METHODS OF DETERMINING THE SIZE AND COMPOSITION OF ALLIGATOR POPULATIONS IN LOUISIANA

By ROBERT H. CHABRECK
Louisiana Wild Life and Fisheries Commission
Grand Chenier, Louisiana

INTRODUCTION

During the late 1950's the high value of alligator (*Alligator mississipiensis*) skins and a rapidly declining alligator population prompted considerable interest in devising sound plans for managing this species. These plans were to serve not only on a state-wide basis, but also to provide guide lines for private landowners interested in these reptiles. In formulating these plans it was evident that for proper management and wise utilization on any area, a knowledge of the size of the population was essential. Several decades ago, Leopold (1933) listed a census of game as the first step in management. Only with some knowledge as to the size of a population could a course of management be planned.

The population status of a species is important also when establishing regulations or quotas. The size and composition of the population plus the annual production and annual mortality should serve as a basis upon which harvest regulations are formulated. Only general information may be needed so far as the size of the population on a statewide basis; however, detail information should be obtained when deciding the number of animals to be removed from a managed area.

Information as to the number of animals occupying a certain area is important also when it is necessary that a particular animal population be kept in balance with its food supply or with other species occupying a common habitat. This is particularly true in the case of large predaceous animals such as alligators, where high populations may result in excessive predation on other species or where the animals may tend to become a nuisance around residential areas.

Several methods used to inventory other species can be used with alligators. However, alligators occupy a wide range of habitat conditions, even on an area of several thousand acres, and various techniques or combinations of techniques must be applied to include all situations. Also, different habitat conditions are used by various sex and age groups which may require the application of various inventory methods.

Many adult alligators (over six feet long) live in densely vegetated marsh in holes and underground dens; while other adults, particularly males, occupy permanent water areas such as canals, bayous and lakes and make dens under the banks (McIlhenny, 1935).

Unlike the adults, immature alligators (less than six feet long) do not build dens, but occupy their mother's den near the nest site. They will remain in the vicinity of the nest during the first or second year after hatching, then begin a gradual dispersal into surrounding waterbodies (Chabreck, 1965). Those hatching in dense marsh depart from the mother's den generally in the second year, but those reared in bank dens along bayous or lakes will disperse during the first year.

One real problem then in censusing alligator populations is preventing an over-count on one segment of the population that may be more evident or an under-count on another segment using a habitat condition in which they are less conspicious and harder to find. For instance immature alligators from dense marsh seek permanent water areas more readily than do their parents. In fact, their wanderings are widespread and since the young follow open water courses, they are more readily seen.

Since 1957 I have used several methods of determining the number of alligators on certain wildlife refuges along the Louisiana coast. The refuges total some 185,000 acres in size and are owned by the Louisiana Wild Life and Fisheries Commission. Also, valuable data have been collected by the U. S. Fish and Wildlife Service on the 142,000-acre Sabine National Wildlife Refuge in Southwestern Louisiana which have been

very useful in determining the size of alligator populations. On these marsh refuges alligators were given rigid protection and the areas supported the highest populations in the state.

METHODS

During studies on Sabine National Wildlife Refuge in 1946, Giles and Childs (1949) found no single factor upon which to base an alligator population estimate but reported that a combination of factors were useful to indicate abundance. The factors they used were the estimated percentage of removal after a known number were harvested, estimated numbers in unhunted areas, the young-adult ratio of the population, hunters' reports of individuals seen and the proportions of alligators in the various size classes. They listed the alligator population on the refuge during the study at 15,000 animals but did not indicate the method used to calculate this figure. Apparently much of the data used in the computations were gathered from estimates.

Of the various methods discussed in this report all are based on systematic counts. Although some methods provide only an index to the alligator population on an area, they reflect trends or relative abundance from year to year. Other methods supply information on the total number of animals on a particular area. Regardless of the method used it should supply information of the desired accuracy, and by considering the various attributes or habits of the species in sampling various sex and age groups a relatively accurate count can be made.

Night Counts. The method used most commonly in Louisiana by land managers for gathering general information on the alligator population of a particular area is night counts. Night counting is popular because it is simple to do and because it furnishes information on the size composition of the alligator population. This method is not suited for locating alligators in densely vegetated areas, but when in open water they can be located very quickly with a bright light. The animal's eyes reflect a bright red glow which can be seen for several hundred yards on a dark night. Usually an alligator will hold to a light long enough for a person to get within range for estimating its size.

