COASTAL ZONE MANAGEMENT SERIES

# BARATARIA BASIN: BIOLOGICAL CHARACTERIZATION

L. M. BAHR - J. J. HEBRARD

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CENTER FOR WETLAND RESOURCES • LOUISIANA STATE UNIVERSITY • BATON ROUGE, LOUISIANA 70803

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# Contents

## List of Figures

# List of Tables

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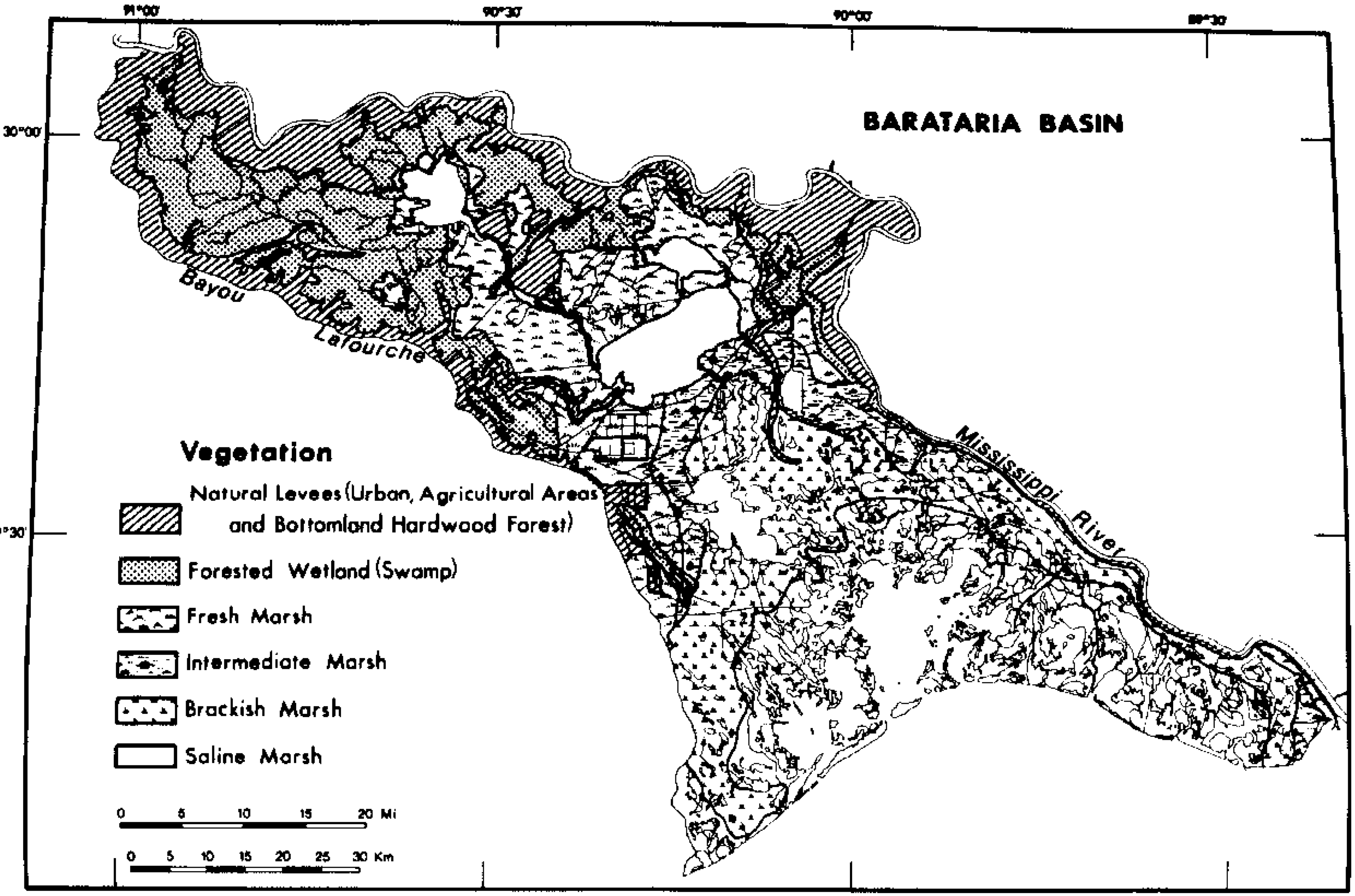


Fig. 1. Vegetation habitats of Barataria Basin.

## Abstract

The biological characterization of the Barataria Basin includes a functional description of biological processes at both the ecosystem (basin) level and the habitat level, as well as summaries of research on distribution and abundance of animal groups.

Water represents the prime integrating feature of the total ecosystem. The importance of rainfall, tidal flow, wind, temperature, storms, meandering of streams, and discharge from the Mississippi River is emphasized in relation to distributions of organisms and nutrients and also as a vehicle for pollutants.

On the habitat level, swamp forests, fresh marshes, brackish marshes (including the intermediate marsh), saline marshes, beaches, and other elevated areas (i.e., chenieres, natural levees, and spoil banks) are discussed in terms of probable energy pathways by classification of organisms as producers, primary consumers (herbivores and detritivores), or secondary consumers (carnivores), with emphasis on water and its relationship to nutrient transport.

## Introduction

This volume presents a description of the biological function of the wetlands, water bodies, and offshore areas of the Barataria Basin. This broad, low-lying region, representing the most recently abandoned Mississippi River delta complex and its adjacent estuarine and offshore waters, is characterized by a set of ecological parameters that are integrated into a complex, dynamic ecosystem of enormous biological productivity. To describe this system is the goal of this report, and the description must include interactions among components as well as an inventory of those components. The biological function of the basin is closely tied to physical and chemical processes; therefore these processes will be considered in terms of their effects on biological activity.

The Barataria Basin system can be divided into five primary environmental units and two secondary units (Fig. 1). Swamp forest, fresh marsh, brackish marsh, saline marsh, and the offshore area are the primary units. For the purposes of this discussion, intermediate marsh (sometimes considered an intermediate stage between fresh and brackish marsh) has been included with brackish marsh. These primary units are treated in order of increasing salinity regimes since net water flow occurs in this direction, and water is considered the major integrative element of the system. Beaches and other elevated areas (cheniers, natural levees, and spoil banks) are the two secondary units. Each of these basic environmental units is shown in Figure 1.

A brief general discussion of the total Barataria Basin is presented first, followed by a detailed description of each environmental unit. The latter accounts deal both with the general biological function of the environmental unit and with the distribution and abundance of various species and biotic groups in the environmental unit. Details on biological function have been derived from a combination of knowledge of the system itself and published information from other similar ecosystems and represent current thinking on principles that have long been recognized by ecologists. Each of the primary units is treated in terms of wetland proper (land that is alternately flooded and drained) and associated water bodies (all permanently inundated areas such as lakes, bayous, and estuaries).

Along with the functional description of a given unit is an inventory of organisms inhabiting it, including a characterization of the vegetation and an account of major vertebrate groups. Since the bulk of biological research in coastal Louisiana is still at the level of reconnaissance, knowledge of many groups of organisms is restricted to a simple list of what species are present. For other groups, some index of abundance is available, which may be a one-time estimate or may show seasonal or annual variations in numbers. Only a few species of plants have been studied in enough detail to fit into a rigorous energy flow scheme, and few animal populations have been examined to this degree, e.g., many functionally important but commercially worthless organisms remain to be examined.

Because many vertebrate species cross over into several environmental units, and because of lack of habitat-specific data for many species, mammals, birds, and amphibians and reptiles are treated in individual sections for the entire basin. Oysters, shrimp, and menhaden, because of their great economic importance and the special problems associated with working from harvest data, are also discussed in detail in separately published reports. In an additional report the principles of chemical nutrient cycling that prevail in the Barataria Basin are addressed, as these principles are extremely important to the biological activity in the region.

It should be stated here that the Barataria Basin is extremely dynamic and, like other sections of the Louisiana coastal area, is undergoing constant change owing to geologic and human processes. The Barataria Basin is a part of the geologically active Mississippi River deltaic plain, in an area that is subsiding and eroding. As man's activities in the area have increased, the already dynamic nature of the system has been magnified, and physical and biological changes are occurring at an ever-increasing rate.

One well-documented example of such change is the northward movement of oyster grounds in the Barataria Basin over the last several decades, which is presented in the section on oysters. The sessile nature of the oyster makes it an ideal indicator of the effects of changes in the physical environment on the habitats and distribution of some estuarine organisms. Motile forms, such as trout and menhaden, are more difficult to sample quantitatively, and the effects of habitat change on their distribution are less well known.

Because of the value and fragility of the enormous biological productivity in the Barataria Basin, planners must pay close attention to environmental changes and their causes and effects. To do this, a basic understanding of the biological function of the Barataria Basin ecosystem is essential. In the fishing discussion, unreferenced data are taken from Gosselink et al. (1976).

## Definitions

Several ecological terms that will be used throughout this discussion are defined as follows:

Primary production: The production of organic carbon through photosynthesis, the photochemical process by which oxidized carbon (carbon dioxide) in the atmosphere is reduced to organic carbon thereby converting solar energy to potential chemical energy. This process requires a biochemical catalyst (chlorophyll) and water as well as sunlight and inorganic nutrients and yields atmospheric oxygen as a by-product. It is the basis for all biological production.

Primary productivity: The rate at which autotrophs (see below) manufacture organic carbon, expressed as grams carbon or organic matter produced per unit area per unit time. Variation in primary productivity between different plants (and different ecosystems) makes this parameter extremely useful as an index of comparison.

Autotroph: Any organism capable of primary production. Autotrophs make up the first trophic level, or level of energy conversion, on which all other trophic levels are ultimately dependent. All green plants are autotrophic. A common synonym for autotroph is "producer."

Heterotroph: Any organism that cannot photosynthesize and thus requires organic carbon, either directly or via another heterotroph. A member of any trophic level above the autrophic level. A common synonym for heterotroph is "consumer."

Herbivore: A primary consumer or member of the second trophic level that feeds on living plant material, e.g., muskrat, aphid.

Detritivore: A member of the second trophic level that feeds on dead organic material, e.g., crawfish, bacteria.

Carnivore: A "flesh eating" heterotroph (predator or parasite), e.g., channel bass, Louisiana heron.

Detritus: Nonliving organic matter (predominantly of plant origin). Most plant material in the coastal zone ultimately ends up as detritus.

Respiration: The complete metabolic oxidation by living organisms of organic material. This process makes the energy of organic compounds available to an organism to do work. Respiration uses oxygen as well as reduced carbon and is equivalent to the opposite of primary production since the energy fixed during photosynthesis is released during respiration.

Energy flow: The transfer of energy from one trophic level to another via ingestion, or to the environment via respiration or egestion.

Standing stock or standing biomass: The density of a particular organism or group of functionally related organisms (e.g., autotrophs) at any given time or averaged over any given period of time, usually given as grams dry weight or grams carbon per unit area.

Eutrophic:. The term used to describe the "unhealthy" state of an aquatic environment, such as a lake or bayou, in which organic matter (especially autotrophs) and inorganic nutrients are too highly concentrated. Eutrophic areas are generally low in dissolved oxygen, especially at night when photosynthesis ceases.

Heterotrophic system: A community of organisms in which total respiration exceeds total production, i.e., local primary production is insufficient to support energy requirements and energy is imported from another area.

Species diversity: A measure of the relationship between numbers of different species and the total number of all organisms in an area. Several mathematical diversity indices are used in ecological studies, but in this report, the term is used in a qualitative sense only and refers to the number of different species found in a particular area. Species diversity is an index of stability in ecological systems, high stability being correlated with high diversity.

Natural selection: A process of elimination of organisms poorly adapted to their environment and survival of well-adapted individuals. Better-adapted individuals are most likely to reproduce and pass on their adaptive traits to their offspring.

Competition: A process by which two or more organisms or groups of organisms, of the same or different species, utilize the same resource (e.g., food) that is in limited supply.

This can result in both long-term (evolutionary) and short-term (behavioral) adjustments that alleviate the competition.

Several groups of organisms often referred to in the discussions of environmental units are based not on trophic relations but rather on life "style" or habitat. These groups are defined below:

Nekton: Large, actively swimming aquatic animals, both vertebrates and invertebrates, e.g., shrimp, finfish.

Phytoplankton: Nonvascular plants that grow suspended in water, primarily single-celled algae.

Zooplankton: Small aquatic animals that spend their life suspended in the water column, e.g., copepods, rotifers, and other small crustacea.

Macrobenthos: The community of larger animals that spend their adult lifetimes living on or in the sediments of aquatic systems. Generally, the sessile or relatively nonmotile forms, such as bivalves, are considered part of the benthic community, while decapods, such as shrimp and blue crabs, which are sometimes buried and sometimes swimming, are considered nekton.

Meiofauna: A somewhat ambiguous group of very small animals that are generally found in bottom sediments of aquatic systems. Nematodes comprise a major portion of total meiofauna. Although these organisms are very small, they are also very numerous, and often they are extremely important to the functioning of an ecosystem. They may, for example, play important roles in nutrient cycling.

# Overview of Ecological Functioning of the Ecosystem

The following brief description of some of the more obvious features of the Barataria Basin ecosystem of southeastern Louisiana includes division of the total system into five primary environmental units and two secondary units. At this time some general ecological principles are presented to demonstrate that the primary units are all interacting components of a coherent ecosystem, and that each possesses analogous features and functions.

A number of factors--the Mississippi River, the climate, and a set of biotic and physical gradients--have interacted to create the specialized and highly productive Louisiana coastal ecosystem, of which the Barataria Basin is a key component. The entire coastal region of the state, including Barataria Basin, is probably the most productive natural area in the United States and is among the most productive in the world. The Louisiana coastal zone supports the nation's largest commercial fishery, with the Barataria Basin during the period 1963-67 producing 30 percent of the state's blue crab harvest, 27 percent of the shrimp harvest, and 47 percent of the menhaden harvest. The basin also provides its share of Louisiana's fur harvest, which is also the largest in the nation. The basin sits at the terminus of the Mississippi flyway--the largest waterfowl migratory route in North America--and provides for millions of user-days of recreational activity. The Lac des Allemands swamps, at the headwaters of the basin, during the early decades of this century housed the world's largest cypress lumber industry, and the massive petroleum productivity of the basin is proof of the areas's biological productivity in past geologic times. In all, this tremendous biological productivity is immensely valuable and deserves to be understood and maintained.

Water is considered the prime integrating feature of the entire ecosystem, as will be discussed below. First, some background information is necessary. Ecosystems are not random associations of independent organisms. Rather, an ecosystem comprises an integrated set of interdependent biological components that are together preadapted to the local set of physical conditions in such a way that all basic biological functions can be carried out. Ecosystems go through stages of development (succession) following major physical disturbances. After maturation, an undisturbed ecosystem remains at a dynamic steady state, during which energy and matter coming into the system are balanced by losses from the system. Individual biological components are prevented from large fluctuations by control mechanisms developing simultaneously with maturation of the system. For example, competition for resources among populations of organisms and the process of natural selection together often lead to the development of feedback loops, preventing the domination of any one group. In other words, those resources that are in shortest supply control or limit the biological processes dependent on them. This control then becomes the basis for a biological cycle. For example, the addition of fertilizer to a pond or marsh area results in a temporary increase in primary production, but as the additional nutrients are incorporated into plant tissue, primary production slows down again. After depletion of existing stores of nutrients, subsequent production becomes dependent on the death and decomposition of living plants. Cycles of matter through an ecosystem are thus keyed to the generation time of individual populations. For example, the turnover rate of organic matter in the swamp forest is much slower than in the salt marsh, because the standing biomass (trees) in the former system is much greater and the generation time of trees much longer than that of oyster grass. A slow turnover rate indicates that a system would take longer to recover from a disturbance.

Large-scale cycles are also triggered by annual physical variations in light and temperature. These variations are most striking in higher latitudes, e.g., the temperate zone where plant production shuts down almost completely during the winter, resulting in dramatic annual pulses of production and consumption. In the Barataria Basin, which borders on a subtropical latitude, there is considerable overlap between production peaks of plants, and seasonal variation in production is less marked, although there is still a marked seasonal pulse of production.

Matter is recycled through ecosystems, but energy flows continuously through the system. Solar energy, the source of all biological energy, is captured in biological compounds by photosynthesis and then released to do biological work through oxidative processes such as respiration. All energy is eventually degraded into heat, which is released into the environment and is no longer available for work. At each tropic stage (primary production, ingestion by primary consumers, predation by carnivores, and death and decomposition of organisms) a large portion of the original energy is lost, and organic carbon is converted to carbon dioxide. Thus a large reduction in biomass production must occur at successively higher trophic levels. For example, predators require on an annual basis an amount of food in the form of prey organisms equivalent to perhaps ten times their own (predator) biomass. The relatively small predator biomass is crucial to the overall system, however, because predators act to regulate herbivores, and this feedback loop ultimately helps to prevent overgrazing by herbivores.

Ecosystems are organized around the first trophic level (autotrophs) on which the capture of solar energy depends. Wetland, marine, and freshwater ecosystems are thus organized around hydrophytes (plants requiring either total or frequent inundation).

Water is required by all living organisms but extreme differences in water requirements have, over millions of years, led to the separation of groups of organisms into systems with similar needs and tolerances.

## Effects of the Hydrologic Regime on the Ecosystem

Water not only supplies physiological requirements of living organisms; it also does work in an ecosystem in the form of transportaint material (Living and nonliving). The coastal ecosystem is regulated directly by water flow, and connections between the various subunits are mediated strictly by their intersecting network of waterbodies, which serve as conduits of matter and information.

The effect of water movement is illustrated by the edge effect, which is a major factor in the function of each primary environmental subunit. The edge or interface principle, briefly stated, indicates that biological (and chemical) activity is most pronounced at the boundary between a terrestrial and an aquatic system. In this sense an estuarine system is a giant interface. Marsh estuaries are considered to be among the most productive of all natural ecosystems.

Close examination of the present study area shows it to be composed of a multitude of edges or boundaries between water and wetland, and there is an apparent trend of increasing boundary surface from swamp forest to salt marsh.

Primary production in wetlands has long been known to be related to proximity to waterbodies Streamside marsh is always more lush than corresponding inland areas. Animal populations are also especially dense and diverse along the streamside. One reason for increased animal diversity at marsh-water interfaces is the fact that both terrestrial and aquatic forms can inhabit the interface zone, and enhanced prey density attracts more predators.

Augmented primary production in streamside areas is thought to be related to water movements, vertical and horizontal. Input of nutrients and flushing away of waste products are two key factors. Optimum productivity occurs between the extremes of excessive water movement, such as is shown on a high energy beach, and stagnation, which often results from disturbance of normal circulation.

The normal circulation patterns across the Barataria Basin are therefore key elements in the functioning of this coastal ecosystem. The biological community found at any location within the system, for instance, is to a major degree a function of the hydrologic regime (the patterns and magnitudes of all water movements) at that point.

Another physical factor regulating the various portions of the coastal ecosystem is water salinity, which is also closely controlled by the hydrologic regime. Salinity represents a physiological stress that is felt most strongly at the southern (Gulf) end of the basin and that is almost negligible in the swamp forest. The primary cause of the gradual decrease in plant diversity as we move seaward in the basin is believed to result from the increased ability of the few salt-tolerant species to dominate the more saline areas. Thus the species composition and function of the southerly end of the basin is controlled more by physicochemical parameters, while the highly diverse swamp forest is regulated more by intense biological competition among a variety of plants and animals.

An additional hydrographic aspect related to ecosystem functioning is the degree to which small waterbodies (bayous and creeks) meander. The tortuous meanders of natural bayous and tidal creeks are extremely important because they maximize interface area, also preventing rapid drainage of the system. Straight canals, such as are inevitably the product of man's "efficiency," not only decrease the water level in an area by augmenting flow rates, they often disrupt a natural drainage network and block normal circulation. For example, a man-made canal dredged across a natural stream will, by blocking and reducing normal flows, alter the downstream portion of the natural waterbody in a different manner than would a parallel canal that would increase flow rates (McHugh and Stone, unpublished data). Also, dredged canals often speed up salinity intrusion, which gradually turns brackish areas to saline areas.

Finally, the Mississippi River is a dominant feature of the hydrologic regime of the marine waters offshore from the Barataria estuaries and also those inshore. Surface salinities in Barataria Bay are partially dependent on Mississippi River discharge. The waters of the Mississippi River also strongly modify salinities in the offshore area, especially in surface waters. This fresh water is nutrient rich, high in nitrates as compared with bay waters that are ammonia-rich. Primary production is probably strongly influenced by these fresh waters, as is planktonic species composition.

In terms of man-produced impacts on the biological function of the Barataria system, the hydrologic pattern in the basin is of great importance because it serves as a means for the introduction and distribution of pollutants. A tremendous amount and incredible variety of industrial and domestic wastes are introduced via the Mississippi River and other waterways. These include heavy metals, pesticides, domestic sewage, and many others. In some cases these pollutants actually directly affect biological productivity of certain functionally or economically important species groups, and in other cases productivity is indirectly affected because species are rendered unfit for human consumption or use.

Just as hydrologic processes affect biological activity, biological processes also exert important forces on hydrologic regime, especially through the formation of wetlands. The major portion of marshland soils in coastal Louisiana is organic matter in the form of peat. This results from the continual production of marsh grass, some of which becomes buried and remains unoxidized. In general, the accumulation of peat and waterborne sediment trapped by marsh plants keeps up with the rate of coastal subsidence (sinking), and marshland maintains a "steady state" balance with sea level. If the marsh grasses are disturbed and their productivity decreased, however, the wetland rapidly sinks below sea level and becomes open water, which is considerably less productive.

Additionally, wetland is extremely valuable as a buffer to storm surges--even a narrow bank of marshland can reduce large waves to minor ones.

An in-depth description of the hydrologic and climatologic processes of the Barataria Basin is separately published in this series.

## Effects of Geological Processes on Biological Functioning of the Ecosystem

Although the coastal hydrologic regime integrates a set of biological processes and thus controls community productivity, this regime is itself a function of the long-term geological processes of sediment accretion and erosion and coastal subsidence. All geographical characteristics of the coastal area are basically the result of the Mississippi River with its historical switching behavior and massive sediment input. Descriptions of the geological history and processes of the Barataria Basin are separately published in this series.

When the river shifts into a new channel, land is built rapidly. Many minor distributaries serve to spread the water and sediment over fairly broad areas. Erosion takes place continuously, but the new delta is dominated by the river during the building stage of the cycle. The total length of land-water interface is relatively short during this stage.

As the river begins to seek a new channel and discharges more and more water through major distributary channels, erosion becomes increasingly more important in the delta area. (This process extends over a period of several hundred years.) As more land is lost, the interface length becomes longer owing to formation of small bays, ponds, and meandering tidal channels. Since total biotic productivity is a function of both interface length (related to the "edge effect") and total marsh area, total productivity for any one bay system reaches a maximum during the erosion cycle after inorganic sediment input diminishes. After this point is reached, however, the productivity losses owing to increasing erosion of marshland are greater than the productivity gains acquired by increasing interface length; therefore, total productivity begins to decrease.

Thus there seems to be juvenile, mature, and senescent stages of interdistributary bay systems. Land area is maximum in the juvenile stage and then decreases in the other two stages. The length of the land-water interface is low during the juvenile stage, increases to a maximum during the mature stage, and then decreases in the senescent stage. Productivity seems to be highest in the mature stage. Because the river has continually changed channels in the past, there have always been fresh juvenile estuaries waiting in the wings. It's similar to a relay race with fresh new runners waiting as the fatigued runner finishes his lap.

Today, however, this natural cycle of deltaic development is no longer operative. Because of artificial leveeing, the river is kept in its present channel and overbank flooding is eliminated. The present delta of the river has built up to the edge of the continental shelf and most of the river's sediment load is being emptied into deep Gulf waters where it is of no use in land-building processes. Yet, despite the fact that natural land-building processes have been all but eliminated, the natural erosion processes continue, with loss of wetland area augmented by activities such as dredging, leveeing, and drainage and reclamation. This biological activity in the Barataria Basin is threatened by the natural erosion process of interdistributary bay systems and by the augmentation of this process by human activities.

## Swamp Forest and Associated Water Bodies

A swamp is defined as a woody community occurring in an area where the soil is usually saturated or covered with water for one or more months of the growing season. The swamp community is strongly affected by water level and drainage. For example, cypress and tupelo are characteristic of the more poorly drained areas, and dense hardwood stands are found in slightly more elevated, better drained areas. A few centimeters of elevation in the swamp has been said to be more critical to the plant community than hundreds of meters in mountainous country.

The following discussion is based on information gained from the des Allemands swamp forest, the upper freshwater basin of the Barataria watershed. The area is funnel-shaped, beginning at the edge of elevated natural levee areas at the intersection of the Mississippi River and Bayou Lafourche and widening to the southeast between these two levee ridges. The swamp forest habitat merges with fresh marsh in the areas surrounding and south of Lac des Allemands and Lake Boeuf (see Fig. 1). Other small areas of swamp forest lie further seaward along the fringes of the natural levee systems of Bayou Lafourche and the Mississippi River.

In the Barataria drainage system, 242,048 acres of swamp forest comprise approximately 21 percent of the wetland of the basin. The ratio of wetland area to waterbody area is highest here and decreases in a seaward direction as waterbodies become more dominant.

Swamp forest is markedly different from other Louisiana wetland by virtue of its characteristic dense stands of woody vegetation dominated by bald cypress, tupelo gum, and drummond red maple. The swamp forest abounds with aesthetic beauty, related both to its complexity and color and to the profound impression gained by even a casual observer that such ecological processes as predation and competition for space are especially intense and dynamic here.

Maximum species diversity of the swamp forest plant community occurs at the environmental interface between wetland proper and water bodies. The wetland is described first, followed by a discussion of waterbodies within the swamp forest unit.

## Swamp Forest Wetland Proper

The boundary between swamp forest and fresh marsh in southeastern Louisiana corresponds approximately with the function of two major soil types, recent Mississippi alluvial soil occupied by swamp forest, and coastal marsh soils on which all marshland occurs.

Soil in the swamp forest (e.g., Mississippi River sediment) is composed largely of clay (38 percent), which is extremely fine and therefore has more surface area than soils composed of coarser particles. Surface area of soils affects their capacity to retain various chemical compounds including heavy metals. Swamp soils in the study area have a concentration of some heavy metals (copper, zinc, and nickel) higher than any of the other environmental units, although iron and inorganic chemical compounds such as sulfides are only moderately high in concentration.

During decomposition, detritus (dead organic matter, mostly plant) releases inorganic nutrients that are required for primary production (nutrients are required for the decomposition process as well). These nutrients accumulate in soils prior to being used by future generations of plants. Nutrient turnover rate (the rate at which nutrients are cycled through the system) is usually quite rapid in hot, damp systems such as swamp forests, where nutrients are used up soon after being released into the soil. Decomposition of litter occurs so rapidly in the swamp forest (and in tropical rainforests) that no buildup of organic matter (detritus) occurs on the forest floor. Soil chemistry is closely related to the flooding regime, which affects the composition rate of detritus and the inorganic oxidation-reduction reactions.

Significant accumulation of nutrients in wetland waters usually occurs only after a system has been disturbed as by impoundment, a disturbance that induces stagnation and prevents normal cyclic plant growth. Consequently, changes in flooding patterns affect the organisms that reside in an area and alter entire communities. In a recent study of swamp forests in Florida, Carter et al. (1973) found that drainage of the cypress forest initiated a canopy-thinning process that led to greater light penetration to the forest floor. The drier understory was unfavorable for litter decay and litter accumulation accelerated. Net primary production was reduced by 40 percent, posing a major threat to dependent wildlife populations.

Autotrophs and Primary Production

In the swamp forest system in the des Allemands area, four general categories of plants are found: trees, vines, herbs, and epiphytes.

Trees dominate total plant biomass, and, by occupying the upper level of growth, filter out most of the sunlight impinging on the system (only one-twentieth of the solar energy that strikes the canopy reaches the forest floor at peak leaf stage). A major portion of tree biomass, however, is composed of woody structural material that does not photosynthesize. Mean standing biomass of all autotrophs in the wetland portion of the swamp forest in the study area has been estimated to average about 3.5 $lb/ft^2$, of which trees make up the major portion.

True swamp forest, the more frequently inundated portion of the wetland, contains in addition to cypress and tupelo gum, swamp maple, and pumpkin ash, and a number of woody shrubs such as Virginia willow and button bush. The areas that are slightly drier than the cypress-tupelo gum swamps contain more diverse communities of swamp maple, tupelo gum, boxelder, cottonwood, and black willow. These communities are termed bottomland hardwood forests. Along the margins of old stream courses, bald cypress tends to fringe the streams along with swamp privet, water locust, and water elm. The natural levees, which are just slightly higher, yield red gum, overcup oak, bitter pecan, persimmon, hackberry, and cherrybark oak.

Conner (1975) has determined frequencies of occurrence of tree species for cypress-tupelo gum swamp forest and bottomland hardwood forest in the des Allemands swamp area. Most frequent tree species are given in Table 1 for both types of stands.

The most abundant forms of nonwoody vegetation in the swamp forest are climbing vines. Poison ivy, Evening trumpet flower, Greenbrier, Silva manso,

Table 1. Percentage of tree species in cypress-tupelo gum swamp and bottomland hardwood forest of the Barataria Basin.

| | |
|---|---|
| Cypress-Tupelo Gum Swamp | |
| *Taxodium distichum* (Cypress) | 33.33 |
| *Nyssa aquatica* (Tupelo gum) | 32.41 |
| *Acer drummondii* (Swamp maple) | 19.44 |
| *Fraxinus tomentosa* (Pumpkin ash) | 8.33 |
| Bottomland Hardwood Forest | |
| *Acer drummondii* (Swamp maple) | 25.00 |
| *Nyssa aquatica* (Tupelo gum) | 11.43 |
| *Acer negundo* (Boxelder) | 7.86 |
| *Populus heterophylla* (Cottonwood) | 2.86 |
| *Taxodium distichum* (Cypress) | 4.29 |
| *Cornus drummondii* (Roughleaf dogwood) | 8.57 |
| *Salix nigra* (Black willow) | 5.71 |
| *Ulmus americana* (American elm) | 5.00 |
| *Carya ovata* (Shagbark hickory) | 4.29 |
| *Fraxinus tomentosa* (Pumpkin ash) | 3.57 |
| *Quercus nigra* (Water oak) | 2.14 |
| *Celtis laevigata* (Hackberry) | 2.14 |
| *Diospyros virginiana* (Persimmon) | 3.57 |
| *Ilex decidua* (Deciduous holly) | 2.86 |
| *Quercus shumardii* (Shumard red oak) | 2.14 |

Source: W. H. Conner. 1975. Productivity and composition of a freshwater swamp in Louisiana. Master's thesis, Louisiana State University, Baton Rouge, La.

and *Ampelopsis cordata* are only a few of the types of vines found. Epiphytes, or nonrooted attached plants, are also very conspicuous, Spanish moss and Mistletoe being the most notable representatives. Ferns and lichens growing on trees are also common, and the latter have been suggested as important in the fixation of atmospheric nitrogen for use by higher plants. Herbs that grow on the swamp forest floor are not abundant because of a combination of long periods of inundation and reduction of light by the canopy of tree leaves.

## Primary Production and Primary Consumption

Calculation of the average annual productivity of the wetland portion of the swamp forest system was estimated at 0.20 $lb/ft^2$ (Burns, unpublished data). Turnover of organic carbon presumably occurs every 20 years, as derived by dividing total standing stock (4 $lb/ft^2$) by annual production (0.20 $lb/ft^2$).

Net primary production captures the energy that drives the entire system. Two major energy pathways are used for the distribution of organic carbon: (a) grazing of living plant material by herbivores, and (b) ingestion of dead plant matter (detritus) by detritivores. Wetland systems in general seem to favor the latter pathway; that is, they are generally detritus-based systems rather than grazing systems. The swamp forest in the study area is no exception to this pattern; it is estimated that at least twice as much energy enters the food web via litterfall as is grazed directly. Litterfall occurs in pulses rather than evenly through the year, and peak litterfall in the study area occurs in early winter.

Energy not consumed within the wetland proper is exported to the waterbodies; this exportation process is described below. Quantification of the standing stocks of primary consumers is at this point extremely crude, but one important member of the herbivore group includes an insect, the forest tent caterpillar (Malacosoma disstria). This ravenous larval insect was observed in the des Allemands swamp area during the first week of April 1974. It was observed feeding on tupelo, maple, willow, and cypress leaves but concentrated mostly on tupelo. These caterpillars have been estimated at densities up to 365 animals per $m^2$. In three weeks, few caterpillars could be found, but the tupelo trees had been almost completely defoliated. This defoliation often reoccurs several times in a year.

