Fall 9-22-1982

River Otter Abundance, Distribution, and Habitat Use in Louisiana

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RIVER OTTER ABUNDANCE, DISTRIBUTION, AND HABITAT USE IN LOUISIANA

A Thesis

Submitted to the Graduate Faculty of the
Louisiana State University and
Agricultural and Mechanical College
in partial fulfillment of the
requirements for the degree of
Master of Science

in

The School of Forestry and Wildlife Management

by

Thomas Lee Edwards
B.S., Northeast Louisiana University, 1978
May 1983

MANUSCRIPT THESES

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ACKNOWLEDGEMENTS

I thank the Louisiana Department of Wildlife and Fisheries for providing financial assistance for this study.

I extend deep appreciation to Dr. Robert H. Chabreck, who provided invaluable assistance in the study and served as major professor.

I am grateful to Mr. Greg Linscombe, Louisiana Department of Wildlife and Fisheries, for his assistance in obtaining otter harvest records and for his help in securing otter scents for this study.

I acknowledge the members of my graduate committee, Dr. Vernon L. Wright, Dr. Mark K. Johnson, and Dr. Robert E. Noble, who carefully reviewed the manuscript.

I especially thank my parents who provided me with financial assistance and moral support throughout my university studies.

The data presented herein were collected and analyzed under Louisiana Agricultural Experiment Station Project 2063 with Dr. Robert H. Chabreck serving as Project Leader. I am grateful for being permitted to use these data for this thesis.

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ABSTRACT

River otter abundance, distribution and habitat use were determined in Louisiana, with emphasis placed on the parishes north of the coastal marshes. Records from 1913 to 1980 indicated that otter harvest and pelt price increased over the years. Data from a trapper survey for the 1980-81 season were used to estimate otter harvest for each parish, and the data were compared in a step-wise regression procedure with independent variables thought to affect otter abundance. Of the factors I considered, those most responsible for variation in trapper harvest among parishes were the area composed of non-forested wetlands, area composed of forested wetlands, number of trapping licenses sold, and area planted to cotton in 1980.

Otter abundance was indexed at selected sites in eight parishes by counting scats along transects during summer 1981 and winter 1981-82. Otter scats occurred along 18.9 percent and 20.3 percent of the survey lines during the summer and winter surveys, respectively. Several environmental variables were measured at each site and related to the abundance of scats. The variables included habitat type, cropland, forested land, shoreline elevation, fish activity, water turbidity, and human disturbance. Most otter sign was observed along streams with heavy fish activity, low human disturbance, and low water turbidity.

INTRODUCTION

The river otter (Lutra canadensis)[1] was known to man, and its pelt used for clothing, long before America was discovered (Arthur 1931). It is a valuable fur animal in Louisiana today and provides one of the highest prices per pelt of any furbearing species. During the 1976-77 season, 11,900 otters were trapped in Louisiana and provided a total income of $535,500, representing an average of $45.00 for each pelt (Ensminger and Linscombe 1980).

According to Lowery (1974), otters were fairly abundant in certain parts of Louisiana, notably in the coastal marshes and Atchafalaya Basin in the early 1970's. He added that elsewhere, however, habitat destruction had probably reduced their numbers to only a fraction of what they once were. He suggested, as did St. Amant (1959), that an intensive statewide study of the otter's status should be undertaken.

An understanding of the distribution of otters in Louisiana is important for proper management of the animal. Knowledge of habitats occupied by otters can aid in determining habitat preferences and more beneficial management practices can be established to insure the preservation of suitable habitat.

The objectives of this study were (1) to determine past trends in otter harvest in Louisiana; (2) to identify areas of greatest abundance

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[1] Scientific names of mammals are from Lowery (1974), except Lutra lutra, which is from Burton (1979).

of otters; (3) to evaluate scent-stations as an index of otter abundance; and, (4) to evaluate environmental factors affecting abundance of otters in areas of Louisiana north of the coastal marshes.

DESCRIPTION OF STUDY AREA

Location and Topography

Louisiana comprises 125,675 km^2 in the south-central United States. It lies at the southern end of the Mississippi River, and is bounded by Mississippi on the east, Arkansas on the north, Texas on the west, and the Gulf of Mexico on the south. Land elevation ranges from about -1.5 m, mean sea level, in Orleans Parish, to about 163 m, mean sea level, at Driskall Mountain in Bienville Parish (Louisiana Department of Public Works 1968: 4). Topographic features can be classified in four groups: uplands, alluvial plains, prairies, and coastal marshes.

Soils

Lytle and Sturgis (1962) described 16 soil associations in Louisiana. The recent alluvial deposits of the Mississippi and Red Rivers cover the greatest amount of surface area in the state, and they are the most productive soils. The Coastal Plain comprises about 25 percent of Louisiana's total area. It consists of sand and clay hill soils, and is located in the west and north-central parts of the state. Mississippi Terrace and loessial hills, made up of wind-blown or alluvial silts, occupy gently sloping benches in the northeastern, southeastern and south-central parts of the state. Coastal Prairie soils are located in the broad plains of southwestern Louisiana. Coastal marsh soils, comprised of silts and clays, were derived from recent stream sediments and marine deposits.

Climate

The climate of Louisiana, influenced by latitude and proximity to

the Gulf of Mexico, is described as humid subtropical (Kniffen 1968). Average annual temperatures range from 18.1 C at Tallulah in the northeast to 21.2 C at Burwood in the south (Louisiana Department of Public Works 1968: 6). Average annual precipitation, which ranges from about 121.92 cm in the northwest to about 167.64 cm in the southeast, is well distributed throughout the year.

Hydrology

Wetlands and water bodies of Louisiana fall into four categories: lakes, streams, marshes, and swamps. The 10,965 km^2 of lakes and streams, the 14,878 km^2 of marshland, and the 8,994 km^2 of swamps, combined, represent 27.7 percent of the total area of the state (Louisiana Department of Public Works 1968: 26).

