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A TELEMETRIC STUDY OF ADULT MALE ALLIGATORS ON ROCKEFELLER REFUGE, LOUISIANA

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ABSTRACT

A telemetric study was conducted on adult male alligators [*Alligator mississippiensis* (Daudin)] on Rockefeller Refuge from April 14, 1971 through March 18, 1972. Fourteen alligators were captured, tagged, marked for identification purposes, outfitted with color coded neck-collar radio transmitters, and released at their respective capture sites. A directional receiving unit was used to follow their daily movements. The size of the animals ranged from 8'3" to 10'5.5".

Minimum home range sizes and habitat preferences were determined for eleven of the alligators under investigation. Radio signals were not detected during the majority of the winter dormancy period which extended from the end of December through mid-February. The longest movement recorded was 33 airline miles from the capture site.

INTRODUCTION

This paper describes movements and activities of adult male alligators and attempts to evaluate this data in order to formulate management practices for the species.

Due largely to excessive hunting pressure as a result of the high market value placed on their hides, Louisiana's coastal alligator population reached its low point in the mid-1950's and early 1960's. A steady decline in population has been documented by naturalists, beginning as early as the 1900's. The drastic decline over the past two decades was primarily an indirect result of the systematic exploration of the oil and gas resources in the coastal marshes of the state. Canals

were dredged into remote marshes for the development of these mineral deposits. In short order, a coast-wide network of canals were established, leaving very few marsh areas inaccessible to man. Accessibility to remote marsh areas was farther enhanced by the development of better modes of travel during recent years. McIlhenny (1935) reported that during periods of drought, alligators were forced to move into canals and were killed by the thousands. However, the demise of the alligator was not experienced along the entire coast. Several large tracts of privately owned lands and intensively managed state and federal refuges which permitted a controlled harvest under close supervision, maintained high populations of alligators throughout this period.

The first Louisiana laws were passed in 1960 aimed at protecting the alligator. A size limit and maximum season length was established in order to curtail some of the hunting pressure. The alligator season was closed statewide in 1963, and enforcement activities were stepped-up in order to afford these animals additional protection.

Intense publicity, beginning in the late 1960's, focused attention on the alligator and brought about an acute national public awareness of its situation. This initiated a wave of legislation aimed at protecting the alligator, stimulated research interest in the animal, and resulted in a dramatic law enforcement effort being directed towards protecting this crocodilian.

The phenominal increase in the population levels from the mid-1960's to the present time in sections of Louisiana's coastal marshes, coupled with acute landowner interest in habitat management, set the stage for recent research endeavors conducted on Rockefeller Refuge.

Studies conducted on the refuge over the past few years have demonstrated that more information was needed on alligator movements and factors affecting movement before habitat management could be initiated. Also, in setting harvest regulations, alligators can be selectively harvested when the movements of certain segments of the population are known. With this in mind, a telemetric study of adult male alligators was conducted on Rockefeller Refuge from April 14, 1971 to March 18, 1972. The objectives of the study were:

1. To capture sexually mature male alligators and attach radio transmitters for the purpose of tracking with a portable receiver.
2. To monitor daily and seasonal movements of individual alligators.
3. To determine the minimum home range of individual alligators.
4. To relate movements and activities to habitat preferences.

It has become quite apparent in the past decade that radio telemetry can contribute significantly to the field of wildlife management. Joanen and McNease (1970) reported that the minimum home ranges for four adult female alligators monitored with telemetry equipment measured 6.4, 12.4, 24.2, and 41.0 acres. The minimum average daily movement for the alligators under study was determined to be 79 feet. Taylor (1969) found that minimum home range size for 13 eastern wild turkeys *(Melaegris gallopavo silvestris)* instrumented with transmitters ranged from 212 to 3,700 acres. Lewis (1968) reported that three white-tailed deer *(Odicoileus virginianus)* exhibited minimum home ranges of 406, 555, and 762 acres when tracked with radio telemetry gear.

The use of radio telemetry allows a more comprehensive study of the alligator in its environmental niche than was possible using the conventional methods of marking and recapturing. Radio tracking provides an excellent means of collecting large quantities of timely movement data over an extended time period.

DESCRIPTION OF STUDY AREA

This study was conducted on Rockefeller Refuge and adjacent privately owned marshland in Southwestern Louisiana. The refuge is owned and operated by the Louisiana Wild Life and Fisheries Commission and encompasses 85,000

acres. It is bounded on the south by the Gulf of Mexico and on the north by the Grand Chenier-Pecan Island stranded beach ridge complex.

Marsh elevation averages approximately 1.1 feet above mean sea level. Tide water enters the refuge from the Gulf of Mexico through five separate channels and then spreads out to various parts of the refuge. The average tidal variation is one foot; however, high tides frequently inundate the marshes with salt water. Marsh areas in the northeastern section of the refuge and the adjacent privately owned marshes are farther influenced by a freshwater canal system emanating from the Grand Lake-White Lake complex.

Three marsh types: brackish, intermediate, and fresh, were used by the alligators under study. A description of the three marsh types were included and described in this report. Classification of marsh types were based on water salinity and vegetative composition.

Brackish Marsh

A brackish marsh was defined as an area of moderate salinity generally lying inland from the saline marshes or around borders of bays and tidal lakes with moderate salinity. Typical vegetation consists, in combination, primarily of: *Spartina patens, Scirpus olneyi, Scirpus robustus, Eleocharis parvula,* and *Ruppia maritima* (Chabreck, 1970).

Intermediate Marsh

Intermediate marsh is that with low salinity and characterized by combinations of the following plants: *Spartina patens, Vigna repens, Scirpus californicus, Echinochloa walteri, Sagittaria sp., Cladium jamaicense,* and *Phragmites communis* (Chabreck, 1970). This marsh type normally separates the brackish marsh from the fresh marsh.

Fresh Marsh

The fresh marsh lies farther inland than the other marsh types and is not influenced by tidal action. Typical plant associations include combinations of the following: *Panicum hemitomon, Hydrocotyle sp., Eichornia crassipes, Pontederia cordata, Sagittaria sp., Alternanthera philoxeroides,* and *Ceratophyllum demersum* (Chabreck, 1970).

STUDY PROCEDURE

Telemetry Equipment

VHF tracking transmitters and receivers were constructed for this study by Sidney L. Markusen, Electronic Specialties, Esko, Minnesota. The transmitters were equipped with 8-½ inch whip type antenna and emitted pulsed signals in the 151.100 to 151.210 megacycle range.

The transmitting components, batteries, and antenna were mounted on a neck collar attachment constructed of heavy rubberized fabric, which was 2-¼ inches in width, 3/16 inch in thickness and adjustable from 18-½ to 36 inches in circumference. Total weight of the radio package and neck collar was about 30 ounces. Four mercury batteries, with an expected life of 11 months, provided the power source. All transmitters were encapsulated in epoxy resin which served as a waterproofing agent in addition to being sealed within an aluminum case.

Portable VHF tracking receivers with corresponding channels tuned to the frequencies of the transmitters were used for the duration of this study. Two receivers were used which were 100 percent transistorized. Ten size D flashlight batteries made up the power source for each receiver. A two element Yagi hand-held directional antenna was the only antenna used during this study. Total weight of the receiver, carrying box, earphones, and antenna was 14 pounds.