The tent caterpillar represents what is perhaps a very important mechanism for moving plant carbon from the tree canopy to the forest floor, packaged in small fecal pellets that are still green as they drop. There is some evidence that such grazing insects in forests actually stimulate tree production. They certainly move organic carbon to the forest floor during spring, a time when very little litterfall occurs.

Other herbivores (grazers) include deer, which according to published estimates may occur in densities of up to 1/30 per acre; rabbits, up to 1/3 per acre; squirrels, 1/4 per acre; and also many small rodents and seed-eating birds (the latter comprised by migratory forms).

Detritivores are of greater functional importance than are grazers in the wetland portion of the swamp forest system since detritus represents the major energy flow pathway. Detritivores in this system consist of a variety of organisms including insects, crustacea, microbiota, and fungi. The intensity and importance of the function of detritivores cannot be overestimated, as shown by the lack of detritus buildup on the forest floor.

No quantitative estimates of the relative contribution of various detritivores in terms of biomass are available, but crawfish seem to represent the most important macroscopic detritivore in the system. These animals mechanically shred leaves after they fall, thereby increasing leaf surface area and consequently hastening further decomposition by the microbial community. Other crustacea, notably freshwater amphipods and aquatic insect larvae, are also important in the fragmentation process.

The utilization of detritus energy seems to consist of a cycle of ingestion by detritivores followed by egestion of unassimilated cellulose material, which is then attacked by bacteria. The particles are enriched by the bacteria converting cellulose into bacterial biomass rich in protein. Often these enriched particles are then reingested by detritivores and converted into animal protein, available in turn to higher trophic levels via predation.

The microbial community in sediments on the swamp forest floor is partly made up of cellulose-decomposing bacteria critical to the mineralization of woody material, but other physiological types are present in abundance; fungal species are also very important.

Termites are extremely important detritivores in tropical rain forests and may function in the decomposition of woody litter in the swamp forest system under study, especially in those areas flooded less frequently.

At least two factors prevent the complete denudation by grazing species of all green plants in any natural ecosystem. One factor is an adaptive (evolved) process by which different plants produce chemical by-products either poisonous or unpalatable to many prospective grazers. The other factor involves the continuous predation on herbivores by carnivorous species. In general, total biomass of the predatory trophic level is far lower than is the standing stock of herbivores. However, the small upper trophic level is important for the continued existence of the natural system. Disastrous population explosions of grazing species have often accompanied the destruction by man of predatory species. Predatory species are generally the most sensitive to perturbations of a system, partly because they exist at the lowest densities and partly because they are often relatively specialized.

Carnivores in the wetland portion of the swamp forest system include spiders and voracious insects such as dragon flies that prey on other insects; reptiles, including snapping turtles, snakes, and alligators; mammals ranging in size from bats and shrews to bobcats; and insectivorous birds and raptorial birds, especially barred owls. Reptiles and amphibians are represented by more species in the swamp forest than in any other wetland subunit.

## Swamp Forest Associated Water Bodies

The constantly flooded portion of the swamp forest system consists mostly of bayous and accounts for only a small percentage of the des Allemands system along the proposed pipeline route. In general, these waterbodies are sluggish, turbid, eutrophic systems. The lakes adjacent to the swamps are rapidly filling in with rooted plants and organic sediments in the classic pattern of lake succession. For example, Lake Boeuf has markedly decreased in area and depth in recent years.

Waterbodies comprise considerably less of the total area of the swamp forest system than in other wetland systems in the study area and are thus less important in terms of total organic production. Instead they seem to serve the vital function of conduits of excess swamp forest production. Rainfall floods the entire system, and excess water flows slowly over the swamp forest floor, carrying with it detritus particles, organic decomposition products, and inorganic nutrients, and depositing them into bayous intersecting the wetlands.

### Primary Production

Primary production in the bayous is the result of (1) rooted aquatic plants such as coontail and fanwort found along the edge of the bayou; (2) floating and emergent aquatics, the most important being duckweed, water hyacinth, smartweed, and alligator weed; and (3) phytoplankton. The latter group is prevented from significant production because of reduced light in the water column owing to shading by overhanging trees and floating plants and by the load of sediment (organic and inorganic) in the water. Consequently, waterbodies in the swamp forest system are heterotrophic, with total consumption exceeding total production (the bayous more so than the lakes).

The higher trophic levels within waterbodies are supported primarily by detritus exported from the swamp forest floor. This export on an annual basis has been estimated at 0.04 lb organic matter per $ft^2$ of wetland. The large quantity of animal protein harvested annually from swamp forest waterbodies is thus directly a function of swamp forest wetland production rather than primary production within the waterbodies. Disruption or destruction of wetland production would therefore be reflected in reduced fishery production. This excess production washed off the swamp forest floor into the waterbodies is also exported from the swamp area to habitats to the south.

Awareness of this process of exportation of organic matter from the swamp forest region of the Barataria Basin to the lower marsh areas is necessary for a full appreciation of the integrated nature of the Barataria ecosystem. Day et al. (1976) calculated the exportation of organic matter, nitrogen (as $NH_4$-N and $NO_2 + NO_3$), and phosphorous (as available $PO_4$) from the des Allemands basin, taking advantage of the fact that approximately 90 percent of the water leaving the des Allemands swamp is carried by Bayou Chevreuil (the remainder flowing down Grand Bayou). Estimates for annual exportation from the upper basin were about 9,900 tons of organic matter, 940 tons of nitrogen, and 140 tons of phosphorous. This organic matter and nutrients are carried into the marsh areas where they can be used for further primary production or for consumption by marsh species.

In essence, the system of waterways connecting the various units of the whole basin acts in a manner similar to the circulatory system of man. Just as the blood carries food and oxygen to the body's cells, the bayous and tidal streams of the basin distribute organic matter and nutrients to the myriads of species forming the complete system. If something happens to damage the lungs, the entire body is affected because of a lack of blood-carried oxygen. The damage may occur over a long period of time, and deterioration of the lung may not be understood as the cause of the body's loss of vigor. Likewise, damaging the productive capacity of the des Allemands swamp forest will have long-term effects on the productive capacity of the entire Barataria system, even though the effects may not be readily visible and direct.

Primary Consumption

The most important primary consumers in the swamp forest waterbodies, both in a functional and economic sense, include crustacea such as amphipods, grass shrimp, and crawfish; flat worms and segmented worms; insect larvae; mollusks; and finfish, as well as the microbial community on which most detritivores depend for the nutritional enrichment of otherwise unassimilable cellulose-rich detritus. Another important group easily overlooked is the meiofauna, the community of minute animals living within the sediments beneath waterbodies. Amphipods appear to dominate, both in numbers and biomass, the detritivorous community in swamp forest waterbodies.

Predation

The upper trophic levels in swamp forest waterbodies contain a wide variety of animals including insect larvae such as midges, zooplankton such as rotifers and waterfleas, and nekton or actively swimming shellfish and finfish. One of the most prominent carnivores in swamp forest waterbodies is the catfish, which is estimated to occur at a density of up to 150 fish per acre of waterbody. Amphibians such as frogs, swimming reptiles such as water snakes, cottonmouth moccasins, turtles, and alligators, and swimming mammals such as otters also obtain at least a portion of their food within the swamp forest waterbodies. Diving birds, such as kingfishers, and wading birds (herons and egrets) often feed along swamp forest bayous as well. (See Survey of Coastal Organisms.)

Man's uses of aquatic animals from the bayous include many forms, notably the harvesting of crawfish, bowfin, bass, and catfish. In the des Allemands system (104 $mi^2$ of wetland and waterbodies) 2.5 million pounds of catfish were harvested in 1961.

Differences between bayous and lakes in the swamp forest system are related to the edge effect, as shown by the smaller relative area of interface between wetland and waterbody in the case of lakes. This results in the reduction of eutrophic conditions in lakes in comparison with bayous since organic material is added at a lower rate in lakes than in bayous. Phytoplankton levels are higher in the lakes, and as a result, primary production there is more significant, although the lakes in the swamp forest system are still considered heterotrophic. Lakes such as Lac des Allemands serve in a sense as water treatment systems or oxidation ponds, in which organic-rich water from the swamp forest proper is exposed to atmospheric oxygen and biological oxidation removes dissolved organic material.

## Organisms of Special Interest or Economic Significance to Man

Bald cypress: The bald cypress is extremely valuable as timber because of decay resistance, its very slow growth rate, and its beauty.

Tupelo gum: Gum grows faster than cypress and makes good timber since it is generally tall and straight.

Crawfish: The crawfish is harvested in quantity in the swamp forest study area and is commercially important as a food item. It is also an important food item for many game fish, including largemouth bass.

Pest insects: Of direct importance to man are the blood-sucking insects, mostly members of the order Diptera (true flies). These insects often have an aquatic stage in their life cycle and occur locally in all wetland areas from the swamp forest to the salt marsh. Various mosquitoes, gnats, green head flies, etc. attack both man and domestic animals. The forest tent caterpillar, which affects the tupelo gum and other trees used by man, also qualifies as a pest species (although its role may in some ways be beneficial).

Catfish: Although several species of catfish are harvested from waterbodies in the swamp forest and fresh marsh areas, the blue catfish and channel catfish are probably most important as a commercial food item.

Other finfish: Miscellaneous fish harvested in swamp forest waterbodies include largemouth bass, bluegills, black crappies, and bowfin.

Alligators: The alligator, which has been considered rare and endangered until recently because of overharvesting, is now making a comeback, and population in the des Allemands swamp forest area in 1973 appeared good.

Mammals: Swamp rabbits, deer, raccoons, and nutria are all hunted or trapped to some extent in the swamp forest study area.

Osprey: Fish hawks are rare in Louisiana and have been seen in the des Allemands swamp forest area. These birds are on the "blue list" of declining species of birds.

Red-shouldered hawk: Included on the blue list of declining species, this hawk has been seen in the des Allemands swamp basin.

# Fresh Marsh and Associated Water Bodies

The fresh marsh portion of the Barataria Basin lies primarily between the natural levee systems of the Mississippi River and Bayou Lafourche, beginning around Lac des Allemands and Lake Boeuf and reaching seaward to the points where the Intracoastal Waterway crosses the basin. The major waterbodies in this area are Lake Salvador and Lake Cataouatche.

In the Barataria drainage system, 223,488 acres of fresh marsh comprise approximately 19 percent of the wetland of the basin. In terms of area, waterbodies are probably more dominant in the fresh marsh area than in the swamp forest region, but are less dominant than in the seaward brackish marsh zone.

Marshland may in general be defined as a periodically flooded zone characterized by primarily nonwoody vascular plants. Freshwater marsh is somewhat more ambiguous and less readily defined than is the swamp forest unit or any of the other wetland units except perhaps the brackish marsh (fresh and brackish marshes merge almost imperceptibly) since the freshwater marsh is the most diverse in terms of numbers of plant associations.

Much of the freshwater marsh environmental unit is represented by flotant or floating marsh. Flotant consists of a dense mat of vegetation supported by detritus several feet thick, which is held together by a matrix of living roots. This floating marsh is indistinguishable from true wetland until trod upon and extends from the true shoreline of a lake into the lake itself. Eventually, as the bottom sediments and the floating layer each accumulate more material, they merge to form a new shoreline and the lake shrinks in size.

Typical marsh wetland in the freshwater marsh area is described below, beginning as before with sediment composition and the autotrophic component on which the total unit is energetically dependent.

## Fresh Marsh Wetland Proper

Chemical characteristics of soils in the freshwater marsh zone both regulate and are regulated by the kinds of autotrophs making up the plant community. One of the most obvious differences between swamp forest wetland and freshwater marshland is the increased thickness of organic sediment in the latter. Coastal marsh soils are of too recent origin to have developed layers, or horizons, such as are found in the recent Mississippi alluvial soils of the swamp forest system.

Detritus deposited on the surface of the fresh marsh remains partially undecomposed in some areas, resulting in a buildup of peat. Clay content of freshwater marsh sediment is slightly lower than in the swamp forest system, averaging about 33 percent. Organic content is approximately 65 percent, or double that of soils in the swamp forest. Sulfides, usually proportional to total organic content, are also relatively high in the freshwater marsh soils as are heavy metals such as copper, lead, zinc, mercury, iron, and manganese. The abundance of all such trace elements is a function of the hydrologic regime of the area and serves to ensure adequate supplies for autotrophs that require small amounts for normal growth and development, as do all living components of an ecosystem.

### Autotrophs and Primary Production

In the total fresh marsh maidencane or paille fine is dominant and covers about 34 percent of the total wetland. Spikerush and bulltongue are also common, but the latter is found as well in slightly brackish or intermediate salinity marshes, and its presence in a given area is considered evidence of occasional saltwater intrusion. Within all marsh types the growth patterns of different species vary, especially in the freshwater marshes, which are characterized by more plant species and groups of associated species than other marshes.

The percentage of occurrence of plant species in fresh marsh portions of the Barataria Basin are shown in Table 2.

At present not enough is known concerning physiological requirements of individual species to explain their distribution patterns; however, these patterns are undoubtedly a reflection of slight local differences in physical conditions such as elevation, inundation time, nutrient abundance, etc.

Table 2. Percentage of plant species in fresh marsh portions of Barataria Basin.

| | |
|---|---|
| *Panicum hemitomon* (Maidencane) | 41.35 |
| *Sagittaria falcata* (Bulltongue) | 17.42 |
| *Eleocharis* sp. (Spikerush) | 12.31 |
| *Alternanthera philoxeroides* (Alligator-weed) | 3.43 |
| *Cyperus odoratus* (Sedge) | 3.21 |
| *Typha* spp. (Cattail) | 2.59 |
| *Echinochloa walteri* (Water millet) | 2.15 |
| *Eichornia crassipes* (Water hyacinth) | 1.99 |
| *Bacopa monnieri* (Water hyssop) | 1.82 |
| *Polygonum* sp. (Smartweed) | 1.60 |
| *Scirpus olneyi* (Three-cornered grass) | 1.48 |
| *Zizaniopsis miliacea* (Giant cutgrass) | 1.36 |

Source: R. H. Chabreck, 1972. Vegetation, water, and soil characteristics of the Louisiana coastal region. Louisiana State University Agr. Exp. Sta. Bull. No. 664.

In all marshes there are three major groups of autotrophs: standing vegetation (mostly grasses with some broadleafed forms), epiphytes (microscopic algae on the surface of the vascular plants), and benthic algae (usually diatoms living on or in the marsh sediment). The latter group increases in significance during the winter months when the standing vegetation dies back allowing more light to impinge on the sediment. Epiphytes can significantly augment primary production year-round, in some cases producing more organic carbon than the "host" plants to which they are attached.

Net annual production for the entire wetland portion of the freshwater marsh system in the study area is roughly estimated (from limited data) to equal that of the swamp forest system (0.22 lb carbon/$ft^2$); this estimate could easily be low by a factor of three in certain areas. The fresh marsh may provide a nearly ideal environment for the emergent plants occurring there, since it provides a continuous water supply without the occurrence of the salt that presumably taxes plants in the saline marshes by forcing them to expend energy, constantly pumping out excess salt from their tissues.

Production in freshwater marshland is seasonal in nature, with peak growth occurring during May and early June, when nutrients are in abundance from the decomposition of the previous year's crop, sunlight is most direct, and the photoperiod is maximal. Nutrients in waters flooding the freshwater marshes decrease sharply in the spring during peak growth, presumably because of uptake by plants. Total live aboveground biomass of the autotrophic community is estimated to equal about 8,000 lb per acre in the freshwater marsh system.

Since the freshwater marsh system is generally beyond the most inland area significantly affected by tidal water level change, it is also restricted from the benefits derived from such "free work" as tidal flushing, stirring, and removal of litter, all of which accrue to marshland closer to the Gulf. Rainfall provides most of the flushing action in freshwater marshes. Occasionally prolonged southeasterly winds back up water in the entire wetland system until the marsh is covered.

Both swamp forest wetland and brackish marsh wetland are characterized by vegetation structurally more resistant to erosion during the winter than some of the dominant vegetation in the freshwater marsh area. During late fall the upper parts of broadleafed plants like bulltongue die back and disintegrate completely. Roseau cane, however, seems to remain in place, although its dead standing stalks are more open and not as dense as the nonliving portions of salt marsh grass. The freshwater marsh areas dominated by bulltongue appear strikingly barren during the winter months, in comparison with their lush green appearance in midsummer. Production by macroscopic vegetation thus appears to shut down almost completely during the winter.

Water movement appears to stimulate marsh production, and growth of emergent vegetation is almost always more extensive (taller and denser) at the edge of waterbodies than further into the marsh. Water movements in fresh marshland are related to gradients set up by rainfall patterns and the speed at which coastal wetland drains off excess water to its downstream marsh unit. Very little gradient occurs across the entire freshwater area, so currents are usually sluggish in most areas.

Primary Consumers

In all Louisiana wetland systems, including freshwater marshes in the Barataria Basin, herbivores appear to occupy a less prominent functional role than do detritivores, since the primary pathway of energy flow from producers to consumers in each system is via detritus. Of the grazers in the fresh marsh, however, insects could be the most important, ingesting probably more than 5 percent and perhaps up to 10 percent of net plant production (live). It is unfortunate, therefore, that practically nothing is as yet known of the insect component of the fresh marsh area, even though the insect community is probably simpler (composed of fewer species) than in more spatially diverse areas.

Of the few large herbivores in the system, nutria are probably the most significant, while muskrats are much less abundant than in more saline marsh systems. The plants that muskrats prefer (brackish marsh grasses such as three-cornered grass) do not occur in fresh marshes, and muskrats were estimated to occur at a density of only about 0.06 animals per acre. Nutria, however, do better in fresh marshes than in any other marsh type, since they feed on maidencane, bulltongue, cattails, pickerel weed, and water hyacinth. Nutria were trapped during one year in fresh marsh at a maximum rate of about 0.9 per acre, which represented a minimum estimate of their total density since all animals are never trapped. Deer have been observed grazing the fresh marsh area and are estimated to occur at a density of about 0.007 animals per acre (or one animal per 142 acres). Fresh marsh has also been estimated to be capable of supporting one rabbit per acre, which is a greater density than rabbits occur in any of the other wetland types; however, most rabbits reside in slightly elevated areas, such as spoil banks, and should not contribute significantly to grazing of marsh vegetation. Total grazing by all larger herbivores probably removes less of the net living primary production than does insect ingestion.

Detritivores

Detritivores in the fresh marsh wetland include most notably small crustacea (amphipods and mysids), which perform the role of shredding detritus fragments carried out by crawfish in the swamp forest. These detritivores occur primarily at the interface between wetland and waterbodies and could be considered members of either marsh component. Microbial forms in the fresh marshes (and all wetlands) represent the functional complement of the "shredders"; that is, bacterial populations are enhanced by increased surface area (substrate) resulting from mechanical shredding, thereby hastening the conversion of detrital carbon to bacterial carbon with its increased nutritional value to detritivores as well as higher forms of heterotrophs. Through this cycle dead plant tissue is transformed into high quality animal protein. Bacteria appear to show two peaks of abundance in freshwater areas, in spring and fall. It is thought that temperature in part determines the rate of colonization of peat particles in freshwater areas. Vegetation types seem to determine the density of various bacterial forms; e.g., cellulose decomposers are often relatively dense in peaty soils.

Fungi undoubtedly also contribute significantly to detrital degradation in freshwater marsh.

Four possible fates await the organic carbon produced within this system: (1) some dies in place and is deposited as incompletely decomposed detritus (peat); (2) some dies in place and enters the detritivore cycle described above; (3) some is grazed (live) by herbivores and subsequently turned into carnivore flesh; and (4) some is partially degraded and exported by rainfall-induced currents to waterbodies draining the marsh.

Carnivores

Of those animal species responsible for shunting energy into the third (or higher) trophic level, the following groups are important in the fresh marsh wetland area:

1) Predatory insects and spiders
2) Reptiles and amphibians
3) Insectivorous and raptorial birds
4) Predatory mammals

Practically nothing is known about either herbivorous or carnivorous (or parasitic) insects in marshes in general, although the density of biting flies and mosquitoes in some marsh areas makes them seem very important to man. Those predatory insects that are functionally most important, however, would be the species that help maintain a check on such grazing species as grasshoppers.

Reptiles and amphibians in freshwater marshes are represented most dramatically by the alligator, which is not present in great abundance in the Barataria Basin. Of the fewer than 10 other species of amphibians and reptiles identified in the fresh marsh area, most seem to occur in the brackish marsh as well and, in fact, alligators seem to favor the latter marsh area. Most of the reptilian species are seen primarily on elevated areas such as levees and spoil banks, rather than in the marsh proper.

Carnivorous birds in the fresh marsh area include: (a) insect eaters, such as marsh wrens, yellowthroats, egrets, and blackbirds; (b) wading birds and fishing birds such as bitterns and gallinules, herons, and egrets; and (c) raptorial birds, such as marsh hawks.

Other predatory animals in the fresh marsh area include: (a) snakes that feed on crawfish, fish, and amphibians; (b) mink, which feed on snakes, frogs, insects, herbivorous mammals, and birds, as well as fish; and (c) raccoons, which are omnivorous, eating insects, reptiles, shellfish and finfish, and plant material (see Survey of Coastal Organisms for further detail).

## Fresh Marsh Associated Water Bodies

Waterbodies of importance in the freshwater marsh area of the Barataria Basin include Lakes Cataouatche and Salvador and bayous and canals. Detrital material and dissolved nutrients washed into fresh marsh area waterbodies support food webs in the water column similar to those that occur on the wetland component.

Primary Production and
Organic Input from Wetland

Since waterbodies in the fresh marsh study area are generally proportionally small in relation to wetland, their primary function to the system is that of a conduit of material to more downstream areas. Primary production in fresh marsh bayous is overshadowed by a high concentration of organic material exported from the wetland proper. The system is both highly eutrophic and heterotrophic, and dissolved oxygen is usually low. Nutrient concentration in the water column seems slightly lower on the average than in bayous within the swamp forest, but not significantly so. The water is turbid and ill suited for optimum phytoplankton growth. The percentage of occurrence of aquatic plant species in fresh marsh areas of the Louisiana coastal zone in general is given in Table 3 (no data are available for Barataria Basin alone).

Table 3. Percentage of aquatic plant species in freshwater habitats for the Louisiana coastal zone in general.

| | |
|---|---|
| *Lemna minor* (Duckweed) | 15.26 |
| *Eleocharis* sp. (Spikerush) | 11.27 |
| *Ceratophyllum demersum* (Coontail) | 11.15 |
| *Myriophyllum spicatum* (Eurasian watermilfoil) | 11.03 |
| *Chara vulgaris* | 8.10 |
| *Utricularia cornuta* (Horned bladderwort) | 5.99 |
| *Najas guadalupensis* (Southern naiad) | 5.75 |
| *Nymphaea odorata* (White waterlily) | 4.93 |
| *Eichornia crassipes* (Water hyacinth) | 4.93 |
| *Cabomba caroliniana* (Fanwort) | 3.64 |
| *Potamogeton pusillus* (Slender pondweed) | 2.70 |

Source: R. H. Chabreck. 1972. Vegetation, water and soil characteristics of the Louisiana coastal region. Louisiana State University Agr. Exp. Sta. Bull. No. 664.

Similar forms of phytoplankton and floating aquatics occur in fresh marsh waterbodies as in the swamp forest bayous since the distribution of aquatic plants is often strictly dependent on individual salinity tolerances. Diversity and production of aquatic plants are partially controlled by both turbidity and flow rate; for example, water hyacinth and water lettuce only do well in sluggish areas. Many species of algae found in the waterbodies are probably washed out from the marshland proper.

Species diversity of phytoplankton is greater in the bayous and ponds of the swamp forest and fresh marshes than in other wetland types. Peak phytoplankton diversity seems to occur in August, but this pattern is based on few samples and phytoplankton is notoriously patchy in distribution. The most numerous forms are diatoms and blue-green algae; the latter forms often reflect generally eutrophic conditions.

Primary Consumers

Herbivores and detritivores in fresh marsh associated bayous are somewhat similar to the forms represented in the swamp forest waterbodies, namely zooplankton, and some nektonic forms; benthic animals including meiofauna; crustacea such as grass shrimp representing detritivores; and waterfowl.

Among the zooplankton, cladocera (water fleas, typical freshwater crustacea) and rotifers are always present in fresh marsh waterbodies. These strictly freshwater species are accompanied by freshwater copepods and, occasionally, brackish water copepods. During spring and fall the zooplankton population seems to peak in freshwater marsh bayous.

Little is known of benthic fauna in the freshwater marsh unit, although crawfish and freshwater shrimp are sometimes included in the benthic category. As salinities increase toward intermediate and brackish areas such mollusks as brackishwater clams (*Rangia cuneata*) occur (shells of this species have been heavily used for roadbuilding in Louisiana).

An edge effect of enhanced biological activity at the edge of a waterbody that is noticeable throughout the entire Barataria Basin applies to freshwater bayous since most benthic forms occur near the interface between marsh and bayou. Exposed root material of emergent vegetation at the edge of a bayou is often found teeming with amphipods. Amphipods assume even more importance in waterbodies in more saline marshes since aquatic insects drop out of the community of detritivores.

Nekton, in general, show a striking tolerance for salinity change, as well as a propensity to migrate long distances. This migration is especially important in true estuarine areas but also affects freshwater marsh areas since it is common for typically marine forms such as menhaden to migrate into freshwater areas. Herbivorous nekton important in the freshwater areas include carp, sheepshead minnow, and the wide-ranging menhaden.

In terms of the entire state of Louisiana, waterfowl (puddle ducks and diving ducks) are predominantly associated with fresh and brackish marshes; however, in the area under consideration this pattern is somewhat aberrant, since much of the local contingent of waterfowl are at present attracted to a brackish water impounded area near the seaward end of Bayou Lafourche. Puddle ducks are usually found in shallow ponds where their preferred food items, such as widgeon grass, occur. Diving ducks prefer deeper lakes (see section on birds).

Carnivores

The uppermost trophic levels in fresh marsh waterbodies include (as in the swamp forest) catfish, bowfin, bluegill, gar, crappie, bass, water snakes, and some occasional marine migrants such as blue crabs (which, in some respects, could perhaps be better classified as detritivores).

Wading birds such as great egrets seem to remove large but unknown quantities of primary consumers from fresh marsh bayous. These birds have been seen to migrate periodically between fresh marshes and more saline marshes nearer to the Gulf.

Reptiles, amphibians, and mammals presumably contribute the same (unknown) proportion of predation in fresh marsh and swamp forest water bodies, although alligators should be more important in the fresh marsh (see separate sections for detailed discussion of these vertebrate groups).

## Organisms of Special Interest or Economic Significance to Man

Water hyacinth: As the water hyacinth was introduced to Louisina, it has few natural enemies. It has become a pest species in sluggish waterbodies in the swamp forest and fresh marsh since it clogs the water surface and makes boat travel difficult. A recent shortage of the herbicide 2,4-D, which has been used in some areas to help control the plant, seems to be exacerbating the problem.

Puddle ducks: Valuable game birds, puddle ducks are prized by hunters and would normally be found mostly in fresh marsh waterbodies; but in the Barataria Basin much of the total population is displaced by the presence of a brackish water impounded area near Bay Champagne. This area is presently producing widgeon grass, the favorite food of these ducks.

Marsh hawks: The predatory marsh hawks normally occur in all marsh types and have been seen in the study area. They are declining in numbers and are, therefore, included on the blue list of declining species.

Alligators: Alligators should become abundant during the next few years since their population now is being regulated and protected.

Nutria: Since its introduction to Louisiana in 1949, nutria has become an important fur species and is trapped in some quantity.

Other mammals: Mink, raccoons, otter, and muskrats are also trapped for fur in the fresh marsh area. Raccoons and opossums are also eaten by man. Muskrats are less abundant in fresh marsh than brackish marsh areas.

Catfish: As in the swamp forest waterbodies, catfish are harvested in quantity from fresh marsh bayous and lakes. The blue catfish and channel catfish are the most important finfish species caught for food in fresh marsh waterbodies.

Other finfish: Bluegill, Largemouth bass, Black crappie, Bowfin, Pirate perch, Spotted sunfish, Carp, and other miscellaneous fish are also caught in fresh marsh waterbodies.

## Brackish Marsh and Estuaries

Between the freshwater and marine ends of the Barataria drainage basin is situated perhaps the most interesting environmental unit, at least from a theoretical standpoint. This is the brackish marsh area, which represents a true intermediate zone in several respects other than just salinity.

Evidence from many studies in different latitudes has given rise to an ecological rule-of-thumb that aquatic areas that are the most stable (unvarying) with respect to their physical characteristics, especially salinity and temperature are likely to show greater species diversity than areas of rapid change. Estuaries are defined loosely as inland bodies of water intermediate between fresh and saline systems and, therefore, mixing zones. They are also notoriously unstable (variable) in terms of salinity. Estuaries extend into the brackish marsh unit of the study transect, thus making the whole system a transitional zone.

The brackish marsh system represents the first unit strongly influenced by tidal effects. Both previously discussed units are characterized by predominantly unidirectional water movements resulting from rainfall runoff. In the brackish marsh, however, water level and salinity are also influenced by the level of Gulf waters at the coast, whether this level results from high tides or storm surges. This "back up" effect produces a complex pattern of water level change in the brackish marsh.

In the Barataria Basin there are approximately 229,824 acres of brackish marsh (including intermediate marsh, an additional category sometimes delineated between fresh and brackish marsh). This comprises approximately 20 percent of the wetland area of the entire basin. There is a significantly higher proportion of water surface than in the freshwater wetland areas to the north.

This brackish marsh area forms a band that stretches across the drainage basin from below the Intracoastal Waterway to the salt marsh fringing Barataria Bay and the many lakes and estuaries leading into it (Fig. 1). In the center of the basin, this band of brackish marsh is approximately 15 miles wide, tapering off as it approaches the Mississippi and Bayou Lafourche to either side. The major bodies of water in this region are Little Lake, Turtle Bay, and Bayou Perot.

Trophic (energy flow) relationships in the brackish marsh system are basically similar to the patterns already described for the two freshwater systems. The entire system is still considered to be detritus-based. Major functional components are described below, first for the wetland proper and then for the associated waterbodies, now considered estuaries.

## Brackish Marsh Wetland Proper

Soils of the brackish marsh unit are intermediate in clay content (16.5 to 30 percent) between swamp forest soils and the nearshore sandy sediment. In terms of organic content, however, the brackish marsh soil shows a higher level of both organic carbon and organic nitrogen than soils in any other unit (27.7 percent and 1.6 percent, respectively). Sulfides in brackish marsh soils, being closely related to organic content, are also maximal in this unit for the entire basin. This indicates a strongly anaerobic regime (devoid of oxygen) below the surface layer. Heavy metals such as iron and copper, often known to concentrate along with organic debris, are also found at high levels in the brackish marsh area, although usually no higher than what could be considered normal concentrations.

The water saturates the soil and fills the spaces between soil particles (termed interstitial water) to play a crucial role in the complex chemical exchange reaction between sediments and overlying water. Plant nutrient concentrations (nitrogen and phosphorus compounds) were higher in brackish marsh interstitial water than in any other area.

The brackish marsh may be a zone where fine particulate organic and inorganic matter is trapped. As fresh water flowing seaward encounters higher salinity water, the ionic constituents of the saline water tend to flocculate fine suspended particles in fresh water, which then settle out.

Autotrophs and Primary Production

Total overall net primary production for brackish marsh wetland is estimated to equal about 0.22 $lb/ft^2$ annually, as in both freshwater wetland systems. This estimate is perhaps the most speculative of all wetland production estimates since in all other wetland types being described there are comparable published estimates from studies on other geographic areas and since almost nothing is known concerning productivity of brackish marsh plants. Primary production even in a more stable and uniform area than brackish marsh seems to vary widely depending on specific chemical and hydrographic features of the environment in which a particular plant species is growing. Also there does not seem to be a constant trend from saline to fresh marshes from which intermediate values could be interpolated.

There are, undoubtedly, physiological advantages to marsh plants in freshwater areas, some of which have been mentioned above. Likewise, there are ecological advantages to plants in salt marsh environments, related both to tidal flushing and to the lessening of competition from plants intolerant to saline water. Presumably in the intermediate zone a lot of trade-offs occur between relative advantages and disadvantages of both extremes.