Major lake types in Louisiana include artificial impoundments, ox-bow cutoffs of the Mississippi and Red Rivers, deltaic lakes near the mouth of the Mississippi River, grabens occupied by Lakes Maurepas, Pontchartrain, and Catahoula, lagoonal lakes formed behind coastal cheniers of southwestern Louisiana, and raft lakes formed by floodwaters of the Red River (Kniffen 1968).

Louisiana contains about 20,000 linear kilometers of freshwater streams. Major river systems include the Mississippi, Red, Atchafalaya, Ouachita, Sabine, and Pearl, all of which possess numerous backwater areas and tributary streams.

Marshes occur along the Louisiana gulf coast, and are described in three classes: delta, sub-delta, and prairie (O'Neil 1949). The delta marshes, located at the mouth of the Mississippi River, consist of about 1,215 km^2. Sub-delta marshes, comprising approximately 10,520 km^2, extend from St. Bernard Parish to Vermilion Parish. The prairie marshes

are located in Cameron and Vermilion Parishes and consist of about 3,075 km^2. All three marsh types are similar in appearance, but each type contains certain edaphic conditions responsible for its distinct vegetative composition.

The major difference between swamps and marshes is that swamps contain dense tree cover and marshes do not. Swamps comprise 7.2 percent of Louisiana and occur along all of its major streams and in many other lowland areas (Louisiana Department of Public Works 1968: 6).

Land Use Changes

Natural forests probably comprised about 75 percent of Louisiana's area at one time. By 1965, the forested area had been reduced to 50.5 percent, and by 2000 it is projected to be less than 50 percent (Louisiana Department of Public Works 1968: 84). Recent improved drainage practices in delta areas have allowed conversion of bottomland forests to agricultural farmlands. The bulk of this agricultural land is used as cropland, primarily for soybeans. The amount of soybeans in Louisiana has increased dramatically during the last two decades, from 87,480 ha in 1960 to 1.36 million ha in 1980 (LSU Cooperative Extension Service 1981). Other major crops in 1980 were rice (249,581 ha), cotton (227,623 ha), and sugar cane (103,275 ha). Pasture is another primary use of the state's agricultural land.

Changes in Wetland Areas

Several factors are contributing to changes in marshland areas of Louisiana, including coastline recession, subsidence, reclamation for urban and agricultural uses, and siltation buildups (Louisiana Department of Public Works 1968: 14). Shoreline erosion occurs principally on beaches exposed to wave action. Siltation is expected to

extend marshes at the mouths of the Mississippi and Atchafalaya Rivers. Swamps continue to decrease in size because of drainage, conversion to farming, and siltation.

METHODS AND MATERIALS

Examination of Otter Harvest Records

The Louisiana otter harvest has been monitored by the State of Louisiana through severance tax collections since the 1913-14 trapping season (St. Amant 1959). I examined catch records to determine trends in otter harvests from the 1913-14 season through the 1979-80 season. Harvest records were obtained from four sources: LSU Cooperative Extension Service (1981), Ensminger and Linscombe (1980), Lowery (1974), and St. Amant (1959). Annual pelt prices were obtained from the 1928-29 season through the 1979-80 season and a regression analysis was performed to determine if harvest levels were related to prevailing pelt prices. I compared trapping license sales for the years 1944-80 with otter harvest and pelt price during this period.

Location of Otter Abundance

The Louisiana Department of Wildlife and Fisheries surveyed trappers in each parish following the 1980-81 season to determine the distribution of otter harvest. The reported otter harvest from that survey were used as an indication of the relative abundance of river otters. These data were converted to the number of otters harvested per km^2 in each parish. The otter harvest from 53 parishes north of the coastal region was also compared with selected environmental factors to determine if a correlation existed between these variables and the reported take of otters. A step-wise regression analysis was employed whereby the coefficient of determination was maximized while only the significant effects of otter harvest were retained in the regression

equation (Barr et al. 1976). Variables included in correlation analysis and a description of the variables are presented in the appendix (Table 9).

Evaluation of Scent-Stations

Since 1978, five southeastern states have employed the artificial scent-station technique to obtain indices of furbearer abundance (Sumner and Hill 1980). According to Roughton and Sweeny (1978), the measurement of relative abundance by scent-stations relies on the assumption that the relationship between the visitation rate and the density of a species is sufficiently consistent for the index to yield reliable and useful information.

Between February and April 1981 an evaluation of the scent-station technique as an index to otter abundance was made in three areas of southeastern Louisiana known to contain relatively high densities of otters. The purpose of this investigation was to test the effectiveness of three scents in attracting otters.

The three scents tested were synthetic fatty acid, otter urine, and fish oil. Scent-stations were located in clusters of three, placed 10 m apart, with one of the three scents applied to each station. Each group of three stations was placed at least 400 m apart along stream banks or pond levees, and near fresh otter scats when possible. Scent-station design was essentially the same as that used by Sumner and Hill (1980), except I set the stations in groups of three whereas they established scent-stations at 0.48-km intervals along a continuous survey line. Stations were 91.4-cm diameter areas of cleared soil upon which a thin sifting of lime was applied. One to two ml of liquid attractant was centrally applied on a sponge contained in a plastic perforated disc.

After establishment, each station was examined the following day for the presence of otter tracks. When an entire set was destroyed by adverse weather, it was reestablished and checked the next day.

Visitation rates at scent-stations were converted to the following index of abundance (Linhart and Knowlton 1975):

