mean depth of the lake is 1.5 m with a maximum depth of 4.0 m. Water levels are maintained by a water control structure on Prairie Creek and normally fluctuate slightly. However, during the spring of 1976 (28

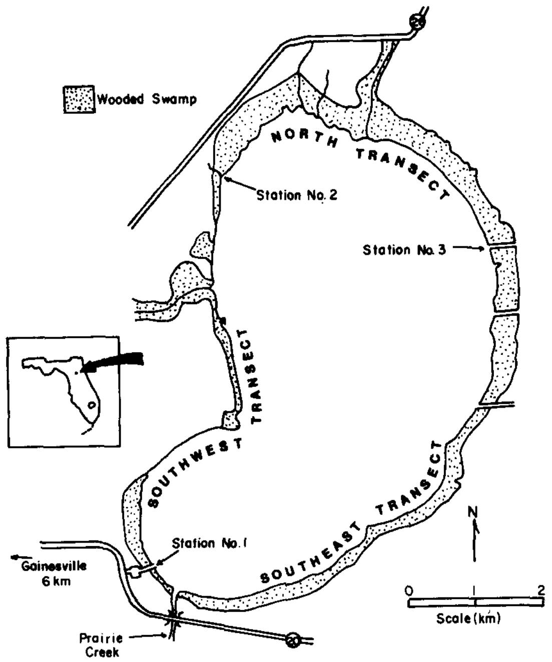


Fig. 1. Map of Newnan's Lake, located 6 km east of Gainesville, Alachua Co., Florida.

April - 10 June), the water level was purposely lowered as far as the control structure would allow as part of a lake management scheme (Fig. 2). The open water contained very little emergent or submergent vegetation.

A 5.2 m square-sterned canoe with a 4 hp outboard motor was used to conduct surveys during the initial stages of the study. However, the canoe proved to be unstable and, thus, unsatisfactory for the study. It was replaced by a flat-bottomed jon boat powered by a 9.9 hp outboard motor. A steel hulled 3.7 m airboat with a 125 hp engine was used for all airboat surveys.

A 4 v. Wheat Lamp (15,000 c.p.) headlamp was used by the observer on all white light surveys. This light produced a detectable eye reflection (alligators eyes reflect a red glow when shined by lights at night) at approximately 150 m. Range varied with the size of the alligator, as larger individuals had a more brilliant reflection. The boat operator used a less powerful 6 v. headlamp. A red lens on a hand-held Q-Beam Super Spot light (200,000 c.p.) was used for alligator counts with red lights. Early experimentation revealed that it was necessary to place a diaphragm over the lens to reduce the range of the red light and provide a light range equivalent to the white light (15,000 c.p.).

Prior to surveying the entire lake, counts were conducted along the northern portion to refine night survey techniques. Surveys of the entire lake were intiated 17 June 1976 and completed 12 July 1977.

The survey craft was operated about 50 m from, and parallel to, the cypress shoreline with the observer in the bow and the boat operator in the stern. A rather constant cruising speed of 12-14 km/hr was maintained while searching for alligators. To spot alligators, the light beam was directed in an arc of approximately 160 degrees to the front of the boat.