Approximately two days before attaching the collar assembly to an alligator, the transmitters were activated by soldering the two "hook-up" wires together. Exposed wiring was then wrapped with vinyl electrical tape in order to protect it from abrasion. The entire neck collar transmitting unit, with the exception of the antenna, was then dipped twice in coal tar epoxy (summer grade—Admiral Paint Co.). The epoxy consisted of one part epoxy activator and four parts coal tar by volume and served as a water-proofing agent. The transmitter was checked periodically until it was attached to the alligator to insure that it was functioning properly.

A Silva Ranger compass, with luminous points for night readings, was used for obtaining compass bearings.

Pre-testing of Equipment

The transmitters and receiving units were tested under actual field conditions prior to attaching the units to the alligators. Range generally approximated one mile under good conditions from the ground. Receiving capabilities were greatly increased by using aircraft. Expertise gained in a previous telemetry study (Joanen and McNease, 1970) plus preliminary tests on the capabilities of the receiving unit showed that ignition interference was quite bad when using a standard factory prepared outboard motor. Ignition interference was reduced by 75 percent whenever the standard plugs and ignition wires were replaced with Packard TV R Suppression ignition wires and AC marine VR40FFM spark plugs manufactured by AC Spark Plug Division, General Motors Corporation.

Methods of Capturing and Marking

All alligators used in this study were captured and tagged as described by Chabreck in an earlier report (Chabreck, 1963).

Transmitter Attachment

The transmitters were attached in the field at the point of capture. After checking a transmitter to make sure it was functioning properly, the collar was adjusted to fit the neck of the alligator. Wooden strips were cut to fit laterally to the four dorsal neck scutes located just posterior to the head and then attached to the collar with vinyl tape. These wooden strips kept the collar in a fixed position with the antenna in an upright position on the dorsal part of the neck. Also, to insure that the antenna remained in its upright position, the collar was tied down with nylon line threaded into small holes drilled through four scutes on the neck. The collar was attached by seating four Belknap pop rivets with backup spacers into prearranged holes located near the ends of the collar. Excess collar material was then trimmed off. Forty-five minutes to an hour was required to attach the collar. During the period of attachment, a sack was placed over the head of the alligator. The sack served to keep the alligator in a semi-relaxed state during the collaring process. The radio signal was checked prior to release of each animal. Each collar was color-coded for ease of identifying individual animals, especially if a radio should malfunction.

Tracking Procedure

Tracking alligators was accomplished almost daily during the spring and summer. An average of four field trips per week were made from mid-autumn up until the alligators went into winter dormancy. No signals were received when the animals were underwater. Also, during the midday heat of summer, the animals appeared to be almost completely submerged with the antenna below the surface of the water. As a result, the majority of the tracking endeavors were undertaken during the early morning hours, late evenings, and at night as more activity was exhibited during this time. Success at locating units was generally much higher at midday during the late autumn, winter, and early spring as this

was the time when basking occurred on sunny days. Transportation employed to monitor the radio equipped alligators included: outboard and airboats, automobiles, helicopters, and fixed wing aircraft.

The triangulation method of plotting units was employed sparingly during this study. The use of helicopters (Bell Model 47-G4A), and fixed-wing aircraft negated the use of triangulation. Aircraft were advantageous over boats for transportation because the range of the radio signal was generally vastly improved. Also when using aircraft, considerably more acreage could be covered more efficiently and in much less time. Approximately one-half of the radio fixes recorded during this study were verified by visual contact. The preference of canals and large open water areas as demonstrated by the animals under investigation made the process of getting a precise fix a fairly simple matter. Occasionally, the triangulation method of determining an animal's location was used whenever ground transportation was employed and a particular alligator was isolated in the marsh proper.

Field data recorded included: date, time and exact location of animal, water depth in the marsh, notes on association with other alligators, and general notes concerning prevailing weather conditions.

Climatological Data

Basic climatological information was collected from a U. S. Weather Service Field Station located at the refuge headquarters complex.

Two Ryan 30-day continuous recording thermometers (Model D-30) were placed at the bottom of a representative canal and a representative marsh pond to monitor fluctuations in water temperature experienced in these two habitat types.

RESULTS AND DISCUSSION

The information presented in this report is based primarily on 569 fixes obtained during the 339 day duration of field phases of the study. A fix, as referred to in this report, constituted a known location of any one animal under study.

Fourteen alligators were studied using radio tracking gear during the period of April 14, 1971 through March 18, 1972 (Table 1). Five hundred and sixty-nine individual alligator locations were plotted on a total of 194 days within the study period. Transmitter life varied from a high of 339 days to a low of one day and averaged 127 days.

Movement data were broken down into four separate time periods in order to evaluate activities of the animals under investigation. These periods were simply the seasons of the year and included the following dates: Spring, March 21-June 20; Summer, June 21-September 21; Autumn, September 22-December 20; Winter, December 21-March 20.

Acreage figures were calculated by using a modified acreage grid marketed by Forestry Suppliers, Inc., Jackson, Mississippi.

Four terms used quite frequently in the discussion of this paper should be defined so that there will be no misconception concerning the terminology. canal-man-made waterway or altered natural bayou characterized by relatively deep water; canals made up approximately 5 percent of the study area. Marsh - refers to areas characterized by dense marsh vegetation, primarily wiregrass, *Spartina patens,* interlaced with small potholes, ditches and land locked ponds. Minimum home range - the amount of acreage included within an area enclosed by connecting the outside points of an animal's plotted movement. Each alligator probably moved outside of the points outlined for this study because of the time interval accruing between readings. A considerable portion of the

Table 1. Length, weight, and identification of alligators captured for radio telemetry study, Rockefeller Refuge, 1971-1972.

Date Instrumented	Mark	Total Length	Weight (Lbs.)	Unit Number	Date Last Radio Contact
4/14/71	A-0	8'6"	190	12	3/18/72
4/14/71	B-0	8'3"	146	11	12/20/71
4/16/71	A-1	9'4"	210	1	5/10/71
4/23/71	BD-0	9'0"	188	7	7/13/71
4/27/71	B-1	10'3.25"	315	2	12/30/71
5/4/71	B-2	9'3.25"	230	6	7/15/71
*5/15/71	C-0	9'10.50"	270	4	11/13/71
**5/17/71	C-1	10'5"	345	8	10/10/71
**5/20/71	C-2	9'0"	182	10	5/20/71
6/1/71	B-3	9'8"	235	9	3/18/72
6/6/71	B-5	9'10.75"	284	3	3/18/72
*6/9/71	BC-6	10'5.50"	360	5	8/26/71
**8/19/71	E-0	8'8"	144	N-2	8/19/71
8/25/71	E-2	10'2.50"	310	N-9	11/2/71

* Lost radio contact; majority of fixes visual only.
**Insufficient data recorded to fulfill objectives of study.

heavily vegetated marsh areas included within some home ranges were probably not used by the animals during this investigation. Minimum daily movement - distance traveled over a 24-hour interval; considered a minimum figure because animal could have moved beyond points determined for him during the periods of the day when he was not monitored.

Table 2 describes habitat preference according to the four time periods as described for this study. Over the duration of this study, 73 percent of the fixes plotted were in canals and 27 percent were in ponds, potholes or dens in the marsh.