No. Visits/No. Operable Stations = Index

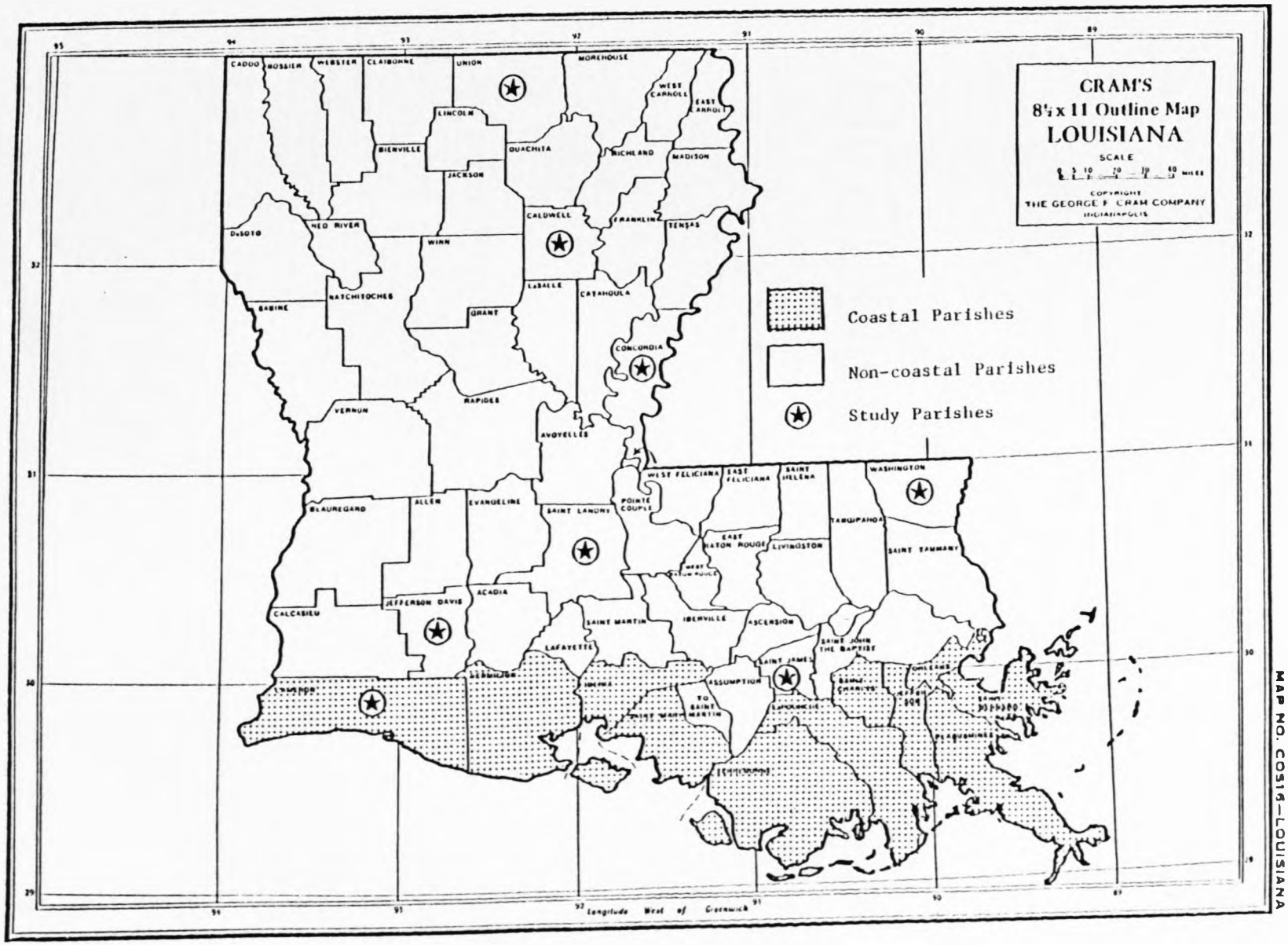
Field Surveys of Local Abundance

Field surveys of otters were conducted in six upland Louisiana parishes (Fig. 1) during the summer of 1981 and the winter of 1981-82 to evaluate habitat preference, survey methods, and factors affecting local abundance. Parishes selected were in different physiographic regions of the state (Fig. 1). Field surveys were also conducted in two parishes of southern Louisiana with much higher otter catches for comparison (Fig. 1). The southern Louisiana parishes surveyed were Cameron and St. James, which are dominated by coastal marsh and swamp habitat, respectively.

Habitats surveyed bordered lakes, rivers, and streams; both swampy and dry shorelines were included. When possible, equal replications of each habitat were sampled. The number of survey lines in any parish ranged from 20 to 26. Otters were inventoried in each habitat type by conducting track and scat counts, a method utilized by MacDonald et al. (1978). Survey lines were designated on topographic maps (scale: 1 to 20,000) prior to their establishment in the field. Alternative routes were established in the field if the original route was unacceptable because of impassibility or high residential development.

During establishment of survey lines, habitat type, land use, shoreline elevation, water turbidity, dominant vegetation types, fish

Figure 1. Location of study areas.



MAP NO. COS16—LOUISIANA

activity, and human disturbance were recorded. Water turbidity was categorized as low, moderate, or high. Fish activity was designated as low or high, based upon the amount of fish observed in water adjacent to survey lines. Low, moderate, and high values for human disturbance were designated according to the following criteria: no person seen during the survey = low; 1-3 people = moderate; 4 or more people = high.

Aerial photographs were examined of each survey line. A grid covering an area of 1 km^2 was placed upon the aerial photograph, centered over each survey line, and percentages were obtained of forested land and cropland within the 1 km^2 area. Forested land was categorized as 0-33 percent, 34-66 percent, and 66-100 percent, while cropland categories were 0 percent, 1-25 percent, and 26-100 percent, so that each category would provide near equal numbers of survey lines.

Counts of otter scats and tracks were conducted along 400-m survey lines 0-5 m from the water's edge. The number of latrine sites and the number of otter tracks were recorded, as well as their location along the survey route.

The presence or absence of otter sign in habitat types, shoreline elevation, land use, fish activity, water turbidity, and human disturbance variables were tested for independence using tests in 2-dimensional contingency tables at the 0.05 level of probability. Because the two southern parishes failed to offer a diversity of habitat types, the data obtained from them were not included in the chi-square tests of independence, but those data were included in a correlation analysis of the number of otters harvested per km^2 with the number of otter latrines per 400-m survey line.