Empirical estimates of plant production rates in the brackish marsh have been based on the assumption of a strong positive relationship between biomass (amount present at any one time) and productivity (amount produced over a long period, usually a year). On this basis, the brackish marsh with its dominant producers (wire grass and salt grass) has the greatest live biomass of any marsh type. Wire grass does not grow tall or coarse as fresh marsh species like maidencane or Roseau cane but rather grows in extremely dense stands. Wire grass covers approximately 46 percent of the total brackish marsh wetland area, and significant increase in dominance of a single species over the case of the freshwater marsh area where the dominant species covered about 40 percent of the total area. This exemplifies the decrease in plant species diversity that occurs as salinity increases. Wire grass is also dominant in terms of total cover over the entire coastal marsh zone. Salt grass is the second most prominent plant in the brackish marsh wetland and together with wire grass comprises almost 75 percent of the total vegetative cover of the area. Table 4 lists the major brackish marsh plant species and their percent occurrence in Barataria Basin.

Table 4. Percentage of plant species in brackish marsh areas of Barataria Basin.

| | |
|---|---|
| *Spartina patens* (Wire grass) | 45.84 |
| *Distichlis spicata* (Salt grass) | 28.96 |
| *Spartina alterniflora* (Oyster grass) | 9.03 |
| *Eleocharis parvula* (Dwarf spikerush) | 5.49 |
| *Juncus romerianus* (Black rush) | 3.26 |
| *Scirpus olneyi* (Three-cornered grass) | 1.26 |

Source: R. H. Chabreck. 1972. Vegetation, water and soil characteristics of the Louisiana coastal region. Louisiana State University Agr. Exp. Sta. Bull. No. 664.

Primary Consumers

It has been estimated in the preceding discussion that herbivorous insects in the wetland freshwater marsh system could remove live plant material equivalent to up to about 10 percent of the annual net primary production. This estimate is based on two points: (1) insects increase in functional importance as salinity decreases; and (2) insects have been reported to graze over 4 percent of the net primary production in a salt marsh in Georgia. If the assumption of an increase in the proportion of primary production grazed by herbivorous insects in fresh marsh areas is valid, then insects should play an intermediate role in brackish marsh wetlands, i.e., perhaps 7 percent of the net live organic production is siphoned off via this pathway.

Among the larger herbivorous animals in the brackish marsh wetlands, the most conspicuous and possibly the most important is the muskrat, which finds brackish marsh most suitable to its life-style. These animals have been estimated to maintain an average population density in brackish marsh in the Barataria Basin of 0.6 animals/acre. Assuming that an average muskrat weighs about 2.2 lb, and since muskrats are known to eat at a rate equivalent to their total body weight every 3 days, then each animal must eat about 266 lb/yr. Muskrat density times ingestion rate therefore equals about 0.004 $lb/ft^2$ of primary production ingested by muskrats annually. This is equivalent to about 2 percent of estimated net primary production, which is quite significant when applied to the entire brackish marsh unit. Muskrat population density often exceeds the average figure used here, and overgrazing in some areas has been blamed for local marsh destruction. In addition, grazing by muskrats is often concentrated on root portions of marsh plants (tubers, etc.) rather than on the grass blades above ground, which reduces the ability of the plants to regenerate. Local areas of marsh destroyed by overgrazing by muskrats are known as "eat outs" (see section on mammals for more discussion of muskrats). These prolific herbivores serve as an important node in the food web of the marsh system, being preyed upon by many forms including reptiles, hawks, and mammals.

Rabbits and deer are not as abundant in brackish or salt marshes as in fresh marsh areas, and squirrels are absent. Small rodents such as rice rats are present at unknown densities.

Detritivores

The fact that a net buildup of detritus (as peat) occurs in the brackish marsh area indicates that a large portion of total net production is neither exported nor used by higher trophic levels within the system. Differences between the relative amounts of detritus used in brackish marsh as opposed to fresh or saline marshes are undoubtedly related to the different flooding regimes in each system and perhaps also to differences in plant structure, wire grass being more resistant to washing out into the estuaries.

Fewer species of benthic forms, which comprise the majority of detritivores, have been noted in brackish marshes than in other marsh types; however, at this point, data on densities of detritivores in the various wetland portions of marsh systems are not of comparable quality, i.e., more data is available for salt marsh detritivores than for species in other marsh systems. Nematodes, which represent probably the most abundant meiobenthic organism in sediments across the entire coastal transect and which are an important form of detritivore, made up about 60 percent of total numbers of animals found at the edges of brackish marsh estuaries. Amphipods, another extremely important detritivore group, are also abundant.

The brackish marsh area is widely used by penaeid shrimp (both brown and white) as extended nursery grounds. Both species immigrate from offshore into the wetlands while still in the postlarval stage. Here they become widely dispersed from saline to fresh marsh areas. They metamorphose to the juvenile life stage, settle to the bottom sediments, and become an important member of the benthic community, feeding mostly on organic material produced by marsh grass decomposition.

Much remains to be learned concerning the areas of wetland that are most valuable as nursery areas, but in general white shrimp seem to prefer less saline areas than do brown shrimp. Commercial concentrations of shrimp occur as far north as Lake Salvador during dry years. Both species emigrate offshore from the wetland as water temperatures begin to decline in the fall, and significant numbers of "yearling" shrimp reenter the wetland area the following spring to take advantage of the rich food supply.

As usual, the edge effect, or predominance of biological activity at the interface between marsh and waterbodies, applies to detritivores in the brackish marsh as well as in all other environmental subunits.

The microbial portion of the detritivore functional unit in the brackish marsh system appears relatively higher in biomass than in the salt marshes further south, probably because microbial density is generally related to organic levels, which are quite high in brackish areas.

Carnivores

Reference has already been made to the importance of muskrats in channeling energy to the upper trophic levels via an array of predators including alligators, various snakes, marsh hawks, and mink. Mink have been found to prefer fresh marsh to brackish marsh, but they become most numerous in the latter area during periods of peak muskrat density.

Marsh birds in brackish marsh areas become extremely numerous during spring and summer; some species are: King rail, Boat-tailed grackle, and Red-winged blackbird. Some of these birds, such as Boat-tailed grackle, have an extremely varied diet and will eat practically any small animal, including crustaceans and a variety of insects. Brackish marsh insects are also preyed upon by bats and by spiders in addition to other insects.

## Brackish Marsh Associated Water Bodies

In the brackish marsh area tidal effects first begin to play a part in determining the frequency and duration of flooding of marshland. Even though a net downstream (seaward) flow occurs, there is also the important effect of the inland movement of water, which not only serves to determine the kinds of vegetation on the marsh wetland but also aids in recirculating nutrients and allows the inland migration of larval forms of estuarine species, many of which are incapable of swimming upstream. Thus, although similar biological processes occur in freshwater bayous and brackish bayous, the latter differ physically in showing some alternating current patterns. Rapid physicochemical changes are characteristic of estuarine areas. Organisms residing in brackish marsh estuaries show remarkable tolerance to these rapid changes, and various physiological mechanisms have developed to allow these forms to maintain stable concentrations of salts in their body tissues.

Primary Production

Primary producers in the brackish marsh estuaries face the same general problem as in fresh marsh waterbodies--turbid conditions that limit photosynthesis. Floating aquatic plants are not prominent in brackish marshes since those forms that often cover the surface of fresh water bayous and lakes--such as duckweed and water hyacinth--are generally restricted to very low salinity areas. Most frequent aquatic plants in brackish water areas of the Louisiana coast in general are given in Table 5 (data for Barataria Basin alone are not available).

Table 5. Percentage of aquatic plant species in brackish water habitats for the Louisiana coastal zone in general.

| | |
|---|---|
| *Ruppia maritima* (Widgeongrass) | 62.69 |
| *Eleocharis parvula* (Dwarf spikerush) | 23.01 |
| *Bacopa monnieri* (Water hyssop) | 4.97 |

Source: R. H. Chabreck. 1972. Vegetation, water, and soil characteristics of the Louisiana coastal region. Louisiana State University Agr. Exp. Sta. Bull. No. 664.

Brackish marsh waterbodies show a marked difference between summer and winter conditions. During the winter, tides and tidal currents are generally low in amplitude, and waterbodies clear up allowing the growth of several macrophytes adapted to reduced temperature. Large mats of filamentous green algae sometimes clog the less saline waterways. During the summer higher turbidity levels restrict primary production in the waterbodies to phytoplankton, except for the shallowest areas, which are colonized by an important benthic diatom community.

Primary Consumers

Waterfowl, including the dabbling ducks prized by hunters, prefer brackish marsh for feeding grounds second only to fresh marsh. The total energetic effect of this grazing is unknown but could be significant in local areas in terms of plants removed. Diving ducks are also found in the brackish marsh and represent the most numerous group of waterfowl that overwinters in the state (see section on birds).

As in every other wetland system in the Barataria Basin, the dominant energy flow pathway in brackish marsh waterbodies goes from the emergent macrophytes (grasses) to the upper trophic levels via detritus washed into the estuaries. Some of this detritus is presumably of fresh marsh or even swamp forest origin, and some is locally derived. Approximately the same contingent of detritivores attacks brackish marsh detritus as in the freshwater marsh system, although most insect larvae begin dropping out as salinity increases to be replaced by species of crustaceans not found in fresh waters. One other group rising to prominence in brackish water areas is the class of segmented worms known as polychaetes, so named because of their possession of multiple pairs of bristles or chaetae. These predominantly benthic forms are important detritivores (and sometimes carnivores) in all estuarine and marine systems, especially in areas with fine sediments. Polychaetes represent a major food item of many predacious finfish and other carnivores. Nematodes, ostracods, and amphipods are also quite prominent in the brackish marsh detritivore community.

Among the brackish marsh zooplankton (floating microscopic animals), copepods are most often the dominant form. *Acartia tonsa* is a copepod species considered to be a typical estuarine form. This cosmopolitan animal, which is probably both herbivorous and detritivorous, serves as food for a great many nektonic species and can hatch, mature, and reproduce in less than 2 weeks.

Carnivores

Wading birds seem to have a prominent role among predators obtaining their food from brackish marsh waterbodies. This group, which includes various egrets, herons, bitters, and ibises, is represented year-round by many forms. The effects of wading birds include recycling nutrients such as phosphorus that are extracted from waterbodies by feeding and returned to wetlands proper by excrement. This pathway represents one of the few feedbacks or reversals in the usual net downstream flux of nutrients. Snowy egrets and Great egrets are the most abundant of ten species of herons and egrets in the Barataria Basin. Migration of wading birds is discussed below under the salt marsh description. Other terrestrial animals that "fish" in the brackish marsh estuaries include such mammals as otters and raccoons, birds such as osprey and kingfishers, and reptiles including alligators and water snakes. Reptiles may generally become less numerous as salinity increases across the coastal transect though populations have not been well sampled. (See sections on reptiles and amphibians.)

The carnivores most often associated with brackish and saline marsh estuaries belong to the nekton category. The voracity of some of these aquatic predators provides sport for a multitude of fishing enthusiasts and establishes a major trophic link between man and brackish marsh primary production. Tides and rainfall patterns both influence the movements of nekton into the brackish marsh estuaries.

Among the finfish species using brackish marsh estuaries for feeding are Spot, Southern flounder, Croaker, Sea trout (speckled trout), and Black and Red drum.

The Blue crab is a decapod crustacean that qualifies as both predator and scavenger and migrates extensively through the entire coastal area, sometimes being found all the way up into the swamp forest system. Blue crab larvae are restricted to relatively high salinities, but young adult crabs are capable of tolerating a wide range of salt concentration.

## Organisms of Special Interest or Economic Significance to Man

Alligators: Alligators seasonally range from the swamp forest all the way to the salt marsh, but probably will be most abundant in fresh and brackish marshes once the alligator population recovers from over-harvesting.

Marsh hawks: Hawks are found in all marsh types but are declining in numbers and are therefore included on the blue list.

Muskrats: Muskrats are valuable fur animals and are more abundant in brackish marsh than in other marsh types, since their primary food consists of grasses normally found in brackish areas.

Other fur species: Raccoons, mink, nutria, and otter are also trapped in brackish marsh areas.

Sport fish: Some typically salt marsh estuary or marine fish are caught in brackish marsh estuaries, e.g., sheepshead and spot. Other fish caught for food or sport include silver perch and finfish.

Blue crabs: Blue crabs are an extremely valuable food species that are harvested from brackish marsh estuaries in the Barataria Basin as well as from saline marsh estuaries and offshore.

Penaeid shrimp: Although only a very small portion of Louisiana's annual shrimp production is harvested within the brackish zone, this area serves as an important (but, as yet unquantified) nursery ground for juvenile shrimp.

# Salt Marsh and Associated Estuaries

More information is available concerning the salt marsh environmental unit than for any other coastal area. From a geological perspective, the salt marsh portion of the Barataria estuary is in a senescent (declining) state in which transgression or the gradual inundation of the wetland by marine waters is occurring. This process is gradual from a biological standpoint, and the erosion of previously stored organic material is possibly a factor in the well-known productivity of upper trophic levels in the southern portion of the basin, including the offshore zone. Historically, what is now salt marsh once probably resembled the present brackish marsh area, in which a net peat accumulation still occurs. The boundary between brackish marsh and salt marsh is gradually migrating inland as the whole coastal zone subsides. (For a detailed look at this process of salinity intrusion and its effects on oyster lease locations in the Barataria Basin, see the separately published report on Salinity Changes and Oyster Distribution in this series.)

Characteristics of the salt marsh area are normally more subject to modification by physical processes than are any of the other major units. Tides are diurnal (one tidal cycle per day) and average about 1 foot, although storm surges produce water levels much higher than the average high tides. A recent study in North Carolina shows that at least on the east coast, winter storms are becoming more severe and numerous (Hayden 1975). Seasonal variation in water level is important (highest average water level occurs in September and lowest from December to March). The wetland in the salt marsh is inundated infrequently during the winter, and winds are therefore critical to marsh flooding during low water-level periods.

In general, the salt marsh system, which is most closely affiliated to the physical regime characteristic of the Gulf of Mexico, is exposed to an average water temperature greater than 68°F, much rainfall, high solar radiation, and low wave energy.

The salt marsh region of the basin surrounds Barataria Bay and its interconnecting water bodies. There are approximately 158,080 acres of salt marsh wetland in the Barataria Basin, comprising about 14 percent of the basin's total wetland area. The wetland:water ratio is the lowest of all the regions considered.

As one flies an aerial transect seaward down the Barataria Basin, the highly irregular shoreline in the salt marsh, which includes numerous water bodies of all sizes ranging from bays to tidal streams and ponds, illustrates the important trend toward increasing total length of edge or interface between wetland and water bodies. The edge effect and its importance to wetland productivity has already been discussed.

## Salt Marsh Wetland Proper

Chemical parameters of sediments in the salt marsh wetlands of the study area reveal no striking variations or discontinuities from other wetland units, although there are differences related mostly to the higher salinities and to the erosional rather than the depositional character of the salt marsh. Organic carbon levels in the sediment are lower than in the brackish marshes and are similar to values for the swamp forest (about 6 to 9 percent). Sulfides in the marsh sediment are similar to values for swamp forest and fresh marsh areas. As expected, heavy metals (especially manganese and iron) are lower in the salt marsh than in other wetland units due to a decrease in clay in the sediment compared to more northerly areas.

### Primary Production

Of all the major wetland systems, the salt marsh unit shows the lowest number of plant species; *Spartina alterniflora* (Oyster grass) covers about 63 percent of the entire salt marsh system and up to 95 percent of the wetland in some local areas. This grass is remarkable for its salt tolerance--it can survive in sediments saturated with water varying from full oceanic salinity to freshwater--but it seems best suited for salt marsh areas where otherwise potential autotrophic competitors are excluded because of their intolerance to salt. Two other grasses are important in the salt marsh unit; Salt grass and

Black rush together make up about 25 percent of the total cover (see Table 6).

Table 6. Percentage of plant species in the salt marsh region of Barataria Basin.

| | |
|---|---|
| Spartina alterniflora (Oystergrass) | 62.79 |
| Juncus romerianus (Black rush) | 14.90 |
| Distichlis spicata (Salt grass) | 10.05 |
| Spartina patens (Wire grass) | 7.77 |

Source: R. H. Chabreck. 1972. Vegetation, water, and soil characteristics of the Louisiana coastal region. Louisiana State University, Agr. Exp. Sta. Bull. No. 664.

The highest production (growth) rate of Oyster grass occurs during late spring, but the highest live biomass does not accumulate until September. The grass produces seeds in the fall, then the upper (above-ground) parts die, and low water levels in the winter allow much of the dead grass to remain on the marsh. During the spring, as water level increases, much of the partly decomposed detritus is washed from the wetland into the estuaries. The spring salt marsh production peak seems to be related to the high average water level, which decreases after spring. Light could also be partially limiting to production late in the summer because Oyster grass belongs to a category of plants whose ability to photosynthesize increases with increasing solar radiation, even light levels beyond those at which most plants can respond. Therefore, at peak biomass some self-shading undoubtedly occurs. Some production by Spartina occurs year-round, since portions of the plant remain alive in Louisiana during the winter.

Other important primary producers in the salt marsh include an epiphytic community that lives on the lower portions of Spartina stems and benthic algae (mostly diatoms), which inhabit creek banks and exposed sediments such as mud flats, as well as the areas between Spartina stems. These two groups are probably most significant during winter and early spring before Spartina becomes dense.

Total annual salt marsh wetland production has been conservatively estimated for the present study at 0.2 $lb/ft^2$, the same estimate arrived at for each of the other wetland types. This estimate does not take into account, however, the unknown proportion of plant production exported into the salt marsh estuaries by tidal flushing. The effect of "free" work done by water movement, in the form of stirring, nutrient supply, oxygenation, etc., is probably greatest in the salt marsh that is most affected by both normal and storm tides than any other wetland units. Published estimates of salt marsh production have exceeded 0.6 $lb/ft^2$; the highest values usually apply to streamside grass where the edge effect enhances growth, and thus the salt marsh system again follows the general rule that plant production is highest at the edge of water bodies and decreases inland.

Two "side effects" of Spartina growth that seem to be of great functional importance to the marsh community are related to the extensive root systems produced by the plant. These roots impart a great deal of erosion resistance to the surface of the sediment. They also act as a nutrient "pump" to extract phosphorus from the anaerobic layers beneath the surface and transport it into the above-ground portions of the plant. Much of this phosphorus is then released into the surrounding waters when the marsh is inundated.

Primary Consumers

The major groups of primary consumers in salt marsh wetland (both detritivores and herbivores) include bacteria and fungi, meiofauna, snails, fiddler crabs, polychaetes, mussels, insects, birds, and mammals. Of these forms, only insects such as grasshoppers can be considered primarily as grazers. It has been estimated that insects account for the removal of about 4 percent of the net primary production in salt marshes in Georgia (Teal 1962), and there is no evidence to indicate that either more or less insect grazing occurs in Louisiana salt marshes. Of the remaining primary consumers, most ingest a combination of detritus and epiphytic or benthic algae. The density of animals in salt marsh wetland is not uniform but is related to distance from a water body (most biomass occurs about 10 feet from an estuary). Thus the edge effect is reflected in salt marsh flora and fauna just as it is in the other wetland systems. Total mean biomass of primary consumers in the salt marsh is estimated at about 0.003 $lb/ft^2$ at the edge of an estuary, increasing to a maximum of about 0.008 $lb/ft^2$, 10 feet inland, and then gradually declining further inland to about 0.001 $lb/ft^2$ (Day et al. 1973).

Fiddler crabs are one of the major components of the primary consumer community. These burrowing animals play an important role in turning over marsh sediments, exposing them to oxygenated water, and releasing nutrients from subsediments. Fiddler crabs feed by ingesting sediment particles, digesting organic material, and egesting unassimilated material. These crabs are an extremely important node in the salt marsh food web since a wide variety of animals including finfish, birds, and mammals use them as a major food source.

Marsh snails are the only primary consumers in the salt marsh that seem relatively unaffected by the edge effect in that they are more uniformly distributed throughout the marsh than other animals. These snails live on the stems of Spartina and graze on the epiphytic algal community found there. Horse mussels are found throughout the salt marsh, living half buried in the sediment. They ingest food filtered from the water-flooded wetland, and they seem to be extremely important in returning phosphorus to the water and sediments after releasing it from ingested food.

Bacterial biomass in salt marsh sediments varies with the amount of organic matter, but in general the highest bacterial populations occur at the edge of water bodies. There seem to be fewer bacteria in salt marsh sediments near the Gulf than in more inland areas. Of the total microbial flora in salt marsh sediments in the Barataria Bay area, about 1 percent were recently found to have the ability to break down cellulose. Species diversity of salt marsh bacteria is lower than in the fresh marsh areas.

Meiofauna and small macrobenthic forms that are important primary consumers in salt marsh sediments include such groups as copepods, amphipods, polychaetes, mites, insect larvae, and nematodes. Feeding habits of the latter group are not clearcut, since some nematodes feed on protozoa and some are strictly detritivores. The organic material ingested by nematodes is undoubtedly significant, since these minute animals are so numerous, occurring in densities expressed in six figures in one square foot of marsh surface. Total annual meiofaunal ingestion in the salt marshes in the study area has been calculated at about 0.02 $lb/ft^2$ (compared to about 0.04 $lb/ft^2$ for the important macrofaunal forms discussed previously).

Carnivores

Predatory species using the saltmarsh wetland as feeding grounds include the same general forms and often the same species that are found in brackish marshes. Insects, spiders, birds, and mammals are all included in the predator community. Reptiles, however, are relatively scarce in the salt marsh. The Gulf salt marsh snake occurs there, and alligators may use the salt marsh occasionally, but otherwise reptiles are not represented.

Among the bird groups, wading birds are preeminent in the salt marsh, although probably more of their prey are caught at the edge of water bodies than in the marsh proper. The edge effect discussed previously acts as a natural concentrator of fauna to give wading birds a distinct advantage over animals whose prey are more randomly distributed. These long-legged birds can stand in one spot and feed efficiently, with little energy expended for searching or chasing prey. Probably an enormous amount of food in the form of animal protein is removed from the marsh daily by wading birds. During breeding season, wading birds concentrate in heronries on marsh islands from which members of mating pairs alternate in feeding forays. Growing birds require proportionally more food than mature birds. Large quantities of bird droppings fall to the sediment beneath the nesting sites and the resulting nutrient input to the surrounding water has been shown in some areas to result in an unusually high density of phytoplankton, zooplankton, and probably fish. The same high concentration of nutrients from bird droppings occurs in roosting areas. Wading birds migrate daily between feeding and roosting areas; e.g., ibises are known to travel up to 50 miles for feeding. However, the pattern and effect of this migration remains to be worked out. Generally roosting occurs in elevated areas such as in mangroves, chenier areas, or levees.

Rails represent another predatory bird group that feeds primarily on crustacea. Shore birds such as sandpipers and plovers also feed at the marsh edge, especially in areas close to the Gulf.

Mammal predation in the salt marsh is exemplified by the raccoon, which feeds on practically anything including fiddler crabs, snails, rail eggs, and even some plant roots. No good estimates of mammal densities in the salt marsh are available; however, Day et al. (1973) lists raccoons as occurring at a density of 0.025/acre (see Survey of Coastal Organisms.)

## Water Bodies (Estuaries)

Interaction between wetland and water bodies is more pronounced in the salt marsh than in any other environmental unit. The higher proportion of water to wetland and the higher frequency of flooding of the wetland by estuarine waters in salt marshes tend to make the distinction between these two components of the marsh/estuarine system somewhat meaningless. Estuaries in the salt marsh system include bays and lakes as well as tidal rivers, bayous, creeks, and even artificial canals, although these man-made canals do not always function in exactly the same manner as do natural water bodies. Man-made canals are typically straight rather than meandering and are often lined with spoil banks higher than natural levees; thus they are limited in their exchange with surrounding wetland.

### Primary Production

The estuarine portion of the saltmarsh unit, especially the inshore waters of Barataria Bay, is shallow and turbid with muddy substrate and is unfavorable for macrophytic species (large aquatic plants). During the winter, however, some local areas such as small ponds and bayou edges become shallow and clear enough to support restricted numbers of these autotrophs. Most primary production in deeper areas results from phytoplankton, which is an extremely variable group both seasonally and in different estuarine areas. The salt marshes contain probably the least heterotrophic water bodies of all the wetland systems examined. This means that water bodies in the salt marsh zone more nearly than any other unit produce as much organic matter as is consumed there. One typical small lake (45 acres) examined near Barataria Bay was net producing during the summer and net consuming (heterotrophic) during the winter, presumably because of the seasonal nature of marsh grass input to the lake (Day et al. 1973).

Water bodies in the salt marsh unit are about one-half as productive as wetland proper (on an area basis), but the protein-rich algal production may be more usable in its original form than the cellulose-rich marsh grass.

Most numerous of the large phytoplankton types are diatoms, coccoid blue-greens, and coccoid green algae; however, perhaps the most important primary producers are the extremely small (nannoplankton and ultraplankton) algal cells that divide rapidly and account for about 90 percent of primary production in open oceans.

Primary Consumption

Detritivores. As in each other unit discussed previously, water bodies in the salt marsh are heterotrophic during most of the year and receive an energy "subsidy" from the salt marsh wetland and upstream marshes in the form of detritus. The edge effect applies to estuaries as well as to wetland proper in that the largest concentration of organisms occurs at or near the marsh water interface where detritus often accumulates. Samples of bottom sediment and detritivores taken from the edge of a lake or bayou in the salt marsh typically teem with a diverse group of detritivores, while the same kind of sampling in the center of the lake or bayou often yields nothing but nematodes.

Herbivorous nekton. The salt marsh estuaries are perhaps best known as nursery ground areas in that immature nekton migrate into the inshore areas during their peak growth period when their food requirements are greatest. It has been noted that the annual immigration of many of these groups occurs in spring, coinciding with the time of peak phytoplankton production in the water bodies and maximum export of reworked detritus from the marshes. Much information has been gathered on immigration times of such commercially important species as penaeid shrimp (white, brown, and pink shrimp). Menhaden and mullet are major herbivorous finfish species that use the estuaries as nursery grounds. Menhaden growth is highest within Barataria Bay, but the fish are harvested mainly offshore (see separately published reports on shrimp and menhaden in this series).

The above familiar primary consumers and numerous other noncommercial nektonic species feed on a combination of detritus, phytoplankton, and some zooplankton.

Zooplankton as a group is composed of a loose assemblage of unrelated animals including small crustacea, as in the less saline wetland systems, decapod larvae such as blue crab larvae, and large planktonic forms that are actually carnivores, such as comb jellies (ctenophores) and sea nettles. Ctenophores often are considered a major factor in the control of small zooplankton.

Zooplankton in estuaries are clearly dominated by the copepod *Acartia tonsa*, which is the only form that maintains a large resident population year round. Spring and fall peaks of zooplankton are characteristic, but this pattern is not clearcut since different species become abundant at different times.

Predation in Salt Marsh Estuaries

Wading birds and their role of predation at estuary margins have been mentioned above. The other large bird predators in the estuaries include fishing birds (such as white and brown pelicans, skimmers, gulls, terns), diving ducks (such as scaup and mergansers), and now, rarely, ospreys. Feeding habits of these birds vary;

e.g., white pelicans feed close inshore, while brown pelicans fish in open water, the latter feeding chiefly on menhaden and mullet. A small colony of brown pelicans has apparently been successfully reestablished in coastal Louisiana. The entire population congregates in one rookery to breed in the spring. The rookery is on Queen Bess Island in Barataria Bay.

A prominent carnivore in salt marsh estuaries and offshore areas is the bottlenosed dolphin, a mammal whose pursuit of fish leads far up the coastal waterbodies, at least to the northern limit of the salt marsh system.

The most familiar carnivores in the saltmarsh estuaries are such sport fish as Spotted sea trout, but many smaller finfish are also important predators including Mosquito fish, Killifish, Sea catfish, and the extremely abundant silversides and anchovies. Anchovies have been described as the most abundant finfish in inshore waters.

## Organisms of Special Interest or Economic Significance to Man

Pest insects: Salt marsh mosquitoes are the most predominant marsh mosquitoes in southeastern United States. Biting midges (no-see-ums) are also quite abundant at times near salt marshes.

Fur animals: Trapping of mammals for fur is somewhat less important in salt marshes than in less saline marsh areas because fur quality is generally lower here. Some raccoons, muskrats, and mink are harvested, however.

Sport fish: In salt marsh estuaries sport fishing is aimed at such important game and food fish as red drum (red fish), spotted sea trout (speckled trout), sand trout, sheepshead, croaker, flounder, and pin fish.

Blue crabs: The blue crab ranks third in total poundage of all commercial fisheries in Louisiana, and fourth in dollar value, after shrimp, menhaden, and oysters. Blue crabs are very abundant in salt marsh estuaries in the basin (Barataria Bay shows the highest per acre yield of blue crabs of any Louisiana coastal area).

Menhaden: Menhaden is an important commercial fish and is more concentrated within salt marsh estuaries than offshore but is harvested only offshore. The menhaden fishery is the largest in total poundage of any Louisiana fishery and second in total dollar value (Stone 1976).

Penaeid shrimp: Brown, white, and pink shrimp are harvested both offshore and within the salt marsh estuaries and bays. The shrimp harvest is the most valuable fishery in Louisiana, accounting for about 60 percent of the total dollar value. The Barataria and Terrebonne estuaries, which encompass the study area, are the most productive shrimping areas of the state (Condrey, in preparation).

Oyster: The oyster fishery is economically very important in coastal Louisiana (third in dollar value). The locations of major oyster leases in the Barataria Basin have shown a net movement inland in past decades due to salinity intrusion in the lower basin areas (Van Sickle et al. 1976). Oysters and other bivalves are often used as indicators of heavy metal pollution since they tend to concentrate in their tissues amounts of heavy metals which are proportional to those found in their environment. Unpublished data from Dr. Clara Ho (Louisiana State University Center for Wetland Resources, Baton Rouge, La.) give heavy metal concentrations in oysters collected from areas just east of the Mississippi River. The following concentrations were found:

| | |
|---|---|
| Zinc | 200-281 mg/100 g dry wt |
| Iron | 61-68 mg/100 g dry wt |
| Copper | 12-22 mg/100 g dry wt |
| Mercury | 15-138 ppb wet wt |

These levels are all below FDA allowable levels in oyster meat. Levels indicate that selective absorption of zinc occurs since in the sediments: Fe>>Mn>Zn>Cu; whereas, in the oyster: Zn>>Fe>Cu>Mn.

Brown pelican: The entire Louisiana population of introduced brown pelicans has established a nesting site inside Barataria Bay on a small island (Queen Bess Island).

White pelican: Many white pelicans can be observed in the salt marsh area. These birds are considered rare enough to be placed on the blue list.

Reddish egret: This wading bird is becoming rare and is now on the blue list. A few can usually be seen in salt marsh and beach areas.

Other rare birds: The following birds are all becoming rare and are on the blue list. They are not limited to the salt marsh study area but have been seen in various wetland portions of the entire basin: Osprey, Black vulture, Loggerhead shrike, and Peregrine falcon.

## Offshore Areas

The combined net organic production exported from all four wetland units is eventually transported to the Gulf via the water bodies that drain the entire coastal ecosystem. This integrated result of wetland primary production consists of a complex of organic matter ranging from relatively undegraded plant fibers to high quality animal protein in the form of nekton, which, having entered the estuaries to take advantage of concentrated food sources, emigrate back to open waters taking their estuary-enhanced biomass with them. Export of wetland production in the form of such highly processed energy represents the culmination of a complex series of natural processes, all carried out at no cost to man, but from which man reaps the final product.

The physical characteristics of the areas offshore from the Barataria Basin are atypical of most marine systems in that they are strongly influenced by the Mississippi River. Every day 361 billion gallons (10 million $m^3$) of fresh water and tons of dissolved and suspended matter are dumped into the Gulf roughly 50 miles to the east of the waters off the Barataria estuary.

Rather than mixing immediately, however, the fresh water forms a huge plume, which, being less dense than Gulf waters, floats on the surface and moves in variable directions, depending on winds, tidal currents, and oceanic currents. Sometimes the plume forms a giant gyre that sweeps in a clockwise direction and directly impinges on the Barataria offshore area. Surface salinities at Barataria Pass then drop to low brackish levels. Surface water salinity in the Barataria offshore area varied from 9.3 to 31.8 ppt during a study conducted in 1973-74. Mid-depth and bottom water showed less change, however. When the difference between surface and bottom salinity was greatest, heavy metal concentrations in the water seemed greatest, but heavy metals never exceeded normal concentrations.

It has been suggested that the richness of fisheries in marine waters off Barataria and Terrebonne Bays (exceeding any other area of the state) are at least partially the result of the entrapment of offshore marine animals prevented from eastward migration by the freshwater discharge of the Mississippi, and by the modern delta, which extends to the edge of the continental slope, resulting in an extremely narrow and restrictive shelf area adjacent to the delta.