A summary of the movement data obtained during this study is presented in Table 3. The total movement (12 alligators) between the 569 fixes recorded for this study amounted to 300.3 miles. The average distance traveled between fixes for the combined movement of all alligators totaled 2,786 feet. The season average figures for spring, autumn, and winter represent data extracted for five individual alligators. Summer average figures are based on data from four individuals.

As expected, when the data was subjected to an analysis of variance there was a highly significant difference between canal and marsh usage (Table 4). The F-

test equalled 10.4 with 1 and 56 degrees of freedom $P < 0.01$). A further analysis indicated no significant difference of the degree of canal usage by season at the 0.05 level of probability ($P < 0.05$), $F = 1.9342$ with 3 and 25 degrees of freedom.

Table 2. Description of habitat preference of adult male alligators as determined by telemetric study on Rockefeller Refuge, 1971-1972.

Period	Season	Date of Period	Location of Males	
			Percent Marsh Fixes	Percent Canal Fixes
I	xSpring	*4/14-6/20	29	71
II	Summer	6/21-9/21	21	79
III	Autumn	9/22-12/20	31	69
IV	Winter	12/21-3/20	**83	17

xIncludes breeding season.
*First alligator equipped with radio on 4/14/71.
**Of 5 animals tracked during the winter period, 3 males over-wintered in marsh, 2 over-wintered in canals.

TABLE 3 - MINIMUM RANGE SIZE, AVERAGE MINIMUM DAILY DISTANCE TRAVELED, AND HABITAT PREFERENCE OF ADULT MALE ALLIGATORS BY SEASON, 1971-1972

Period	Season	Days Monitored/ Individual Alligator	Alligator Number	Habitat Preference (Percent Canal vs. Percent Marsh)	Minimum Range (Acres)	Average Minimum Daily Distance Traveled
I	Spring	4/14-6/20	12	100 canal	1,726	3,895'
		4/14-6/20	11	58 canal:42 marsh	569	1,342'
		4/18-6/20	2	33 canal:67 marsh	182	761'
		4/16-5/10	1	22 canal:78 marsh	106	1,330'
		4/23-6/20	7	100 canal	938	2,305'
		5/4-6/20	6	95 canal:05 marsh	689	4,213'
		5/16-6/20	4	100 canal	98	1,175'
		6/1-6/20	9	100 canal	641	1,531'
		6/6-6/20	3	29 canal:71 marsh	103	1,967'
		6/9-6/20	5	100 canal	222	3,775'
		Average		71 canal:29 marsh	821	2,503'
II	Summer	6/21-9/21	12	48 canal:52 marsh	3,666	4,200'
		6/21-9/21	11	97 canal:03 marsh	2,021	2,850'
		6/21-9/21	2	32 canal:68 marsh	2,198	1,483'
		6/21-7/13	7	100 canal	*	*
		6/21-7/5	6	100 canal	*	*
		6/21-9/21	4	100 canal	338	5,600'
		6/21-9/21	9	59 canal:41 marsh	883	2,688'
		6/21-9/21	3	**	**	**
		6/21-8/26	5	91 canal:09 marsh	449	3,370'
		8/25-9/21	N-9	100 canal	*	*
		Average		79 canal:21 marsh	2,192	2,805'
III	Autumn	9/22-12/20	12	85 canal:15 marsh	2,533	3,792'
		9/22-12/20	11	96 canal:04 marsh	641	2,636'
		9/22-12/20	2	70 canal:30 marsh	1,955	643'
		9/22-11/13	4	*	*	*
		9/22-12/20	9	56 canal:44 marsh	224	2,204'
		9/22-12/20	3	37 canal:63 marsh	146	356'
		9/22-11/2	N-9	40 canal:60 marsh	196	2,000'
		Average		69 canal:31 marsh	1,100	1,926'
IV	Winter	12/21-3/18	3	100 marsh	No Movement[x]	No Movement[x]
		12/21-3/18	12	100 canal	No Movement[x]	No Movement[x]
		12/21-3/18	9	100 marsh	No Movement[x]	No Movement[x]
		Average[xx]		60% wintered in marsh	No Movement	No Movement

*Insufficient data.
**Lost for period.
[x]Readings limited for winter period; movement confined to general area around den site.
[xx]Radios functional on three alligators; two monitored visually.

Table 4. Analysis of variance for male alligator usage of canals and marsh areas, Rockefeller Refuge, 1971-1972.

Source of Variation	df	Canal Usage Versus Marsh Usage SS	F
Between treatments	1	1009.7240	10.4051**
Within treatments	56	5434.2760	
Total	57	6444.0000	

Source of Variation	df	Canal Usage by Season SS	F
Between Seasons	3	6885.8356	1.9342NS
Within Seasons	25	29666.5296	
Total	28	36552.3652	

**Highly significant.
NS Non Significant.

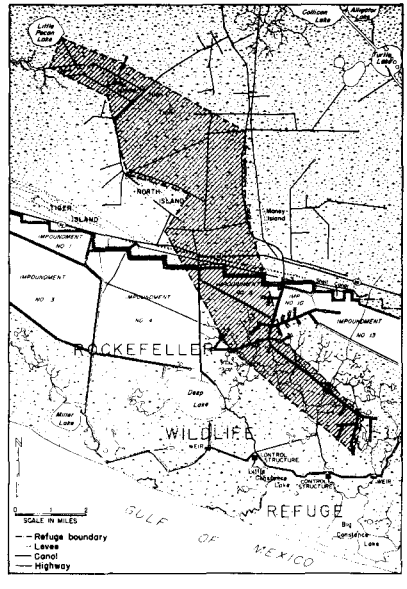

Figure 1. Minimum home range (12,660 ac.) for alligator no. 12 as determined by radio fixes from April 14, 1971 to March 18, 1972.

Movements of Individual Alligators

Alligator No. 12. This 8'6" alligator was equipped with radio transmitter number 12 on April 14, 1971 and was tracked until March 18, 1972. The minimum home range exhibited during this period was 12,660 acres (Figure 1). Three marsh types; brackish, intermediate, and fresh, were extensively used by this animal during the study. The south end of his home range overlapped the ranges of six radio equipped alligators.

Spring Movement. During the period from Arpil 14 to June 20, unit 12 maintained a minimum range of 1,726 acres. All fixes recorded during this period were in canals. Average minimum daily distance traveled amounted to 3,895 feet. The brackish marsh was the only type used during this period. On eight separate occasions, alligator no. 12 was discovered to be in association with four different radio equipped bulls. He showed particular affection for alligator no. 7, a 9 footer, as he was located with no. 7 on five separate occasions.

Several instances were noted where no. 12 was associated with groups of 3 or 4 alligators in the 6 to 8 foot size class. The sex of alligators were not determined, so it is impossible to determine if the collared alligator's vistis with them were for courting purposes or purely social in nature.

Summer Movement. Locations plotted for the summer season showed that unit 12 moved a minimum of six miles north of the area used during Period 1, and never returned to the area utilized during the spring. Summer movement was confined to 1 3,666 acre area composed of fresh and intermediate marsh types. The average minimum daily distance traversed during this period was 4,200 feet. His range during late summer overlapped portions of the range of alligator 2. All fixes recorded for this period were found to be in canals.