RESULTS AND DISCUSSION

Otter Harvest Trends

Apparently, the otter has never been abundant in Louisiana. Le Page du Pratz (1774) reported that otters were rarely seen during his travels in Louisiana during the early 18th century. Audubon and Bachman (1854) stated that otters were still present on the rivers of Louisiana during the mid 19th century. Arthur (1931) reported that the species was never abundant anywhere in North America, but noted that Bayou la Loutre and Pass a la Loutre in Louisiana were so named because of the number of otters seen in them. He believed that the shy and solitary habits of otters enabled them to retain their original range and numbers in spite of an increased human population, an increased number of trappers, and an increased pelt value. However, Lowery (1936) said otter trapping had a detrimental effect on its population, and it is "by no means as plentiful now as in former days." He added that at one time otters were common in the streams of Madison, Richland, and Tensas Parishes in northeast Louisiana, but that now, the animal is rare in those areas. Lowery (1943) reported that the otter is confined to the alluvial bottomlands of the central part of Louisiana and to the coastal marshes.

Otter harvest varied from 278 in 1921-22 to 11,900 in 1976-77, when pelt prices peaked at $45.00 (Table 1). The lowest otter pelt price on record was $5.00, during the 1932-33 and 1940-41 seasons. During the 1928-29 season, the average otter pelt sold for $22.00, and over 3000 otters were trapped. Two major slumps in harvest occurred. The first

Table 1. Otter harvests in Louisiana[a] from 1914 to 1980, annual pelt prices from 1929 to 1980, and license sales from 1944 to 1980.

Trapping season	No. otters harvested	Pelt price[c] (dollars)	No. trapping licenses
1913-14	2,860		
1914-15	NA[b]		
1915-16	3,540		
1916-17	6,940		
1917-18	1,985		
1918-19	2,428		
1919-20	1,680		
1920-21	321		
1921-22	278		
1922-23	530		
1923-24	NA		
1924-25	2,110		
1925-26	2,024		
1926-27	2,554		
1927-28	1,190		
1928-29	3,048	22.00	
1929-30	1,447	11.50	
1930-31	1,396	12.00	
1931-32	1,664	8.00	
1932-33	870	5.00	
1933-34	780	7.00	
1934-35	789	10.00	
1935-36	650	7.00	
1936-37	780	9.00	
1937-38	920	7.00	
1938-39	NA	NA	
1939-40	1,392	6.60	
1940-41	1,728	5.00	
1941-42	1,760	6.00	
1942-43	1,399	7.50	
1943-44	2,404	6.00	
1944-45	1,912	6.00	8,603
1945-46	2,367	20.00	NA
1946-47	2,832	12.50	12,258
1947-48	5,078	18.00	9,899
1948-49	2,222	12.00	8,841
1949-50	2,968	8.00	7,110
1950-51	4,801	12.15	8,000
1951-52	4,849	11.00	6,120
1952-53	4,198	11.00	4,328
1953-54	3,884	13.00	4,986
1954-55	5,407	16.00	5,202
1955-56	4,653	18.00	5,520
1956-57	5,261	16.00	4,260

Table 1. Continued.

Trapping season	No. otters harvested	Pelt price (dollars)	No. trapping licenses
1957-58	4,382	14.00	3,868
1958-59	5,166	14.00	3,932
1959-60	5,559	18.00	3,747
1960-61	3,602	17.00	3,613
1961-62	4,195	16.00	3,004
1962-63	8,484	17.00	3,666
1963-64	4,274	18.00	3,029
1964-65	3,288	25.00	3,061
1965-66	3,588	20.00	3,088
1966-67	4,118	18.00	3,592
1967-68	3,466	14.00	2,495
1968-69	5,426	20.00	3,601
1969-70	6,632	23.00	4,444
1970-71	4,808	25.00	3,510
1971-72	5,440	38.00	2,761
1972-73	7,668	42.00	4,741
1973-74	5,989	30.00	6,295
1974-75	6,118	25.00	7,528
1975-76	5,730	25.00	6,404
1976-77	11,900	45.00	9,329
1977-78	6,597	25.00	12,069
1978-79	9,745	35.00	11,106
1979-80	9,324	40.00	12,239

[a]Sources: LSU Cooperative Extension Service (1981), Ensminger and Linscombe (1980), Lowery (1974), and St. Amant (1959).

[b]NA = Not Available

[c]Average price received by trappers for one otter pelt.

one was during the early 1920's and the other was during the mid-1930's. From that time, the otter harvest and average pelt price gradually increased for the most part until the record harvest of 1976-77. St. Amant (1959) explained that the State's highest otter production attained was a pelt to 192 ha, while the average ranges from 419 ha to 1,109 ha per pelt. He stated that, although the total otter population in Louisiana is only a few thousand, there is no evidence that trapping is hurting the species.

Bachrach (1953) explained that pelt price of furbearers fluctuates with supply and demand and current economic situations. The pelt price of otters is generally thought to be influenced chiefly by the demand for coats and jackets made from short-haired furbearers (R.G. Linscombe 1982, personal communication, Louisiana Department of Wildlife and Fisheries, New Iberia). This then raises the question of the relationship between pelt price and the annual otter harvest. Erickson and Sampson (1978) found a significant positive relationship ($P < 0.01$) between total furbearer harvest in Missouri and the mean pelt value of all species. However, they did not test the relationship between the otter harvest and pelt value of the species. Correlation of the annual otter harvest in Louisiana with pelt price disclosed a positive relationship ($r = 0.79$, $n = 51$, $P < 0.01$) between the two variables, suggesting that an annual increase in the value of an otter pelt caused trappers to work harder to capture the animal.

Few trappers in Louisiana trap only for otters and most otters are thought to be taken in traps set for other species such as nutrias (Myocastor coypus) (R.G. Linscombe 1982, personal communication, Louisiana Department of Wildlife and Fisheries, New Iberia). Nutrias

were introduced into Louisiana in 1938 (Lowery 1974) and became a major part of the state's fur harvest after 1960. The size of an adult nutria is similar to the size of an adult otter, and increased effort to trap nutrias after 1960 may have caused an increase in the take of otters. Therefore, the effect of otter pelt price on otter harvest before and after 1960 was tested to determine if a relationship existed during both periods. The correlation coefficients indicate that otter harvests were associated with pelt prices before ($r = 0.67$, $n = 29$, $P < 0.05$) and after ($r = 0.73$, $n = 21$, $P < 0.05$) 1960.