A phenomenon that is possibly also related to the Mississippi River discharge has been noted in the waters offshore from Barataria Bay. This is a large mass of oxygen-free water of undetermined spatial and temporal distribution. Similar smaller zones of oxygen deficit have periodically been noted in offshore areas adjacent to Mississippi Sound. These occurrences have been called "jubilees," and they are often correlated with periods of high freshwater discharge from land and high temperature. The name refers to the mass emigration of decapod crustacea and fish toward shallower water in an effort to flee the oxygen deficient area. The mechanisms that cause the oxygen deficit are not yet understood, although they are possibly related to the density gradient set up by the fresh water plume of the Mississippi River. Relatively warm fresh water floating on top of the colder more saline bottom water discourages mixing and effectively isolates the bottom layer. High levels of organic matter in bottom sediments, which have been found in the offshore area, indicate rapid uptake of dissolved oxygen from the water covering these sediments. Thus the bottom water could become oxygen deficient. A large area of bottom waters appears to be affected, perhaps 1,000 square miles or more. In the lowest 2 or 3 meters of water sometimes no oxygen can be detected. If winds and tidal currents displace the surface waters in an offshore direction, the oxygen deficient bottom water can be displaced into shallower water, resulting in jubilees and fish kills. A fish kill in the area during July 1973 appears to have resulted from such a phenomenon.

Whether or not the development of large areas of deoxyngenated bottom water in the area offshore from Barataria Basin is becoming more frequent is not known. The chemical characteristic of the offshore environmental unit is affected by the onshore units in terms of export of organic material from the estuaries to the Gulf (outwelling). They are also affected as noted above by the Mississippi River drainage. Nearshore waters are generally higher in nutrients and trace elements than waters farther offshore. A recent study has shown a distinct gradient of total organic matter (suspended and dissolved) in water along a study transect beginning inside Barataria Bay and extending into the nearshore waters of the Gulf. However, examination of the more offshore portion of the study area has revealed no clear trends or gradients of either inorganic nutrients or organic material in Gulf waters.

Primary Production

No direct measurements of primary production have been made in the offshore study area; however, extrapolations from other similar areas are feasible based on kinds of autotrophs present and also on estimates of the density of primary and secondary consumers supported partially by these autotrophs and partially by energy exported from wetland systems.

The flora of the Gulf is made up almost entirely of planktonic species, with macrophytes being limited to man-made structures such as oil production platforms. About 35 species have been enumerated in past studies and diatoms and dinoflagellates are dominant. The highest number of species and the greatest density of algal cells have been found at the nearshore sampling locations.

As in the saline inshore waters, it is likely that the most important primary producers in the open Gulf are nannoplankton and ultraplankton, which are too small to be retained by a normal plankton net and which are believed to account for 90 percent of primary production in open ocean waters.

Phytoplankton require sunlight that penetrates deep water bodies to an extent highly dependent on the turbidity of the surface waters. Sunlight energy required for primary production is available only in the upper layer or "euphotic zone," which in the study area is fairly shallow.

Primary Consumption

Zooplankton comprise a major link between primary production and higher trophic levels in the offshore Gulf waters. The dominant copepod, *Acartia tonsa*, has been found in peak densities exceeding $57/ft^3$ in June. This species and many other zooplanktonic crustacea seem capable of ingesting both phytoplankton and detritus particles. Total zooplankton density in the Barataria offshore area is highest at the more nearshore locations, corresponding to the phytoplankton concentration gradient. Zooplankton are most numerous during early summer and least numerous during the winter.

Of the finfish such as mullet and menhaden that represent major detritivores in the offshore and estuarine systems, there seems to be a trend of trophic change paralleling growth and development of the fish. Many fish that seem to feed rather indiscriminantly as adults and are considered filter feeders are more selective as larval and young fish and actually search out individual food items such as small zooplankton forms like the copepod Acartia tonsa. This trend of changing diet with size seems to apply to anchovies, croakers, silversides, and threadfins, as well as to mullet and menhaden. Menhaden represent the largest portion (by weight) of total fisheries harvest in Louisiana and comprise a major portion of the total primary consumer biomass in offshore, nearshore, and estuarine waters. There is some evidence that present yields of menhaden in the waters off Barataria Bay are near the maximum that can be sustained. Peak concentration of menhaden occurs off the Barataria estuary.

The passes connecting the salt marsh estuaries of Barataria Basin with the nearshore waters beyond the coastline are major thoroughfares for a variety of species in various stages of their life cycles. Most nektonic species (shrimp, snappers, groupers, drum, menhaden) spawn offshore, the larval stages being carried inshore into estuarine waters where they grow rapidly, and then the juvenile organisms begin moving back out to sea to complete their life cycle. Speckled trout show a different life history in that they generally spawn in inshore waters. The major movements through these vital passes are inshore during the spring and seaward during fall. Menhaden are classed as unusually "early" fish, in that they begin moving inshore in winter and are generally gone from the estuaries by midsummer.

During a past study detritivorous (as well as carnivorous) nekton seemed to be more abundant in shallower (nearshore) and deeper (offshore) locations than in the intermediate area associated with low oxygen bottom water. Total nekton seemed to decrease from east to west. Among the detritivorous finfish captured during sampling, the Bay anchovy was most abundant at three out of four locations.

Shrimp, including the commercially important Sea bob, Brown shrimp, and White shrimp, comprise only about 2 percent by weight of nekton samples. These species are, however, of great economic value to the people residing in and around the Barataria Basin. Shrimp ecology is discussed in some detail in a separate publication in this series.

Often the specific forms making up the benthic community are determined by the bottom sediment into which many of them burrow. Benthic macrofauna that burrow and feed on detritus in the sediment or filter it from the water as it settles include mollusks such as clams, many species of polychaete worms, and echinoderms such as sand dollars and sea cucumbers. Another group of benthic organisms resides on the upper surface of the bottom or on something hard such as a shell, and this group characteristically filters particles from the water. These epibenthic forms include minute bryozoa, sponges, barnacles, some polychaetes, and mussels. Motile forms such as mud crabs, mud snails, and amphipods crawl over the bottom and scrape detritus from the surface.

The rich benthic community (which in turn is the source of food for bottom feeding nekton such as flounders) is thus dependent on a continual rain of detritus from the upper euphotic zone of the offshore waters. A community of much smaller benthic meiofauna or interstitial animals such as nematodes, small crustacea, and ciliate protozoa also resides in the rich sediments on the bottom of the Barataria offshore zone and, together with the microbial community, makes up another major portion of the benthic detritivore complement. Insects are conspicuous by their total absence from this and most other marine communities.

During a recent study of the benthic community in the offshore study area, samples contained an average of over 84 macrofaunal organisms per square foot although density of this community decreased sharply beyond 50 foot depth. The deepest sampling locations showed only one fourth the number of animals found closer to shore. Polychaetes were usually dominant, and maximum density was found in June.

Carnivores

Predators in the offshore study area are comprised essentially of the same groups (if not identical species) that are found in salt marsh estuaries, except for those relatively rare forms avoiding shallow turbid areas because of their high oxygen requirements. These are the large, fast-swimming forms such as Blue marlin, which are prized as game fish by deep sea fishermen. Commercially harvested carnivorous finfish taken in or near the study area include Spotted sea-trout, Red snapper, King fish, Black drum, Red drum, Flounder, and a number of lesser species. Fishing from oil well platforms in the study area often yields Red snapper, Amberjack, Bluefish, and Cobia.

Some predacious invertebrates are restricted to marine salinities, including echinoderms such as starfish and some boring snails. Both of these groups feed largely on bivalves.

Predatory birds that feed offshore include gulls such as the Laughing gull, Ring billed gull, and Herring gull; several species of terns; Man-o-war or frigate birds; and Brown pelicans. Often the latter birds can be seen perched on oil well platforms.

Reptiles are normally not found in the northern Gulf of Mexico, with the exception of the Green sea turtles that are occasionally drowned in shrimpers' nets. Man represents the most significant predator in the offshore area; and a major source of the energy required to support the food web from which man harvests his prey is the coastal wetland system, which annually exports a portion of its net production into offshore marine waters.

## Organisms of Special Interest or Economic Significance to Man

Penaeid shrimp: Brown, white and pink shrimp, and the small form known as the Sea bob are harvested mainly in the Gulf and bay waters. These shrimp represent the most valuable fishery in Louisiana in terms of dollar value.

Green sea turtle: Although the Green sea turtle does not maintain nesting grounds on the north shores of the Gulf of Mexico, these large reptiles occur in offshore waters of the study area and are sometimes drowned in shrimpers' nets. They are considered rare and endangered.

Brown pelican: The Brown pelican, a fishing bird, obtains its major food item (menhaden) mostly in the offshore area.

Lesser Scaup: As a common waterfowl the Lesser Scaup feeds offshore and is an important game bird (in southeastern Louisiana) in the salt marsh area.

Menhaden: The maximum harvest of menhaden in one year in Louisiana was about one billion pounds, but the average catch per unit effort has been decreasing, indicating that the total net production is being harvested. Essentially the entire commercial harvest of this fish in Louisiana waters occurs off Barataria and Terrebonne Bays (1,070 lbs per acre) (Stone 1976).

Other commercial or sport finfish: Spotted sea trout (speckled trout), Red snapper, King fish, Black drum, Red drum, Flounder, and a number of lesser species are all caught on a commercial basis offshore in the Barataria Basin.

# Beaches

The beach areas of Barataria Basin represent an extremely small area in proportion to the wetland systems of the basin. These areas are subject to varying degrees of wave energy and are important owing to their ability to defend more vulnerable marsh areas from the eroding effects of waves, tides, and storm surges. The sands forming these beaches portray a net westerly drift, and in some areas, such as that around Bay Champagne near the mouth of Bayou Lafourche, rapid erosion and a dearth of available sand produces a retreating beach with practically no dunes.

In most beaches there is a community of minute detritivores and predators living totally unobserved to the casual observer in the lower forebeach in the interstices between sand grains. This community of microbes and small meiofauna (predominantly crustacea) is supported by organic carbon filtering onto sand grains from the marine water that soaks into the sand. Thus a system is set up somewhat comparable to a trickle filter used in the treatment of sewage. Stirring by the surf ensures adequate oxygen supply for respiration, and the community is quite active. Shore birds such as plovers, sandpipers, and willets represent a major beneficiary through predation of the community of animals residing on the beaches. Plovers are known to feed mainly on flea hoppers rather than meiofauna. Small fish feed both on meiofauna and the larger benthic macrofauna, such as butterfly coquinas and other bivalves.

## Beach Vegetation

Sauer (1967) states that "the dominant coastal species are all evergreen perennials, showing remarkably little seasonal change in aspect." Many are xerophytic and adapted to natural disturbance and can thus persist in areas heavily occupied by man.

Brown (1951, unpublished manuscript) noted plants along a transect across Grand Isle near the old LSU Marine Laboratory.

Along the leeward edge of the island is a band of low salt marsh consisting of Oystergrass

(Spartina alterniflora), Saltgrass (Distichlis spicata), Black rush (Juncus roemerianus), Black-mangrove (Avicennia nitida), Glasswort (Salicornia sp.), Batis (Batis maritima), and Widgeongrass (Ruppia sp.).

Approaching the higher ground on the island is a narrow zone of high marsh (transition marsh). Plants in this zone include Marsh-elder (Iva frustescens), Saltmarsh fimbristylis (Fimbristylis castanea), Three-cornered grass (Scirpus olneyi), Leafy three-square (Scirpus robustus), Wiregrass (Spartina patens), and Sea-oxeye (Borrichia frutescens).

On the highest ground down the center of the island is a wooded area, with trees including Live oak (Quercus virginiana), Hackberry (Celtis laevigata), Hercules-club (Zanthoxylum clava-herculis), Wax myrtle (Myrica cerifera), and St. Augustine grass (Stenotophrum secundatum). The wooded zone may be reduced or lacking on islands of lower elevation.

Toward the Gulf from the wooded area is a broad zone of meadow habitat. Plants encountered along the transect here included: Beard grass (Andropogon sp.), Finger grass (Chloris petraea), Saltmarsh fimbristylis, Frogbit (Lippia lanceolata), Erigeron repens, Pennywort (Hydrocotyle bonariensis), Black rush, Three-cornered grass, Softstem bulrush (Scirpus validus), Widgeongrass (Ruppia maritima), Sandspur (Cenchrus sp.), Morning glory (Ipomoea stolonifera), Heterotheca subaxilaris, Sabbatia (Sabbatia sp.), Wiregrass, Dog tooth grass (Panicum repens), and Bermuda grass (Cynodon dactylon).

The dune habitat is the closest to the Gulf to support rooted vegetation. Plants here include Dog tooth grass (Panicum repens), Beach morning glory (Ipomoea pes-caprae), Morning glory, Frogbit, Heterotheca, Evening primrose (Oenothera), Sandspur, and Sea rocket (Cakile).

Sauer (1967) classified beach plants according to their origins and distributions. Although Sauer studied beach plants along the Mexican Gulf Coast, some species range through the northern Gulf Coast as well.

Four of the species found on Grand Isle by Brown (Pennywort, Morning glory, Blackmangrove, and Beach morning glory) are classified by Sauer (1967) as having natural transoceanic ranges.

They are primarily coastal species and occur on all Gulf shores in appropriate habitat. The Beach morning glory is the most conspicuous species in the outpost zone on a worldwide basis.

Sea-oxeye and Sea rocket are primarily coastal species whose ranges are restricted to the New World. Scattered individuals of Sea-oxeye may occur in inland salt marshes. Two species of Sea rocket have been recorded from Gulf shorelines, one species being restricted to the southern Gulf and the other ranging to the northern Gulf coast as well.

Sandspur, Bermuda grass, and Heterotheca are primarily inland plants that reach the margins of their distributions in seashore habitats. Sandspur occurs on both the North American mainland and in the West Indies, while Heterotheca is restricted to the mainland. Bermuda grass is a recent introduction from the Old World.

# Elevated Coastal Areas

Natural levees, which form adjacent to bayous in all wetland systems as a result of periodic flooding and sediment deposition, are extremely important as ecological reservoirs of species diversity. These low relief features in wetland areas provide for the establishment of many "high ground" plant species that add more to the system in terms of spatial diversity (habitats) than to the production of organic carbon. The provision of stable areas for nesting sites, etc. is perhaps most important to the terrestrial animals in the system. Reptiles, for example are often associated with natural levees and spoil banks.

The precise elevation of natural levees is strictly controlled by the cyclic changes in water level and represents a "self-designing" feature of a wetland system. Relative elevation between land and water has previously been described as extremely critical to the periodic flooding of wetland, which is essential to the maintenance of high production in these systems.

Man-made relief features in wetland areas often take the form of spoil banks resulting from dredging of canals. Piles of spoil material that line the banks of water bodies differ from natural levees in elevation and orientation. Rather than being regulated by long-term natural processes, they are often imposed on a system carelessly and in a manner that can create severe impairment to water movement.

Spoil banks in the Barataria Basin quickly become populated by a plant community and eventually serve as feeding and nesting sites for many animals. With time much of the organic matter in the dredged material oxidizes, some of the spoil is washed away by rain, and the elevation eventually decreases, sometimes almost to the original marsh level. By this time, however, much adjacent wetland can be destroyed because the death of marsh grass often results in oxidation of underlying sediments that lowers the level of the entire area, and less productive water bodies form in the place of wetland. Vegetation succession on spoil banks will be described in detail later.

Palmisano (1970) characterizes the vegetation on spoil banks and natural levees in coastal marshes (Table 7) and for large crevasses and natural levees in the deltaic plain (Table 8). Species composition undoubtedly varies across the coast and within each hydrologic unit, so this list must be considered tentative for the Barataria Basin.

Table 7. Plant species composition of spoil banks and natural levees in coastal Louisiana.

| |
|---|
| *Baccharis* sp. (Groundsel tree) |
| *Iva frutescens* (Marsh elder) |
| *Cynodon dactylon* (Bermuda grass) |
| *Spartina patens* (Marshhay cordgrass) |
| *Distichlis spicata* (Saltgrass) |
| *Phragmites communis* (Roseau cane) |
| *Rubus* sp. (Blackberry) |
| Trees (when present) |
| *Salix nigra* (Black willow) |
| *Sapium sebiferum* (Tallow tree) |

Source: A. W. Palmisano. 1970. Plant community-soil relationships in Louisiana coastal marshes. Ph.D. diss. Louisiana State University, Baton Rouge, La.

Table 8. Plant species composition of large crevasses and natural levees in the Louisiana deltaic plain.

| |
|---|
| *Taxodium distichum* (Cypress) |
| *Nyssa aquatica* (Tupelo gum) |
| *Acer drummondii* (Swamp maple) |
| *Cephalanthus occidentalis* (Buttonbush) |
| *Salix nigra* (Black willow) |
| *Fraxinus pennsylvanica* (Green ash) |
| *Gleditsia triacanthos* (Honey-locust) |

Source: A. W. Palmisano. 1970. Plant community-soil relationships in Louisiana coastal marshes. Ph.D. diss. Louisiana State University, Baton Rouge, La.

Tree species composition for chenier ridges (marsh-stranded beaches) has also been given by Palmisano (1970). These ridges provide islands of terrestrial habitat in the coastal marshes. Live oak (*Quercus virginiana*) is often the most frequent tree species (Table 9).

Table 9. Tree species composition of cheniers in coastal Louisiana.

| |
|---|
| *Quercus virginiana* (Live oak) |
| *Celtis laevigata* (Hackberry) |
| *Ulmus americana* (American elm) |
| *Acer drummondii* (Swamp maple) |
| *Taxodium distichum* (Cypress) |
| *Gleditsia triacanthos* (Honey-locust) |
| *Zanthoxylum clava-herculis* (Hercules-club) |
| *Diospyros virginiana* (Persimmon) |
| *Quercus nigra* (Water oak) |

Source: A. W. Palmisano. 1970. Plant community-soil relationships in Louisiana coastal marshes. Ph.D. diss. Louisiana State University, Baton Rouge, La.

# Vegetation Succession on Spoil Banks

Monte (unpublished MS) conducted transects of spoil banks ranging in age from 1 to 30 years old in freshwater swamp, fresh marsh, brackish marsh, and saline marsh. A transect was also run in a bottomland hardwood forest habitat for comparison.

Mean cover values were determined for all species and from these were calculated species dominance, zonation, life forms, and diversity. Diversity was calculated by taking the ratio of observed diversity to the maximum diversity possible with the same number of species. Patterns of succession in the different environments were studied using the formulas of Bray and Curtis (1957) and Community Ordination Analysis (Cox 1967). These calculations facilitated comparison of spoil bank vegetation communities both within and between habitats.

## Saline Marsh

Monte found that, in the first year, a spoil bank in the saline marsh was dominated by Oyster grass (*Spartina alterniflora*), with almost 50 percent of the spoil bank being bare ground. After 4 to 5 years, Wiregrass (*Spartina patens*) had become the dominant species, and there were scattered shrubs of Baccharis (*Baccharis halmifolia*). By the tenth year, shrubs of Baccharis and Marsh elder (*Iva frutescens*) had reached a height of seven feet and had begun to shade out the wiregrass, a process that was virtually complete by the twentieth year. Thre were occasional Black mangroves (*Avicennia germinans*), especially along the coast. This species prefers higher, drier habitats (Thom 1967).

In the thirtieth year, trees dominated spoil banks in the saline marsh, the major species being Toothache tree (*Zanthoxylum clava-herculis*) and Hackberry (*Celtis laevigata*). The dominant shrub in the understory was Elderberry (*Sambucus anadensis*).

## Brackish Marsh

The first year spoil bank studied in the brackish marsh by Monte (unpublished MS) had been invaded by Wiregrass and Baccharis but there were also large areas of bare ground. In the second and third year, Wiregrass and Saltgrass (Distichlis spicata) together covered 70 percent of the spoil bank and there were scattered shrubs of Baccharis. As the Baccharis increased in size, the grasses were shaded out and by the tenth year were virtually gone. Marsh elder and Goldenrod (Solidago sp.) were found growing along the edge of the ten-year-old spoil bank. A few scattered Toothache trees had appeared by the tenth year.

After fifteen and twenty years, the shrub layer was well developed and included Baccharis, Wax myrtle (Myrica cerifera) and Elderberry with scattered Toothache trees and Elm (Ulmus americana). The herb layer consisted mostly of Goldenrod and Melonette vine (Melothria pendula). On a twenty-five-year-old bank, Elderberry was the dominant shrub and the Melonette vine had increased in abundance.

On the thirty-year-old spoil bank the tree canopy was about thirty feet high and consisted of Hackberry, Black willow (Salix nigra), Toothache tree, and Chinaberry (Melia azedarach). The twelve foot high shrub layer was dominated by Elderberry. Other important understory plants included Cow-itch (Cissus incisa) and Bloodberry (Rivina humilis).

## Fresh Marsh

Small Baccharis shrubs and a mixture of herbs had invaded a one-year-old spoil bank in fresh marsh (Monte, unpublished MS). Water hyssop (Bacopa monnieri), Flatsedge (Cyperus sp.), Bulltongue (Sagittaria lancifolia), and Smartweed (Polygonum punctatum) were found growing along the edge of the spoil bank, while Goldenrod, Aster (Aster sp.), Yankeeweed (Eupatorium capillifolium, Saltmarsh mallow (Kosteletzkya virginica), and Hemp sesbania (Sesbania macrocarpa) were more abundant in higher elevations. Seedlings of Willow (Salix sp.) were also present the first year.

By the third year, the willows had grown to 10 to 12 feet and six-foot tall Baccharis was widespread. By the fifth year the herbs had been shaded out.

After 15 years trees were becoming dominant. Twenty-foot high Willow and Swamp maple (Acer drummondii) were present, and the ten- to twelve-foot high shrub layer consisted of Baccharis, Elderberry, and White snakeroot (Eupatorium rugosum).

Trees continued to increase in dominance until the thirtieth year, when the spoil bank was virtually covered with trees. Dominant trees were Hackberry and Willow, with Toothache trees and Chinese tallow (Sapium sebiferum) being scattered in the understory. Shrubs, vines, and herbs consisted of Boxelder (Acer negundo), Elderberry, Wax myrtle, Hackberry seedlings, Roughleaf dogwood (Cornus drummondii), Goldenrod, and Melonette.

## Swamp

The swamp spoil banks sampled by Monte were more heterogeneous than those in marsh areas because of local disturbances of the vegetation by industrial and agricultural activities. These disturbances undoubtedly influenced the successional sequence inferred from the transects.

Herbs such as Giant ragweed (Ambrosia trifida), Goldenrod, and Yankeeweed dominated the one-year-old spoil bank in the swamp habitat. Also present were shrubs such as White snakeroot and Baccharis, and small tree seedlings. Vines included Peppervine (Ampelopsis arborea), Deer pea (Vigna repens), and Coralbeads (Cocculus carolinus).

The four-year-old spoil bank was covered with trees and vines reaching heights of 20 and 10 feet, respectively. Dominant trees included Willow, Cottonwood (Populus deltoides), and Swamp maple while the major vines were Dewberry (Rubus louisianus), Peppervine, Climbing hempweed (Mikania scandens), and Passion flower (Passiflora incarnata). Some shade-tolerant herbs such as

Smartweed and Lizard's tail (Saururus cernus) grew at ground level.

On older spoil banks trees continued to dominate and increase in size. The tree community succeeded from Willow-Cottonwood to Maple-Elm, to Hackberry-Water oak (Quercus nigra). Dominant shrubs on the older banks included Elderberry, Poison ivy (Rhus radicans), Wax myrtle, and Baccharis. Vines such as Dewberry, Peppervine, Cow-itch, and Rattan vine (Berchemia scandens) were also present.

## Overview

The number of species of plants found on spoil banks generally decreased from fresh swamp to saline marsh, and the number of species tended to increase with age in each habitat.

The Shannon-Wiener diversity index showed an increase in diversity proceeding from saline marsh to fresh swamp. Diversity values increased with age on saline marsh spoil banks and showed a slight decrease with age in the fresh swamp. These values tended to converge for the four environments over time, ranging from 1.0 to 3.4 in the first year and from 2.6 to 3.3 for the thirtieth year.

Vegetation communities in the different environments were also compared by calculating dissimilarity values. These values tended to decrease through time, a further indication of convergence. Some of the species held in common among spoil banks in the different environments--especially Willow, Hackberry, and Elderberry--have been recognized as occurring in succession in bottomland hardwood forest.

Succession rates appeared to be greatest on fresh swamp spoil banks, where the tree stage was reached by the fifth year, and slowest in saline marsh, where the tree stage was not reached into the thirtieth year.

Finally, a transect through mature bottomland hardwood forest was compared with thirty-year-old spoil bank communities in each wetland habitat. Calculation of similarity values showed 34 percent similarity to fresh swamp spoil banks, 18 percent to fresh marsh banks, 16 percent to brackish marsh banks, and 4 percent to saline marsh banks. This comparison further illustrated differences in rates of succession.

# Survey of Selected Coastal Organisms

This section deals primarily with the distribution and abundance of selected animal groups within the Barataria Basin. It is by no means exhaustive and concentrates on animal groups that have received some attention from researchers.

Most groups are poorly studied. Very often the only information available for a species is its presence or absence in the basin. For others there are isolated observations of food habits, habitat relationships, or other aspects of life history.

## Invertebrate Example (Blue Crab)

Jaworski (1972) gives an outline of the life history of the Blue crab (Callinectes sapidus). Females spawn in waters of relatively high salinity in the lower estuary and marine area during the warmer months. After hatching, this species passes through two larval stages (zoea and megalops) and is found primarily in marine areas and tidal inlets. After attaining the first true crab stage (46-84 days after hatching), they move into the lower and upper estuaries where they undergo 4-17 molts and attain a size of 6-100 millimeters in the first year. Part of the second year is spent in the upper estuary where they undergo 3-16 more molts, reaching sexual maturity at a carapace (shell) width of 125-200 millimeters. Mating takes place in relatively low salinity waters, after which females migrate to higher salinity areas and males remain in brackish areas or even migrate farther up rivers (Van Engel 1958). Figure 2 shows subhabitats used by blue crabs in the Barataria Basin.

As a species that uses most habitats in a given basin at some stage in its life cycle, the Blue crab populations are bound to be reduced by saltwater encroachment. Reduction in brackish habitat would effect the species during the important stages of growth and maturation.

Annual landings of blue crabs in the Barataria estuary have declined since 1959 (Jaworski 1972). This decline (Fig. 3) has been particularly noticeable in the upper estuary, e.g., Lake Salvador. Most crab fishing is now centered in Barataria and Caminada bays. This decline has

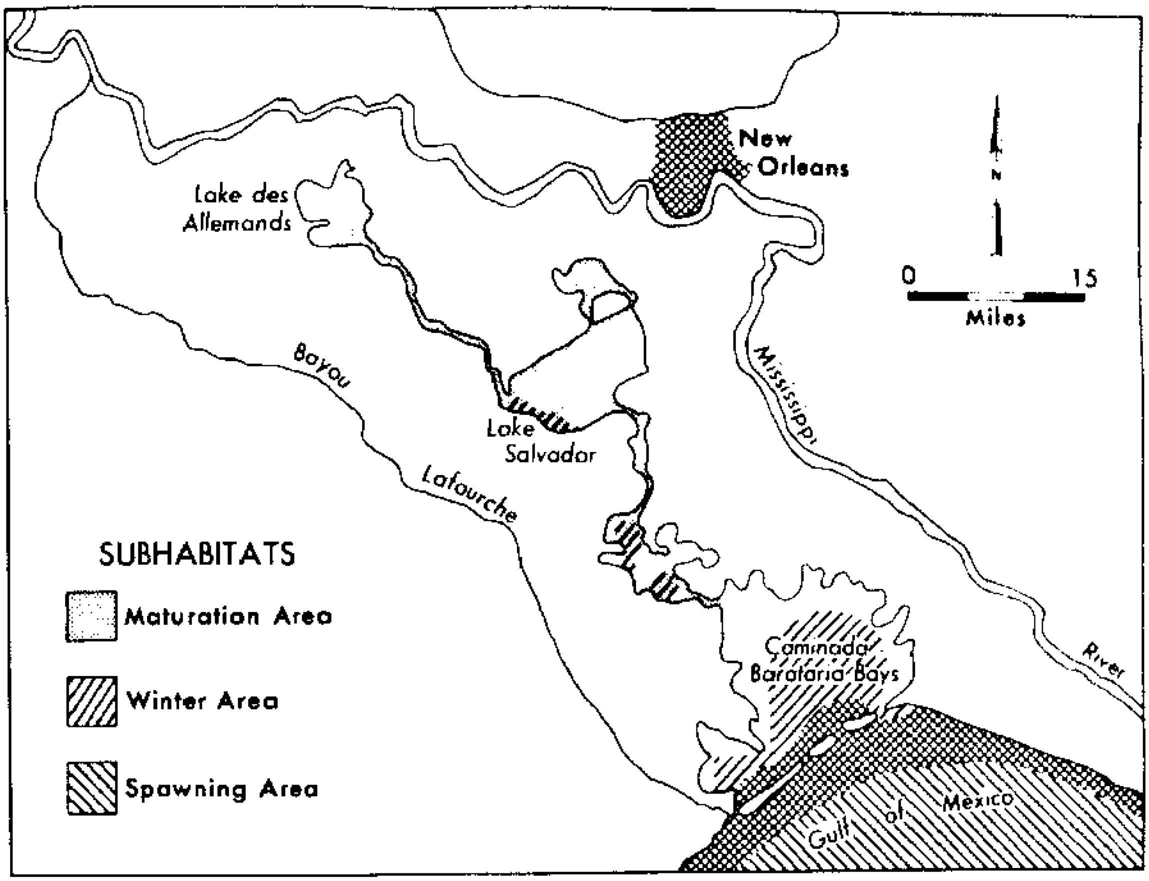


Fig. 2. Model of the Blue Crab subhabitat in the Barataria estuary (after Jaworski 1972).

been attributed in the past to increased use of nonselective crab pots, which catch gravid females and thus presumably reduce the reproductive potential of populations. Blue crabs have extremely high reproductive rates, however, and reduction of breeding stock does not seem a likely cause of the decline. Jaworski (1972) presents evidence that an increase in the amount and kinds of pollution in the upper estuary may more likely be responsible for lowering of crab landings in this area.

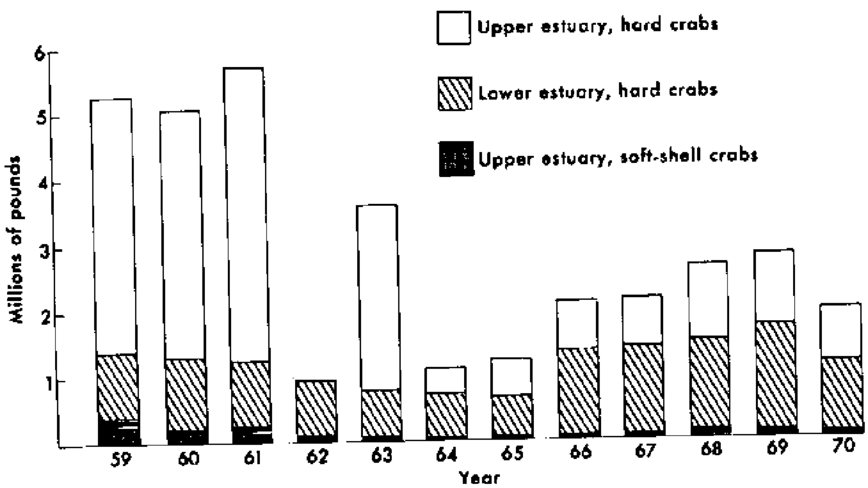


Fig. 3. Crab landings from the Barataria estuary, 1959-70. Lake Salvador and Little Lake are included in the upper estuary, and Caminada and Barataria bays comprise the lower estuary. Source: National Marine Fisheries Service. 1959-1970. Landing Records: Louisiana Coastal Parishes, Form 2-164 SA&G; New Orleans, La., Fish and Wildlife Service, U.S. Dept. Commerce. After Jaworski 1972.

## Fish

The fish of the Barataria Basin represent a diverse assemblage of species, and their high mobility coupled with their great variety of responses to environmental parameters makes detailed analysis of community structure difficult at this time. Fish species collected in the four major habitat types in the Louisiana Offshore Oil Port study (LOOP Report 1976) are given in Table 10. This tabulation represents a static view of fish distribution when in reality few, if any, of these species are restricted to a single habitat type. Seasonal movements of fish populations are quite widespread and as a result marine fish commonly penetrate inland to freshwater habitats and freshwater species sometimes occur in more saline water. The terms stenohaline (narrow salinity tolerance) and euryhaline (broad salinity tolerance) have not been rigorously defined and the distinction between the two is highly arbitrary (Gunter 1942). Whether fish species respond to salinity per se in their seasonal movements is not known. The lower reaches of freshwater streams may serve as nursery areas for young of some marine species (Saul 1974).