Practically an entire month (late June-late July) was spent in the vicinity of an oil company boat dock. Apparently, heavy boat traffic and recreational activities by humans had no adverse effect on his activities during this period. Unit 12 spent the majority of the latter portion of the summer in approximately a two mile section of isolated oil company canal. Association with other alligators seemed to be nil during the late summer.

Autumn Movement. Fall movement, with a minimum range of 2.533 acres, was intermediate in size between the large area covered during the summer and the smaller range size of spring. The average minimum daily distance moved averaged 3,792 feet. Practically all (85 percent) of the locations plotted for this animal for the fall were in canals.

The major portion of the autumn period was spent in an intermediate marsh type approximately three miles north of the range exhibited for the summer period.

Movement during November and December was much reduced from that shown previously. The majority of his time was spent around the area where he later chose to over-winter.

Winter Movement. Alligator 12 wintered at the end of an oil company canal in a very isolated piece of marsh. Movement for this period was largely vertical, with the alligator coming up on warm, sunny winter days to bask. Unit 12 over-wintered 14 air-line miles from the original capture site.

Alligator No. 11. Radio no. 11 was attached to an 8 foot 3 inch bull on April 14 and monitored until December 20, 1971. Minimum home range size amounted to 3,366 acres (Figure 2). Both the intermediate and brackish marsh types were used during this investigation. Although the home range size was

large, this animal wintered less than one mile from the point where he was originally captured. Unit 11's home range overlapped, in part, that of six other collared alligators.

Spring Movement. The minimum range exhibited during Period 1 was 569 acres. The average minimum daily distance traveled was 1,342 feet. Fifteen of the 26 fixes (58 percent) recorded for the period were in canals. Alligator 11 was located in association with three other radio equipped bulls on separate occasions during the early spring segment of the study. Two instances were noted where he was associated with groups of up to six alligators in the 7 to 11 foot size class. The entire of May, which covered the major portion of the courting period, was spent in marsh ponds and tidal bayous.

Summer Movement. The minimum range covered during Period IIa-mounted to 2,201 acres, the largest amount of acreage occupied during any of the three periods he was followed. The average minimum daily distance traveled was determined to be 2,850 feet.

Alligator 11 used the same areas during July as were used for June, mainly shifting positions within a mile of canal. The latter two-thirds of Period II showed widespread shifting movements along a canal for a distance of 3.5 miles. This canal paralleled the Gulf of Mexico, being separated by only 1.5 miles of marsh. The canal was influenced by tidal flow and there fore salinities became quite high at times.

Autumn Movement. The minimum range plotted for this period was 641 acres. The average minimum daily distance traveled was calculated to be 2,636 feet. Twenty-five out of a total of 26 (96 percent) locations plotted for alligator 11 were in canals. The range size and average minimum daily distance traveled for this period were intermediate between the spring and summer.

Movement during late September through October 24 was simply a replay of that exhibited during the latter two-thirds of the summer period. Nineteen known locations were noted from October 25 through December 20 and all were located within portion of an acre at the dead end of an oil company canal. This area, where he also over-wintered, was 6,100 feet from the site where he was originally captured.

Winter Movement. No readings were obtained for alligator 11 during the winter dormancy period. Telemetry data recorded during December and visual observations obtained during March strongly suggested that this animal remained in the general area of his den site.

Alligator No. 2. A 10' 3.25" male was instrumented with transmitter no. 2 on April 27 and was followed through December 30, 1971. The minimum home range size determined for this eight month period was 3,411 acres (Figure 3). Both intermediate and fresh marsh types were used by this alligator. During the early portion of the study, the range for alligator 2 overlapped that of six radio equipped alligators. The range for late summer overlapped a portion of the range that had previously been occupied by another collared animal.

*Spring Movement.*The minimum range covered during the spring totaled 182 acres. The average minimum daily distance traveled during this period was 761 feet. Sixty-seven percent of the locations mapped during the period were in the marsh. All of the canal readings were taken between April 27 and May 11. Data recorded from mid-May through June 20 indicated

that this animal ranged over 39 acres of marsh with the majority of his time being spent in a seven acre marsh pond. Visual observations indicated there were 8 to 10 additional alligators ranging in size from 6 to 8 feet long within the small marsh area covered during this period.

Summer Movement. The minimum range covered during Period II totaled 2,198 acres. The average minimum daily distance traveled was computed to be 1,483 feet. The range occupied during the time interval between June 21, and August 21 was in an area of approximately 200 acres. Between August 21-24, he moved some 28,000 feet to the north into a fresh marsh habitat. The majority of the fixes (68 percent) recorded were from the marsh, with all of these marsh readings being made between June 21 and August 1.

Autumn Movement. The minimum range calculated for this period was 1,955 acres with an average minimum daily distance traveled of 643 feet. Seventy percent of the fixes recorded during Period III were in canals.

The early part of autumn was spent in the same area as was used for late summer. Alligator 2 once again made a 28,000 foot move in late October back to the area where he spent the spring and early summer. Very little movement was ixhibited during November and December, once he had moved to the seven acre marsh pond he had frequented during the breeding season. Limited movement during December seemed to be centralized around a den site.

Winter Movement. Although no telementry readings were obtained during the winter, the actions of this animal during December strongly suggested that he over-wintered in the north end of the seven acre pond. The point of capture was only 1,100 feet from the area where he probably overwintered.

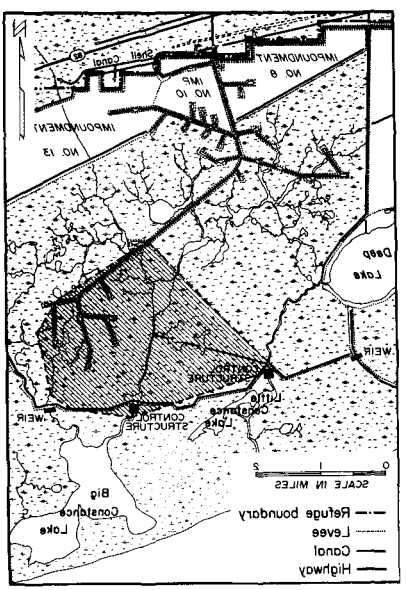

Figure 2. Minimum home range (3,366 ac.) for alligator no. 11 as determined by radio fixes from April 14 to December 20, 1971.

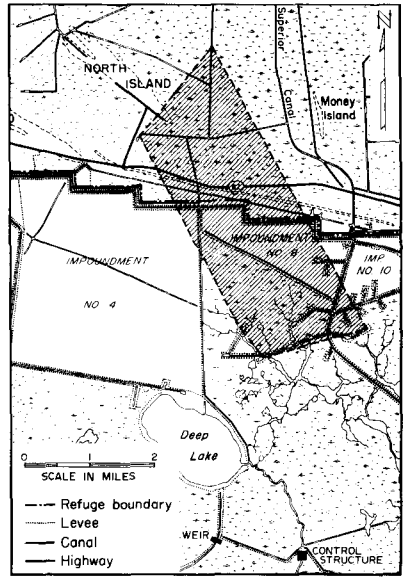

Figure 3. Minimum home range (3,411 ac.) for alligator no. 2 as determined by radio fixes from April 27 to December 30, 1971.