Classifying alligators into size classes can be done very easily during this time, if the animals are not exceptionally wild. As shown in Table 1 the distance from the eye to the tip of snout in inches is very

TABLE 1. THE RELATION OF TOTAL LENGTH TO SNOUT LENGTH OF ALLIGATORS IN LOUISIANA

Total Length (Feet)	No. Animals	Snout Length (In.)
1	8	1.0
2	3	1.8
3	9	2.8
4	12	3.9
5	7	5.2
6	2	6.3
7	4	7.3
8	4	8.3
9	1	10.5
10	3	11.3
11	1	13.0

similar to the total length in feet, and skilled observers can make this estimate with surprising accuracy at distance up to 30 feet. If the alligators are exceptionally wild this distance can be extended considerably with binoculars.

Giles and Childs (1949) stated that night counts gave a fair indication of the population of young if made when the alligators were concentrated in open water. However, if data from night counts are to be used to establish population trends from year to year several points

should be emphasized. First of all, the system should be standardized in a number of ways. Certain census routes should be set up and the same routes checked every year. These routes should be made to cover as many habitat conditions as possible so as to include all segments of the population. The number of lines needed or the distance between lines will depend on the size of the area and the distribution of alligators on the area. The sample should be taken in such a manner as to be as nearly representative of the area as possible.

Another factor to be standardized is the time of year. Since alligator activity varies considerably from season to season, the results of night counts at different seasons will certainly vary. The best time to make night counts is during late April or early May. Alligators are very active at this time, since they have recently started feeding after the winter's hibernation, and move about considerably in search of food. Also, the breeding season is at a peak and adults of both sexes travel a great deal. The marshes usually hold water during this season, therefore problems of traveling about will be reduced.

Having the same observer conduct the counts every year would be another method of standardizing the survey. Also, a skilled observer should be used, particularly if a size estimate is to be made of the animals. Higher accuracy can be expected if the tally is made during the dark of the moon and on a still night with wind velocity less than eight miles per hour.

Very little equipment is needed under normal situations. An outboard motor and a hull can be used in deep water; however, an air boat should be available for checking lines in shallow water areas or broken marsh with scattered ponds.

Recapture of Tagged Alligators. While capturing and tagging alligators for growth studies I had an opportunity to compute the total alligator population of an area using a method based on the ratio of tagged animals recaptured, frequently called "Lincoln Index." In June, 1960, we tagged and released 75 alligators of various sizes on an 800-acre impoundment on the Rockefeller Wildlife Refuge in Southwestern Louisiana. Then on July 13, less than one month later, we returned to the impoundment and captured 52 alligators. Of these 12 had been tagged and released there the previous month. Then by applying the method described by Petersen (1896) I calculated that there were 325 alligators in the lake.

This method would not be very practical for normal use because of the difficulties and time involved in capturing and tagging alligators, particularly larger animals. However, its use may be justified where the total population of a small area must be known for some special purpose.

If the captures and recaptures are made during a period of only a few weeks, changes of a significant number of animals moving into or out of the area are unlikely. One problem which may arise using this method would be the tagging of a higher proportion of one segment of the population which may be more easily captured. For instance, alligators under four feet long are not as wild and, therefore, are easier to capture than those over four feet long. Consequently, attempts should be made to have a sample with about the same composition as the total population.

Call Counts. Call counts can be used to index the alligator breeding population of a certain area. The call or bellow, as some referred to it, is a deep roar and can be heard for distances up to one-half mile on a still morning. The breeding season extends through April and May, but the calling peaks in early May as determined from weekly counts by Ted Joanen on Rockefeller Wildlife Refuge.

The call is given by the male so that other alligators in the vicinity will know his position. McIlhenny (1935) believed that the call was a challenge to other males, but Oliver (1955) stated that the bellow served to attract females in the vicinity as well as to notify other males. Shortly before sunrise on a spring morning it was not uncommon to remain in one place and hear four or five males bellowing.

Whether or not all sexually mature males in an area call is not known and the variation in the rate of call between males is not known. Nevertheless, if counts were made from year to year to establish population trends these factors would remain constant. Also, the procedures used from year to year must be standardized as discussed under night counts. I would recommend making the counts daily in late April or early May and extending them over a two-week period, placing emphasis on still mornings.

On Rockefeller Wildlife Refuge call counts were made from a boat by traveling one-half mile and listening there for 10 minutes, then traveling another one-half mile and listening another 10 minutes. The number of alligators calling at each station was recorded. By beginning 45 minutes before sunrise and continuing 30 minutes after sunrise about four stops were made per morning.

While there are a number of fallacies in any such counts based on frequency of occurrence, call counts may be the most practical way to sample alligators under certain situations. Where the animals inhabit densely vegetated marshland or swamps, they are difficult to locate and not subject to most inventory methods. Consequently, carefully standardized call counts can be used to establish breeding population trends and to locate alligator concentrations in such areas.