Day et al. (1973) reported the abundance of certain fish species in Caminada Bay during spring and early summer. Three species, the Bay anchovy (Anchoa mitchilli), menhaden (Brevoortia patronus), and Spot (Leiostomus xanthurus), made

Table 10. Fish species collected in the four major habitat types in the Louisiana Offshore Oil Port study (LOOP Report).

Salt Marsh

Bull shark (Carcharhinus leucas)
Alligator gar (Lepisosteus spatula)
Bowfin (Amia calva)
Ladyfish (Elops saurus)
Shrimp eel (Ophichthus gomesi)
Skipjack herring (Alosa chrysochloris)
Gizzard shad (Dorosoma cepedianum)
Atlantic thread herring (Opisthonema oglinum)
Scaled sardine (Harengula pensacolae)
Striped anchovy (Anchoa hepsetus)
Dusky anchovy (Anchoa lyolepis)
Inshore lizardfish (Synodus foetens)
(Aphredoderus sayanus)
Gulf toadfish (Opsanus beta)
Atlantic midshipmann (Porichhythys porosissmus)
Southern hake (Urophycis floridanus)
Atlantic needlefish (Strongylura marina)
Diamond killifish (Adinia xenica)
Sheepshead minnow (Cyprinodon variegatus)
Gulf killifish (Fundulus grandis)
Longnose killifish (Fundulus similus)
Rainwater killifish (Lucanis parva)
Mosquitofish (Gambrusia affinis)
Least killifish (Heterandria formosa)
Sailfin molly (Poecilia latipinna)
Tidewater silverside (Menidia beryllina)
Dusky pipefish (Syngnathus floridae)
Chain pipefish (Syngnathus louisianae)
Gulf pipefish (Syngnathus scovelli)
Crevalle jack (Caranx hippos)
Atlantic bumper (Chloroscembrus chrysures)
Leather jacket (Aligoplites saurus)
Lookdown (Selene vomer)

Table 10. Continued.

Florida pompano (Trachinotus carolinus)
Atlantic moonfish (Vomer setapinnis)
Gray snapper (Lutjanus griseus)
Spotfin majarra (Eucinostomus argenteus)
Silver jenny (Eucinostomus gula)
Sheepshead (Archosargus probatacephalus)
Pinfish (Lagodon rhomboides)
Sand seatrout (Cynoscion arenarius)
Southern kingfish (Menticirrhus americanus)
Gulf kingfish (Menticirrhus littoralis)
Black drum (Pogonias cromis)
Star drum (Stellifer lanceolatus)
Atlantic spadefish (Chaetodipterus faber)
Striped mullet (Mugil cephalus)
Atlantic threadfin (Polydactylus octonemus)
Southern stargazer (Astroscopus y-graecum)
Emerald sleeper (Erotelis smaragdus)
Fillfin goby (Bathygobius soporator)
Darter goby (Gobionellus boleosoma)
Sharptail goby (Gobinellus hastatus)
Freshwater goby (Gobionellus shufeldti)
Naked goby (Gobiosoma bosci)
Code goby (Gobiosoma robustum)
Clown goby (Microgobius gulosus)
Atlantic cutlassfish (Trichiurus lepturus)
Spanish mackerel (Scomberomorus maculatus)
Harvest fish (Peprilus alepidotus)
Gulf butterfish (Peprilus burti)
Blackfin searobin (Prionotus nubio)
Bighead searobin (Prionotus tribulus)
Bay whiff (Citharichthys spilopterus)
Fringed flounder (Etropus crossostus)
Southern flounder (Paralichthys lathostigma)
Lined sole (Achirus lineatus)
Blackcheck tonguefish (Symphurus plagiusa)
Least puffer (Sphoeroides parvus)
Striped burrfish (Chilomycterus schoepfi)

Fresh Marsh

Spotted gar (Lepisosteus oculatus)
Gulf menhaden (Brevoortia patronus)
Bay anchovy (Anchoa mitchilli)
Carp (Cyprinus carpio)
Black bullhead (Ictalurus melas)
Yellow bullhead (Ictalurus natalis)
Channel catfish (Ictalurus punctatus)
Sheepshead minnow (Cyprinodon variegatus)

Table 10. Continued.

Golden topminnow (*Fundulus chrysotus*)
Bayou killifish (*Fundulus pulvereus*)
Tidewater silverside (*Menidia beryllina*)
Gulf pipefish (*Syngnathus scovelli*)
Flier (*Centrarchus macropterus*)
Banded pygmy sunfish (*Elassoma zonatum*)
Bluegill (*Lepomis macrochirus*)
Spotted sunfish (*Lepomis punctatus*)
Bantam sunfish (*Lepomis symmetricus*)
Largemouth bass (*Micropterus salmoides*)
Black crappie (*Pomoxis nigromaculatus*)
Pinfish (*Lagodon rhomboides*)
Silver perch (*Bairdiella chrysura*)
Spotted seatrout (*Cynoscion nebulosus*)
Spot (*Leiostomus xanthurus*)
Atlantic croaker (*Micropogon undulatus*)
Striped mullet (*Mugil cephalus*)
Fat sleeper (*Dormitator maculatus*)
Naked goby (*Gobisoma bosci*)
Clown goby (*Microgobius gulosus*)
Atlantic cuttlefish (*Trichiurus lepturus*)
Lined sole (*Achirus lineatus*)
Hogchoker (*Trinectes maculatus*)

Swamp Forest

Spotted gar (*Lepisosteus oculatus*)
Longnose gar (*Lepisosteus osseus*)
Shortnose gar (*Lepisosteus platostomus*)
Alligator gar (*Lepisosteus spatula*)
Bowfin (*Amia calva*)
Gizzard shad (*Dorosoma cepedianum*)
Threadfin shad (*Dorosoma petenense*)
Carp (*Cyprinus carpio*)
Golden shinner (*Notemigonus crysoleucas*)
Lake chubsucker (*Erimyzon sucetta*)
Blue catfish (*Ictalurus furcatus*)
Black bullhead (*Ictalurus melas*)
Yellow bullhead (*Ictalurus natalis*)
Channel catfish (*Ictalurus punctatus*)
Tadpole madton (*Noturus gyrinus*)
Flathead catfish (*Pylodictis olivaris*)
(*Aphredoderus sayanus*)
Golden topminnow (*Fundulus chrysotus*)
Mosquitofish (*Gambusia affinis*)
Least killifish (*Heterandria formosa*)
Sailfin molly (*Poecilia latipinna*)
Yellow bass (*morone mississippiensis*)

Table 10. Continued.

Flier (*Centrarchus macropterus*)
Banded pygmy sunfish (*Elassoma zonatum*)
Bluegill (*Lepomis macrochirus*)
Bluegill X spotted sunfish (*Lepomis punctatus* X *macrochrirus*)
Spotted sunfish (*Lepomis punctatus*)
Bantam sunfish (*Lepomis symmetricus*)
Largemouth bass (*Micropterus salmoides*)
Black crappie (*Pomoxis nigromaculatus*)
Striped mullet (*Mugil cephalus*)

Brackish Marsh

Atlantic stingray (*Dasyatis sabina*)
Spotted gar (*Lepisosteus oculatus*)
Shortnose gar (*Lepisosteus platostomus*)
Ladyfish (*Elops saurus*)
Speckled worm eel (*Myrophis punctatus*)
Shrimp eel (*Ophichtus gomesi*)
Skipjack herring (*Alosa chrysochloris*)
Atlantic thread herring (*Opisthonema oglinum*)
Scaled sardine (*Harengula pensacolae*)
Inshore lizardfish (*Synodus foetens*)
Sea catfish (*Arius felis*)
Diamond killifish (*Adinia xenica*)
Rainwater killifish (*Lucania parva*)
Gulf killifish (*Fundulus grandis*)
Bayou killifish (*Fundulus pulvereus*)
Longnose killifish (*Fundulus similus*)
Sailfin molly (*Poecilia latipinna*)
Rough silverside (*Membras martinica*)
Chain pipefish (*Syngnathus louisianae*)
Pinfish (*Lagodon rhomboides*)
Silver perch (*Bairdiella chrysura*)
Spotted seatrout (*Cynoscion nebulosus*)
Spot (*Leiostomus xanthurus*)
Red drum (*Pogonias cromis*)
Striped mullet (*Mugil cephalus*)
Fat sleeper (*Dormitator maculatus*)
Sharptail goby (*Gobionellus hastatus*)
Freshwater goby (*Gobionellus shufeldi*)
Southern flounder (*Paralichtys legostigma*)

Source: D. W. Mabie, in unpublished MS.

up over 75 percent of the total catch in their samples. Total fish biomass in Barataria Bay is highest in the spring and is related to a general inshore movement of various marine species. Lowest biomass and diversity occur in winter, concurrent with lowest temperatures.

Many marine species spawn in the Gulf and then move into the estuaries, where they remain until nearly mature. Included in this category are: Croaker (Micropogon undulatus), Spot, Sand seatrout (Cynoscion arenarius), Sea catfish (Arius felis), menhaden, Striped mullet (Mugil cephalus), and Bay whiff (Citharichthyes spilopterus). Reduction in size of the estuarine zone through intrusion of more saline water would have the effect of reducing population sizes of fish that undergo maturation here.

Species such as the Bay anchovy and Tidewater silverside (Menidia beryllina) may be closest to truly estuarine species. The bulk of their populations occupy the estuarine zone throughout their entire life cycles.

Among freshwater forms, catfish (Ictalurus sp.) are harvested commercially, particularly in the area of Lac des Allemands (J. W. Day, Jr., personal communication). Swamp forest bayous and freshwater lakes support diverse fish communities, many of which are exploited for sporting or lesser commercial use. This category includes gars (Lepisosteus sp.), Bowfin (Amia calva), Carp (Cyprinus carpio), Sunfish (Lepomis sp.), Largemouth bass (Micropterus salmoides), and Crappie (Pomoxis sp.). The Mosquitofish (Gambusia affinis) is extremely abundant in freshwater areas and is undoubtedly an important component of aquatic predatory food chains.

A detailed analysis of menhaden harvest data will be discussed in a separately published section.

## Amphibians and Reptiles

Reptile and amphibian communities apparently show a general trend of decreasing diversity as one moves from the swamp forest habitat through fresh, intermediate brackish, and saline marshes (D. Mabie, unpublished MS). The greater structural diversity of swamp forest vegetation may be related to the relatively high diversity of the herpetofauna (amphibians and reptiles) in this habitat (see Schoener and Schoener 1971, MacArthur et al. 1962). Relatively high salinities may limit species diversity in the coastal marsh environments, though numerous reptiles and amphibians around the world have adapted to high salinities. Mating choruses of the Eastern narrow-mouthed toad (Gastrophryne carolinensis) have been observed in brackish water in the marshes north of Grand Isle (Hebrard, personal observation). The Gulf salt marsh snake (Natrix fasciata clarki) will not drink salt water, while the Broadbanded water snake (Natrix fasciata confluens) that occurs in freshwater areas will, and will succumb to its effects (Pettus 1963).

Chenier ridges in the coastal marshes apparently act as terrestrial islands within the marsh, supporting a herpetofauna similar to more inland localities. Snakes are sometimes abundant on these wooded ridges. Chenier Caminada, north of Grand Isle, supports such species as Speckled kingsnake (Lampropeltis gelulus), Western ribbon snake (Thamnophis proximus), and racer (Coluber constrictor) as well as the Cottonmouth (Agkistrodon piscivorous) (Hebrard, personal observation). Mabie (unpublished MS) states that natural levees and spoil banks serve as centers of concentration for reptiles and amphibians.

Population studies of amphibians and reptiles on the Louisiana coast have been few. These animals fill a variety of roles ranging from detritivores (tadpoles), to herbivores (some turtles) to carnivores (snakes). Their abundance in this region makes them particularly suitable for future study.

Tinkle (1959) conducted a study of snake populations in a swamp habitat near New Orleans (not in Barataria Basin). He found the greatest abundance and diversity of snakes along ridges and noted changes in local densities associated with changes in water level.

Table 11 presents population estimates for alligators by marsh type along the Louisiana coast (from Joanen and McNease 1972). Though not specific for Barataria Basin, these are the only data currently available. The estimates are

Table 11. Percentage alligator populations according to marsh zone and marsh types.

| Marsh Type | MARSH ZONES: Chenier Plain Pop. Est. (%) | Chenier Plain Acreage | Sub Delta Pop. Est. (%) | Sub Delta Acreage | Active Delta Pop. Est. (%) | Active Delta Acreage | Percent of Pop/ Marsh Type | Percent of Acreage/Marsh Type |
|---|---|---|---|---|---|---|---|---|
| Fresh | 23.66 | 425,100 | 12.86 | 744,900 | 3.81 | 129,340 | 40.33 | 40.88 |
| Intermediate | 20.54 | 354,594 | 5.85 | 230,400 | 3.78 | 106,800 | 30.17 | 21.77 |
| Brackish | 13.05 | 332,466 | 15.74 | 838,786 | 0.70 | 15,747 | 29.49 | 37.35 |
| Total Acreage | | 1,112,160 | | 1,814,086 | | 251,887 | | |
| Percent Population, Percent Acreage/ Marsh Zone | 57.25 | 34.99* | 34.46 | 57.08 | 8.29 | 7.93 | | |

*Total population some 170,000 in 1972.
Source: T. Joanen and L. McNease. 1972. Population distribution of alligators with special reference to Louisiana coastal marshes. Symp. Amer. Alligator Council, Lake Charles, La.

probably low as they do not reflect recent increases in alligator populations. Greg Linscombe of the Louisiana Wildlife and Fisheries Commission has gathered detailed data for alligator populations covering several years, but the data have not yet been summarized.

The alligator is commonly associated with fresh, intermediate, and slightly brackish habitats, according to Joanen and McNease (1972). Highest populations were found in intermediate marsh, and those areas with lakes, ponds, canals, or rivers with salinities below 10 ppt are preferred. Joanen and McNease determined that 34.5 percent of coastal Louisiana's alligator population was in the subdelta region.

Chabreck (1971) found that crayfish comprise 61 percent of the alligator's food in fresh water, while in brackish water blue crabs comprised 50 percent of the diet. Alligators also eat birds, fiddler crabs, fish, insects, muskrats, turtles, shrimp, grasses, and snails.

Tables 12 and 13 give lists of reptiles and amphibians that probably occur in all habitats of

Barataria Basin. These lists are taken from Mabie (unpublished MS) with updated information from Conant (1975). This list is subject to change and refinement as more information is gathered.

Table 12. Reptiles known or likely to occur in Barataria Basin (all habitats).

| |
|---|
| American alligator (Alligator mississippiensis) |
| Snapping turtle (Chelydra serpentina) |
| Alligator snapping turtle (Macroclemys temmincki) |
| Stinkpot (Sternotherus odoratus) |
| Mud turtle (Kinosternon subrubrum) |
| Diamondback terrapin (Malaclemys terrapin) |
| Mississippi map turtle (Graptemys kohni) |
| Red-eared turtle (Chrysemys scripta) |
| Painted turtle (Chrysemys picta) |
| Green anole (Anolis carolinensis) |
| Ground skink (Leiolopisma laterale) |
| Five-lined skink (Eumeces fasciatus) |
| Broad-headed skink (Eumeces laticeps) |
| Eastern glass lizard (Ophisaurus ventralis) |
| Green water snake (Natrix cyclopion) |
| Diamondbacked water snake (Natrix rhombifera) |
| Yellow-bellied water snake (Natrix erythrogaster) |
| Broad-banded water snake (Natrix fasciata confluens) |
| Gulf salt marsh snake (Natrix fasciata clarki) |
| Brown snake (Storeria dekayi) |
| Western ribbon snake (Thamnophis proximus) |
| Mud snake (Farancia abacura) |
| Racer (Coluber constrictor) |
| Rough green snake (Opheodrys aestivus) |
| Speckled kingsnake (Lampropeltis getulus) |
| Cottonmouth (Agkistrodon piscivorous) |

Source: D. W. Mabie unpublished MS; R. Conant. 1975. A field guide to reptiles and amphibians of eastern and central North America. Houghton-Mifflin Co., Boston, Mass.; D. A. Rossman, personal communication.

Table 13. Amphibians known or likely to occur in Barataria Basin (all habitats).

Three-toed amphiuma (*Amphiuma tridactylum*)
Lesser siren (*Siren intermedia*)
Central newt (*Notophthalmus viridescens*)
Fowler's toad (*Bufo woodhousei*)
Gulf coast toad (*Bufo valliceps*)
Cricket frog (*Acris crepitans*)
Spring peeper (*Hyla crucifer*)
Green treefrog (*Hyla cinerea*)
Squirrel treefrog (*Hyla squirella*)
Eastern narrow-mouthed toad (*Gastrophryne carolinensis*)
Bullfrog (*Rana catesbeiana*)
Pig frog (*Rana grylio*)
Bronze frog (*Rana clamitans*)
Southern leopard frog (*Rana pipiens*)

Source: D. W. Mabie unpublished MS; R. Conant. 1975. A field guide to reptiles and amphibians of eastern and central North America. Houghton-Mifflin Co., Boston, Mass.

## Birds

Birds perform a variety of important ecological functions in coastal ecosystems of Louisiana, varying from herbivores to top carnivores. A large proportion are insectivorous to some degree and are undoubtedly important controls on insect populations. In order to handle the wide variety of bird types and their relationship to the coastal zone, seven major groups of birds will be discussed in the context of the environmental units (marsh types and swamp). The groups include: fishing birds, shore birds, birds of prey, wading birds, waterfowl, rails and gallinules, and passerines.

Findings from the Gosselink et al. (1976), Environmental Baseline Study (LOOP Report) are cited freely throughout this discussion (Mabie, unpublished MS). Although a portion of this study was conducted on the west side of Bayou Lafourche (outside Barataria Basin) the results are still meaningful. Bayou Lafourche does not represent a significant barrier to highly mobile organisms such as birds.

A complete list of birds for all habitats of Barataria Basin is given in Table 14.

Table 14. A list of 216 species of birds identified in all habitats of Barataria Basin.

Common loon (*Gavia immer*)
Horned grebe (*Podiceps auritus*)
Eared grebe (*Podiceps nigricollis*)
Pied-billed grebe (*Pocilymbus podiceps*)
White pelican (*Pelecanus erythrorhynchos*)
Brown pelican (*Pelecanus occidentalis*)
Northern gannet (*Morus bassanus*)
Double-crested cormorant (*Phalacrocorax auritus*)
Anhinga (*Anhinga anhinga*)
Man-O'-War bird (*Fregata magnificens*)
Great blue heron (*Ardea herodias*)
Great egret (*Casmerodius albus*)
Snowy egret (*Egretta thula*)
Cattle egret (*Bubulcus ibis*)
Reddish egret (*Dichromanassa rufescens*)
Louisiana heron (*Hydranassa tricolor*)
Little blue heron (*Florida caerulea*)
Green heron (*Butorides virescens*)
Black-crowned night heron (*Nycticorax nycticorax*)
Yellow-crowned night heron (*Nyctanassa violacea*)
American bittern (*Botaurus lentiginosus*)
Least bittern (*Ixobrychus exilis*)
Glossy ibis (*Plegadis falcinellus*)
White-faced glossy ibis (*Plegadis chihi*)
White ibis (*Eudocimus albus*)
Snow goose (*Chen caerulescens*)
Mallard (*Anas platyrhynchos*)
Mottled duck (*Anas fulvigula*)
Gadwall (*Anas strepera*)
Pintail (*Anas acuta*)
Green-winged teal (*Anas crecca*)
Blue-winged teal (*Anas discors*)
American widgeon (*Anas americana*)
Northern shoveler (*Spatula clypeata*)
Wood duck (*Aix sponsa*)

Table 14. Continued.

Redhead (*Aythya americana*)
Ring-necked duck (*Aythya collaris*)
Canvasback (*Aythya valisineria*)
Lesser scaup duck (*Aythya affinis*)
Bufflehead (*Bucephala albeola*)
Ruddy duck (*Oxyura jamaicensis*)
Hooded merganser (*Lophodytes cucullatus*)
Red-breasted merganser (*Mergus serrator*)
Turkey vulture (*Cathartes aura*)
Black vulture (*Coragyps atratus*)
Swallow-tailed kite (*Elanoides forficatus*)
Mississippi kite (*Ictinia mississippiensis*)
Red-tailed hawk (*Buteo jamaicensis*)
Red-shouldered hawk (*Buteo lineatus*)
Bald eagle (*Haliaeetus leucocephalus*)
Marsh hawk (*Circus cyaneus*)
Osprey (*Pandion haliaetus*)
Peregrine falcon (*Falco peregrinus*)
American kestrel (*Falco sparverius*)
King rail (*Rallus elegans*)
Clapper rail (*Rallus longirostris*)
Sora (*Porzana carolina*)
Purple gallinule (*Porphyrula martinica*)
Common gallinule (*Gallinula chloropus*)
American coot (*Fulica americana*)
Piping plover (*Charadrius melodus*)
*Snowy plover (*Charadrius alexandrinus*)
Semipalmated plover (*Charadrius semipalmatus*)
Wilson's plover (*Charadrius wilsonia*)
Killdeer (*Charadrius vociferus*)
Black-bellied plover (*Pluvialis squatarola*)
Upland sandpiper (*Bartramia longicauda*)
Ruddy turnstone (*Arenaria interpres*)
Common snipe (*Capella gallinago*)
*Spotted sandpiper (*Actitis macularia*)
Solitary sandpiper (*Tringa solitaria*)
Willet (*Catoptrophorus semipalmatus*)
*Greater yellow-legs (*Tringa melanoleuca*)
*Lesser yellow-legs (*Tringa flavipes*)
Red knot (*Calidris canutus*)
*Pectoral sandpiper (*Calidris melanotos*)
White-rumped sandpiper (*Calidris fuscicollis*)
*Baird's sandpiper (*Calidris bairdii*)
Least sandpiper (*Calidris minutilla*)
Dunlin (*Calidris alpina*)
Dowitcher (*Limnodromus griseus*, *L. scolopaceus*)

Table 14. Continued.

Semipalmated sandpiper (Calidris pusilla)
Western sandpiper (Calidris mauri)
Marbled godwit (Limosa fedoa)
Sanderling (Calidris alba)
Avocet (Recurvirostra americana)
Black-necked stilt (Himantopus mexicanus)
*Wilson's phalarope (Steganopus tricolor)
Herring gull (Larus argentatus)
Ring-billed gull (Larus delawarensis)
Laughing gull (Larus atricilla)
*Franklin's gull (Larus pipixcan)
*Bonaparte's gull (Larus philadelphia)
*Gull-billed tern (Gelochelidon nilotica)
Forster's tern (Sterna forsteri)
Common tern (Sterna hirundo)
Least tern (Sterna albifrons)
Royal tern (Thalasseus maximus)
Sandwich tern (Thalasseus sandvicensis)
Caspian tern (Hydroprogne caspia)
Black tern (Chilidonias nigra)
Black skimmer (Rynchops niger)
Rock pigeon (Columba livia)
Mourning dove (Zenaida macroura)
Yellow-billed cuckoo (Coccyzus americanus)
Black-billed cuckoo (Coccyzus erythophthalmus)
Groove-billed ani (Crotophaga sulcirostris)
Barn owl (Tyto alba)
Great horned owl (Bubo virginianus)
Common screech owl (Otus asio)
*Burrowing owl (Speotyto cunicularia)
Barred owl (Strix varia)
Chuck-Will's-Widow (Caprimulgus carolinensis)
Common nighthawk (Chordeiles minor)
Chimney swift (Chaetura pelagica)
Ruby-throated hummingbird (Archilochus colubris)
Belted kingfisher (Megaceryle alcyon alcyon)
Common flicker (Colaptes auratus)
Pileated woodpecker (Dryocopus pileatus)
Red-bellied woodpecker (Centurus carolinus)
Red-headed woodpecker (Melanerpes erythrocephalus)
Yellow-bellied sapsucker (Sphyrapicus varius)
Downy woodpecker (Dendrocopos pubescens)
Eastern kingbird (Tyrannus tyrannus)
Great crested flycatcher (Myiarchus crinitus)
Eastern phoebe (Sayornis phoebe)
Empidonax sp.

Table 14. Continued.

Eastern wood pewee (*Contopus virens*)
Tree swallow (*Iridoprocne bicolor*)
Barn swallow (*Hirundo rustica*)
Rough-winged swallow (*Stelgidopteryx ruficollis*)
Purple martin (*Progne subis*)
Blue jay (*Cyanocitta cristata*)
Common crow (*Corvus brachyrhynchos*)
Fish crow (*Corvus ossifragus*)
Carolina chickadee (*Parus carolinensis*)
Tufted titmouse (*Parus bicolor*)
Northern house wren (*Troglodytes aedon*)
Carolina wren (*Thryothorus ludovicianus*)
Marsh wren (*Telmatodytes palustris*)
Sedge wren (*Cistothorus platensis*)
Northern mockingbird (*Mimus polyglottos*)
Gray catbird (*Dumetella carolinensis*)
Brown thrasher (*Toxostoma rufum*)
American robin (*Turdus migratorius*)
Wood thrush (*Hylocichla mustelina*)
Hermit thrush (*Catharus guttata*)
Swainson's thrush (*Catharus ustulata*)
Gray-cheeked thrush (*Catharus minimus*)
Veery (*Catharus fuscescens*)
Eastern bluebird (*Sialia sialis*)
Blue-gray gnatcatcher (*Polioptila caerulea*)
Golden-crowned kinglet (*Regulus satrapa*)
Ruby-crowned kinglet (*Regulus calendula*)
Water pipit (*Anthus spinoletta*)
Cedar waxwing (*Bombycilla cedorum*)
Loggerhead shrike (*Lanius ludovicianus*)
European starling (*Sturnus vulgaris*)
White-eyed vireo (*Vireo griseus*)
Yellow-throated vireo (*Vireo flavifrons*)
Solitary vireo (*Vireo solitarius*)
Red-eyed vireo (*Vireo olivaceus*)
Black-and-white warbler (*Mniotilta varia*)
Prothonotary warbler (*Protonotaria citrea*)
Swainson's warbler (*Limnothlypis swainsoni*)
Worm-eating warbler (*Helmintheros vermivorus*)
Golden-winged warbler (*Vermivora chrysoptera*)
Blue-winged warbler (*Vermivora pinus*)
Tennessee warbler (*Vermivora peregrina*)
Orange-crowned warbler (*Vermivora celata*)
Northern parula warbler (*Parula americana*)
Yellow warbler (*Dendroica petechia*)
Magnolia warbler (*Dendroica magnolia*)

Table 14. Continued.

Cape may warbler (Dendroica tigrina)
Black-throated blue warbler (Dendroica caerulescens)
Myrtle warbler (Dendroica coronata)
Black-throated green warbler (Dendroica virens)
Cerulean warbler (Dendroica cerulea)
Blackburnian warbler (Dendroica fusca)
Yellow-throated warbler (Dendroica dominica)
Chestnut-sided warbler (Dendroica pensylvanica
Bay-breasted warbler (Dendroica castanea)
Blackpoll warbler (Dendroica striata)
Prairie warbler (Dendroica discolor)
Palm warbler (Dendroica palmarum)
Ovenbird (Seiurus aurocapillus)
Northern waterthrush (Seiurus noveboracensis)
Louisiana waterthrush (Seiurus motacilla)
Kentucky warbler (Geothlypis formosa)
Common yellowthroat (Geothlypis trichas)
Yellow-breasted chat (Icteria virens)
Hooded warbler (Wilsonia citrina)
American redstart (Setophaga ruticilla)
House sparrow (Passer domesticus)
Bobolink (Dolichonyx oryzivorus)
Eastern meadowlark (Sturnella magna)
Redwinged blackbird (Agelaius phoeniceus)
Orchard oriole (Icterus spurius)
Baltimore oriole (Icterus galbula)
Boat-tailed grackle (Cassidix major)
Common grackle (Quiscalus quiscula)
Brown-headed cowbird (Molothrus ater)
Scarlet tanager (Piranga olivacea)
Summer tanager (Piranga rubra)
Northern cardinal (Cardinalis cardinalis)
Rose-breasted grosbeak (Pheucticus ludovicianus)
Blue grosbeak (Guiraca caerulea)
Indigo bunting (Passerina cyanea)
Dickcissel (Spiza americana)
Rufous-sided towhee (Pipilo erythophthalmus)
Savannah sparrow (Passerculus sandwichensis)
Sharp-tailed sparrow (Ammospiza caudacuta)
Seaside sparrow (Ammospiza maritima)
White-throated sparrow (Zonotrichia albicollis)
Swamp sparrow (Melospiza georgiana)
Song sparrow (Melospiza melodia)

*Birds that may occur in this area (personal communication, Robert J. Newman) but were not observed by either Mabie or Hebrard.

Source: D. W. Mabie, unpublished MS.

Fishing Birds
(gulls, terns, pelicans, skimmers)

Seasonal occurrence of fishing birds along the beach at Bay Champagne on the coast just east of the mouth of Bayou Lafourche is given in Table 15. The offshore and nearshore environments are used primarily as feeding and resting areas by

Table 15. Seasonal occurrence of fishing birds along beach area of Bay Champagne.

| | N | D | J | F | M | All Year |
|---|---|---|---|---|---|---|
| Herring gull (*Larus argentatus*) | x | | x | x | x | |
| Ring-billed gull (*Larus delawarensis*) | x | x | x | x | x | |
| Laughing gull (*Larus atricilla*) | x | x | x | x | x | x |
| Forster's tern (*Sterna forsteri*) | x | x | x | x | x | x |
| Common tern (*Sterna hirundo*) | x | x | x | x | | |
| Royal tern (*Thalasseus maximus*) | x | x | x | x | x | x |
| Caspian tern (*Hydroprogne caspia*) | x | x | | x | | x |
| Black skimmer (*Rynchops niger*)* | x | x | x | x | x | x |
| White pelican (*Pelecanus erythrorhynchos*) | x | | x | x | | |
| Brown pelican (*Pelecanus occidentalis*) | x | | x | | | x |

*Dominant species
Source: Helga Cernicek, Observer

many fishing birds and some waterfowl (e.g., Lesser scaup). Although not restricted exclusively to offshore and nearshore environments, the Brown pelican has been observed almost entirely in these habitats.

The abundance of fishing birds is influenced by seasonal migration, with the exception of the Black skimmer, Brown pelican, Laughing gull, Forster's tern, Royal tern, and Caspian tern, which are year-round residents of Louisiana (Lowery). These species eat primarily fish and shrimp.

The Brown pelican, which became extinct in Louisiana around 1961, has been reintroduced and is struggling to survive once again. Queen Bess Island in Barataria Bay has been the nesting site. Approximately 200 individuals were observed on 29 March 1974, with another 100 young birds in the nest. A 1975 survey revealed only 25 pairs with 13 young produced (Ray Aycock, personal communication). One hundred new birds were introduced in 1975 (Ralph Latapie, personal communication). Food of the Brown pelican consists entirely of fish, chiefly menhaden and mullet (Bent 1922).

The White pelican, a migratory species of fishing bird, was first observed during the LOOP study in October 1973. Approximately 1,000 of these large white birds were seen in the vicinity of Airplane Lake and Bay Champagne from October through March, at which time the northward migration began that left the marsh bare of this species. On each aerial survey from October through March these birds were observed feeding in a freshwater impoundment and on several occasions along the beach area of Bay Champagne. Scattered individuals were spotted in saline and brackish areas within the marsh.