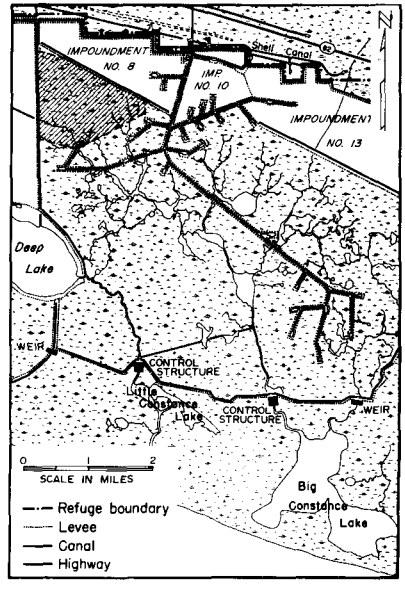

Figure 4. Minimum home range (968 ac.) for alligator no. 9 as determined by radio fixes from June 1, 1971 to March 18, 1972.

Alligator No. 9. A 9'8" alligator was outfitted with radio transmitter no. 9 on June 1, 1971 and tracked until March 18, 1972. The minimum home range determined for this animal was 968 acres (Figure 4). The intermediate marsh was the predominant type used. The home range of no. 9 slightly overlapped the ranges of alligator numbers 2 and 3.

Spring Movement. A minimum range of 641 acres was demonstrated during the 20 days of spring when the transmitter was functional. The minimal amount of data recorded over this brief period showed an average minimum daily movement of 1,531 feet. All movements recorded during the spring were in the marsh proper.

Summer Movement. The minimum range recorded was 883 acres with an average minimum daily movement of 2,688 feet. Forty-one percent of the fixes were determined to be in the marsh during the first half of summer. Habitat preferred during late summer consisted of 1.25 miles of canal and a small marsh pond which drained into this canal.

Autumn Movement. The minimum range determined for alligator 9 during the fall was 224 acres. The average minimum daily distance traveled was 2,204 feet. Forty-four percent of his time appeared to be spent in the marsh. The area covered during the early autumn was simply a small area in the southern portion of the range covered during late summer. Late autumn fixes placed alligator 9 at a den site in an old bayou. The den was approximately 100 yards from the canal which served as the west boundary of his range.

Winter Movement. Two readings made during this period (February 15 and March 18, 1972) indicated that the alligator under investigation remained exclusively in the area chosen as a winter den site. Movement seemed to be "vertical" with the alligator coming up from the bottom of his den on warm, sunny days to bask.

Alligator No. 7. A 9' 0" alligator received the dubious honor of having transmitter no. 7 fitted to his neck. This unit was tracked from April 23 through July 13, 1971. The minimum home range for this animal measured 938 acres (Figure 5). Parts of the home range overlapped that of six other radio equipped animals. The intermediate marsh type was the only one used during the 91 days that the radio was functional.

Spring Movement. The minimum range dtected for this period (April 23-June 20) totaled 938 acres. Average minimum daily movement was calculated as 2,305 feet. All of the locations logged for Period I were in canals. The majority of the fixes for the spring were located within an 8,500 foot length of canal. A considerable amount of repeatous movement was recorded for this alligator. Only 10 visual contacts were made on this alligator; therefore, it is difficult to evaluate his association with other alligators.

Summer Movement. A minimum range of 7 acres and average minimum daily movement of 378 feet were demonstrated by alligator 7 during the brief summer period that the transmitter functioned 'June 21- July 13).

Visual contacts made after the radio ceased functioning (late summer-fall) indicated that this alligator remained fairly close to the capture site.

Alligator No. 6. Transmitter no. 6 was attached to a 9'3.25" male on May 4. Twenty-five fixes were determined until contact was lost on July 5, 1971. The minimum home range size during this two month period was 689 acres (Figure 6). The only marsh type used during this investigation was intermediate.

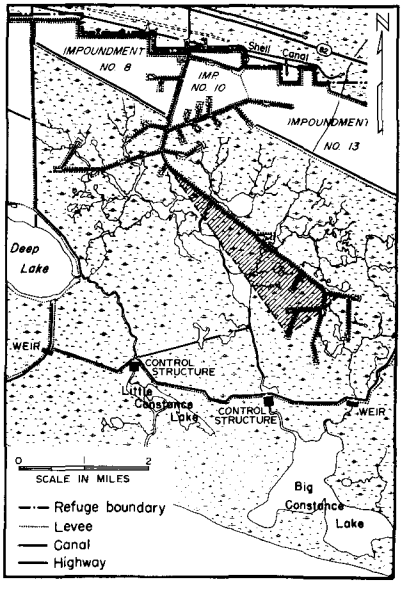

Figure 5. Minimum home range (938 ac.) for alligator no. 7 as determined by radio fixes from April 23 to July 13, 1971.

Although the range size of alligator 6 was smaller than that of alligator 7, the preferred habitat was virtually the same marsh area for both alligators. The range of alligator 6 also encompassed parts of the ranges of six other radio equipped alligators.

Spring Movement. The minimum range size and average minimum daily distance traveled during the 47 days covered by Period I amounted to 689 acres and 4,213 feet, respectively. Ninety-five percent of the fixes plotted were in canals. On three separate occasions alligator 6 was determined to be associated with one of the following alligators, listed according to unit number; 12, 7, or 11.

Summer Movement. A minimum range size of 49 acres and an average minimum daily distance traveled of 1,200 feet was determined for the 15-day period in which the radio was operational. The location of the alligator was in canals for all of the readings taken.

Alligator No. 5. Transmitting unit 5 was attached to a 10'5.5" bull on June 9 and monitored until August 26, 1971. Minimum home range size was calculated as 611 acres (Figure 7) for the 2.5 month duration of the track period. The intermediate marsh type was the only one represented within this home range. The home range of alligator 5 partly overlapped those of alligator no. 2 and no. 3.

Spring Movement. A minimum range of 222 acres and an average daily distance traveled of 3,775 feet were exhibited during the 11 days included in Period I. All fixes were in canals.

Summer Movement. Radio contact was maintained from June 9 through July 6; visual contact was made with alligator 5 from August 5 through August 26. The minimum range amounted to 449 acres during Period II and the minimum daily distance traveled averaged 3,370 feet. Ninety-one percent of his locations were in canals.

Alligator No. 3. A minimum home range of 452 acres (Figure 8) was determined for alligator no. 3 (9'10.75" total length) by radio fixes from June 6, 1971 to March 18, 1972. Brackish and intermediate marsh types were used by this animal. His home range overlapped the ranges for two other collared alligators.

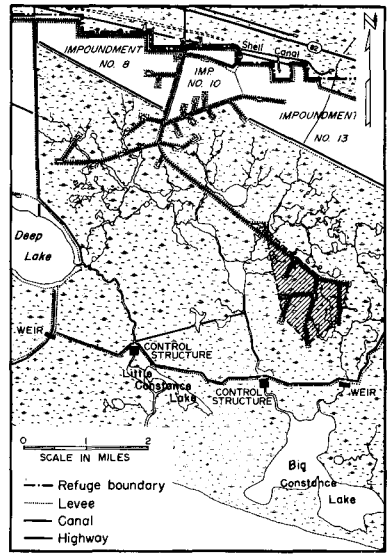

Figure 6. Minimum home range (689 ac.) for alligator no. 6 as determined by radio fixes from May 4 to July 5, 1971.