Nest Counts. An alligator nest count is the best known method of determining the alligator breeding population of a marsh area. The number of nests in the marsh is indicative of the number of nesting females in the marsh. However, like call counts, nest counts include only one segment of the alligator population. But where call counts supply only an index to the adult males in an area, nest counts will provide a total number of breeding females in the same area.

Following the mating season the adult female begins nest construction in early June. By mid-June the nest is mostly completed and by early July laying is completed. The nest is constructed only a short distance from the female's den. Although most nests are built in the marsh, a few are usually constructed on levees. Also, a female may abandon a nest after it is completed and build another nest nearby. Therefore, if a nest is seen within 100 feet of another it should be considered a renest and not included in the count.

The nest is constructed of grass which she strips from an area approximately 10 feet around the nest. Twigs or other organic debris and even clay soil may be mixed in with the grass. The completed nest looks very much like a muskrat lodge and the two are often confused by persons not well familiar with the difference.

Since 1960 I have made alligator nest counts on portions of Rockefeller Wildlife Refuge. Also, in 1961 we began a nesting study and since then have gradually improved our methods of locating alligator nests.

Most of the coastal marsh in Louisiana is dominated by wiregrass (*Spartina patens*) growing in dense stands and about three feet tall. Most alligator nests are only a little over two feet high and, consequently, are very difficult to locate. In the early stages of the nesting study I was able to locate a few nests by using a boat to check levees along a canal and a marsh buggy in the marsh; however, most nests were overlooked. I then attempted aerial surveys for locating nests and, after trying several types of airplanes, found that a slow flying craft such as the Piper Supercub could be used effectively under certain conditions. Although helicopters were not tested, they probably would have been far superior to airplanes.

Alligator nests usually blend in well with the background and unless certain precautions are followed, many will be overlooked. One of the most important factors affecting an accurate count is the time of year. An alligator nest is easiest to locate immediately after it is completed. If the nest count is made during the first week of July, all nests will be completed and all will be relatively new. The new nest has the color of new hay and is in contrast with the dark green wiregrass. But after a few weeks and a few thunder showers the color

darkens and the nest is difficult to see. Also, the female strips an area about 20 feet in diameter for material with which to build her nest. This bare area makes a new nest stand out even more, but the grass puts on new growth at a rate of about one inch per day and after several weeks this area is completely revegetated.

Trails made by the male during the breeding season often reveal the location of a nest. A large male weighs 200 pounds or better and after crossing a wiregrass marsh his trail is well marked and clearly visible from the air. The male in response to the answer of a female alligator will travel in almost a straight line to join her. His trail marks the way to her den and subsequently the nest.

Muddy ponds or holes in the marsh very often indicate the presence of an alligator. These stand out when viewed from the air and frequently are the first clue that an observer notices. Then, once the presence of an alligator den is detected, the area is scanned quickly for a nest.

Other factors important in locating nests are the time of day and the flight altitude. The presence or absence of sunlight does not seem to affect one's ability to spot nests, as long as the visibility is good. However, on sunny days I prefer to fly between 10 A.M. and 2 P.M. Shadows produced by early morning and late afternoon sunlight make nest spotting very difficult.

Most of my nest spotting has been done in conjunction with a ground crew on a marsh buggy. During this time we were attempting to locate all nests in a particular area and flew at an altitude of about 200 feet. As we located each nest we marked it by dropping a roll of tissue paper nearby. When total counting small areas this method of marking will prevent duplication.

If information is desired on the number of alligator nests on an area of as much as 10,000 acres or larger, a sampling technique may be employed. The percent of the area to be sampled will depend on the accuracy desired. Flying a line with two observers and each counting nests on different sides for one-eighth mile out from the line, will produce a strip one-quarter mile wide. Such a line at one-mile intervals will provide a 25 per cent sample. To facilitate spotting nests at one-eighth mile away from the plane the flight altitude should be increased to 300 feet and the forward speed reduced to the minimum.

In addition to providing information on the number of nesting females in a marsh, nest counts also give a measure of nesting success. Alligator nests which produce young are opened by the female. The calling of the newly hatched young signals the mother alligator to the nest. She then makes a large hole in the side of the nest with her mouth, hence releasing them from the nest. This hole can be easily spotted from the air. A survey of nesting success should be made in mid-September; however, because of the difficulty in spotting nests at that time, not all will be located. Also, experienced observers are needed then for differentiating between alligator nests and muskrat lodges and between alligator nests opened by the female and those opened by raccoons (*Procyon lotor*).