Additional analyses were made to determine whether the pelt price of otters would attract additional trappers and whether an increase in the number of trappers would result in an increase in the otter harvest. No relationship was indicated between otter pelt prices and the number of licenses sold ($r = 0.20$, $n = 35$, $P > 0.05$). Also, no relationship was noted between license sales and the number of otters harvested ($r = 0.28$, $n = 35$, $P > 0.05$). Note, however, that the Louisiana trapping license permits the licensee to trap all furbearing animals. Increased license sales may be related to increased pelt value for other furbearers.

According to MacDaniel (1963), fluctuation of water levels from year to year seems to influence the otter catch by trappers. During periods of low water, fish are restricted in movements, making them easy prey for otters. This, in turn, tends to concentrate otters in smaller areas, making them easier to trap than usual. Water level variations were not evaluated in this study.

Otter Distribution and Abundance

Reported Harvest

A survey of licensed trappers was conducted by the Louisiana Department of Wildlife and Fisheries at the end of the 1980-81 trapping season and provided information on the otter harvest by parish (Table 2). The reporting rate of trappers varied by parish and a correction factor for this variation was entered into the reported otter harvest.

Most high otter harvests were reported from coastal parishes and those in the Atchafalaya Basin. However, the highest reported otter catch (0.169/$km^{2)}$ was from St. James Parish, which is comprised mostly of forested wetlands along the lower Mississippi River and the Lake Maurepas swamp.

Upland parishes with relatively high reported harvests included Washington (0.079 otter/km^2) and Union (0.029 otter/km^2). Major areas of the state with low otter harvests included the northwest hill parishes and the northeast delta parishes. Only in two parishes, Evangeline and West Carroll, were no harvested otter reported.

According to MacDonald and Mason (1976), previous reports of the status of otters have usually been based on evidence provided by trappers. Otter status is often expressed as the number of animals taken in one trapping season. Trappers are more likely to trap those areas they know to contain high otter populations. Therefore, catch records would only indicate areas of greatest otter abundance. However, in Louisiana, most otters are taken in traps set for other species and the otter take reported by trappers may serve as an indication of local otter abundance during a given year (R.G. Linscombe 1981, personal

Table 2. Reported otter harvest in Louisiana by parish during the 1980-81 trapping season.

Parish	Otter harvest	Harvest/km^2
Acadia	9.3	0.006
Allen	33.7	0.017
Ascension	21.9	0.028
Assumption	13.0	0.014
Avoyelles	40.5	0.019
Beauregard	19.8	0.007
Bienville	13.0	0.006
Bossier	3.0	0.001
Caddo	1.4	0.001
Calcasieu	176.0	0.062
Caldwell	10.6	0.008
Cameron	560.9	0.119
Catahoula	11.0	0.006
Claiborne	7.5	0.004
Concordia	45.7	0.024
DeSoto	36.4	0.016
East Baton Rouge	16.3	0.014
East Carroll	4.4	0.004
East Feliciana	7.0	0.006
Evangeline	0.0	0.000
Franklin	2.6	0.002
Grant	7.3	0.004
Iberia	152.0	0.077
Iberville	118.3	0.070
Jackson	12.8	0.008
Jefferson	164.4	0.110
Jefferson Davis	81.7	0.048
Lafayette	2.7	0.004
Lafourche	559.1	0.154
LaSalle	14.3	0.008
Lincoln	9.3	0.007
Livingston	34.2	0.019
Madison	19.6	0.012
Morehouse	4.5	0.002
Natchitoches	6.9	0.002
Orleans	9.4	0.011
Ouachita	8.3	0.005
Plaquemines	367.5	0.093
Pointe Coupee	76.9	0.051
Rapides	37.4	0.011
Red River	5.9	0.006
Richland	14.4	0.011
Sabine	11.4	0.004
St. Bernard	340.8	0.108
St. Charles	25.1	0.023

Table 2. Continued.

Parish	Otter harvest	Harvest/km^2
St. Helena	9.5	0.009
St. James	107.3	0.169
St. John the Baptist	40.9	0.042
St. Landry	53.1	0.022
St. Martin	99.4	0.047
St. Mary	225.4	0.109
St. Tammany	65.6	0.023
Tangipahoa	73.8	0.034
Tensas	10.0	0.006
Terrebonne	508.0	0.107
Union	66.3	0.029
Vermilion	169.6	0.042
Vernon	30.1	0.009
Washington	136.2	0.079
Webster	1.5	0.001
West Baton Rouge	16.1	0.031
West Carroll	0.0	0.000
West Feliciana	7.6	0.007
Winn	37.0	0.015

communication, Louisiana Department of Wildlife and Fisheries, New Iberia).

Correlations

Correlation coefficients between all variables suggested that some variables were too strongly correlated to assume independence (Appendix, Table 8). These variables were removed and the final analysis was conducted with nine independent variables on the reported harvest of otters/km^2 by parish. Independent variables displaying little correlation among themselves which were retained for step-wise regression included human population, number of licenses sold, distance of parish from wetland, and amount of: cotton in 1980, soybeans in 1980, deciduous upland forests, non-deciduous upland forests, forested wetlands, and nonforested wetlands.

A "best" four-variable model was obtained from tests of data from the 53 non-coastal Louisiana parishes (Table 3). The four variables, which accounted for 46.79 percent of the variation in otter harvest, were non-forested wetlands, number of licenses sold, amount of cotton in 1980, and forested wetlands. All variables except the amount of cotton in 1980 showed a positive correlation with the otter harvest per parish (Table 3).

The value of wetlands to otter is well known. Ensminger and Linscombe (1980) reported that their greatest numbers in the state occur in the marshes and swamps of southern Louisiana. My analysis demonstrates that upland parish wetlands, although representing less land area, are also very important for otter production.

The number of licenses sold per parish was correlated with the otter harvest per parish during the 1980-81 season. However,

Table 3. Best 4-variable model from stepwise regression procedure with otter harvest/km^2 in 1980-81 as dependent variable.