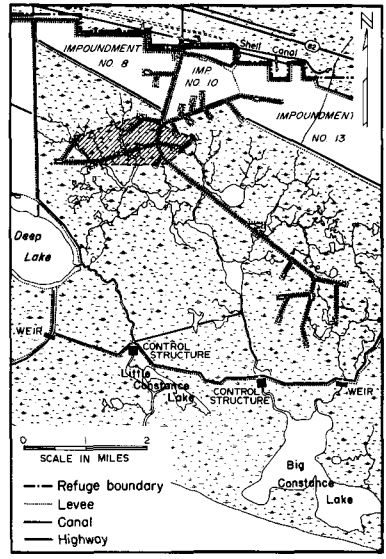

Figure 7. Minimum home range (611 ac.) for alligator no. 5 as determined by radio fixes from June 9 to August 26, 1971.

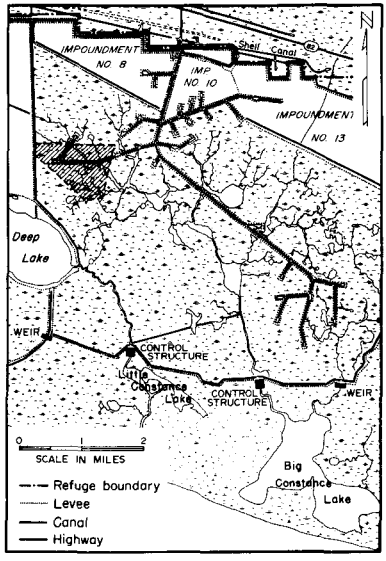

Figure 8. Minimum home range (452 ac.) for alligator no. 3 as determined by radio fixes from June 6, 1971 to March 18, 1972.

Spring Movement. The minimum range covered during the spring amounted to 103 acres. The average minimum daily distance traveled was 1,967 feet. These two figures, especially the range size, are probably depressed because of the very short period of time (14 days) included in Period I. Seventy-one percent of the locations plotted for this alligator were in the marsh.

Summer Movement. Radio contact was lost for all of Period II.

Autumn Movement. After being lost for 3.5 months, unit 3 was found on October 7 and tracked for the remainder of Period III. The minimum range computed for the 2.5 month period was 146 acres. The average minimum daily distance traveled was 356 feet.

Alligator 3 moved about within a 1,400 foot stretch of canal from October 7 through October 15. The northern extent of these plotted movements was only 900 feet from the den site of unit 9. This animal was lost from October 15 through November 11. When found on November 11, unit 3 had moved a mile out into some very dense and isolated marsh ponds. The range covered by this alligator from November 11 to December 20 was computed to be only 23 acres. Movement consisted mainly of travel between three marsh ponds, each less than two acres in size.

Winter Movement. Two readings made during this period (December 30 and March 18) indicated that alligator 3 remained in the area "prepared" as a winter den site. Both times the animal was located, he was basking in an area just adjacent to his den.

Alligator No. 4. Radio transmitter no. 4 was attached to a 9 foot 10.5 inch male on May 15. However, the radio slipped out of position shortly after we released this alligator. Visual sightings from aircraft indicated the antenna and radio were positioned on the ventral portion of his neck below the water.

Only 24 visual fixes were recorded from May 15 through November 13, so movement data was not sufficient to allow an analysis by periods.

The minimum home range size determined on the basis of the 24 observations was 338 acres (Figure 9). This range was totally encompassed by intermediate marsh.

Alligator No. N-9. Transmitter no. N-9 was strapped to a 10'2.5" bull on August 25. Only 17 fixes were made between August 25 and November 2; therefore, only a minimal amount of useable information was gained from our study of this animal.

The minimum home range size was computed to be 196 acres (Figure 10). Approximately 50 percent of the fixes plotted over the 2.25 month period were in canals.

Alligator No. 1. A 9'4" male was equipped with transmitter no. 1 on April 16 and was followed until May 10. The minimum range during this period was 106 acres (Figure 11). The average minimum daily movement was 1,330 feet. Seventy-eight percent of the fixes tallied for this animal were in marsh ponds and small, shallow bayous.

Alligator No. 8. Radio no. 8 was attached to a 10'5" bull on May 17. He was tracked until May 27 at which time contact was temporarily lost. Canal movement from May 17 to May 27 did not exceed 1.5 miles from the point of capture. Alligator no. 8 was sighted crossing Louisiana Highway 82, 33 air-line miles west of the capture location on October 10 (Figure 12).

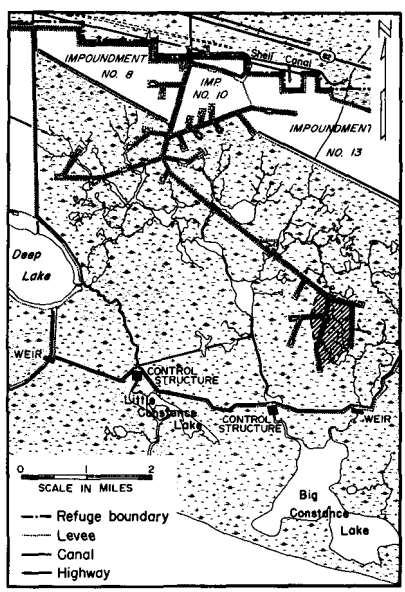

Figure 9. Minimum home range (338 ac.) for alligator no. 4 as determined by observations from May 15 to November 13, 1971.

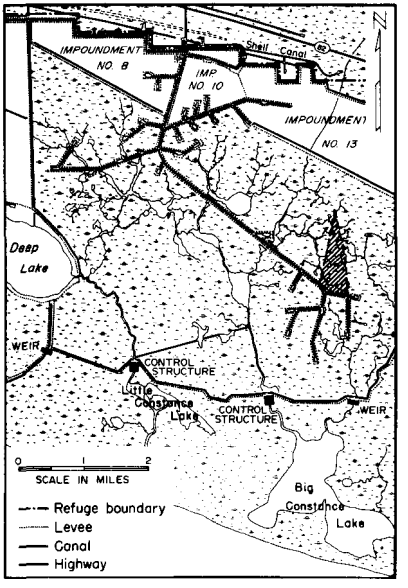

Figure 10. Minimum home range (196 ac.) for alligator no. N-9 as determined by radio fixes from August 25 to November 2, 1971.

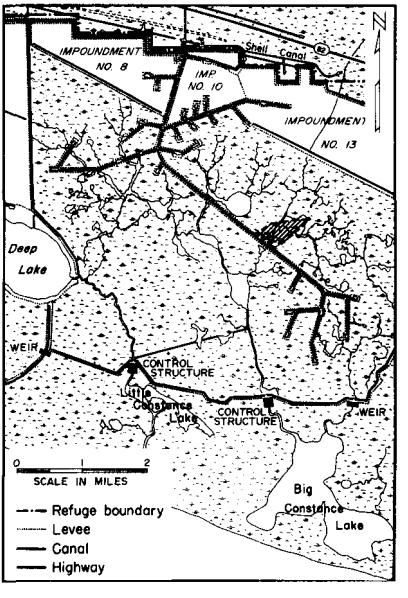

Figure 11. Minimum home range (106 ac.) for alligator no. 1 as determined by radio fixes from April 16 to May 10, 1971.