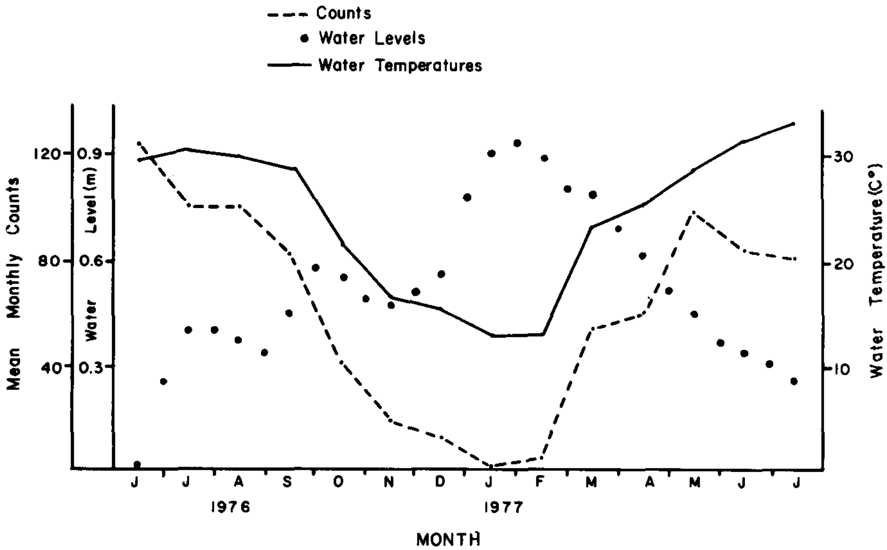


Fig. 2. Water level fluctuations, mean monthly water temperature and mean monthly alligators counted on Newnan's Lake, June 1976-July 1977.

The boat operator used his headlamp mainly for navigational purposes. When an eye reflection was spotted, the alligator was approached for a size estimate. Cruising speed was maintained when approaching an alligator unless it submerged, at which time the speed was reduced to an idle. If the alligator failed to re-emerge, cruising speed was regained upon passing the point of submergence. If the alligator reappeared, a size estimate was taken and the survey was continued. Size estimates were made by estimating the snout length of the animal then converting to total length. The assumption is that 1 inch (2.54 cm) of snout length is roughly equivalent to 1 foot (0.3 m) of body length (Chabreck 1966, A. Woodward 1977 unpublished data). All size estimates were made in 1 foot (0.3 m) increments to be consistent with the previous literature.

Weather conditions were monitored at stations no. 1, 2, and 3 (Fig. 1). Air and surface temperatures were recorded and wind speed 50 m from the shoreline was measured with a hand-held wind meter. Wind direction was recorded on the basis of 4 cardinal directions and midpoints. Wave height from trough to crest was estimated in cm. Water levels were obtained from weekly readings by the U.S. Geological Survey.

Lunar phase was indexed on a scale of 0-5 representing the new moon and full moon, respectively. Moon duration was combined total of actual durations over each of the transects with 0 as no duration and 3 representing a moon duration over the entire survey. Available moonlight was estimated by observing the presence or absence of clouds obstructing the light, and was indexed from 0 (corresponding to heavy cloud cover) to 4 (representing an unobstructed moon). A combination of lunar phase, moon duration, and available moonlight was used as an index of moonlight with a range of 0-12.

Nocturnal cloud cover was estimated as the proportion of sky covered with clouds. Type of precipitation (none, mist, rain) during the survey was noted and indexed from 0-2 respectively. Rainfall prior to the survey, maximum and minimum temperatures during the day of the survey were all obtained from the weather station at the Gainesville International Airport located 3 km northwest of the lake.

Data from transects between each of the stations served as distinct subsurveys. Future references will be made to these subsurveys as the southwest transect (station no. 1 to station no. 2), the north transect (station no. 2 to station no. 3), and the southeast transect (station no. 3 to station no. 1) (Fig. 1).

Surveys were initiated at about 1 hour after sunset to insure that maximum available darkness was realized so that alligator eye reflections would be detectable. The time each subsurvey ws begun was recorded at each station.

Statistical Analyses

All counts and approachabilities reflected the entire number of alligators 0.6 m and longer observed during a survey. Young alligators (< 0.6 m) were excluded from the analyses for reasons to be explained later. Approachability was reported as a proportion of alligators successfully approached within an adequate distance (approximately 10 m) to make a size estimate.

*Effects of Environmental Variables on Surveys*—To reduce variability and retain as many observations as possible, only white light counts were used when evaluating environmental variables. White light counts were analyzed as a whole (n = 44), then divided into warm weather (May-Oct.) counts (n = 22) and cool weather (Oct.-May) counts (n = 22) for further analysis (Table 1). Each data set was analyzed by stepwise multiple linear regression to sequentially determine regression models accounting for most of the variation in the dependent variables (Barr et al. 1976). Models were retained if all independent variables contained within them were significant at the 5% level of probability.