While alligator nest counts in a marsh area can be made from aerial surveys, in timbered swampy areas these can not be used. Under such conditions ground surveys are the only alternate.

Total Population Computation. By combining the information from several population survey methods and from kill-surveys I have been able to compute the total alligator population on an area by size classes. Assuming that the number of nests is equal to the number of nesting females, then the information needed for this computation was the number of alligator nests on the area and the percentage of the total population made up of nesting females. The number of alligators in a particular marsh can then be computed by using the following formula:

$$P = \frac{N}{A\ F\ E}$$

where; P = Total alligator population in the area
N = Total number of alligator nests on the area
A = Per cent of alligator population over six feet long
F = Per cent of females among alligators over six feet long
E = Per cent of adult females nesting

Data on the number of alligator nests on the area (N) were collected by aerial counts as described in this report. But, figures on the percentage of the total population composed of nesting females (AFE) required data from several sources. First of all, through night counts (as described in this report) I was able to determine the size composition of alligators on the area and the per cent over six feet long (A). Alligators over six feet long were classified as sexually mature adults and those less than six feet as immature animals.

All authorities agree that the Louisiana alligator reaches maturity at six feet. McIlhenny (1935) stated that they nested at Avery Island, Louisiana, when six feet long which was usually age five. Giles and Childs (1949) reported that of all female alligators examined internally on Sabine Refuge only one was less than six feet long, but even that individual was approaching six feet. An identical situation was found during nesting studies on Rockefeller Refuge.

The next bit of information needed for determining the percentage of nesting females was the sex ratio among adult alligators. Data from 186 alligators over six feet long killed at random by hunters on Sabine Refuge in 1964 listed the adult population as 60.8 per cent males and 39.2 per cent females (Walthers and Ivy, 1964). Of 46 adults checked on Rockefeller Refuge 60.1 per cent were males and 39.9 per cent were females. A surplus of males seems to be typical of all size class in an alligator population. While some change probably takes place from year to year in the sex ratio, it is unlikely that this change is very great. In view of this and the fact that more recent data on alligator sex ratios are not available, this information was used in determining the value for F in the formula.

Knowing the size (age) composition of the alligator population as determined from night counts and by using past adult sex ratios I was able to determine the percentage of the population composed of adult females. However, not all adult females nest and the study by Walthers and Ivy (1964) on Sabine Refuge in early summer showed 68.1 per cent of 69 adult females with either eggs in the oviduct or showing signs of having already laid. Then assuming that each year 68.1 per cent of the adult females in all alligator populations nest (E), I was able to compute the per cent of the total population made up of nesting females (AFE).

Under normal situations the adult sex ratio and the per cent of adult females to nest will remain fairly constant from year to year. Therefore, factors F and E in the formula may be considered *basic factors* with values not subject to renewal annually. Nevertheless, data should be obtained at every opportunity from a local area to substantiate these figures. Also, if additional data become available it may be desirable to break down adult alligators into size classes and consider each class individually. Sex ratios and productivity between size classes may vary enough annually to justify correcting the data to allow for the differences.

The size composition of the alligator population and the number of nests on an area are *annual factors* and subject to change each year. Consequently, data for factors A and N in the formula must be collected on the area annually.

As an example to the use of this method the data in Table 2 are

TABLE 2. THE RESULTS OF NIGHT COUNTS AND TOTAL POPULATION COMPUTATION FOR ALLIGATORS ON ROCKEFELLER WILDLIFE REFUGE, 1966

Total Length Size Classes (Ft.)	No.[1] Seen	Percentage Composition	Total No.[2] on Refuge
1 - 2	45	25.3	1339
2 - 3	33	18.5	979
3 - 4	30	16.8	88
4 - 5	24	13.5	714
5 - 6	18	10.1	534
6 - 7	13	7.3	386
7 - 8	8	4.5	238
8 - 9	4	2.3	122
9 - 10	2	1.1	58
10+	1	.6	32
Total	178	100.0	5291

[1] Source: Night counts during 1966.
[2] Source: Computed from P in the formula.

substituted into the formula. Other information to be included are:

Per cent of alligators over six feet (A)—15.8% (Source: Table 2)

Adult sex ratio — 60.1% males and 39.9% females (F) (Source: Past field records on Rockefeller Refuge)

Per cent of adult females nesting (E) — 68.1% (Source: Walthers and Ivy, 1964)

Number of nests — 227 (Source: Aerial census in 1966)

$$P = \frac{227}{(.158)\ (.399)\ (.681)}$$

$$P = \frac{227}{.0429}$$

$$P = 5291$$

I have not attempted to check the accuracy of this method, but where an adequate sample is taken and where sampling is set up to be representative of the population, the accuracy should be within desirable limits.