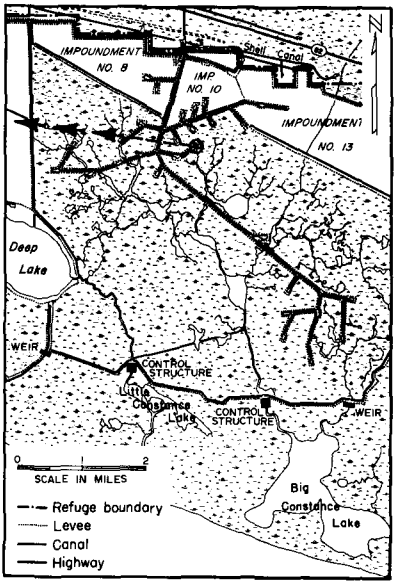

Figure 12. Alligator no. 8 moved 33 air-line miles from the point of capture between May 17 and October 10, 1971.

Alligator No. 10. Transmitter no. 10 was attached to a 9'0" male on May 20. The radio slipped out of position and only one fix was recorded after the animal was released. A three month interval elapsed between the two signals.

Alligator No. N-2. An 8'8" male was outfitted with radio unit no. N-2 and was never heard from or seen after being released on August 19.

Movement According to Periods

Daily movement was quite extensive for all of the alligators followed during this study. The longest minimum daily movement recorded was 27,750 feet. Thirty instances were recorded (242 daily distance movements were tallied during the study) where minimum daily distance traveled exceeded 5,000 feet. Sixty-six movements over a 24-hour period ranged between 1000 and 5000 feet.

Minimum daily movement for individuals tracked during the spring, summer and fall averaged 2,411 feet. A previous study (Joanen and McNease, 1970) showed that the average minimum daily movement for adult female alligators was 79 feet for the period May 18 through November 10, 1969.

The longest seasonal average daily movement (2,805 feet) and largest seasonal minimum range size (2,192 acres) were recorded during the summer (average for four alligators). The autumn period exhibited the second largest range size (average for five alligators) of 1,100 acres. The minimum range covered by five alligators for the spring averaged 821 acres while the average minimum daily distance traveled amounted to 2,503 feet.

Generalized movement patterns will be characterized according to the four periods as broken down for this study in the discussion that follows.

Period I—Spring. The spring period, which included the courtship and breeding season, exhibited the third largest average range size and the second largest

average minimum daily distance traveled when compared to the other three periods. Average minimum range size for five males followed for the majority of Period I was found to be 821 acres. Movements during this period were closely associated with canals and bayous (Table 4). Seventy-one percent of the fixes recorded for the alligators studied during the spring were located in canals and bayous.

The minimum daily distance traveled for five animals during Period I averaged 2,503 feet.

Chabreck (1965) reported that the greatest movement by adult male alligators probably occurred in the spring during the breeding season. The results from this study indicated that the largest range sizes and also daily movements were recorded during the summer (Period II).

Information gathered during this investigation indicated that the defense of territory was not particularly strong and that quite a lot of interchange occurred among adult male alligators, especially during the breeding season. However, this assumption merits further study. On several occasions adult males were observed within a few feet of each other apparently undisturbed by the presence of the other. Groups of 6 to 8 adult animals of various size classes were observed only during this period.

No aggressive behavior other than bellowing was observed during the entire study. However, a close examination of the adult males during the collaring process revealed several animals had recently taken part in combat. This was apparent by fresh wounds usually on the tail, sides, and belly portions.

Period II—Summer. Range sizes and daily movements exhibited during this study were larger during summer than for any of the other three seasons of the year. The average minimum daily distance traveled of 2,805 feet and an average minimum range of 2,192 acres for the summer period is based on the averages of four alligators which provided data over the three month interval covered by the period. Seventy-nine percent of the alligator locations plotted for the summer were in canals. Groups of animals at this time had dispersed. Generally, the animals under study remained to themselves for the remainder of the year. Only on rare occasions were they found in association with other adult animals after the spring courtship period.

Chabreck (1965) reported that adult male alligators have a territory covering perhaps 50 to 100 acres which they wander over throughout the warm weather months. The summer range size for one alligator monitored during this study amounted to 3,666 acres. The average summer range size for four mature bull alligators was determined to be 2,192 acres.

As was demonstrated by Chabreck (1965) the radio equipped adult males tended to prefer deep water areas during the warm weather months.

Telemetry data verified that movement covered substantial distances (one animal was recovered 33 air-line miles from the point of capture) and that as many as three different marsh types were used by one individual during the warm weather months.

Period III—Autumn. The average minimum range size for five alligators throughout the fall was 1,100 acres, intermediate in size between the smaller spring ranges and the larger summer ranges. The minimum daily distance traveled averaged 1,926 feet. Sixty-nine percent of the locations plotted during Period III were in canals.

The first one-half of Period III showed more movement over a larger range than was demonstrated late in the period. Activities in late fall appeared to be associated with preparing for the winter dormancy period. Movements during early December pretty well stabilized around a den site or a particularly small section of a canal, usually dead end, which served as a center for their activities.

Period IV—Winter. Data recorded during our tracking endeavors for the winter season was extremely limited. All indications were that movement was confined to the general area around the den site. Three out of five animals followed during Period IV wintered in the marsh. Animals were observed basking on extraordinarily warm days during the winter. McIlhenny (1935) reported that the adult male remains in a den throughout the winter and ventures out only when the air temperature exceeds that of the water.

Effects of Handling and Transmitter Attachment on Alligators

Movements during the first week after the collar was attached did not appear to differ appreciably from that demonstrated during the remainder of the season. However, on one occasion a large bull after being released crashed through some two to three inch diameter *Baccharis halimifolia* bushes, located on the crown of a levee, promptly destroying his new transmitter.

An 8′6.5″ male was recaptured one year after the collar assembly was attached. An external examination of the area of his neck affected by the collar revealed that very little abrasion had been caused by the assembly. One slight abrasion was noted where the edge of the belting contacted the dorsal surface of the neck. Quite to the contrary, the transmitter and collar showed extensive wear.

Environmental Factors

Temperature. As would be expected for a poikilothermic animal, seasonal temperature changes have a definite influence on the activities of alligators. Chabreck (1965) reported that alligators go into a partial hibernation during periods of cold weather, only surfacing periodically to breathe.

Giles and Childs (1949) reported that alligators on Sabine National Wildlife Refuge tended to move from the shallow open water areas of the marsh in June because the water in these shallow areas became excessively hot. They also noted that in natural tidal marsh, summer movement was from the shallow marsh to deep open water in response to low water levels and high temperatures in the marsh.

Seasonal changes in activity patterns noted during this study strongly suggested that temperature had a direct influence on alligator activity. During the spring and fall, when temperatures ranged from cool to moderate (average monthly air temperature ranged from 65° F. to 75° F.), more successful fixes were recorded during the period around mid-day. Conversely, during the summer (average monthly air temperature ranged from 75° F. to 85° F.). success was usually higher in locating an alligator's position at night and near dawn, indicating that the males were more active during the cooler periods of the day.