Table 1. Criteria for data sets used in stepwise regression analyses: number of observations (n), amount of variability accounted for in the retained models ($r^2$), significant variables and their correlation and regression coefficients.

| *Data Set* | *n* | *$r^2$ of Retained Models* | *Significant Variables Contained in Models* | *Correlation Coefficient (r)* | *Regression Coefficient[a] (b)* |
|---|---|---|---|---|---|
| 1) All white light counts | 44 | 0.90 | Water temperature** | 0.94 | 0.404 |
| | | | Water level* | -0.57 | -0.006 |
| 2) Warm weather counts (May-Oct) | 22 | 0.64 | Water level** | -0.73 | -0.018 |
| | | | Moonlight* | -0.01 | 0.084 |
| 3) Cool weather counts (Oct-May) | 22 | 0.91 | Water temperature** | 0.92 | 0.512 |
| | | | Wave height* | 0.08 | -0.560 |
| | | | Cloud Cover* | 0.14 | 0.147 |

[a]Reflects the relationships of transformed count data to each of the variables.

*$P < 0.05$

**$P < 0.01$

Total count was the dependent variable in the regression models. Quantitative environmental variables (water temperature, air temperature, wind speed, wave height, cloud cover, water level, moonlight index, precipitation index, 24-hour maximum temperature, 24-hour minimum temperature, 24-hour precipitation) were independent variables in the regression models. Total counts were transformed by square root technique. (Steel and Torrie 1960:157-158), before inclusion in the model. Two-way interactions of significant ($P < 0.05$) independent variables were tested by entering the variables and their products in multiple regression equations. If the product of the 2 independent variables was not significant at the $P < 0.05$ level, interaction was assumed to be absent. Curvilinear responses of counts to each of the environmental factors in retained models were detected by polynomial regressions of the third degree. Simple correlation coefficients were calculated for counts with the 11 environmental variables.

*Effects of Size Composition on Counts*—To determine the relationship of season to observed size composition of the population, mean monthly water temperatures were correlated with observability indices of 3 size classes of alligators; young (< 0.6 m), juveniles (0.6-1.8 m), and adults (> 1.8 m). Observability indices represented the mean number of alligators observed in each size class per survey per month expressed as a proportion of the greatest mean number of alligators observed per survey during any one month.

*Effects of Boat and Light Types on Night Surveys*—Six airboat vs. motorboat comparisons were conducted from 29 June 1976 to 14 April 1977 and 10 red light vs. white light comparisons were performed from 15 April 1977 to 12 July 1977. Each comparison consisted of a survey of each type run at random within a 5-day period. A Wilcoxon matched-pairs signed-ranks non-parametric test (Siegel 1956:75-80) was used to test the differences in total counts and approachability for each of the techniques. If the test statistic was significant at the $P = 0.05$ level, the difference was considered significant.

## RESULTS AND DISCUSSION

### Preliminary Results

Throughout the study, an attempt was made to minimize variability due to equipment and techniques. Differences in boat operators during the study seemed to have little effect on counts, however, approachability may have been influenced dependent on the operator's skill and experience. It was evident that, when comparing counts over a series of nights, surveys should be initiated at the same station and run in the same direction at approximately the same time to reduce experimental error. Another important consideration when running comparative surveys was standardization of the craft speed.

*Young Alligators*—During the study, we identified 5 groups (pods) of hatchling alligators. Hatchlings were mobile and migrated as pods in and out of the cypress fringe (20-50 m) through their second year. This behavior caused considerable fluctuations in counts which could have potentially increased error in subsequent analyses. Consequently, all analyses were limited to alligators greater than 0.6 m in length. At approximately 0.6 m, alligators tend to disperse and become more independent of one another (Chabreck 1965, Fogarty 1974, D. Deitz 1977 pers. comm.).

*Light Intensity*—The maximum count during 56 surveys with the normal white light (150 m range) was 139 on 25 June 1976. Seven paired counts of a high intensity red light (210 m range) and a white light (150 m range) indicated that the light with the greater range exhibited significantly higher ($P < 0.02$) counts. Color of light somewhat confounded the interpretation of these results; however, as demonstrated later by a test of red and white lights of comparable ranges, red color had no significant effect on counts. The greater intensity light increased the area sampled and detected alligators which would normally not have been observed or which would have submerged before entering the range of the less powerful light.