### Shorebirds
(plovers, sandpipers, snipe, etc.)

Thirteen species of shorebirds were identified along the beach environment of Bay Champagne by LOOP study investigators. Table 16 shows the patterns of seasonal occurrence for these 13 species. The Western sandpiper and Semipalmated sandpiper were found to be the most abundant overall. The plovers, sandpipers, and other shorebirds were found feeding along mud flats in

Table 16. Seasonal occurrence of shore birds along beach area of Bay Champagne.

| | Nov | Dec | Jan | Feb | Mar |
|---|---|---|---|---|---|
| Piping plover (*Charadrius melodus*) | X | | | | X |
| Semipalmated plover (*Charadrius semipalmatus*) | X | X | | | X |
| Wilson's plover (*Charadrius wilsonia*) | X | | | | X |
| Black-bellied plover (*Pluvialis squatarola*) | X | | X | X | X |
| Ruddy turnstone (*Arenaria interpres*) | X | X | | X | X |
| Willet (*Catoptrophorus semipalmatus*) | X | | X | | X |
| Dowitcher (*Limnodromus* sp.) | X | X | X | | |
| Semipalmated sandpiper (*Calidris pusilla*)* | X | X | X | X | |
| Western sandpiper (*Calidris mauri*) | X | X | X | X | X |
| Sanderling (*Calidris alba*) | X | X | X | X | X |
| Dunlin (*Calidris alpina*) | | X | X | X | X |
| Killdeer (*Charadrius vociferus*) | | | X | | |
| Avocet (*Recurvirostra americana*) | | | | X | |

*Dominant species
Source: Helga Cernicek, Observer

the salt marsh and along the beach area of Bay Champagne.

### Rails

Studies by Bateman (1965) and Oney (1954) of food items of the Clapper rail show this species to be an important consumer species in the saline marsh. Among its foods are snails, crabs, insects, spiders, fish, and plants. During the LOOP study, the Clapper rail was found exclusively in the saline area with some intrusion into brackish marsh zones, while the King rail was found predominantly in fresh marsh with some extension into brackish marsh. The small Sora rail is abundant during migration and during the winter.

The Red-shouldered hawk, Sparrow hawk, Marsh hawk, Osprey, and Barred owl were the birds of prey observed by LOOP study investigators. Peregrin falcons were observed near the chenier area east of Bay Champagne in the spring of 1972 by Hebrard (unpublished data). There are two active nests of the Southern bald eagle in Barataria Basin (Ray Aycock, personal communication).

Marsh hawks were found to be in all marsh environments during the LOOP study. Numerous individuals were seen in the salt and brackish marsh in November 1973. An Osprey was observed feeding in a freshwater impounded area on one occasion and in the swamp area along Bayou Citamon on several occasions. Barred owls were seen only in the swamp environment but were seen there year-round. Sparrow hawks were observed only during the winter months, usually sitting on power lines along roadsides.

## Wading Birds

Wading birds comprise a large segment of the coastal bird populations, ranging in habitat from beaches to swamps. Ten species of wading birds were observed during the LOOP study, including Great egret, Snowy egret, Cattle egret, Reddish egret, Louisiana heron, Little blue heron, Great blue heron, Black-crowned night heron, Yellow-crowned heron, Green heron, White ibis, Glossy ibis, White-faced ibis, American bittern, and Least bittern.

Data collected from aerial surveys during the LOOP study show seasonal abundance, density, and marsh preference of many of the species listed (Tables 17 through 20). Densities of all species are given in Table 22.

Herons and Egrets. Four transects along the same line were flown by LOOP study investigators on the same day once a month from August 1973 through July 1974. From the numbers calculated per day, the lowest density usually occurred at midday or early afternoon. This daily variation is related to the diurnal movement of wading birds from roosting areas to feeding areas that may cover over 50 miles each day (Lowery 1974). Because of this factor, mean and peak numbers were used in the calculation of wading bird density by marsh type (Table 21). Definite changes occurred monthly in density of wading birds by marsh type and abundance. Peak numbers were seen during September and October of 1973, with a gradual decline beginning in November and continuing through March. Although density of the wading birds changed by marsh type during the year, the highest percentage of the total number of wading birds observed was usually in the saline marsh. Movement of virtually all species during November through March was related to migration, though not necessarily migration out of the state.

Of the herons and egrets observed in the LOOP study, the Snowy egret and Great egret were found to be the most abundant. The reddish egret was least abundant, with only two individuals ever seen at one time and only along the beach environment. Little blue herons were found in large numbers only in association with agricultural areas, except during the breeding season when they became associated with other egrets and herons within the heronries.

Ibises. Four species of ibis have been recorded in Louisiana (Lowery 1974), three of which were observed during the LOOP study. These included the White ibis, Glossy ibis, and White-faced ibis. Lowery (1974) considers the Glossy ibis to be rare in the state with only a few definite records from the Grand Isle area. White and White-faced ibises are abundant along the coast at all seasons, and the Glossy Ibis is permanent residents in the southeastern section though they are seldom observed (Palmisano 1971). Nearly all dark ibises (Glossy and White-faced) are restricted to marsh habitats, while the White ibises occur throughout the marshes and swamplands of southeast Louisiana. LOOP study aerial surveys showed that the ibises comprise a relatively small portion of the total number of wading birds in the Barataria Basin.

Bitterns. The American bittern is most numerous on the Louisiana coast in winter when there is a large influx of migrants from the north, while the Least bittern is only present in

Table 17. Peak number of individual wading birds/100 acres observed August 1973-July 1974 with a mean value for the year in the fresh marsh areas of Barataria Basin

| Species | 8/22 | 9/20 | 10/25 | 11/29 | 12/21 | 1/30 | 2/22 | 3/29 | 4/26 | 5/13 | 6/26 | 7/30 | Av |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Great Egret (*Casmerodius albus*) | 6.3 | 6.1 | 5 | 6.2 | 3.9 | 4.6 | 1.5 | 1.2 | .4 | .7 | 3.9 | 3.2 | 3.6 |
| Snowy Egret* (*Egretta thula*) | 8.9 | 13.2 | 11.3 | 1.7 | 6.4 | 19.9 | 3.5 | 3.7 | 2.1 | 4 | 2.3 | 4.8 | 6.8 |
| Cattle Egret (*Bubulcuc ibis*) | 29.3 | 53 | 8.2 | .3 | 0 | 2.7 | .4 | 2.3 | 4.2 | 1.3 | 13.5 | 43.1 | 13.2 |
| Reddish Egret** (*Dichromanassa rufescens*) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Louisiana Heron (*Hydranassa tricolor*) | 2.3 | 2.1 | .5 | .5 | 1.7 | 1.9 | 2.5 | .07 | .2 | .3 | .2 | .1 | 1.1 |
| Little Blue Heron (*Florida caerulea*) | .9 | 3.9 | .8 | 1.3 | 2.4 | .3 | 3 | 2.8 | .1 | .2 | .08 | 1.9 | 1.5 |
| Great Blue Heron (*Ardea herodias*) | .3 | .2 | .3 | .2 | .2 | .4 | .2 | .07 | .1 | .2 | .2 | 0 | .2 |
| Black-Crowned Night Heron* (*Nycticorax nycticorax*) | 0 | .07 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | .08 | .08 | .02 |
| Yellow-Crowned Night Heron (*Nyctanassa violacea*) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| White Ibis** (*Eudocinus albus*) | 14.3 | 0 | .4 | 1.1 | 0 | 0 | 0 | 0 | 0 | .4 | 0 | .08 | 1.4 |
| Dark Ibis Glossy (*Plegadis facinellus*) White Faced (*Plegadis chihi*)** | 0 | 1.1 | 3.9 | 1 | 0 | .3 | .9 | 0 | 0 | 0 | .4 | .9 | .7 |

* Snowy Egret numbers also include Immature Little Blue Herons.
** Blue list species.
Area observed: 1,280 acres.

Source: D. W. Mabrie, unpublished ms.

Table 18. Peak number of individual wading birds/100 acres observed August 1973-July 1974 with a mean value for the year in the brackish marsh area along Bayou Lafourche.

| Species | 8/22 | 9/20 | 10/25 | 11/29 | 12/21 | 1/30 | 2/22 | 3/29 | 4/26 | 5/13 | 6/26 | 7/30 | Av |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Great Egret (*Casmerodius albus*) | 8.5 | 15.8 | 6.4 | 18.6 | 2.6 | 7.1 | .9 | 1.8 | .7 | 2.4 | 11.8 | 4.2 | 6.7 |
| Snowy Egret* (*Egretta thula*) | 9.8 | 18 | 10 | 14 | 9.3 | 3.8 | 1.3 | 2.7 | 3.2 | 3.2 | 10.6 | 11.8 | 8.1 |
| Cattle Egret (*Bubulcuc ibis*) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Reddish Egret** (*Dichromanassa rufescens*) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Louisiana Heron (*Hydranassa tricolor*) | 4 | 10 | 1.1 | 1.1 | 2.6 | 1.5 | 4 | .8 | 2 | 1.5 | 2.1 | 5 | 2.9 |
| Little Blue Heron (*Florida caerulea*) | 1.7 | 2.7 | .9 | .6 | .4 | .5 | .3 | .09 | 0 | .2 | 2.7 | 1.5 | .9 |
| Great Blue Heron (*Ardea herodias*) | .09 | .4 | .2 | .2 | .2 | .2 | .2 | 0 | .09 | 0 | .09 | .09 | .14 |
| Black-Crowned Night Heron** (*Nycticorax nycticorax*) | 0 | .2 | .3 | 0 | 0 | 0 | .2 | 0 | 0 | 0 | 0 | 0 | .06 |
| Yellow-Crowned Night Heron (*Nyctanassa violacea*) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| White Ibis** (*Eudocimus albus*) | 0 | 0 | 0 | 0 | .4 | 0 | 0 | 0 | 0 | 0 | 5.6 | .5 | .5 |
| Dark Ibis Glossy (*Plegadis facinellus*) White Faced (*Plegadis chihi*)** | 0 | 13.3 | 5.3 | 0 | 0 | 0 | 0 | 0 | .6 | .4 | 4.3 | 0 | 2 |

* Snowy Egret numbers also include immature Little Blue Herons
** Blue list species
Area observed: 1,120 acres

Table 19. Peak number of individual wading birds/100 acres observed August 1973-July 1974 with a mean value for the year in the salt marsh area along Bayou Lafourche.

| Species | 8/22 | 9/20 | 10/25 | 11/29 | 12/21 | 1/30 | 2/22 | 3/29 | 4/26 | 5/13 | 6/26 | 7/30 | Av |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Great Egret (Casmerodius albus) | 7.3 | 16.4 | 32 | 11.5 | 18.75 | 11.1 | .7 | 1.1 | 3.9 | 2.5 | 20.5 | 16 | 11.8 |
| Snowy Egret* (Egretta thula) | 12.7 | 21.4 | 35.5 | 17.2 | 7.8 | 10 | 3.1 | 2.6 | 12.3 | 8.7 | 29.6 | 37.1 | 16.5 |
| Cattle Egret (Bubulcuc ibis) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Reddish Egret** (Dichromanassa rufescens) | 0 | 0 | 0 | .07 | 0 | .03 | .03 | 0 | 0 | .03 | 0 | 0 | .01 |
| Louisiana Heron (Hydranassa tricolor) | 2.8 | 8.6 | 10.2 | 2.9 | 14.9 | 5.0 | 3.6 | .9 | 1.4 | 2.9 | 8.3 | 9 | 5.9 |
| Little Blue Heron (Florida caerulea) | 1.1 | 3.6 | 1.8 | .7 | .4 | .03 | .07 | .07 | .07 | .07 | .5 | .3 | .73 |
| Great Blue Heron (Ardea herodias) | .2 | .2 | .5 | .5 | .8 | 1 | 1.3 | .4 | .1 | .03 | .1 | .07 | .44 |
| Black-Crowned Night Heron** (Nycticorax nycticorax) | .1 | .07 | .07 | .4 | .9 | .07 | 0 | .2 | .07 | .07 | 0 | .03 | .16 |
| Yellow-Crowned Night Heron (Nyctanassa violacea) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| White Ibis** (Eudocinus albus) | 3.6 | .2 | 2.2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1.7 | 5.2 | 1.1 |
| Dark Ibis Glossy (Plegadis facinellus) White Faced (Plegadis chihi)** | .4 | 6.3 | 1.3 | 1.9 | 0 | 0 | .03 | 0 | .4 | .3 | 2.4 | 6.4 | 1.6 |

* Snowy Egret numbers also include immature Little Blue Herons
** Blue list species
Area observed: 2,720 acres
Source: D. W. Mabie, unpublished ms.

Table 20. Peak number of individual wading birds/100 acres observed August 1973-July 1974 with a mean value for the year in an impounded area north of the mouth of Bayou Lafourche

| Species | 8/22 | 9/20 | 10/25 | 11/29 | 12/21 | 1/30 | 2/22 | 3/29 | 4/26 | 5/13 | 6/26 | 7/30 | Av |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Great Egret (Casmerodius albus) | 167 | 23.5 | 60 | 6 | 0 | 2.5 | 3.5 | 16.5 | 40.5 | 35 | 3 | 13.5 | 29.3 |
| Snowy Egret* (Egretta thula) | 471 | 52 | 14.5 | 4 | 0 | 6.5 | 31.5 | 44.5 | 193 | 63.5 | 3 | 53 | 78 |
| Cattle Egret (Bubulcuc ibis) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Reddish Egret** (Dichromanassa rufescens) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Louisiana Heron (Hydranassa tricolor) | 76 | 8 | 18 | 18.5 | 9.5 | 17 | 25 | 1.5 | 6 | 8 | 1.5 | 10.5 | 16.6 |
| Little Blue Heron (Florida caerulea) | 12 | .5 | 1 | 1.5 | .5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1.3 |
| Great Blue Heron (Ardea herodias) | 3.5 | 1 | 1 | .5 | 1 | 2 | 1 | 1 | .5 | .5 | .5 | .5 | 1 |
| Black-Crowned Night Heron** (Nycticorax nycticorax) | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | .5 | 5.5 | .5 | 0 | .71 |
| Yellow-Crowned Night Heron (Nyctanassa violacea) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| White Ibis** (Eudocinus albus) | 0 | 0 | 37.5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3.1 |
| Dark Ibis Glossy (Plegadis facinellus) White Faced (Plegadis chihi)** | 7.5 | 0 | 60 | 75 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 46.5 | 15.6 |

* Snowy Egret numbers also include immature Little Blue Herons
** Blue list species
Area observed: 200 acres
Source: D. W. Mabie, unpublished ms.

Table 21. Wading birds/100 acres in the marsh environments of southeast Louisiana along a 400-m wide transect.

| | Fresh | | Brackish | | Saline | | Total of All Marsh Types | |
|---|---|---|---|---|---|---|---|---|
| | Mean | Peak | Mean | Peak | Mean | Peak | Mean | Peak |
| Aug. 22, 1973 | 31.2 | 39.4 | 13.1 | 25.0 | 12.0 | 24.6 | 17.2 | 25.7 |
| Sept. 20, 1973 | 52.3 | 65.8 | 26.3 | 55.0 | 34.4 | 48.5 | 37.1 | 49.6 |
| Oct. 25, 1973 | 18.3 | 22.8 | 9.7 | 23.9 | 60.9 | 77.3 | 39.0 | 47.3 |
| Nov. 29, 1973 | 5.2 | 12.4 | 15.4 | 34.6 | 24.1 | 35.3 | 17.6 | 27.2 |
| Dec. 21, 1973 | 7.3 | 14.8 | 6.6 | 15.6 | 29.3 | 43.7 | 18.8 | 24.0 |
| Jan. 30, 1974 | 18.2 | 27.5 | 5.4 | 13.2 | 17.3 | 25.2 | 14.9 | 19.4 |
| Feb. 22, 1974 | 7.5 | 11.6 | 3.8 | 5.4 | 5.8 | 8.5 | 6.8 | 12.5 |
| March 29, 1974 | 5.3 | 8.8 | 2.5 | 4.9 | 4.3 | 5.0 | 4.1 | 4.5 |
| April 26, 1974 | 5.0 | 6.3 | 3.6 | 4.8 | 13.2 | 17.3 | 9.1 | 11.1 |
| May 13, 1974 | 3.5 | 5.4 | 3.5 | 6.2 | 9.9 | 14.6 | 6.9 | 9.9 |
| June 26, 1974 | 11.4 | 19.3 | 20.4 | 31.0 | 51.6 | 58.1 | 34.8 | 41.6 |
| July 30, 31, 1974 | 23.5 | 46.6 | 12.1 | 22.9 | 39.2 | 74.2 | 29.4 | 46.0 |

*Herons: Louisiana, Little Blue, Great Blue, Black-Crowned Night, Yellow-Crowned Night

Egrets: American, Snowy, Cattle, Reddish

Ibises: White, Glossy, White-faced

**1280 Acres of fresh marsh
1120 Acres of brackish marsh
2720 Acres of saline marsh
5120 Total of all marsh types

Source: D. W. Mabie, unpublished ms.

spring and summer (Lowery 1974).

Bitterns are secretive wading birds and are rather difficult to observe. LOOP investigators walked transects in the marsh in search of these species. With great effort only one American bittern was found, this in the saline marsh. Several Least bitterns were flushed in fresh, brackish, and saline areas.

## Nesting Colonies of Wading Birds

Nesting generally occurs in large colonies (heronries) with herons, egrets, and ibises all in the same colony. The adaptive significance of colonial nesting is poorly known. Allen and Mangels (1940) state that flock stimulation "very likely is essential to reproduction" in Black-crowned night herons. Darling (1952) concluded from studies of gulls that social displays probably synchronize reproduction in breeding colonies. Mutual defense against predators has also been proposed as an advantage to colonial nesters. Table 22 shows location and species composition of known heronries in Barataria Basin.

Five heronries were located during the LOOP study, all on islands within bays. Most consisted of Black mangrove trees (Avicennia nitida) that provided a structure for nest building. Ibises nested primarily in Cordgrass (Spartina alterniflora).

Table 22. Bird rookeries and their populations in Barataria Bay system.

1974 Survey (breeding pairs)

St. John the Baptist Parish--Lac des Allemands
- Little Blue heron--1,200
- Cattle egret--1,000
- Great egret--50
- Snowy egret--2,000
- Louisiana heron--300
- Black-crowned night heron--12

Lafourche Parish--Lake Bouef
- Little blue heron--700
- Cattle egret--360
- Snowy egret--840
- Louisiana heron--300
- Great egret--500
- White ibis--500

Lafourche Parish--Gheens
- Great blue heron--75
- Great egret--800
- Little blue heron--200
- Cattle egret--50
- Snowy egret--50
- Louisiana heron--25

Lafourche-St. Charles-Jefferson Parish--Lake Salvador
- Little blue heron--350
- Cattle egret--250
- Snowy egret--100
- Louisiana heron--50

Jefferson Parish--Queen Bess Island
- Brown pelican--35
- Little blue heron--5
- Great egret--20
- Snowy egret--65
- Louisiana heron--175
- Black-crowned night heron--5
- Dark ibis--140

Table 22. Continued.

Plaquemines Parish--Barataria Bay "East"
- Green heron--3
- Little blue heron--240
- Great Egret--1,150
- Snowy egret--1,600
- Louisiana heron--570
- Black-crowned night heron--19
- Dark ibis--200
- White ibis--1,100

Jefferson Parish--Barataria Bay "West"
- Green heron--6
- Little blue heron--40
- Cattle egret--10
- Great egret--790
- Snowy egret--995
- Louisiana heron--445
- Black-crowned night heron--1
- Dark ibis--50
- White ibis--20

St. Charles Parish--(T14S, R22E, S11)
- Great egret--100
- Snowy egret--50
- Cattle egret--3,000
- Louisiana heron--500
- Little blue heron--2,000
- White ibis--100
- Dark ibis--100

St. John the Baptist Parish--Wallace (just S Hwy. 18)
- Great egret--500
- Snowy egret--500
- Cattle egret--500
- Louisiana heron--500
- Little blue heron--500
- White ibis--500

St. Charles Parish--(T15S, R22E, S )
- Night heron--75
- Little blue heron--700
- Great and Snowy egret--300

1975 Survey

Lafourche Parish--2 mi S Little Lake/3 mi ENE Golden Meadow; a little S of West Fork Bayou L'Ours
- Great egret--1,000
- Snowy egret--1,000
- Louisiana heron--1,000
- Little blue heron--1,000

Table 22. Continued.

Plaquemines Parish--NE Barataria Bay/S Bay Batiste;
Big (or Bia) Island
   Great blue heron--25
   Great egret--1,000
   Snowy egret--1,000
   Little blue heron--25
Jefferson Parish--Queen Bess Island
   White ibis--200+
   Brown pelican--25 pair + 13 young
Lafourche Parish--Midway between Lake Salvador
and Gheens
   White ibis--1,500
   Dark ibis--500

Source: Louisiana Wildlife and Fisheries Commission, Ray Aycock, Jr., comp.

Nesting begins in April but varies from colony to colony. Weather conditions may influence the time of nesting (Palmisano 1971). Fledglings were observed in late May and early June 1974 during the LOOP study, but during this period newly hatched birds were also observed, indicating a prolonged breeding period from April through June.

These nesting colonies are important areas of wetland habitats. Zelickman and Golovkin (1972) found during a study of plankton communities near bird colonies that a correlation existed between a steady increase in abundance of domimant zooplankton species and the enrichment of the water with nutrients from bird excrement. Enrichment of the waters occurs not only during nesting periods but also throughout the year because of the daily aggregation of wading birds in roosts.

Data pertaining to the longevity of heronries are few. Most heron nests are situated above the ground, and Vermeer (1969) reports that heron colonies in Alberta were abandoned when trees died and fell. He further suggests that excrement from the colony itself may contribute to the death of trees. In the absence of structural damage to vegetation, however, heronries can be quite long lived. An artifically maintained heronry on Avery Island has been continuously occupied for approximately 80 years (McIlhenny 1934; Lowery, personal communication).

## Waterfowl

Dabbling Ducks. This category of ducks is characterized by their habit of feeding in relatively shallow water. Included are Mallard, Mottled duck, Black duck, Gadwall, Pintail, Green-winged teal, Blue-winged teal, Baldpate (American widgeon), and Shoveler. These ducks are the most diverse group of waterfowl that winter in coastal Louisiana. Data on density of dabbling ducks acquired by LOOP study investigators by marsh type from August 1973 to July 1974 are given in Tables 23 and 24. Abundances of individual species by habitat type are given in Tables 25 through 28.

The southward migration of dabbling ducks begins in August with the arrival of Blue-winged teal, and continues through December with the final Mallard migration into the state. In general, the main dabbler movements in the fall and winter are the Blue-winged teal and Pintail in August and September; Pintail in early October

Table 23. Puddle ducks*/100 acres in the marsh environments of southeast Louisiana along a 400-m wide transect.**

| | Fresh | | Brackish | | Saline | | Total of All Marsh Types | |
|---|---|---|---|---|---|---|---|---|
| | Mean | Peak | Mean | Peak | Mean | Peak | Mean | Peak |
| Aug. 22, 1973 | 4.1 | 15.7 | 5.3 | 10.9 | 0.1 | 0.4 | 2.2 | 4.3 |
| Sept. 20, 1973 | 21.8 | 34.6 | 14.1 | 20.3 | 5.4 | 7.3 | 11.4 | 16.2 |
| Oct. 25, 1973 | 64.9 | 146.0 | 110.4 | 137.7 | 8.4 | 20.5 | 44.9 | 69.3 |
| Nov. 29, 1973 | 30.6 | 47.5 | 20.6 | 29.4 | 35.7 | 60.4 | 31.1 | 42.7 |
| Dec. 21, 1973 | 2.9 | 6.2 | 11.6 | 32.6 | 75.1 | 89.8 | 43.1 | 48.6 |
| Jan. 30, 1974 | 2.9 | 5.2 | 115.3 | 124.6 | 118.2 | 170.6 | 88.7 | 118.8 |
| Feb. 22, 1974 | 13.3 | 23.2 | 53.9 | 76.1 | 37.2 | 42.6 | 34.5 | 39.6 |
| March 29, 1974 | 7.0 | 13.5 | 13.4 | 18.4 | 30.2 | 36.6 | 10.3 | 15.2 |
| April 26, 1974 | 2.6 | 5.8 | 2.5 | 3.6 | 0.70 | 1.4 | 1.6 | 3.0 |
| May 13, 1974 | .15 | .23 | .53 | 1.25 | .08 | .22 | .2 | .39 |
| June 26, 1974 | .039 | .15 | .13 | .26 | .13 | [illegible] | .11 | .15 |
| July 30, 31, 1974 | 0 | 0 | .044 | .089 | .13 | .25 | .083 | .13 |

*Mallard
Mottled Duck
Gadwall
Pintail
Green-winged Teal
Blue-winged Teal
Baldpate
Shoveller

**1280 Acres of fresh marsh
1120 Acres of brackish marsh
2720 Acres of saline marsh
5120 Total of all marsh types

Table 24. Mean and peak numbers of puddle ducks seen in each marsh type and total (mean and peak) numbers of puddle ducks seen for all marsh types.

| | Fresh | | Brackish | | Saline | | Tank Farm (Fresh) | | Total No. Birds Seen | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Mean | Peak | Mean | Peak | Mean | Peak | Mean | Peak | Mean | Peak |
| Aug. 22, 1973 | 53 | 201 | 59.5 | 123 | 3.25 | 11 | 161.5 | 269 | 277.25 | 367 |
| Sept. 20, 1973 | 279 | 443 | 158 | 228 | 149 | 199 | 541 | 720 | 1115.75 | 1426 |
| Oct. 25, 1973 | 831.5 | 1870 | 1237.25 | 1543 | 230.5 | 558 | 1131.5 | 2093 | 3430.75 | 4573 |
| Nov. 29, 1973 | 391.5 | 609 | 231 | 330 | 971.25 | 1644 | 1458.5 | 1626 | 3052.25 | 3816 |
| Dec. 21, 1973 | 37.75 | 79 | 129.75 | 366 | 2043 | 2443 | 5295.75 | 5883 | 7506.75 | 8120 |
| Jan. 30, 1974 | 37.25 | 66 | 1291.75 | 1396 | 3216.25 | 4643 | 2271.25 | 2795 | 6816.5 | [illegible] |
| Feb. 22, 1974 | 170.75 | 297 | 603.75 | 852 | 1011.5 | 1158 | 2190.25 | 2595 | 3957 | 4386 |
| March 29, 1974 | 90 | 173 | 160.3 | 206 | 288.6 | 389 | 822.6 | 996 | 1351.6 | 1642 |
| April 26, 1974 | 33.25 | 74 | 28 | 40 | 19 | 37 | 10 | 20 | 80.25 | 151 |
| May 13, 1974 | 2 | 3 | 6 | 14 | 2.25 | 4 | 1.5 | 3 | 13.75 | 23 |
| June 26, 1974 | .5 | 2 | 1.5 | 3 | 3.75 | 6 | 1.25 | 3 | 7 | 13 |
| July 30, 31, 1974 | 0 | 0 | .5 | 1 | 3.75 | 7 | 6 | 16 | 10.25 | 21 |

Table 25. Peak number of individual waterfowl species/100 acres observed Autust 1973-July 1974 in fresh marsh areas in Barataria Basin with a mean value for the period.

| Species | 8/22 | 9/22 | 10/25 | 11/29 | 12/21 | 1/30 | 2/22 | 3/29 | 4/26 | 5/13 | 6/26 | 7/30 | Av |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Mallard<br>Anas platyrhynchos | 0 | 2.5 | 3.7 | .9 | 2.1 | 1 | 1.4 | 1.8 | .15 | 0 | 0 | 0 | 1.1 |
| Mottled Duck*<br>Anas fulvigula | 2 | 3 | 4.3 | 1.7 | .6 | .9 | 1.5 | 0 | .62 | .23 | .15 | 0 | 1.3 |
| Gadwall*<br>Anas strepera | 0 | 0 | .08 | 3.9 | 0 | 2.8 | 8.2 | .93 | 0 | 0 | 0 | 0 | 1.3 |
| Pintail*<br>Anas acuta | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Green-Winged Teal<br>Anas crecca | 0 | 0 | 0 | 0 | .6 | .15 | 14.1 | 0 | 0 | 0 | 0 | 0 | 1.2 |
| Blue-Winged Teal<br>Anas discors | 13.6 | 34.2 | 133 | 46.6 | 3.7 | 3.9 | 8.1 | 10.5 | 5.4 | .15 | 0 | 0 | 21.6 |
| American Wigeon<br>Anas americana | 0 | 0 | 5.4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | .45 |
| Shoveller*<br>Anas clypeata | 0 | 0 | 0 | 0 | 0 | 0 | .15 | 1.8 | 1 | 0 | 0 | 0 | .25 |
| Lesser Scaup**<br>Aythya affinis | 0 | 0 | 0 | 0 | 15.6 | 0 | 6.6 | 1.9 | 3.7 | 0 | 0 | 0 | 2.3 |
| Red Head**<br>Aythya americana | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Red-Breasted Merganser**<br>Mergus serrator | 0 | 0 | 0 | 0 | .46 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | .04 |
| Coot***<br>Fulica americana | 0 | 0 | 23.4 | 15.6 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | .15 | 3.3 |

Notes: *Puddle Ducks **Diving Ducks ***Coots Area observed: 1,280 acres

Source: D. W. Mabie, unpublished ms.

Table 26. Peak number of individual waterfowl species/100 acres observed August 1973-July 1974 with a mean value for the year in brackish marsh areas in Barataria Basin.

| Species | 8/22 | 9/22 | 10/25 | 11/29 | 12/21 | 1/30 | 2/22 | 3/29 | 4/26 | 5/13 | 6/26 | 7/30 | Av |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Mallard<br>*Anas platyrhynchos* | 0 | .53 | 7.5 | 1 | 2.7 | 10.7 | .17 | 0 | 0 | 0 | 0 | 0 | 1.9 |
| Mottled Duck*<br>*Anas fulvigula* | 1 | 4.1 | 6.7 | 1.2 | 3.1 | .7 | 1.7 | .71 | 1.8 | 1.1 | .26 | .89 | 1.9 |
| Gadwall*<br>*Anas strepera* | 0 | 0 | 23.9 | .17 | 13.4 | 40.5 | 26.7 | 3.3 | 0 | 0 | 0 | 0 | 8.9 |
| Pintail*<br>*Anas acuta* | 0 | 0 | 0 | 1 | 2.1 | 5.3 | 0 | 0 | 0 | 0 | 0 | 0 | .7 |
| Green-Winged Teal<br>*Anas crecca* | 0 | 1 | 0 | 0 | 26.7 | 18.6 | 0 | 0 | 0 | 0 | 0 | 0 | 3.9 |
| Blue-Winged Teal<br>*Anas discors* | 9.9 | 16.1 | 102.5 | 27.1 | 3.5 | 26.7 | 21.4 | 15.3 | 3.2 | .08 | 0 | .89 | 18.9 |
| American Wigeon<br>*Anas americana* | 0 | 0 | 13.2 | 0 | 13.4 | 26.7 | 16.7 | 4.5 | 0 | 0 | 0 | 0 | 6.2 |
| Shoveller*<br>*Anas clypeata* | 0 | 0 | 0 | 0 | 0 | 4.5 | .71 | 0 | 0 | 0 | 0 | 0 | .43 |
| Lesser Scaup**<br>*Aythya affinis* | 0 | 0 | 0 | 0 | 23.9 | 28.6 | 20.7 | 8.2 | 3.4 | 0 | 0 | 0 | 7.1 |
| Red Head**<br>*Aythya americana* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Red-Breasted Merganser**<br>*Mergus serrator* | 0 | 0 | 0 | 0 | .44 | 1.3 | 6.7 | 2.4 | 0 | 0 | 0 | 0 | .9 |
| Coot***<br>*Fulica americana* | 0 | .17 | 2.1 | 3.4 | 35.7 | 31.2 | 26.8 | 0 | 0 | 0 | 0 | 0 | 8.3 |

Notes: *Puddle Ducks **Diving Ducks ***Coots Area observed: 1,120 acres
Source: D. W. Mabie, unpublished ms.