It is difficult to correlate the choice of a particular habitat preference as a direct result of temperature. The extended movements exhibited and the preference of the large males for canals makes it plausible to conceive that this preference might be influenced by the buffering effect of the deeper waters of canals to the extremes in temperature experienced during the various seasons. This would definitely lessen the dependance on established dens. The average temperature for the bottom of a representative canal (7′ deep) for the study area was 61.03° F. for the months of December and January, while temperatures on the bottom of a typical marhs pond (3' deep) averaged 54.62° F. for the same period. The opposite trend was true for the February through May period with the average temperature for the marsh pond bottom being 70.15° F. and the canal bottom averaging 66.33° F.

Also, not to be overlooked is the fact that canals offer a practical means whereby the animals could make the extended movements traversed during this study.

Water Levels. Water levels were the lowest (marsh floor level) during the spring than for any other period included in this study. Spring rainfall amounts were four inches below the average for the 1961-1970 period. However, a carry over of a substantial surplus of surface water from the above average winter rainfall (6.45" above the 10 year mean) maintained near normal water levels for the spring.

Precipitation during summer was equivalent to the 1961-1970 average. Fall rainfall was 6.34 inches higher than the 10 year average. Fall and winter water depths were exceedingly high as a result of flooding by the almost 15 inches of rain accompanying Hurricane Edith in September and by very heavy rainfall (16 inches) during December.

Water depths probably did not appreciably effect canal movement during this study. However, it is conceivable that water depths and water flow could effect water salinities in canals affected by salt water intrusion and thereby indirectly effect movement. No extraordinary movements were noted by the alligators under study following the September hurricane.

Chabreck (1965) related that alligator movement increases whenever marshes are flooded as a result of excessive rainfall and high tides. He further reported that immature alligators seem to respond to flooding more than do adults.

Water Salinity. High water salinities may have limited the southern range of one of the alligators under study. During September and October this animal utilized an area which was usually characterized by moderate (5 ppt) to high (17 ppt) salinity levels. Water salinities of the three vegetative types within the study area as determined in a 1968 survey had a mean of 0.74 ppt for the fresh marsh, 2.57 ppt for the intermediate marsh, and 4.13 ppt for the brackish marsh. However, the range was 0.1-2.0, 0.5-6.0, 1.0-9.6 ppt, respectively (Chabreck, 1970).

Management Implications

Habitat Management. Movement and activity data, as analyzed for this study, indicated that canals and deep water bayous are extremely important in all phases of the life history of the adult male alligator. While it is impractical to initiate management procedures for anything as extensive as South Louisiana's canal and bayou systems, it is imperative that we preserve the marshes in as natural a state as possible. Only through private landowner interest and financial incentive to the landowner for him to preserve marsh lands as such can we expect to conserve this unique habitat type and ultimately the prosperity of the alligator.

As was pointed out by Joanen and McNease (1970), the control of water levels and percent water coverage is important in certain phases of the life history of the female alligator. The tendency of both the males and females to selectively seek out open water areas during the courtship and breeding period demonstrates that this is an important consideration to be made in the management of the alligator.

The use of weirs as a management technique in marshes affected by tidal exchange were found desirable in stabilizing water levels, reducing turbidity, and restricting rates of tidal exchange (Chabreck and Hoffpauer, 1962). Weirs permit the flow of tide water back and forth over the structures, yet prohibit excessive drainage of marsh bayous, ponds, potholes, and lakes during periods of low tide. This type of management would maintain the open water situation needed by the alligator during the period of courtship. Also, the use of weirs would enhance the value of the water areas for aquatic forms of life which are so important in the alligator's food chain (Joanen and McNease, 1970).

SUMMARY

A study was conducted on Rockefeller Refuge and adjacent privately owned marshland from April 14, 1971 through March 18, 1972 to gather information on the movements and activities of adult male alligators. Fourteen alligators were equipped with collar-type transmitters and monitored during a 339 day period.

Minimum home range sizes of the alligators followed over the major portion of the investigation varied from 452 acres to 12,560 acres. The longest movement recorded was 33 air-line miles from the capture site.

Daily movement was quite extensive for all of the alligators followed during this study, the longest minimum daily distance traveled being 27,750 feet. Minimum daily movement for individuals tracked during the spring, summer, and fall averaged 2,411 feet.

The largest seasonal range size was recorded during the summer period, followed in decreasing order of size by the autumn and the spring. Winter movement was confined to the general area around the den site.

A highly significant difference existed statistically between canal and marsh usage. Over the duration of this study, 73 percent of the fixes plotted were in canals and 27percent were in ponds, potholes or dens in the marsh. However, three out of five of the animals followed during the winter remained in the marsh. An analysis of variance indicated no significant difference of the degree of canal usage by season at the 0.05 level of probability ($P < 0.05$).

Movement and activity data indicated that canals and deep water bayous are extremely important in all phases of the life history of the adult male alligator.

ACKNOWLEDGEMENTS

The writers gratefully acknowledge the efforts of Mr. Allan Ensminger, Louisiana Wild Life and Fisheries Commission, for the administrative supervision of a very costly and demanding study. His assistance in piloting aircraft during field phases of the investigation is likewise appreciated. A note of gratitude is also expressed to Mr. W. Guthrie Perry, Jr., Fisheries Biologist, for assistance in the statistical analysis of the data and for assisting in the initial field phases of the study. Appreciation is also extended to Mr. James Nunes, Refuge Warden, for his valuable assistance throughout this project and for the use of his airplane. Special thanks are extended to Mr. Eddie L. Bennett, Engineering Specialist, for preparing the maps included in this paper. Local residents deserve special credit for reporting their sightings of radio equipped alligators. Mrs. Mae Ann Hebert, Secretary, Rockefeller Refuge, merits recognition for her efforts in typing and assembling this paper.

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A SURVEY OF HUNTERS' ATTITUDES TOWARDS HUNTERS AND HUNTING DOGS ON THE OCALA NATIONAL FOREST, FLORIDA

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A stratified, random sample of hunters on the Ocala National Forest produced 1,598 questionnaires which were coded and analyzed at Florida State University's Computing Center. One section of the survey explored hunter attitudes concerning other hunters and toward hunting white-tailed deer with dogs. This paper discusses the results from part of the survey. The cooperation of personnel in the Florida Game and Fresh Water Fish Commission and U. S. Forest Service in conducting the interviews is gratefully acknowledged.

DOG OWNERSHIP AND USE

Hunting with dogs is the most popular method of hunting on the Ocala. Of the hunters interviewed, 65 percent hunt with dogs and 44 percent indicated they owned 2,975 deer hunting dogs. These hunters average 4.2 dogs per dog owner, 2.9 dogs per dog user and 1.9 dogs for every hunter on the Forest.

These averages only tell part of the story. Forty-two percent of the hunters that use dogs use five or less dogs and yet these animals make up only 17 percent of the total dog population. A full 80 percent of the dog-using hunters use 10 or less dogs and these animals make up 47 percent of the total dog population. Conversely, 20 percent of the hunters that use dogs are using 53 percent of the total dog population.

This is an area where restrictions can be effectively placed. One-fifth of the hunters use one-half of the dogs. The innate disturbance caused by these animals could be reduced by regulating the number of dogs per party, per vehicle or per hunter.

HUNTER ATTITUDES*

*See Table I for summary of hunter attitudes