High intensity red lights (210 m range) produced a significantly ($P < 0.05$) lower approachability compared with a white light (150 m range) in 7 paired surveys. Once more, light color confused the interpretation of results. However, red color had no significant effect on approachability as demonstrated later by a comparison of red and white lights of similar ranges. The apparent differences in approachability can be explained by some alligators submerging before entering the range of the lower intensity light. With the high intensity light, these alligators were counted but submerged before a size estimate could be made, thereby decreasing the overall proportion sized.

*Monthly Counts*—Mean monthly counts using a white light showed considerable variation in numbers throughout the study (Fig. 2). The highest of the mean monthly counts (122.3) occurred in June 1976. Mean count declined to 84.7 during June 1977. The decline was reflected in a reduction in the relative abundance of adult alligators observed. The apparent decrease could have resulted from a number of factors including mortality, emigration, adverse environmental factors, or movement beyond the range of survey lights. No major die-off was observed during the study nor are there any nearby bodies of water which might facilitate emigration by a large number of alligators. Fishermen reported aggregations of 15-25 large (> 2 m) alligators near their fishing lines located in the middle portions of the lake during June and July 1977. Upon investigation at night, numerous large alligators were sighted outside the normal range of the survey lights. As a result, the decline is alligators counted in 1977 was attributed to alligators moving into the middle of the lake. Counts after 1 June 1977 were, therefore, excluded from analysis of environmental variables.

Effects of Environmental Variables on Counts

*The Models*—The first stepwise regression analysis included counts from all 44 white light surveys from 17 June 1976 through 30 May 1977. A 2-variable model was retained with water temperature and water level accounting for most of the variation in counts ($r^2 = 0.90$). The second stepwise analysis included all white light surveys ($n = 22$) performed from 17 June to 1 October 1976 and during May 1977 (warm weather counts, Table 1). A 2-variable model including water level and moonlight intensity accounted for 64% of the variation in counts over this time period. The third stepwise analysis included 22 white light surveys conducted from 1 October 1976 through April 1977 (cool weather counts). A 3-variable model including water temperature, wave height, and cloud cover explained most of the variation in counts over this period ($r^2 = 0.91$).

*Water Temperatures*—Alligator counts were positively correlated with water temperature both in white light surveys ($n = 44$, $r = 0.94$) and in cool weather counts ($n = 22$, $r = 0.92$). Water temperatures also accounted for most of the variation in both data sets. Counts during the warm weather period were relatively unaffected by water temperature.

It was apparent from a plot of counts versus water temperatures (Fig. 3) that a close relationship existed between the two parameters at low water temperatures. However, a scattering of responses occurred as water temperature surpassed the 27-28°C interval. Murphy (1977) reported a similar response of counts to water temperature in a South Carolina alligator population. Because of the relatively high latitude of his study area, he had few surveys with water temperatures greater than 30°C. Nonetheless, he predicted a sigmoidal relationship of counts to water temperature with counts reaching a plateau as the upper temperature tolerance limits (35-38°C) for the species are approached. Our non-transformed count data appeared to level off somewhat at higher temperatures (Fig. 3) but no significant curvilinear relationships were detected in the analysis.

Aside from daytime basking activities, alligators rely on their immediate environment (usually mud or water) to maintain body temperatures. Smith (1975) found seasonal and daily activity patterns in alligators to be closely related to body temperature. Therefore, as water temperature changes, so does the activity and, hence, the visibility of alligators.

The slope (regression coefficient) of the regression line of counts on water temperature provides a relatively accurate description of the response of an alligator population to water temperature changes. However, we must emphasize that the relationship is dependent on the size composition of the population. For instance, a population with a more heavily represented juvenile segment would not have the same slope as the Newnan's Lake population. The slope could be used to adjust counts made at various water temperatures to some standard temperature for purposes of trend analysis. However, baseline data are required to determine the slope for each distinct population size distribution.