Variables	B value	F	Prob > F
Licenses	0.0961	4.62	0.0366
Cotton-1980	-0.0034	4.47	0.0398
Forested wetlands	0.0017	7.49	0.0087
Non-forested wetlands	0.0112	9.53	0.0034

correlation analysis of the otter harvest on license sales on a statewide basis between 1944 and 1980 disclosed no relationship between these variables (Table 1). The reason for this difference was probably the effect of annual pelt price variation on the otter harvest over the 36-year period. During the 1980-81 season, pelt price was a constant factor in all parishes.

Several possible causes for the negative correlation between the number of otters harvested and the acreage of cotton in 1980 were evaluated. Northeastern Louisiana is the major cotton-producing area of the state, and according to Walker (1977), the widespread use of toxaphene and other pesticides on cotton caused extensive fish mortalities during 1974. Toxaphene is very toxic to fish and, therefore, may have been available to otters in their food (Beck 1977). Otters may feed on sick fish or poisoned carrion and accumulate toxaphene in their tissues. Stickel (1973) stated that the greatest population reduction caused by environmental contamination would probably be sustained by a species such as the river otter, a fisheater which is relatively scarce and has a low reproductive rate. Rue (1981) said that the worst enemy of otters is the poison ingested with contaminated fish, which may explain the low otter catch in areas with an abundance of cotton. However, according to Graves et al. (1981), the use of toxaphene decreased rapidly after 1975, and their study indicated that, by 1979, residues of organochlorine insecticides were practically non-existant in fish collected from a major northeastern Louisiana watershed. Nevertheless, if the otter population in this area was reduced by poisoning, several years may be required for it to recover.

In Sweden, Erlinge (1978) examined game records and found that the

number of European otters (Lutra lutra) killed annually declined after 1950, indicating a significant decrease over the years. He stated the possible causes for this population decline might include destruction of habitat and killing otters in fish traps. Habitat alteration by land clearing and stream channelization for cotton farming in Louisiana was also considered as a possible cause for the negative correlation between otter harvest and acreage of cotton. Land clearing and stream channelization are also common practices for soybean farming; however, I was unable to detect a relationship between otter harvest and the amount of land planted to soybeans. This would suggest that something other than habitat alteration was responsible for the negative relationship of otter harvest to acreage of cotton. Habitat conditions within a parish vary widely, and small amounts of high quality habitat may support a good population of otters in a parish where a large portion of the habitat has been seriously altered.

Evaluation of Scent-Stations

Only one of 69 stations was visited by otters during the investigation, for an index of 0.015. The attractant at this station was otter urine. Due to the length of time required to conduct the scent-station examination and the lack of sufficient data to provide a reliable index of otter abundance, this portion of the study was discontinued in May 1981.

My results indicate that the scent-station technique as employed is not feasable for obtaining indices of otter abundance. However, comparisons of indices should be made among the various seasons of the year because movement behavior associated with food and reproduction may influence the rates of visitation by otters. Humphrey and Zinn (1982)

used line transects of chalk-dusted trackboards and anal scent attractant to document seasonal use by river otters in southwestern Florida. They found that seasonal effects on otter visitation rates were highly significant ($P < 0.001$), with the visitation rate highest during autumn and lowest during spring. I did not test the anal gland scent.

Field Surveys

In some of the six upland study parishes, the requirements for suitability were not entirely met. For this reason, some parishes had more replications of one habitat type than of another. Neither of the two south Louisiana study parishes (Cameron and St. James) provided a diversity of habitat types. All 14 Cameron Parish survey lines were located in coastal marshes, whereas all 15 survey lines in St. James Parish were along a small stream surrounded by forested wetlands.

A total of 143 survey lines were examined in the six upland parishes during summer and winter surveys. More survey lines were established along small streams than along lakes or large streams because small streams comprised a substantially larger proportion of water body types in most parishes (Table 4). Surveys were also conducted along 29 routes in the two southern parishes during summer and winter.

I determined that track counts provide insufficient data for an index of otter abundance. The best index of abundance was provided by the presence or absence of otter scats along each survey route. These data were used for quantitative analysis of variation among the selected environmental variables.

Table 4. Habitat types surveyed in six upland Louisiana parishes during summer 1981 and winter 1981-82.

Parish	No. survey lines	Habitat types		
		Lakes	Streams	Rivers
Washington	24	5	11	8
Jefferson Davis	20	4	8	8
St. Landry	25	7	13	5
Concordia	24	8	8	8
Caldwell	24	11	7	6
Union	26	8	9	9
Totals	143	43	56	44

Summer Survey

Upland Parishes.-- Otter scats were observed along 27 of 143 lines in the six upland study parishes during the summer survey, yielding a frequency of 18.9 percent (Table 5).

The highest frequency of occurrence of otter sign was obtained from Union Parish, where scat was found along 11 of the 26 survey lines (42.3 %). The lowest frequency of occurrence was taken from Concordia Parish, where only 2 of 24 lines (8.3 %) contained otter scat.

Southern Parishes.-- Otter scats were observed along 19 of 29 (65.5 %) survey lines in the two south Louisiana parishes during the summer survey. Only 1 of 14 lines in Cameron Parish failed to contain otter scat. This abundance of otter sign agrees with the high reported otter harvest in Cameron Parish ($0.119/km^2$).

Winter Survey

Upland Parishes.-- Otter scats were observed along 29 of 143 (20.3%) lines during the winter survey in the upland study parishes (Table 6). The highest index was again obtained from Union Parish, where 9 of 26 survey lines contained scat (34.6 %). Concordia Parish continued to yield the lowest index, with only 1 of 24 lines having otter scat (4.2 %).

Southern Parishes.-- Otter scats were observed along 17 of 29 (58.6 %) survey lines in the two south Louisiana parishes during the winter survey. As in the summer survey, only 1 of 14 lines in Cameron Parish failed to yield otter scat.

Chi-square Tests

The presence of otter scat did not differ significantly ($P > 0.05$; $\chi^2 = 0.09$, 1 d.f.) between the summer and winter surveys in the six

Table 5. Percent occurrence of survey lines with otter scat in six upland Louisiana parishes during summer 1981.