The areas checked in Louisiana revealed that the nesting females constitute between four and five percent of the total alligator population. Therefore, as a *rule of thumb* for making a rapid estimate of the number of alligators on a particular marsh, multiply the number of nests on the area by 20. Detailed examinations elsewhere may suggest that this figure be altered slightly.

SUMMARY

For proper management of any species the size and composition of the population must be determined. The methods used for alligators in Louisiana were night counts, recapture of tagged animals, call counts, nest counts and computations based on numerous factors.

Night counting is widely used because it is easy to do and provides a size composition of the population. Call counts and nest courts provide information on the breeding population. Applying the "Lincoln Index" to recaptured tagged animals may be suitable for special studies.

A method of total population computations using a combination of night counts, nest counts and data from kill surveys gave the size and the composition of an alligator population.

LITERATURE CITED

Chabreck, Robert H. 1965. The movement of alligators in Louisiana.

Proc. 19th Conf. S. E. Assoc. of Game and Fish Comm. (In print).

Giles, Leroy W. and V. L. Childs. 1949. Alligator management of the Sabine National Wildlife Refuge. J. Wildl. Mgmt. 13(1):16-28.

Leopold, Aldo. 1933. Game management. Scribner and Sons, N. Y. 481 pp.

McIlhenny, E. A. 1935. The alligator's life history. The Christopher Publishing House, Boston. 117 pp.

Oliver, James A. 1955. The natural history of North American amphibians and reptiles. D. Van Nostrand Co., Inc., Princeton, N. J. 359 pp.

Petersen, C. G. J. 1896. The yearly immigration of young plaice into the Limfjord from the German Sea. Dept. Danish Biological Sta. for 1895, 6:1-17.

Walthers, John and Larry Ivy. 1964. Alligator kill survey records from Sabine National Wildlife Refuge. Typewritten rpt. (Unpublished).

THE FOODS AND FEEDING HABITS OF THE NUTRIA ON HATTERAS ISLAND, NORTH CAROLINA

By ROBERT C. MILNE[1] AND THOMAS L. QUAY[2]

INTRODUCTION

Hatteras Island, in the Cape Hatteras National Seashore Recreational Area, is the longest and easternmost of the barrier islands that constitute the "outer banks" of North Carolina (Stick, 1958). The island is 40 miles long from Oregon Inlet to Cape Hatteras and another 15 miles on to Hatteras Inlet. The distance from ocean to sound is only 1,500 to 3,000 feet at most places. The land widens to about one mile at Pea Island, Avon, and Hatteras and to three miles in the Buxton-Cape Hatteras region (Figure 1). Pamlico Sound separates Hatteras Island from the mainland by 12 to 30 miles of open and often stormy waters. The inshore sound, from one to 12 feet deep, has extensive growths of rooted aquatic plants; the open sound is from 12 to 23 feet deep and has little or no rooted plant life.

The ocean dunes of Hatteras Island are relatively low. Topographic variations are slight, with the highest elevations occurring in the Buxton Woods where the wooded hilltops reach 56 feet in two locations. The island habitats between the ocean beaches and the sound-side tidal marshes, occurring in both linear and mosaic patterns, are: herbaceous beaches and dunes, herb-shrub habitats, shrub thickets, thicket woodlands, woods (Buxton Woods, only), fresh-water ponds and marshes, salt and brackish tidal ponds and marshes, and edificarian habitats (Quay, 1959; Parnell, 1962, Milne, 1963).

The maritime climate of Hatteras Island produces cooler summer temperatures than on the mainland (78 degrees F, midsummer mean), 90 degrees F being an unusual occurrence. Proximity to the Gulf Stream adds to the mildness of the winters, with freezing occurring only about half as many times as in the interior of North Carolina. There is a midwinter mean temperature of 46 degrees F. The annual mean temperature is 62 degrees F. Rainfall averages higher than at other points along the North Carolina coast, being 54.7 inches per year (United States Department of Commerce Weather Bureau, 1961).

The nutria was introduced on Hatteras Island at Hatteras village, at the southern tip of the island, by the Gooseville Gunning Club in 1941 (Quay, 1959). This original and only introduction on Hatteras Island consisted of one male and two females. Establishment and spread were immediately successful, with substantial numbers being found for the first time at Pea Island, the northern end of Hatteras Island, in

[1] African Wildlife Leadership Foundation, Nairobi, Kenya.
[2] Zoology Department, North Carolina State University, Raleigh, North Carolina.