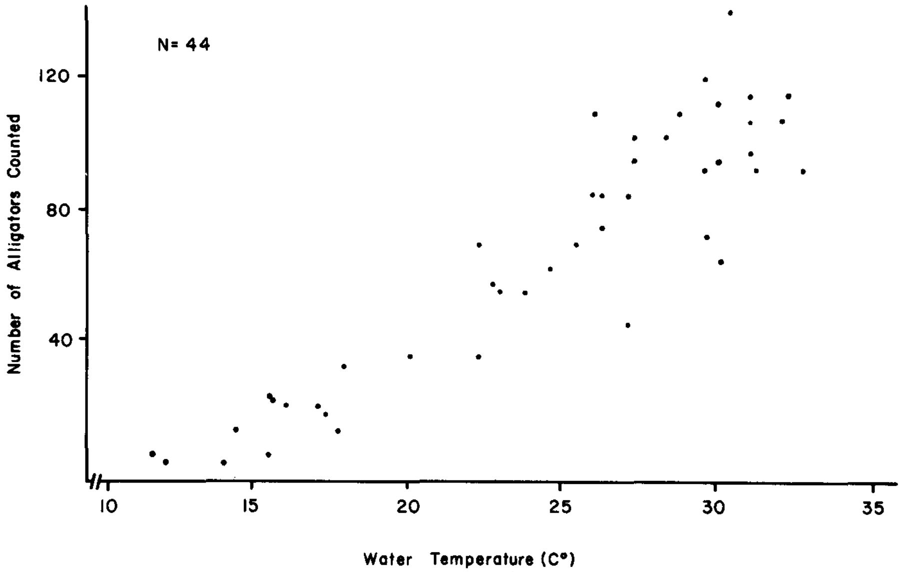


Fig. 3. Relationship between number of alligators counted and water temperature in night alligator surveys on Newnan's Lake from 23 June 1976 to 30 May 1977.

*Wave Height*—Results from cool weather surveys indicate that wave height contributed a significant ($P < 0.05$) amount of variability to counts. The negative regression coefficient (Table 1) shows that counts decreased with an increase in wave height. It is possible that this relationship is caused by a tendency for alligators to spend more time submerged to avoid wave disturbance at the surface or by a reduction in visibility of alligators in choppy water. It is likely that a combination of the 2 factors contributed to the overall negative relationship.

*Water Level*—Water level was negatively correlated ($r = -0.57$) with counts and accounted for a significant ($P < 0.05$) amount of variation in all white light counts. Analysis of warm weather counts showed water level to be a highly significant ($P < 0.01$) factor which accounted for the majority of variability in the model ($r^2 = 0.53$). Water level was not important in cool weather counts.

Newnan's Lake is characterized by water level changes (Fig. 2) which substantially influence the area of wet swamp on the lake's periphery. A slight increase in water level can cause a large area of swamp to be inundated and, therefore, available to alligators. When utilizing the wooded swamp, alligators are more difficult to detect with survey lights and some are completely beyond the range of the light. Consequently, counts increased with decreasing water levels.

*Moonlight*—Only warm weather counts were affected significantly ($P < 0.05$) by moonlight. The regression coefficient (Table 1) revealed a positive relationship between counts and nocturnal light. This indicated that night counts increase with greater moonlight.

This finding is contrary to popular belief and deserves closer scrutiny. Traditionally, moonlight was thought to have a negative effect on counts, presumably because of the added brightness it produces which reduces the effectiveness of detecting alligator eye reflections. During warm weather, alligators might be stimulated by moonlight (or possible moon phase, which is included in the moonlight index) and become more active. Moonlight accounted for 10% of the variability in warm weather counts indicating that a standard should be set for moonlight when conducting trend surveys. Additional investigation is needed to determine which components of the moonlight index are responsible for this relationship.

*Precipitation*—Precipitation had no significant effect in any of the 3 data sets. However, only 5% (2 of 44) of the surveys had any type of precipitation. We had a difficult time obtaining data on precipitation because it was usually accompanied by lightning and rough water conditions. It is likely that precipitation, either in the form of rain, mist, or fog would substantially limit visibility and cause a negative effect on counts. No significant relationship was noted between counts and amount of rainfall during the day of the survey.

*Air Temperature*—Air temperature during the survey was not a significant variable in any of the data sets. Water serves as a buffer between air temperature and an alligator. Although air temperature directly affects water temperature, the lag time between changes in air temperature and resulting water temperature changes can be lengthy. Thus, air temperature cannot be substituted for water temperature as a standard for conducting night surveys.