Parish	No. survey lines	No. lines w/scat	Percent occurrence
Washington	24	4	16.7
Jefferson Davis	20	2	10.0
St. Landry	25	5	20.0
Concordia	24	2	8.3
Caldwell	24	3	12.5
Union	26	11	42.3
Totals	143	27	18.9

Table 6. Percent occurrence of survey lines with otter scat in six upland Louisiana parishes during winter 1981-82.

Parish	No. survey lines	No. lines w/scat	Percent occurrence
Washington	24	6	25.0
Jefferson Davis	20	4	20.0
St. Landry	25	5	20.0
Concordia	24	1	4.2
Caldwell	24	4	16.7
Union	26	9	34.6
Totals	143	29	20.3

upland parishes. Therefore, the data from each survey period were combined for chi-square tests of independence on the selected environmental variables.

The presence of otter scat was significantly related to the type of habitat surveyed ($P < 0.01$; $\chi^2 = 10.26$, 2 d.f.) (Table 7). Only 8 percent of the lakes sampled contained otter sign, while 24 percent and 25 percent of large and small streams, respectively, revealed otter scat. One possible cause for these results is that many of the lakes sampled were in high human disturbance areas. Also, otters prefer feeding in shallow water near shore (Sheldon and Toll 1964), and streams may have provided more of this habitat.

A relationship existed between the presence of otter scat and the percentage of cropland comprising the 1-km^2 area around the survey lines ($P < 0.05$; $\chi^2 = 9.13$, 2 d.f.). In areas with greater than 25 percent cropland, only 10 percent of the survey lines had otter scat, whereas 24 percent of the lines in areas with less than 25 percent cropland contained scat. The amount of otter sign was not affected by the percentage of forested land ($P > 0.05$; $\chi^2 = 2.74$, 2 d.f.). However, the high number (182) of survey lines containing 67-100 percent forested land and the relatively small number (52) of lines with 0-33 percent forested land may have contributed to this finding.

MacDonald et al. (1978) studied the distribution of European otters (Lutra lutra) along the Teme River in western England and eastern Wales. The method he used involved walking the banks in search of scats, food remains, and tracks of otters. He found that areas which supported resident otters contained more woodland abutting onto the river bank, a greater density of trees, and more potential den sites than areas

Table 7. Chi-square test results from 7 variables on presence of otter scat during summer 1981 and winter 1981-82.

Variable	Chi-square	Degrees of freedom
Habitat type	10.263**	2
Cropland (%)	9.127*	2
Forested land (%)	2.735	2
Shoreline elevation	4.640	2
Fish activity	20.155**	1
Water turbidity	3.511	2
Human disturbance	10.342**	2

*Significant at P/0.05 level of probability.

**Significant at P/0.01 level of probability.

containing no otters. I did not determine tree density and potential den sites in my study.

The presence of otter scat was not significantly related to shoreline elevation ($P > 0.05$; $\chi^2 = 4.640$, 2 d.f.). However, in low elevation areas, 25 percent of survey lines contained scat; in moderate shoreline areas, 14 percent of lines had scat; and 20 percent of lines in high shoreline areas contained scat.

Heavy fish activity was strongly related to the presence of otter scat ($P < 0.01$; $\chi^2 = 20.16$, 1 d.f.). In heavy fish activity areas, 32 percent of the survey lines contained otter scat, while in light activity areas only 10 percent of the routes had scat. These results indicate that otters were possibly attracted to areas containing high fish populations. Holcombe (1980) found fish to be the major food of otters in Louisiana. Yeager (1938) surveyed otter trappers in the delta hardwood region of Mississippi and concluded that the ideal habitat for otters was a deep-water swamp adjacent to a log-filled, fish-producing lake.

Statistical tests failed to reveal a significant relationship between otter sign and water turbidity ($P > 0.05$; $\chi^2 = 3.51$, 2 d.f.), possibly because turbidity is such an ever-changing factor in most water bodies.

The number of lines with otter scats was inversely related to the degree of human disturbance ($P < 0.01$; $\chi^2 = 10.34$, 2 d.f.). In areas with little human disturbance, 25 percent of the survey lines contained scat; in moderately disturbed areas, 14 percent of the lines had scat; while in heavily disturbed areas, only 5 percent of the lines contained scat. My data support the contention of Lowery (1936), that the river

otter is very secretive and avoids areas frequented by humans.

Note that the above tests are not independent of one another. Therefore, it is impossible to recognize the extent to which each environmental factor affects the presence of otter sign.

Relationship Between Harvest and Scat Counts

Otter harvest in the eight study parishes was not significantly related to the number of scats found in my survey ($r = 0.539$ in summer, $r = 0.468$ in winter; $P > 0.05$). The otter harvest in a parish is no doubt related to the otter population in the parish but may vary annually with pelt price, as discussed previously. Otters may have been harvested at higher or lower rates in certain parishes, but the results of these correlations probably reflect wide variation in scat counts. The areas sampled within study parishes made up only a small portion of the parish. Also, in certain areas otter scat was more difficult to locate than in other areas.

SUMMARY AND CONCLUSIONS

This study was initiated to examine river otter abundance, distribution and habitat use in Louisiana, with emphasis placed on the parishes north of the coastal marshes. Harvest records from 1913 to 1981 were examined for trends in otter catch. The records indicate that the average annual otter harvest has generally increased, probably because of an increase in the average pelt price.

Results of a 1980-81 trapper survey were used to determine the reported otter catch by parish and was compared with numerous independent variables in a multiple regression procedure. Analysis of the otter harvest per km^2 by parish revealed four independent factors significantly related to the variation in harvest. Factors displaying a positive effect on harvest were the amount of forested and non-forested wetlands and the number of trapping licenses sold. Cotton area by parish in 1980 showed a negative effect on otter harvest.

The probable causes for low otter numbers in certain areas of Louisiana are a lack of abundant wetlands and habitat destruction (Lowery 1974). Large areas in northeastern parishes were originally forested wetlands and have recently been drained, cleared, and converted to cropland (National Research Council 1982). The heavy amount of chemicals applied in the past to these cropland areas was detrimental to fish populations and possibly to otters. Some areas with low otter harvests have probably never contained high otter populations, whereas certain isolated areas, such as Union Parish, probably have a history of high otter numbers. This is indicated by the fact that one of the major

streams in Union Parish is named Bayou L'Outre, meaning "bayou of the otter".