Table 27. Peak number of individual waterfowl species/100 acres observed August 1973-July 1974 with a mean value for the year in salt marsh areas in Barataria Basin.

| Species | 8/22 | 9/22 | 10/25 | 11/29 | 12/21 | 1/30 | 2/22 | 3/29 | 4/26 | 5/13 | 6/26 | 7/30 | Av |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Mallard<br>*Anas platyrhynchos* | 0 | 2.4 | .07 | 1.3 | 4 | 1.3 | 2.2 | 0 | 0 | 0 | 0 | 0 | .9 |
| Mottled Duck*<br>*Anas fulvigula* | .03 | .44 | .88 | .40 | .69 | .55 | .73 | .18 | .22 | .14 | .22 | .25 | .4 |
| Gadwall*<br>*Anas strepera* | 0 | 0 | 0 | 21.3 | 30.9 | 31.6 | 6.6 | 4.7 | 0 | 0 | 0 | 0 | 7.9 |
| Pintail*<br>*Anas acuta* | 0 | 0 | 0 | 5.0 | 13.9 | 6.0 | 0 | 0 | 0 | 0 | 0 | 0 | 2.1 |
| Green-Winged Teal<br>*Anas crecca* | 0 | 0 | 0 | 0 | 5.3 | 90.6 | 32.5 | 0 | 0 | 0 | 0 | 0 | 10.7 |
| Blue-Winged Teal<br>*Anas discors* | .4 | 6.8 | 19.5 | 17.6 | 17.5 | 18.0 | 4.5 | 8.6 | 1.2 | 0 | 0 | 0 | 7.8 |
| American Wigeon<br>*Anas americana* | 0 | 0 | .11 | 21.5 | 27.7 | 23.1 | 3.6 | 2.6 | 0 | 0 | 0 | 0 | 6.6 |
| Shoveller*<br>*Anas clypeata* | 0 | 0 | .03 | 1.8 | 4.7 | 3.8 | 4.4 | 1.3 | 0 | 0 | 0 | 0 | 1.3 |
| Lesser Scaup**<br>*Aythya affinis* | 0 | 0 | 0 | 1.4 | 15.8 | 56.5 | 14.8 | .66 | 1.9 | .14 | 0 | 0 | 7.6 |
| Red Head**<br>*Aythya americana* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Red-Breasted Merganser**<br>*Mergus serrator* | 0 | 0 | 0 | 0 | 5.8 | 3.4 | 1.5 | .25 | .07 | .11 | 0 | 0 | .92 |
| Coot***<br>*Fulica americana* | 0 | 0 | .44 | .33 | 1.28 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | .17 |

Notes: *Puddle Ducks **Diving Ducks ***Coots Area observed: 2,720 acres
Source: D. W. Mabie, unpublished ms.

Table 28. Peak number of individual waterfowl species/100 acres observed August 1973-July 1974 with a mean value for the year in an impounded area north of the mouth of Bayou Lafourche.

| Species | 8/22 | 9/22 | 10/25 | 11/29 | 12/21 | 1/30 | 2/22 | 3/29 | 4/26 | 5/13 | 6/26 | 7/30 | Av |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Mallard<br>*Anas platyrhynchos* | 0 | 49.5 | 142 | 91 | 391 | 18.5 | 8 | 0 | .5 | 0 | 0 | 0 | 58.4 |
| Mottled Duck*<br>*Anas fulvigula* | 2.5 | 78.5 | 11.5 | 13.5 | 3 | 0 | 2 | 3.5 | 3 | 1.5 | 1.5 | 2 | 10.2 |
| Gadwall*<br>*Anas strepera* | 0 | 0 | 290 | 225 | 817.5 | 430.5 | 386.5 | 168 | 0 | 0 | 0 | 0 | 193.1 |
| Pintail*<br>*Anas acuta* | 0 | 0 | 0 | 75 | 598 | 107.5 | 0 | 0 | 0 | 0 | 0 | 0 | 65 |
| Green-Winged Teal<br>*Anas crecca* | 0 | 0 | 0 | 0 | 37.5 | 537 | 280.5 | 36 | 0 | 0 | 0 | 0 | 74.3 |
| Blue-Winged Teal<br>*Anas discors* | 133.5 | 266.5 | 309.5 | 178.5 | 500 | 76 | 87.5 | 159.5 | 7 | 0 | 0 | 6 | 143.6 |
| American Wigeon<br>*Anas americana* | 0 | 0 | 331 | 246 | 731 | 317.5 | 519.5 | 184 | 0 | .5 | 0 | 0 | 194.1 |
| Shoveller*<br>*Anas clypeata* | 0 | 0 | 12 | 10.5 | 412 | 87.5 | 112.5 | 54.5 | 0 | 0 | 0 | 0 | 57.4 |
| Lesser Scaup**<br>*Aythya affinis* | 0 | 0 | 0 | 56 | 1372.5 | 543.5 | 383.5 | 430.5 | 22.5 | 6 0 | 0 | 0 | 234.5 |
| Red Head**<br>*Aythya americana* | 0 | 0 | 9 | 6 | 6 | 6 | 8.5 | 0 | 0 | 0 | 0 | 0 | 3 |
| Red-Breasted Merganser**<br>*Mergus serrator* | 0 | 0 | 0 | 0 | 190 | 105 | 70.5 | 63 | 0 | 0 | 0 | 0 | 35.7 |
| Coot***<br>*Fulica americana* | .03 | 6.3 | 4 | 8 | 6.8 | 5.9 | 0 | 0 | 0 | 0 | 0 | .039 | 2.6 |

Notes: *Puddle Ducks **Diving Ducks ***Coots Area observed: 200 acres
Source: D. W. Mabie, unpublished ms.

and early November; and the Mallard flights of November, December, and January (LWFC 1961).

In southeastern Louisiana 80 percent of the puddle ducks that wintered along the coastal areas were found in fresh marsh, 8.04 percent in intermediate marsh, 21.6 percent in brackish marsh, and 5.3 percent in saline marsh (Palmisano 1972a). Under normal conditions this would presumably be the general trend of waterfowl along the coast. The findings from the LOOP study show a different distribution that may be explained by high rainfall during the year of study (Mabie unpublished MS).

During December 1973, LOOP study investigators found 67.1 percent of the dabbling ducks in a freshwater impoundment in the salt marsh and only 0.8 percent in the fresh marsh. The brackish marsh held 4.2 percent, with 27.9 percent in the saline marsh. This was the general trend of dabbling duck distribution throughout the year.

Gadwall, American widgeon, and Blue-winged teal comprised the largest percentage of the eight species tabulated during LOOP study.

The Wood duck is another waterfowl species occurring in Barataria Basin. It is found primarily in the heavily wooded swamps of the state and is a fairly common permanent resident (Lowery 1974). Several individuals were observed in the swamp area along Bayou Citamon during the LOOP study.

Diving Ducks. Diving ducks are characterized by their habit of feeding in relatively deep water. Because of the great numbers of Scaup (*Aythya* sp.) that winter in Louisiana, the diving ducks are the most numerous type of waterfowl wintering in the state (LWFC 1961). Data on density of diving ducks in the various marsh environments from August 1973 to July 1974 are given in Tables 29 and 30. Included among the diving ducks are Redhead, Canvasback, Scaup, Ringnecked duck, Ruddy duck, and Mergansers.

The main flights of diving ducks (primarily Scaup) arrive in late October and early November. These ducks remain in the state until March or April.

Results of a LOOP study census in December, the time of peak occurrence showed 73.9 percent of the population in an impounded freshwater site, 14.6 percent in saline marsh, 6.6 percent in brackish marsh, and 4.9 percent in fresh water.

Coots. Major flights of the American coot begin in October, but the majority of the first arrivals are transients (LWFC 1961). This species is found primarily on freshwater lakes and brackish ponds throughout the state (Lowery 1974). Tables 31 and 32 show densities of coots by marsh type (Mabie unpublished MS).

LOOP study investigators found 74.9 percent of the coots censused in a freshwater impoundment, 2.0 percent in saline marsh, 23.1 percent in brackish marsh, and none in fresh marsh.

Louisiana Wildlife and Fisheries Data

Hugh Bateman of the Louisiana Wildlife and Fisheries Commission (LWFC) conducted aerial censuses of waterfowl populations, excluding geese and wood ducks, on the Louisiana coast since 1968. Summaries are presented in Tables 33 through 38. At this level of resolution it is not feasible to look at the data in terms of a

Table 29. Diving ducks*/100 acres in the marsh environments of southeast Louisiana along a 400-m wide transect.**

| | Fresh | | Brackish | | Saline | | Total of All Marsh Types | |
|---|---|---|---|---|---|---|---|---|
| | Mean | Peak | Mean | Peak | Mean | Peak | Mean | Peak |
| Aug. 22, 1973 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Sept. 20, 1973 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Oct. 25, 1973 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Nov. 29, 1973 | 0 | 0 | 0.06 | 0.26 | 1.42 | 1.58 | 0.77 | 0.83 |
| Dec. 21, 1973 | 11.0 | 15.6 | 19.1 | 23.9 | 18.3 | 21.7 | 16.6 | 19.0 |
| Jan. 30, 1974 | 0 | 0 | 9.6 | 28.5 | 16.0 | 28.1 | 10.6 | 17.1 |
| Feb. 22, 1974 | 4.3 | 6.6 | 9.4 | 22.5 | 12.1 | 15.5 | 9.6 | 12.2 |
| March 29, 1974 | 0.93 | 2.0 | 5.8 | 10.6 | 1.9 | 2.1 | 1.9 | 2.8 |
| April 26, 1974 | 0.93 | 3.75 | 1.5 | 3.5 | 0.91 | 2.0 | 1.0 | 1.9 |
| May 13, 1974 | 0 | 0 | 0 | 0 | .06 | .14 | .03 | .07 |
| June 26, 1974 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| July 30, 31, 1974 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

*Lesser Scaup
Red Head
Mergansers

**1280 Acres of fresh marsh
1120 Acres of brackish marsh
2720 Acres of saline marsh
5120 Total of all marsh types

Table 30. Mean and peak numbers of diving ducks seen in each marsh type and total (mean and peak) numbers of diving ducks seen for all marsh types.

| | Fresh | | Brackish | | Saline | | Tank Farm (Fresh) | | Total No. Birds Seen | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Mean | Peak | Mean | Peak | Mean | Peak | Mean | Peak | Mean | Peak |
| Aug. 22, 1973 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Sept. 20, 1973 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Oct. 25, 1973 | 0 | 0 | 0 | 0 | 0 | 0 | 7.5 | 18 | 7.5 | 18 |
| Nov. 29, 1973 | 0 | 0 | 0.75 | 3 | 38.75 | 43 | 88.5 | 114 | 128 | 155 |
| Dec. 21, 1973 | 142 | 200 | 214 | 268 | 498.25 | 591 | 1852 | 2997 | 2706.25 | 3595 |
| Jan. 30, 1974 | 0 | 0 | 107.5 | 320 | 435.25 | 767 | 840 | 1297 | 1382.75 | 2075 |
| Feb. 22, 1974 | 55 | 85 | 105.75 | 252 | 329.5 | 421 | 534.75 | 908 | 1025 | 1333 |
| March 29, 1974 | 12.3 | 25 | 64.6 | 119 | 21.3 | 24 | 554.6 | 862 | 644.6 | 892 |
| April 26, 1974 | 12 | 48 | 17.25 | 39 | 25 | 54 | 12.25 | 45 | 54.25 | 93 |
| May 13, 1974 | 0 | 0 | 0 | 0 | 1.75 | 4 | 3.25 | 12 | 5 | 12 |
| June 26, 1974 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| July 30,31, 1974 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

specific drainage basin or for a specific habitat type. The data are presently being put on computer cards, after which they may be broken down according to a variety of geographical criteria.

As they are, these data clearly show arrival times of the species in southeastern Louisiana. They also allow comparison of abundances on a year-to-year basis.

Table 31. Coots (Fulica americana)/100 acres in the marsh environments of southeast Louisiana long a 400-m wide transect.*

| | Fresh | | Brackish | | Saline | | Total of All Marsh Types | |
|---|---|---|---|---|---|---|---|---|
| | Mean | Peak | Mean | Peak | Mean | Peak | Mean | Peak |
| Aug. 22, 1973 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Sept. 20, 1973 | 0 | 0 | 0.08 | 0.17 | 0 | 0 | 0.01 | 0.03 |
| Oct. 25, 1973 | 11.2 | 23.4 | 0.80 | 2.1 | 0.15 | 0.44 | 3.0 | 6.3 |
| Nov. 29, 1973 | 13.0 | 15.6 | 0.93 | 3.4 | 0.10 | 0.33 | 3.5 | 4.0 |
| Dec. 21, 1973 | 0 | 0 | 30.9 | 35.7 | 0.32 | 1.28 | 6.9 | 8.0 |
| Jan. 30, 1974 | 0 | 0 | 11.1 | 31.2 | 0 | 0 | 2.4 | 6.8 |
| Feb. 22, 1974 | 0 | 0 | 6.9 | 26.8 | 0 | 0 | 1.5 | 5.9 |
| March 29, 1974 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| April 26, 1974 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| May 13, 1974 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| June 26, 1974 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| July 30, 31, 1974 | .039 | .15 | 0 | 0 | 0 | 0 | .0097 | .039 |

*1280 Acres of fresh marsh
1120 Acres of brackish marsh
2720 Acres of saline marsh
5120 Total of all marsh types

Table 32. Mean and peak numbers of coot (Fulica americana) seen in each marsh type and total (mean and peak) numbers of coots seen for all marsh types.

| | Fresh | | Brackish | | Saline | | Tank Farm (Fresh) | | Total No. Birds Seen | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Mean | Peak | Mean | Peak | Mean | Peak | Mean | Peak | Mean | Peak |
| Aug. 22, 1973 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Sept. 20, 1973 | 0 | 0 | 1 | 2 | 0 | 0 | 7.25 | 29 | 7.75 | 31 |
| Oct. 25, 1973 | 143.75 | 300 | 9 | 24 | 4.25 | 12 | 461.5 | 603 | 618.5 | 879 |
| Nov. 29, 1973 | 167.5 | 200 | 10.5 | 39 | 2.75 | 9 | 950 | 1000 | 1130.75 | 1150 |
| Dec. 21, 1973 | 0 | 0 | 346.25 | 400 | 8.75 | 35 | 1170 | 1300 | 1525 | 1680 |
| Jan. 30, 1974 | 0 | 0 | 125 | 350 | 0 | 0 | 254.25 | 422 | 379.25 | 572 |
| Feb. 22, 1974 | 0 | 0 | 76.75 | 300 | 0 | 0 | 0 | 0 | 76.75 | 300 |
| March 29, 1974 | 0 | 0 | 0 | 0 | 0 | 0 | 741.6 | 822 | 741.6 | 822 |
| April 26, 1974 | 0 | 0 | 0 | 0 | 0 | 0 | 13.5 | 48 | 13.5 | 48 |
| May 13, 1974 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| June 26, 1974 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| July 30,31, 1974 | .5 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | .5 | 2 |

Table 33. September waterfowl populations (in thousands) for southeastern Louisiana (Atchafalaya Bay-Lake Borgne)

| | 1968 | 1969 | 1970 | 1971 | 1972 | 1973 | 1974 |
|---|---|---|---|---|---|---|---|
| Mallard *Anas platyrhynchos* | .5 | TRACE | 0 | 0 | 0 | <.5 | <.5 |
| Mottled Duck, Black Duck *Anas fulvigula, A. rubripes* | 21 | 56 | 39 | 21 | 29 | 29 | 17 |
| Gadwall *Anas strepera* | 0 | 0 | 0 | 0 | 0 | 0 | <.5 |
| Pintail *Anas acuta* | .75 | TRACE | 5 | <.5 | 1 | 0 | <.5 |
| Green-winged Teal *Anas crecca* | .5 | TRACE | 3 | <.5 | <.5 | 0 | <.5 |
| Blue-winged Teal *Anas discors* | 37 | 90 | 88 | 23 | 81 | 74 | 68 |
| American wigeon *Anas americana* | .5 | TRACE | 2 | 0 | <.5 | <.5 | <.5 |
| Shoveler *Spatula clypeata* | .75 | TRACE | 1 | <.5 | 1 | <.5 | <.5 |
| Redhead *Aythya americana* | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Canvasback *Aythya valisineria* | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Ring-necked Duck *Aythya collaris* | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Scaup *Aythya affinis, A. marila* | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Ruddy Duck *Oxyura jamaicensis* | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Hooded Merganser *Lophodytes cucullatus* | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

Source: Hugh Bateman, Comp., Louisiana Wildlife and Fisheries Commission.

## Passerines (perching birds)

Forty-three percent of the 216 bird species listed in Table 14 are passerines. Every species on the list beginning with the Eastern kingbird and ending with the Song sparrow are in this category. For convenience, several other species will be discussed with this group. These include Mourning dove, Rock pigeon, Yellow-billed cuckoo, Black-billed cuckoo, Chuck-will's-widow, Common nighthawk, Chimney swift, Ruby-throated hummingbird, Belted kingfisher, and six species of woodpeckers. They may be divided into four categories based on seasonal occurrence in the coastal zone: winter residents, summer residents, permanent residents, and transients. They occupy virtually every habitat in the coastal zone at some time of year, from swamp forest to beaches.

Table 34. October waterfowl populations (in thousands) for southeastern Louisiana (Atchafalaya Bay-Lake Borgne)

| | 1968 | 1969 | 1970 | 1971 | 1972 | 1973 | 1974 |
|---|---|---|---|---|---|---|---|
| Mallard<br>*Anas platyrhynchos* | .2 | 1 | <.5 | 1 | <.5 | <.5 | <.5 |
| Mottled Duck, Black Duck<br>*Anas fulvigula*, *A. rubripes* | 30.8 | 42 | 37 | 29 | 24 | 35 | 27 |
| Gadwall<br>*Anas strepera* | 24.7 | 43 | 28 | 53 | 25 | 6 | 111 |
| Pintail<br>*Anas acuta* | 39.2 | 63 | 40 | 1 | 1 | 16 | 88 |
| Green-winged Teal<br>*Anas crecca* | 80.9 | 40 | 18 | 6 | 26 | 16 | 96 |
| Blue-winged Teal<br>*Anas discors* | 145.5 | 237 | 180 | 100 | 124 | 292 | 142 |
| American wigeon<br>*Anas americana* | 29.4 | 70 | 37 | 26 | 22 | 52 | 78 |
| Shoveler<br>*Spatula clypeata* | 12.4 | 43 | 57 | 23 | 3 | 3 | 67 |
| Redhead<br>*Aythya americana* | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Canvasback<br>*Aythya valisineria* | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Ring-necked Duck<br>*Aythya collaris* | 0 | 0 | <.5 | <.5 | <.5 | 0 | 0 |
| Scaup<br>*Aythya affinis*, *A. marila* | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Ruddy Duck<br>*Oxyura jamaicensis* | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Hooded Merganser<br>*Lophodytes cucullatus* | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

Source: Hugh Bateman, comp. Louisiana Wildlife and Fisheries Commission.

Winter Residents. Included in this category are the Yellow-bellied sapsucker, Tree swallow, House wren, Sedge wren, Robin, Hermit thrush, Golden-crowned kinglet, Ruby-crowned kinglet, Water pipit, Cedar waxwing, Solitary vireo, Orange-crowned warbler, Myrtle warbler, Palm warbler, Sharp-tailed sparrow, White-throated sparrow, Swamp sparrow, and Song sparrow (Lowery 1974).

These birds move into the coastal zone from more northern latitudes in the fall and depart in the spring. Of this group, only the Sharp-tailed sparrow is restricted in habitat to the marsh. The rest can be found in a variety of habitats from swamp forest to marsh edge and on wooded cheniers and natural levees.

Summer Residents. These species migrate northward into the coastal zone to breed after

Table 35. **November** waterfowl populations (in thousands) for southeastern Louisiana (Atchafalaya Bay-Lake Borgne)

| | 1968 | 1969 | 1970 | 1971 | 1972 | 1973 | 1974 |
|---|---|---|---|---|---|---|---|
| Mallard<br>*Anas platyrhynchos* | 139 | 63 | 101 | 118 | 30 | 62 | 60 |
| Mottled Duck, Black Duck<br>*Anas fulvigula, A. rubripes* | 68 | 30 | 33 | 40 | 36 | 39 | 29 |
| Gadwall<br>*Anas strepera* | 456 | 326 | 484 | 269 | 186 | 705 | 326 |
| Pintail<br>*Anas acuta* | 104 | 80 | 108 | 107 | 30 | 170 | 125 |
| Green-winged Teal<br>*Anas crecca* | 188 | 190 | 299 | 161 | 185 | 754 | 79 |
| Blue-winged Teal<br>*Anas discors* | 40 | 34 | 46 | 64 | 183 | 519 | 82 |
| **American wigeon**<br>***Anas americana*** | 378 | 108 | 248 | 154 | 156 | 441 | 49 |
| Shoveler<br>*Spatula clypeata* | 138 | 48 | 66 | 38 | 63 | 69 | 50 |
| Redhead<br>*Aythya americana* | 0 | 0 | <.5 | | | <.5 | <.5 |
| Canvasback<br>*Aythya valisineria* | 0 | 0 | 5 | | | <.5 | <.5 |
| Ring-necked Duck<br>*Aythya collaris* | 5 | <.5 | 1 | <.5 | 6 | <.5 | <.5 |
| Scaup<br>*Aythya affinis, A. marila* | 0 | <.5 | 500 | | 250 | 3 | 2 |
| Ruddy Duck<br>*Oxyura jamaicensis* | 0 | <.5 | <.5 | <.5 | | <.5 | <.5 |
| Hooded Merganser<br>*Lophodytes cucullatus* | 9 | <.5 | 4 | 3 | 2 | 1 | <.5 |

**Source: Hugh Bateman, comp. Louisiana Wildlife and Fisheries Commission.**

wintering in Central and South America. Among the summer residents are Eastern kingbird, Yellow-billed cuckoo, Common nighthawk, Chimney swift, Ruby-throated hummingbird Great crested flycatcher, Acadian flycatcher, Rough-winged swallow, Purple martin, Wood thrush, White-eyed vireo, Yellow-throated vireo, Prothonotary warbler, Swainson's warbler, Parula warbler, Yellow-throated warbler, Kentucky warbler, Yellowthroat, Yellow-breasted chat, Hooded warbler, Orchard oriole, Baltimore oriole, Summer tanager, Indigo bunting, and Painted bunting (Lowery 1974). Some individuals of some of these species may occur in small numbers on the Louisiana coast during mild winters, but populations are highest during spring and summer (Lowery 1974).

Of these, only the Yellowthroat breeds in marsh environments. A few species breed on

Table 36. December waterfowl populations (in thousands) for southeastern Louisiana (Atchafalaya Bay-Lake Borgne)

| | 1968 | 1969 | 1970 | 1971 | 1972 | 1973 | 1974 |
|---|---|---|---|---|---|---|---|
| Mallard<br>*Anas platyrhynchos* | 81 | 115 | 129 | 186 | 117 | 87 | |
| Mottled Duck, Black Duck<br>*Anas fulvigula*, *A. rubripes* | 50 | 47 | 28 | 39 | 26 | 44 | |
| Gadwall<br>*Anas strepera* | 447 | 653 | 631 | 504 | 582 | 657 | |
| Pintail<br>*Anas acuta* | 42 | 72 | 270 | 126 | 246 | 91 | |
| Green-winged Teal<br>*Anas crecca* | 448 | 422 | 543 | 318 | 253 | 573 | |
| Blue-winged Teal<br>*Anas discors* | 32 | 20 | 17 | 31 | 94 | 286 | |
| American wigeon<br>*Anas americana* | 234 | 264 | 433 | 286 | 341 | 372 | |
| Shoveler<br>*Spatula clypeata* | 58 | 59 | 61 | 31 | 81 | 53 | |
| Redhead<br>*Aythya americana* | 0 | 8 | 5 | | | <.5 | |
| Canvasback<br>*Aythya valisineria* | 0 | 5 | | | | <.5 | |
| Ring-necked Duck<br>*Aythya collaris* | 1 | 7 | 3 | <.5 | 11 | <.5 | |
| Scaup<br>*Aythya affinis*, *A. marila* | 2 | 600 | 750 | 861 | 504 | 47 | |
| Ruddy Duck<br>*Oxyura jamaicensis* | 0 | <.5 | <.5 | | TRACE | <.5 | |
| Hooded Merganser<br>*Lophodytes cucullatus* | 12 | 10 | 29 | 4 | 6 | 8 | |

Source: Hugh Bateman, comp. Louisiana Wildlife and Fisheries Commission.

cheniers and other forested ridges near the coast (e.g., Orchard oriole, Purple martin, Yellow-throat, Eastern kingbird), but the majority breed in forested swamps, bottomland hardwood, and forest edges.

Permanent Residents. These birds are present year-round and breed in the coastal zone. Included in this group are Rock pigeon, Mourning dove, Belted king fisher, Common flicker, Dileated woodpecker, Red-bellied woodpecker, Downy woodpecker, Blue jay, Common crow, Fish crow, Carolina chickadee, Tufted titmouse, Carolina wren, Marsh wren, Mockingbird, Brown thrasher, Eastern bluebird, Blue-gray gnatcatcher, Loggerhead shrike, Starling, House sparrow, Eastern meadowlark, Red-winged blackbird, Common grackle, Boat-tailed grackle, Brown-headed cowbird, Cardinal, Rufous-sided towhee, and Seaside sparrow (Lowery 1974).

Table 37. January waterfowl populations (in thousands) for southeastern Louisiana (Atchafalaya Bay-Lake Borgne)

| | 1969 | 1970 | 1971 | 1972 | 1973 | 1974 | 1975 |
|---|---|---|---|---|---|---|---|
| Mallard<br>Anas platyrhynchos | 65 | 91 | 139 | 64 | 107 | 33 | 61 |
| Mottled Duck, Black Duck<br>Anas fulvigula, A. rubripes | 40 | 24 | 57 | 27 | 37 | 31 | 34 |
| Gadwall<br>Anas strepera | 507 | 377 | 431 | 192 | 364 | 275 | 225 |
| Pintail<br>Anas acuta | 212 | 56 | 157 | 76 | 86 | 26 | 28 |
| Green-winged Teal<br>Anas crecca | 448 | 355 | 344 | 185 | 274 | 350 | 123 |
| Blue-winged Teal<br>Anas discors | 26 | 14 | 34 | 46 | 96 | 284 | 162 |
| American wigeon<br>Anas americana | 161 | 67 | 117 | 89 | 128 | 59 | 49 |
| Shoveler<br>Spatula clypeata | 110 | 36 | 48 | 54 | 45 | 62 | 43 |
| Redhead<br>Aythya americana | 8 | 10 | 5 | | | | <.5 |
| Canvasback<br>Aythya valisineria | 1 | 2 | <.5 | | | | <.5 |
| Ring-necked Duck<br>Aythya collaris | 2 | 3 | 7 | 10 | 8 | 7 | <.5 |
| Scaup<br>Aythya affinis, A. marila | 595 | 650 | 850 | 844 | 762 | | 136 |
| Ruddy Duck<br>Oxyura jamaicensis | 5 | <.5 | <.5 | | | | <.5 |
| Merganser<br>Lophodytes cucullatus | 12 | 8 | 13 | 0 | 5 | 2 | 5 |

Source: Hugh Bateman, comp. Louisiana Wildlife and Fisheries Commission.

Of these the Marsh wren, Boat-tailed grackle, and Seaside sparrow are not found far from coastal marshes. House sparrows and Starlings are restricted mainly to man-disturbed areas. The rest are found in a variety of wooded or agricultural areas.

Transients. This group of species utilizes coastal habitats only during spring and fall migration. All breed for the most part north of the coastal zone, many far north of Louisiana. They winter in Mexico, Central America, and South America. Included are Black-billed cuckoo, Chuck-Will's widow, Empidonax flycatchers, Eastern wood pewee, Barn swallow, Catbird, Swainson's thrush, Gray-cheeked thrush, Veery, Red-eyed vireo, Black-and-white warbler, Tennesse warbler, all Dendroica warblers (except Myrtle, Yellow-throated, and Palm), Ovenbird, Northern, and

Table 38. February waterfowl populations (in thousands) for southeastern Louisiana (Atchafalaya Bay-Lake Borgne)

| | 1969 | 1970 | 1971 | 1972 | 1973 | 1974 | 1975 |
|---|---|---|---|---|---|---|---|
| Mallard <br> *Anas platyrhynchos* | 38 | 74 | 97 | | | 34 | |
| Mottled Duck, Black Duck <br> *Anas fulvigula*, *A. rubripes* | 38 | 36 | 46 | NO CENSUS | NO CENSUS | 34 | NO CENSUS |
| Gadwall <br> *Anas strepera* | 451 | 369 | 355 | | | 375 | |
| Pintail <br> *Anas acuta* | 137 | 47 | 113 | | | 54 | |
| Green-winged Teal <br> *Anas crecca* | 242 | 292 | 353 | | | 186 | |
| Blue-winged Teal <br> *Anas discors* | 72 | 37 | 56 | | | 334 | |
| American wigeon <br> *Anas americana* | 481 | 50 | 231 | | | 161 | |
| Shoveler <br> *Spatula clypeata* | 147 | 73 | 93 | | | 80 | |
| Redhead <br> *Aythya americana* | 0 | | | | | | |
| Canvasback <br> *Aythya valisineria* | 5 | | | | | | |
| Ring-necked Duck <br> *Aythya collaris* | 2 | <.5 | 2 | | | 19 | |
| Scaup <br> *Aythya affinis*, *A. marila* | 210 | 528 | 558 | | | 267 | |
| Ruddy Duck <br> *Oxyura jamaicensis* | 0 | <.5 | <.5 | | | | |
| Merganser <br> *Lophodytes cucullatus* | 9 | 17 | 6 | | | 2 | |

Source: Hugh Bateman, comp. Louisiana Wildlife and Fisheries Commission.

Louisiana waterthrush, American redstart, Bobolink, Scarlet tanager, Blue grosbeak, and Dickcissel.

Patterns of spring migration of these species (and some summer residents) have been studied by Lowery (1945), Hebrard (1971), and Gauthreaux (1971). Over 70 species of songbirds cross the Gulf of Mexico almost every day beginning around the first of April and continuing until the middle of May. The great majority of these species usually begin migration shortly after sunset, fly all night, and alight at dawn. Because of the length of the trans-Gulf flight, birds leave Mexico and areas further south at sunset are over water at dawn and must continue flying until they reach land. Each day during the spring migration period, birds arrive over the Louisiana coast in tremendous numbers in late morning and all afternoon. Most continue inland to forested areas, but during bad weather many land in chenier woods. When such a "fallout" occurs, these coastal woodlands are literally full of vireos, warblers, thrushes, tanagers, grosbeaks, and buntings. Nowhere except on the northern Gulf of Mexico do such concentrations of songbirds occur.

Table 39 shows the results of daily bird censuses on chenier Caminada during the spring of 1972 (Hebrard, unpublished data).

## Mammals

### Marine Mammals

The only marine mammal (cetacean) that is normally seen in Louisiana inshore waters is the Atlantic bottle-nosed dolphin (*Tursiops truncatus*). Dolphins can be observed feeding in Bay Champagne (at the western end of Barataria Basin's coastal edge), and it is not uncommon to see them as far north as Little Lake. This mammal is rather common within the coastal waters of Louisiana and is found in greatest numbers in the vicinity of passes connecting the larger bays with the Gulf (Lowery 1974). It should be mentioned that although this species is common, their numbers now appear to be reduced (Lowery 1974).

Food of the bottle-nosed dolphin along the northern Gulf coast consists primarily of mullet, but they also eat Puffer, Sheepshead, Needle gar, Black drum, Spotted trout, Flounder, Spot, and Croaker. They are also known to consume quantities of shrimp (Lowery 1974). This species is highly intelligent (Lilly 1969).

The Atlantic bottle-nosed dolphin is not the only marine mammal associated with the coastal waters of Louisiana, but it is the only species recorded from the Barataria Basin area. The checklist of mammals of Louisiana by Lowery (1973) gives 21 species of marine mammals that could occur along the Louisiana coast.