*Cloud Cover*—Cloud cover had a significant positive effect on cool weather counts (Table 1). We have no ready explanation for this association.

*Twenty-four Hour Maximum and Minimum Temperatures*—The effects of temperature extremes were expected to be evident during the cool months but no significant relationship was found. Alligators are more dependent on air temperature and solar radiation for thermoregulation during the cooler months and we anticipated that this might ultimately affect night activity of alligators.

Effects of Size Composition and Distribution of the Population on Counts

*Size Composition*—Seasonal changes in the size composition of the Newnan's Lake alligator population were evident when looking at percent composition in 0.3 m (1 ft.) size increments (Fig. 4).

Young alligators were not observed from October when monthly water temperatures were 21.4 C through March when water temperatures averaged 25.6 C. Although both young and juvenile alligators showed a high positive correlation between observability and mean monthly water temperature ($r = 0.74$ and 0.76, respectively), the observability of adult alligators was not significantly correlated with water temperature ($r = 0.52$).

These relationships suggest a greater tolerance of adult alligators for cooler water. As a result, thermoregulatory differences in alligators were primarily responsible for seasonal changes in observability of size classes in Newnan's Lake. As with most ectotherms, alligators attempt to keep their body temperature at an optimum level. Colbert et al. (1946) determined that 32-35C was optimum for the species. Alligators appeared to function normally at that temperature range. When their body temperatures rise above or fall below optimum, alligators attempt to recover optimum by thermoregulation. It is likely that thermoregulatory behavior has a pronounced influence on the activity of alligators. However, beyond certain thermal limits, alligators cannot function at normal levels (Smith 1975). It has been demonstrated that size plays an important part in the heating and cooling rates of alligators, as larger alligators have a lower rate (thermal lag) than smaller individuals (Spotila et al. 1972; Smith 1975). This was apparent in night counts since larger individuals remain active for a longer period of time following temperature declines.

*Distribution*—During the summer, a relatively equal number of alligators could be found along all 3 transects. As fall approached, a greater proportion of alligators were counted on the north transect. Daytime basking counts conducted in November 1976 showed 41 of 52 (79%) alligators observed to be on the north transect.

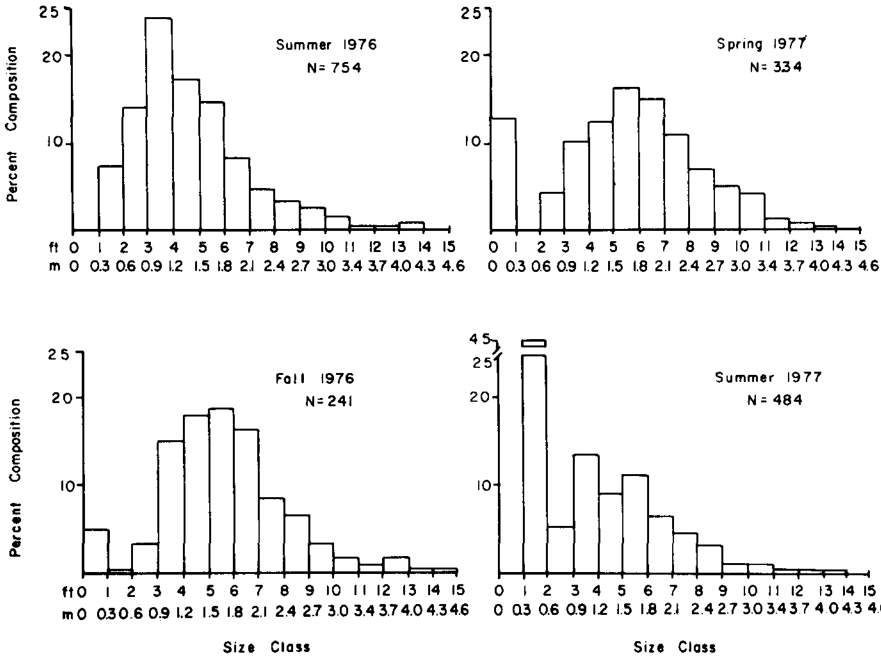


Fig. 4. Seasonal changes in the size composition of the Newnan's Lake alligator population described in 1 ft. (0.3 m) increments.