Otters were inventoried for abundance in various habitat types in six non-coastal Louisiana parishes and in monotypic habitats of two south Louisiana parishes by conducting scat counts along standardized survey routes. Surveys were conducted during the summer of 1981 and the winter of 1981-82. During the summer survey, otter scats occurred along 27 of 143 survey lines (18.9 percent). In the winter of 1981-82, 29 of the 143 lines contained otter scat (20.3 percent). Most otter sign was observed along streams possessing heavy fish activity, low human disturbance, and low water turbidity. Also, a negative relationship was found between the amount of cropland along the survey routes and the presence of otter scat. No relationship was found between the number of scats per survey line in a parish and number of otter harvested/km^2 in the parish.

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APPENDIX

Table 8. Correlation coefficients (r)[1] among reported otter harvest and selected environmental variables in Louisiana during the 1980-81 trapping season.

	D	PS	HP	NL	S	L	C	C8	S8	C7	S7	C6	S6	DF	OF	FW	NF	Distance from Wetland (DW)
Harvest (H)	.792	.205	.094	.363	.357	.107	.151	-.272	.036	-.303	-.128	-.300	-.218	-.045	-.094	.380	.554	-.184
Density (D)		-.162	-.028	.041	.328	.038	-.056	-.229	-.077	-.285	-.167	-.300	-.205	-.174	-.242	.303	.229	-.242
Parish Size (PS)			.154	.628	-.056	.194	.253	-.086	.132	.005	-.015	.061	-.094	.448	.687	.033	.319	.113
Human Population (HP)				.265	.032	.085	.142	-.073	-.061	-.006	-.121	.053	-.158	.148	-.003	-.141	.265	-.225
Number Licenses (NL)					-.201	.070	.197	.046	-.028	.015	.009	-.008	-.085	.303	.413	-.048	.378	-.001
Streams (S)						-.016	.285	.016	.456	.151	.327	.118	.436	-.045	-.480	.627	.174	-.458
Lakes (L)							-.222	-.133	-.225	-.182	-.203	-.199	-.150	-.171	.098	.140	.569	-.194
Cropland (C)								.425	.829	.585	.763	.624	.476	.256	-.377	.105	.144	-.095
Cotton-1980 (C8)									.207	.900	.618	.803	.610	.112	-.288	-.049	-.118	-.021
Soybeans-1980 (S8)										.478	.807	.536	.576	.202	-.440	.303	-.053	-.097
Cotton-1970 (C7)											.765	.970	.718	.240	-.331	.015	-.169	-.077
Soybeans-1970 (S7)												.736	.787	.086	-.478	.198	-.119	-.061
Cotton-1960 (C6)													.640	.337	-.311	-.001	-.186	-.051
Soybeans-1960 (S6)														.146	-.408	.163	-.147	-.116
Deciduous Forests (DF)															.223	-.275	-.064	.080
Other Forests (OF)																-.405	-.024	.373
Forested Wetlands (FW)																	.223	-.390
Non-forested Wetlands (NF)																		-.163

[1] Least significant r at 1% level = .351. Least significant r at 5% level = .271.

Table 9. Variables included in correlation analysis with otter harvest in non-coastal Louisiana parishes during 1980-81 trapping season.

Dependent Variable:

Harvest - the take of otters per parish by trappers as reported in a mail questionnaire for the 1980-81 season (R.G. Linscombe 1981, personal communication, Louisiana Department of Wildlife and Fisheries, New Iberia).

Independent Variables:

Density - the otter harvest per km^2 by parish.

Parish size - the area of each parish, measured in km^2 (U.S. Geological Survey 1972).

Human population - the number of people per km^2 residing in each parish (U.S. Department of Commerce 1980).

Number of licenses - the number of trapping licenses sold per km^2 in each parish for the 1980-81 season (R.G. Linscombe 1981, personal communication, Louisiana Department of Wildlife and Fisheries, New Iberia).

Streams - the area, in ha, comprised of streams in each parish (U.S. Geological Survey 1972).

Lakes - the area, in ha, comprised of lakes in each parish (U.S. Geological Survey 1972).

Cropland - the total area, in ha, comprised of cropland in each parish (U.S. Geological Survey 1972).

Cotton 1980 - the area, in ha, comprised of cotton in 1980 in each parish (LSU Cooperative Extension Service 1981).

Soybeans 1980 - the area, in ha, comprised of soybeans in 1980 in each parish (LSU Cooperative Extension Service 1981).

Cotton 1970 - the area, in ha, comprised of cotton in 1970 in each parish (Woodrow 1972).

Soybeans 1970 - the area, in ha, comprised of soybeans in 1970 in each parish (Hoffman 1971).

Cotton 1960 - the area, in ha, comprised of cotton in 1960 in each parish (Parker 1961).

Soybeans 1960 - the area, in ha, comprised of soybeans in 1960 in each parish (Parker 1967).

Table 9. Continued.

Deciduous forests - the area, in ha, comprised of deciduous forests in each parish (U.S. Geological Survey 1972).

Other forests - the area, in ha, comprised of non-deciduous forests in each parish (U.S. Geological Survey 1972).

Forested wetlands - the area, in ha, comprised of forested wetlands in each parish (U.S. Geological Survey 1972).

Non-forested wetlands - the area, in ha, comprised of non-forested wetlands in each parish (U.S. Geological Survey 1972).

Distance from wetland - the average distance, in km, each parish lies from a major wetland area, such as a marsh, swamp or large river.

VITA

Thomas Lee Edwards was born in New Orleans, Louisiana on 4 May 1955, the son of Joyce M. and George D. Edwards, Jr. He attended public schools in Delhi, Louisiana, and graduated from Delhi High School in May 1973.

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EXAMINATION AND THESIS REPORT

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Title of Thesis: River Otter Abundance, Distribution, and Habitat Use in Louisiana

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