As spring and warmer weather approached, the number of alligators counted increased on the entire lake (Fig. 2). Concentrations of large alligators were noted in coves at stream inlets on the north shoreline with as many as 14 adults observed during April 1977 in a single, small (0 < 0.5 ha) cove. As water temperatures increased, the larger alligators were observed radiating out from these areas of concentration, dispersing along the shoreline.

Counts on Newnan's Lake peaked in late May 1977 then declined sharply in June 1977 (Fig. 2). This decline coincides with the onset of nesting activities by female alligators (Giles and Childs 1949, Joanen and McNease 1970, and Forgarty 1974). Goodwin (1977) found that all 5 radio-monitored female alligators restricted their activities in late June to the wooded swamp and adjacent marsh of Newnan's Lake. These individuals were usually beyond the range of the survey lights and were not represented in night counts. Assuming that a large percentage of female alligators behave similarly, a sizeable proportion of the population of adult alligators would be poorly represented in summer counts. These predicted decreases in summer counts were observed in both 1976 and 1977, and in both cases, a decline in observability of the adult population contributed significantly to the decrease in counts.

It was evident that special care should be taken when delineating transects on a body of water. In this specific case, different size distributions were apparent on different portions of the lake. Coupling these spatial changes with seasonal changes in the observed size distribution, a serious error can be introduced into the final analysis of count indices.

Airboat vs. Motorboat Comparisons

In 4 of 6 paired surveys, motorboat counts were somewhat higher than airboat counts, but this difference was not significant. Alligators could be approached equally well with both craft types.

The small sample size (6) of comparisons limited the extent to which definite conclusions could be drawn from the test. However, no obvious disparities existed between the responses to the 2 craft types. Consequently, for the purposes of year-to-year trend analyses airboats and motorboats can be used interchangeably (assuming identical survey transects are used) without a significant bias.

Red vs. White Light Comparison

In 7 of 10 surveys, counts using a red light were higher than those with a white light, but the differences were not significant. Alligators could be more easily approached in 6 of 10 surveys using a white light but, again, the differences were not significant. These results do not indicate any detectable differences in alligator behavior due to color of light. Underwood (1970) reported that the retinae of alligator eyes are well equipped with rods (necessary for night vision) and, to a lesser extent, cones (necessary for color vision). On the basis of eye physiology, it would appear that alligators are capable of seeing colors and possibly red light of the type we used during the comparisons. Reese (1925) found that young alligators were equally aware of both red and white light in laboratory experiments. In view of these experiments and the tests on Newnan's Lake, it is evident that red lights and white lights of equal intensity are comparable in effectiveness at counting and approaching alligators.

## CONCLUSIONS

Trend analyses of alligator populations are mainly concerned with monitoring changes in the population relative to some initial level. To accurately describe these trends, sources of variation beyond actual population changes must be minimal. Consequently, standardization of survey methods and procedures is of primary importance.

When selecting transects and transect size for year to year comparisons, potential changes in the distribution of the population on or near the transect should be taken into account. Young (<0.6 m) alligators should be counted but due to erratic movements and extreme variability on observability they should be excluded from trend analyses. The effect of water level on counts is dependent on the habitat being surveyed and an attempt should be made to conduct yearly surveys when water levels are comparable.

If the main objective of conducting counts is to monitor population trends, counts should be made during the cooler months at approximately the same water temperature. In this study, water temperatures of 26-28 C provided reasonably high counts with relatively low variability. Moonlight and cloud conditions should be standardized as much as possible.

If maximum counts are desired, surveys should be conducted in late May or early June when water temperatures are high and female alligators have not yet initiated nesting. Surveys should be performed using lights with maximum range (we suggest 200,000 c.p.). Cruising speed should be as slow as time permits, but standardized from year to year. Conditions such as excessive wave action, fog and rain should be avoided. All sizes of alligators were best represented in late May and early June. Thus, if a representative size composition is needed, a survey should be made at that time.

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