### Terrestrial Mammals

Mammals of greatest economic and ecological importance in the marsh and swamp environments are the Muskrat (*Ondatra zibethicus*), Nutria (*Myocastor coypus*), Raccoon (*Procyon lotor*), Mink

Table 39. Migrant species of birds observed 21 March-10 May 1972 in the Caminada Chenier.

| Species | 21 Mar 73 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 | 1 Apr 73 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 1 May 73 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | Number Each Species |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Mourning Dove (*Zenaida macroura*) | | | | 1 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 1 |
| Yellow-billed Cuckoo (*Coccyzus americanus*) | | | | | | | | | | | | | | | | | | | | | | 2 | | 1 | | | 5 | 1 | 6 | 3 | | 1 | 4 | | | 2 | 1 | | | | 1 | | | 1 | | 2 | 1 | 4 | | 1 | | 36 |
| Black-billed Cuckoo (*Coccyzus erythropthalmus*) | | | | | | | | | | | | | | | | | | | | | | 1 | | | | | | | | | | | | | | | | | | | | | | | | | | 1 | | | | 2 |
| Common Nighthawk (*Chordeiles minor*) | | | | | | | | | | | | | | | | | | | | | | | 1 | | | | 1 | | | | | | | | | | | | | | | | | | | | | | | | | 2 |
| Ruby-throated Hummingbird (*Archilochus colubris*) | | | | | | 2 | 3 | 2 | | | 4 | 2 | 1 | | | 4 | 3 | 1 | | 4 | 1 | 1 | 1 | | | | 1 | | | | | | | | 1 | | | | | | | | | | | | | | | | | 31 |
| Yellow-bellied Sapsucker (*Sphyrapicus varius*) | | 1 | 1 | 2 | | 2 | 1 | | 1 | | 1 | 1 | | | 1 | 1 | | 2 | | | | | | 1 | | | | | | | | | | | | | | | | | 2 | | | | | | | | | | | 17 |
| Eastern Kingbird (*Tyrannus tyrannus*) | | | | | 1 | | | | 5 | | 2 | 2 | 3 | 1 | | | | 1 | | | | 2 | 1 | 3 | 1 | 2 | 17 | | 4 | 2 | 4 | 1 | 3 | | 2 | 15 | | | 1 | 2 | 2 | 2 | | | 6 | 2 | 9 | 4 | 20 | 3 | | 123 |
| Acadian Flycatcher (*Empidonax virescens*) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 2 | | | | | | | | 2 |
| Least Flycatcher (*Empidonax minimus*) | | | | | | | | | | | | | | | 1 | | | | | | | | | | | | 2 | | | | | | 1 | | | | | | | | | | | | 2 | | | | | | | 6 |
| Eastern Wood Pewee (*Contopus virens*) | | | | | | | | | | | | | | | | | | 1 | 1 | | | | | 1 | | | 3 | | | 2 | | | 2 | | | | | | | | | | | 1 | | | | | 4 | 2 | 1 | 19 |
| Rough-winged Swallow (*Stelgidopteryx ruficollis*) | | | | | | | 2 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 2 |
| Barn Swallow (*Hirundo rustica*) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 51 | | | | 1 | | | | | | | | | | | | 52 |
| Purple Martin (*Progne subis*) | 1 | | | | 2 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 3 |
| Blue Jay (*Cyanocitta cristata*) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 1 | | 1 |
| Northern House Wren (*Troglodytes aedon*) | 2 | 1 | 1 | 4 | 3 | 2 | 3 | 4 | 5 | 2 | 3 | 3 | 3 | 2 | 1 | 2 | 4 | 2 | 3 | 4 | 2 | 1 | 3 | | | | | 1 | 1 | 1 | | | | | | 1 | | | | 1 | | | | | | | | | | | | 65 |
| Carolina Wren (*Thryothorus ludovicianus*) | 8 | 5 | 5 | 7 | 5 | 3 | 4 | 6 | 4 | 1 | 5 | 3 | 1 | 5 | 5 | 7 | 4 | 2 | 5 | 5 | 4 | 4 | 5 | 6 | 3 | 5 | 4 | 6 | 6 | 6 | 2 | 4 | 8 | 3 | 5 | 6 | 4 | 4 | 2 | 4 | 3 | 2 | 2 | 2 | 3 | 2 | 2 | 1 | 2 | 8 | 2 | 210 |
| Northern Mockingbird (*Mimus polyglottos*) | 12 | 3 | 6 | 8 | 2 | 7 | 7 | 6 | 1 | | 5 | 5 | 4 | 1 | 4 | 1 | 3 | 1 | | 2 | 1 | | | 1 | | | | | | | | | | | | | | | | | | | | | | | | | | | | 80 |
| Gray Catbird (*Dumetella carolinensis*) | 4 | 8 | 11 | 7 | 6 | 3 | 4 | 7 | 3 | 2 | 7 | 11 | 5 | 3 | 6 | 3 | 4 | 1 | 3 | 4 | 1 | 3 | 7 | 6 | 5 | 2 | 4 | 4 | 2 | 2 | 8 | 3 | 125 | 4 | 10 | 14 | 8 | 3 | 1 | 3 | 1 | 1 | | 3 | 6 | 3 | 4 | 2 | 11 | 11 | | 359 |
| Brown Thrasher (*Toxostoma rufum*) | 2 | 2 | 2 | 1 | 1 | | | | | | | | | | | | | | | | | | | | | | 1 | | 1 | 2 | | | | | | | | | | | | | | | | | | | | | | 12 |
| Wood Thrush (*Hylocichla mustelina*) | | | | | | | | | | | 9 | 7 | 10 | 4 | 60 | 22 | 20 | | 1 | 4 | 1 | 1 | | | 1 | | 6 | 3 | | | | | 4 | | | 3 | | | | | | | | | 2 | 2 | | | 2 | | | 162 |
| Swainson's Thrush (*Catharus ustulata*) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 27 | | 1 | 2 | | | | | | | | 1 | 5 | 1 | | | | 1 | | 38 |
| Gray-cheeked Thrush (*Catharus minimus*) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 29 | 1 | 1 | 2 | 1 | 1 | | | | | | | 3 | 1 | | | 1 | | | 40 |
| Veery (*Catharus fuscescens*) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 4 | 2 | | | | | | | | | 1 | 2 | | | | | 9 |
| Ruby-crowned Kinglet (*Regulus calendula*) | 2 | 1 | | | | | | | | | | | | | | 2 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 5 |
| Cedar Waxwing (*Bombycilla cedrorum*) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 2 | 4 | | 4 | 50 | 26 | | 86 |
| White-eyed Vireo (*Vireo griseus*) | | 8 | 10 | 1 | | 2 | 5 | 6 | 1 | 1 | 8 | 4 | 3 | | 175 | 215 | 9 | | 3 | 40 | 4 | 2 | 2 | 2 | 2 | | | 1 | | | | 1 | | | | | 1 | | | | | | | | | | | | | | | 506 |
| Yellow-throated Vireo (*Vireo flavifrons*) | | | | | | | | 2 | 3 | 1 | 2 | 2 | 1 | | 7 | 4 | | | | 3 | | 1 | | 3 | | | 3 | | | | | 1 | 2 | | | | | | | | | | | | 1 | 1 | 2 | | 1 | | | 40 |
| Red-eyed Vireo (*Vireo olivaceus*) | | 2 | | | | | 2 | | 1 | | 7 | 5 | 4 | 2 | 11 | 24 | 4 | 4 | 1 | 7 | | 3 | 1 | 3 | | | 13 | 1 | 1 | 2 | 2 | 2 | 6 | | | 6 | 2 | | | 2 | 1 | 3 | | | 8 | 3 | 4 | | 14 | | | 151 |
| Philadelphia Vireo (*Vireo philadelphicus*) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 1 | | | | | | | 1 |
| Black and White Warbler (*Mniotilta varia*) | | | 1 | 1 | 1 | 1 | | | | | 6 | 10 | 8 | 2 | 4 | | 2 | | | 4 | | 1 | | | | | 2 | 2 | 1 | 3 | | 1 | 6 | | | 4 | 1 | | | | | | | 3 | 3 | | 2 | | 2 | 1 | | 72 |
| Prothonotary Warbler (*Protonotaria citrea*) | | | | | 1 | | | | 1 | 1 | 13 | 9 | 11 | 2 | 5 | 14 | 1 | | 1 | 5 | | | | | 1 | | | | | | | | | | | | 1 | | | | | 1 | | | | | | | | | | 67 |
| Swainson's Warbler (*Limnothlypis swainsonii*) | | | | | | | | | | | 1 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 1 |
| Worm-eating Warbler (*Helmitheros vermivorus*) | | | | | | | 3 | 4 | | | 5 | 2 | 2 | 3 | 2 | | 2 | | | 3 | 2 | 2 | 2 | | 1 | | | | | | | | | 1 | | | | | | | | | | | | | | | | | | 34 |
| Golden-winged Warbler (*Vermivora chrysoptera*) | | | | | | | | | | | | | | | | | | | | | | | | | | | 1 | | | | | | 2 | | | | | | | | | | | | | | | | | | | 3 |
| Blue-winged Warbler (*Vermivora pinus*) | | | | | | | | | | | | 1 | | | | | | | | 2 | | | | | | | 4 | 1 | | | | | 1 | | | | | | | | | | | 2 | | | | | | | | 11 |
| Tennessee Warbler (*Vermivora peregrina*) | | | | | | | | | | | 3 | 3 | 1 | 2 | 1 | 3 | | | | 3 | | | | | | | 5 | | | | | | 4 | | | | | | | | | | | 1 | 1 | | | | | | | 27 |
| Orange-crowned Warbler (*Vermivora celata*) | 3 | 1 | 3 | | | | | | | | | | | | 1 | | | 1 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 9 |
| Northern Parula Warbler (*Parula americana*) | | 12 | 15 | 3 | 2 | 9 | 4 | 5 | | | 3 | 2 | 1 | 1 | 260 | 20 | 3 | | | 2 | | | | | | | 1 | 1 | | | | | 4 | | | 1 | | | | | 1 | 2 | | 1 | | | | | | | | 353 |
| Yellow Warbler (*Dendroica petechia*) | | | | | | | | | | | | | | | | | | | | 1 | | 1 | | | | | 6 | | | 1 | 1 | | 2 | | 1 | | | | | | | | | | 1 | | 1 | | 1 | | | 16 |
| Magnolia Warbler (*Dendroica magnolia*) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 2 | | | | | | | | | 1 | | 3 | 1 | | | | 2 | | | 9 |
| Cape May Warbler (*Dendroica tigrina*) | | | | | | | | | | | | | | | | | | | | 1 | | 1 | | | | | | | | | | | | | | | | | | | | 1 | | | | | | | | | | 3 |
| Myrtle Warbler (*Dendroica coronata*) | 40 | 34 | 50 | 45 | 28 | 43 | 28 | 22 | 20 | 6 | 32 | 22 | 16 | 14 | 11 | 9 | 15 | 5 | 5 | 6 | 8 | 4 | 1 | 1 | 1 | 1 | | | | | | | | | | | | | | | | | | | | | | | | | | 467 |
| Black-throated Green Warbler (*Dendroica virens*) | | | | | | | | | | | | | | | | | | | | | | | | | | | 5 | | | | | | 5 | | | 1 | | | | | | 2 | | | 2 | | | | 2 | 1 | | 18 |
| Cerulean Warbler (*Dendroica cerulea*) | | | | | | | | | | | | | | | | | | | | | | | | | | | 2 | 1 | | | | | 1 | | | | | | | | | | | | | | | | | | | 4 |
| Blackburnian Warbler (*Dendroica fusca*) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 1 | 2 | | | | | | | 3 |
| Yellow-throated Warbler (*Dendroica dominica*) | | | | | | | | | | | | 1 | 1 | | 2 | | | | | 2 | | | | | | | | 1 | | | | | | | | | | | | | | | | | | | | | | | | 7 |
| Chestnut-sided Warbler (*Dendroica pensylvanica*) | | | | | | | | | | | | | | | | | | | | | | | | | | | 3 | | | | | | 3 | | | | | | | | | | | | | | | | 2 | | | 8 |
| Bay-breasted Warbler (*Dendroica castanea*) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 1 | 1 | 1 | | | 2 | | | 5 |
| Blackpoll Warbler (*Dendroica striata*) | | | | | | | | | | | | | | | | | | | | | | 1 | | | | | | | | 6 | | | | | | | | | | | | | | | | | | | | | | 7 |
| Prairie Warbler (*Dendroica discolor*) | | | | | | | | | | | | | | | | | | | | | | 1 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 1 |
| Ovenbird (*Seiurus aurocapillus*) | | | | | | | | | | | | | | | | | | | | 1 | | | | | | | | | | | | | 3 | | | 1 | | | | 1 | | 1 | | | | | | | | | | 7 |

Table 39. Continued.

| Species | Daily numbers (non-blank entries, left to right) | Total |
|---|---|---|
| Northern Waterthrush (*Seiurus noveboracensis*) | 2, 1, 1, 1 | 5 |
| Louisiana Waterthrush (*Seiurus motacilla*) | 1, 3, 1, 1, 1 | 7 |
| Kentucky Warbler (*Geothlypis formosa*) | 1, 1, 1, 2, 1, 2, 1, 1 | 10 |
| Common Yellowthroat (*Geothylypis trichas*) | 3, 4, 3, 1, 4, 2, 2, 1, 2, 1, 4, 3, 2, 3, 5, 2, 2, 1, 4, 2, 2, 3, 2, 2, 1, 3, 2, 2, 3, 2, 1, 2, 1, 2, 2, 3, 1, 2, 1, 3 | 91 |
| Yellow-breasted Chat (*Icteria virens*) | 1 | 1 |
| Hooded Warbler (*Wilsonia citrina*) | 1, 4, 2, 4, 10, 28, 9, 1, 1, 17, 4, 1, 1, 2, 5, 3, 2, 1, 3, 1, 2 | 102 |
| American Redstart (*Setophaga ruticilla*) | 1, 1, 4, 1, 5, 1, 1, 1, 3, 2, 1, 2, 2, 1, 1, 2, 4, 3, 1, 4 | 41 |
| Orchard Oriole (*Icterus spurius*) | 1, 2, 5, 2, 13, 2, 2, 1, 7, 20, 1, 5, 10, 35, 4, 1, 1, 5, 2, 1, 14, 4, 2, 8, 3, 5, 3, 1, 1, 1 | 162 |
| Baltimore Oriole (*Icterus galbula*) | 1, 1, 4, 1 | 7 |
| Brown-headed Cowbird (*Molothrus ater*) | 1, 4 | 5 |
| Scarlet Tanager (*Piranga olivacea*) | 2, 1, 1, 18, 4, 1, 9, 1, 4, 1, 1, 1, 2, 5, 3, 3, 14, 1 | 72 |
| Summer Tanager (*Piranga rubra*) | 2, 3, 4, 1, 1, 2, 5, 4, 1, 10, 14, 2, 1, 1, 3, 2, 1, 1, 1, 1, 1, 1, 1, 1, 4, 2 | 70 |
| Northern Cardinal (*Cardinalis cardinalis*) | 3, 2, 3, 3, 1, 1, 1, 3, 1, 2, 4, 2, 3, 2, 1, 2, 2, 1, 3, 1, 2, 1, 5, 2, 2, 1, 2, 3, 3, 4, 2, 2, 2, 3, 2, 2, 3, 2, 3, 1, 2, 1, 1, 2, 1, 2, 3, 2 | 102 |
| Rose-breasted Grosbeak (*Pheucticus ludovicianus*) | 1, 1, 10, 5, 1, 3, 6, 1, 5, 1, 3, 1, 2, 20, 4, 6, 18, 5, 13, 2 | 108 |
| Blue Grosbeak (*Guiraca caerulea*) | 1, 5, 1 | 7 |
| Indigo Bunting (*Passerina cyanea*) | 3, 1, 2, 3, 1, 1, 9, 75, 8, 3, 96, 20, 4, 3, 3, 1, 1, 5, 32, 8, 10, 9, 12, 5, 75, 5, 1, 1, 2, 1, 2, 9, 1, 2, 1, 2, 1, 13, 4 | 435 |
| Painted Bunting (*Passerina ciris*) | 2, 1, 2, 1, 2, 2, 1, 5, 1 | 17 |
| Swamp Sparrow (*Melospiza georgiana*) | 2, 2, 1, 3, 2, 1 | 11 |

| Day | Total Birds/Day | Birds/100 M²/Day |
|---|---|---|
| 1 | 80 | 2 |
| 2 | 84 | 2 |
| 3 | 109 | 3 |
| 4 | 87 | 2 |
| 5 | 58 | 1 |
| 6 | 78 | 2 |
| 7 | 73 | 2 |
| 8 | 75 | 2 |
| 9 | 57 | 1 |
| 10 | 18 | .4 |
| 11 | 146 | 4 |
| 12 | 113 | 3 |
| 13 | 91 | 2 |
| 14 | 52 | 1 |
| 15 | 602 | 15 |
| 16 | 461 | 12 |
| 17 | 98 | 2 |
| 18 | 39 | .9 |
| 19 | 133 | 3 |
| 20 | 187 | 5 |
| 21 | 42 | 1 |
| 22 | 46 | 1 |
| 23 | 40 | 1 |
| 24 | 56 | 1 |
| 25 | 24 | .6 |
| 26 | 22 | .5 |
| 27 | 191 | 5 |
| 28 | 55 | 1 |
| 29 | 45 | 1 |
| 30 | 59 | 1 |
| 31 | 47 | 1 |
| 32 | 27 | .6 |
| 33 | 356 | 9 |
| 34 | 20 | .5 |
| 35 | 36 | .9 |
| 36 | 128 | 3 |
| 37 | 31 | .7 |
| 38 | 14 | .3 |
| 39 | 9 | .2 |
| 40 | 26 | .6 |
| 41 | 22 | .5 |
| 42 | 48 | 1 |
| 43 | 5 | .1 |
| 44 | 37 | .9 |
| 45 | 70 | 2 |
| 46 | 47 | 1 |
| 47 | 46 | 1 |
| 48 | 19 | .4 |
| 49 | 166 | 4 |
| 50 | 68 | 2 |
| 51 | 3 | .07 |

Notes: Table gives daily numbers of each species, total numbers of each species for 51-day period, daily numbers of all species combined, and daily densities for all species combined. The mean density of birds for the 51-day period was 2.12/100 $M^2$. Total area observed: 4,000$M^2$.

Source: J. J. Hebrard, unpublished data.

(Mustella vison), and Otter (Lutra canadensis). Little information is presently available on population densities of these mammals in Louisiana. Greg Linscombe (LWFC) has acquired detailed data on all furbearing species in coastal Louisiana, but the data have not yet been summarized. When available, these data will allow detailed analysis of population phenomena and geographic distribution. A discussion of individual species and groups of species follows.

Common Muskrat (Ondatra zibethicus). O'Neil (1949) reported details of the life history of this species; this information has been summarized and updated by Lowery (1974). A brief synopsis follows.

The Common muskrat is reproductively active throughout the year, though there are peaks in November and March and a low point in July and August. The female produces an average of about four young per litter with five to six litters produced per year. They may reach sexual maturity at an age of 6 to 8 weeks.

Muskrats build grass houses, apparently only in areas lacking suitable substrate for burrowing. Muskrats trapped in marshes and released in upland areas immediately lost the house-building trait, living in burrows instead (O'Neil 1949).

In marsh areas, each house contains as many as four nests, each nest usually containing a brood in some state of development. As broods develop they are driven out of the house after which they construct their own. By this process, muskrat "colonies" can be started by relatively few pairs.

Palmisano (1972b) conducted a survey to determine the distribution and abundance of muskrats in the various marsh types of coastal Louisiana. The census was conducted by airplane and a count was made of the number of muskrat houses along transects through the marshes. O'Neil (1949) used an estimate of five trappable muskrats per house, while Palmisano (1972b) gives an estimate of three. Populations in swamp forest areas were not included in this survey, as the animals in this habitat live in streamside burrows rather than easily visible houses constructed of marshgrass.

The survey results were divided into two subdivisions: southwest and southeast. The southeastern section includes Atchafalaya Bay and extends east to the mouth of the Mississippi River; it is the section of interest in this report since it includes Barataria Basin. Results are given in Table 40. The figures are probably generally applicable to smaller areas but more importantly are the only ones available at present. Greg Linscombe (personal communication, LWFC) has accumulated more detailed information covering several years, but these data are as yet not summarized.

Table 40. Density of muskrat houses in Barataria Basin.

| | No. Houses/ 100/acres | Total No. Houses |
|---|---|---|
| Saline Marsh | 14.98 | 54,312 |
| Brackish Marsh (including intermediate marsh areas) | 30.92 | 106,823 |
| Fresh Marsh | 2.27 | 7,573 |

Source: A. Palmisano. 1972. The distribution and abundance of Muskrats...in Louisiana coastal marshes. 26th Ann. Meeting S.E. Assoc. Game and Fish Comm.

Palmisano found the greatest density of muskrat houses in brackish marsh areas. It is here that the preferred food of the muskrat, Three-cornered grass, *Scirpus olneyi*, grows most abundantly.

Palmisano conducted five surveys over a roughly 2-year period (November 1969-December 1971). The figures presented in Table 40 represent means of these five surveys. Populations and distributions were relatively stable for the first four counts, but the count of December 1971 showed an abrupt decline in brackish marsh populations. This count followed two abnormally dry summers, and this may have been a reason for the decline.

According to O'Neil (1949) overpopulation and subsequent overexploitation of food resources are important factors in population fluctuations. He also notes that periods of severely reduced populations are sometimes followed in a few years by peak catches.

Comparative takes of fur animals in Louisiana for the 1971-72 season and the 1972-73 season are shown in Table 41. These data apply to the state as a whole, since data for Barataria Basin alone are not available at this time. However, the harvest values for muskrat (and nutria) are categorized for eastern and western Louisiana (Barataria Basin is in the eastern segment). From these figures it can be seen that the eastern portion of the coastal zone contributed only 30% of the total take in 1971-72, yet the eastern and western portions of the state had very similar yields in 1972-73. Of course, harvest figures for any one area are strongly affected by intensity of trapping effort as well as muskrat abundance.

Nutria (Myocastor coypus). The nutria was first introduced to Louisiana in 1938. The population continued to increase from that time, and by 1945 the animal was found throughout all the Louisiana coastal marsh (Dozier 1951). Since that time the nutria has become an important fur-bearing mammal to the industry of the state (Harris 1956).

Lowery (1974) has summarized the life history of this species. Nutria reach sexual maturity at an age of four to eight months. Litters contain from one to nine young, the average being four and a half. The gestation period is about 130 days and the female goes into estrus within one or two days after giving birth. Nongravid females go into estrus every 24 to 26 days.

Evidence for competition between nutria and muskrats is generally lacking though it is almost certain to exist in areas where the two species are sympatric (occur together). There is an apparent habitat separation between the two species, however, that could serve to alleviate competitive effects to some degree. Muskrat populations are highest in brackish marsh while Nutria are more characteristic of freshwater situations.

Table 41. Harvest values for fur animals in Louisiana during the 1971-72 and 1972-73 seasons.

| 1971-72 Season | No. Pelts | | Approximate Price to Trapper | Value |
|---|---|---|---|---|
| *Muskrat (Eastern) | 98,000 | @ | $ 2.00 | $ 196,000.00 |
| *Muskrat (Western) | 228,513 | @ | 3.50 | 799,795.50 |
| Mink | 24,299 | @ | 4.00 | 97,196.00 |
| *Nutria (Eastern) | 500,000 | @ | 2.00 | 1,000,000.00 |
| *Nutria (Western) | 786,622 | @ | 4.00 | 3,146,488.00 |
| Raccoon (Coastal) | 30,000 | @ | 2.00 | 60,000.00 |
| Raccoon (Upland) | 50,632 | @ | 3.50 | 177,212.00 |
| Opossum | 8,310 | @ | .50 | 4,155.00 |
| Otter | 5,440 | @ | 38.00 | 206,720.00 |
| Skunk | 114 | @ | .50 | 57.00 |
| Fox | 476 | @ | 4.50 | 2,142.00 |
| Bobcat | 136 | @ | 6.00 | 816.00 |
| Beaver | 126 | @ | 6.00 | 756.00 |
| Coyote | 11 | @ | 5.00 | 55.00 |
| Civet Cat (spotted skunk) | 3 | @ | 2.00 | 6.00 |
| Total Pelts | 1,732,682 | | | $5,691,398.50 |
| Nutria Meat | 8,250,000 lbs | @ | .08 | 660,000.00 |
| Muskrat Meat | 200,000 lbs | @ | .08 | 16,000.00 |
| Raccoon Meat | 440,000 lbs | @ | .20 | 88,000.00 |
| Opossum Meat | 80,000 lbs | @ | .20 | 16,000.00 |
| Total Meat | 8,970,000 | | | $ 780,000.00 |
| Total Pelts and Meat | | | | $6,471,398.50 |
| **1972-73 Season** | | | | |
| *Muskrat (Eastern) | 173,393 | @ | $3.50 | $ 606,875.50 |
| Muskrat (Western) | 173,394 | @ | 4.75 | 823,621.50 |
| Mink | 44,062 | @ | 6.00 | 264,372.00 |
| *Nutria (Eastern) | 611,623 | @ | 3.25 | 1,987,774.75 |
| *Nutria (Western) | 1,000,000 | @ | 4.75 | 4,750,000.00 |
| Raccoon (Coastal) | 49,274 | @ | 4.50 | 221,733.00 |
| Raccoon (Upland) | 100,000 | @ | 6.00 | 600,000.00 |
| Opossum | 17,065 | @ | 1.25 | 21,331.25 |
| Otter | 7,668 | @ | 42.00 | 322,056.00 |
| Skunk | 405 | @ | 1.00 | 405.00 |
| Fox | 1,899 | @ | 10.00 | 18,990.00 |
| Bobcat | 481 | @ | 12.00 | 5,772.00 |
| Beaver | 956 | @ | 5.00 | 4,780.00 |
| Coyote | 112 | @ | 10.00 | 1,120.00 |
| Total Pelts | 2,180,332 | | | $ 9,626,831.00 |
| Nutria Meat | 10,000,000 lbs | @ | .08 | 800,000.00 |
| Muskrat Meat | 300,000 lbs | @ | .08 | 24,000.00 |
| Raccoon Meat | 840,000 lbs | @ | .22 | 184,800.00 |
| Opossum Meat | 160,000 lbs | @ | .20 | 32,000.00 |
| Total Meat | 11,300,000 | | | $ 1,040,800.00 |
| Total Pelts and Meat | | | | $10,667,631.00 |

*Primarily coastal.
Source: Louisiana Wildlife and Fisheries Commission, 1973.

Population estimates of Nutria come primarily from catch data from trappers within the state. Numbers of Nutria trapped in Louisiana during the 1971-72 season and the 1972-73 season are shown in Table 41. During both years, harvesting was greater in the western section of the state than in the eastern area containing Barataria Basin. However, even though harvest values for the basin alone are not available, nutria are an important resource of the region. Palmisano (1972a) shows a trend of declining catch records in marshes of high salinity. Highest production occurs in the fresh marsh habitat. From these data maximum production of nutria has been found to come from the fresh marsh areas where 884 pelts per 1,000 acres were produced; maximum production in brackish marshes was 191 pelts per 1,000 acres (Palmisano 1972a). Kays (1956) found population density of nutria to be 3 per acre in the brackish marsh surrounding a freshwater lake in Rockefeller Wildlife Refuge in the southwestern coastal area of the state. Chabreck and Dupuie (1970) say a marsh will produce only a certain number of nutria, and this harvest is one nutria per acre or less.

Nutria feed on coarser types of vegetation than do muskrats (O'Neil 1949). Foods eaten throughout the year in order of preference were found by Kays (1956) to be as follows: Pickerelweed (*Pontederia cordata*), Bull-tongue (*Sagittaria falcata*), Cattail (*Typha* sp.), Arrowhead (*Sagittaria graminia*), Squarestem rush (*Eleocharis quadrangulata*), Maidencane (*Panicum hemitomon*), water hyacinth (*Eichornia crassipes*), Break rush (*Rhynchospora* sp.), and Water hyssop (*Bacopa monnieri*).

*Deer, Squirrel and Rabbit.* Data were obtained on populations of white-tailed deer (*Odocoileus virginianus*), squirrel (*Sciurus* sp.), rabbit (*Sylvilagus* sp.) from R. Murry and J. Kidd of the Louisiana Wildlife and Fisheries Commission (personal communication). The potential carrying capacity of marsh and swamp areas in Barataria Basin and present population estimates of the mammals in these areas are shown in Table 42.

Table 42. Potential carrying capacity and present population estimates of deer, squirrel, and rabbit of the marsh and swamp areas of Barataria Basin.

| | - - - - Per Acre - - - - - - - | | |
|---|---|---|---|
| | Deer | Squirrel | Rabbit |
| Swamp | 1/30 | 1/4 | 1/3 |
| Fresh Marsh | 1/140* | absent | 1/1 |
| Brackish Marsh | 1/1000* | absent | 1/6 |
| Intermediate Marsh | 1/1000* | absent | 1/3 |
| Saline Marsh | absent | absent | 1/10 |

*Present populations
Source: R. Murry and J. Kidd, La. State Fish and Game Comm., personal communication.

During field investigations in Barataria Basin in 1973-74 conducted by the Center for Wetland Resources for Louisiana Offshore Oil Port, Inc., observations of deer, squirrel, and rabbit followed usual trends. Spoil banks in all marsh types and in the swamp were heavily utilized by rabbit. Three deer were seen during aerial observations in fresh marsh area just south of the Intracoastal Waterway. Deer tracks were observed in the swamp area usually along spoil banks and flat semi-dry areas within the swamp. The only squirrels observed in agreement with Table 42 were in the swamp area.

Mink, Otter, and Raccoon. In his study in southwest Louisiana, Kays (1956) found that Mink (*Mustela vison*) prefer fresh water habitats and that high populations in brackish marshes occur simultaneously with peaks in muskrat populations, since muskrats are a prefered food item.

Recent mink harvest for the state are shown in Table 41. From catch records, Palmisano (1972a) found no significant difference in peak mink production among vegetation types. Mean maximum catch value ranged from 11.9 per 1,000 acres in intermediate marsh (between true brackish marsh and fresh marsh) to 14.2 per 1,000 acres in fresh marsh (Palmisano 1972a).

Two Otters (Lutra canadensis) were seen during the LOOP study, one in the salt marsh and one in the swamp area. As Arthur (1928) states, the Otter is a solitary animal and very shy. The sight of one in its native habitat is very rare.

The Raccoon (Procyon lotor), from the aerial observations made in the LOOP study, is found throughout the basin. Although more were seen in saline environments, Palmisano (1972a) shows raccoon yield to be considerably higher in freshwater areas. This was related to the higher prices paid for the pelts and not necessarily a reflection of population differences.

### Other Mammals

Table 43 presents a list of mammals likely to be found in the various habitats of Barataria Basin (G. Lowery and S. Guthans, personal communication). Except for those species already discussed, none has received intensive study in this area.

Table 43. Mammals that may occur in the various environmental units of Barataria Basin.

| |
|---|
| *Virginia opossum (Didelphis virginiana), S, F |
| **Southeastern myotis (Myotis austroriparius), S |
| **Eastern pipistrelle (Pipistrellus subflavus), S |
| **Red bat (Lasiurus borealis), S |
| **Seminole bat (Lasiurus seminolus), S |
| **Hoary bat (Lasiurus cinereus), S |
| **Northern yellow bat (Lasiurus intermedius), S |
| **Evening bat (Nycticeius humeralis), S |
| *Nine-banded armadillo (Dasypus novemcinctus), S, F |
| *Swamp rabbit (Sylvilagus aquaticus), All |
| *Fox squirrel (Sciurus niger), S |
| **Marsh rice rat (Oryzomys palustris), S, F |
| **Fulvous harvest mouse (Reithrodontomys fulvescens) |
| **White-footed mouse (Peromyscus leucopus) |
| **Cotton mouse (Peromyscus gossypinus) |
| **Hispid cotton rat (Sigmodon hispidus) |
| **Eastern wood rat (Neotoma floridana) |
| *Muskrat (Ondatra zibethicus), All |
| *Nutria (Myocastor coypus), All |
| *Atlantic bottle-nosed dolphin (Tursiops truncatus), Offshore, Bay, Sa |
| *Raccoon (Procyon lotor), All |
| *Mink (Mustella vison), All |
| *Otter (Lutra canadensis), All |
| *White-tailed deer (Odocoileus virginianus), S, F, B |

Notes: *Sighted during LOOP Report study. **Known to occur (personal communications, G. Lowrey, S. Guthans. S=swamp; F=fresh marsh; B=brackish marsh; Sa=salt marsh; T=impounded tank farm.

Source: LOOP Report 1976.

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# Appendix: Louisiana's Refuges, Wildlife Management Areas, and Game Preserves

J. J. Hebrard and L. A. Shiflett

## NOMENCLATURE

About 688,195 acres in coastal Louisiana are maintained or managed for wildlife and game species. Some 434,110 acres of this land are owned or leased by the State of Louisiana and are maintained or managed by the Louisiana Wildlife and Fisheries Commission (LWFC). There are approximately 227,924 acres of coastal habitat owned by the Federal government and administered by the Department of the Interior as wildlife refuges. The National Audubon Society owns the 26,161-acre Paul J. Rainey Wildlife Refuge and Game Preserve. Figure 1 shows these areas and their status. Of these Wisner and Salvador Wildlife Management Areas are located in Barataria Basin.

State-controlled wildlife areas are of two general types, Wildlife Management Areas and Refuges/Game Preserves. The major distinction between the two types is that hunting is allowed on Wildlife Management Areas while no hunting is allowed on Refuges and Game Preserves (Alan Ensminger, LWFC, personal communication).

Federal refuges in coastal Louisiana are of two general types: (1) Special purpose for colonial nongame birds, and (2) for migratory waterfowl. No large-scale management practices are employed on the first type except for occasional predator control (Gabrielson 1943). Extensive management practices are used on migratory waterfowl refuges. The Migratory Bird Treaty Act makes conservation of these birds a Federal obligation. The Migratory Waterfowl Hunting Stamp Act provides funds for development and maintenance of these areas.

## MANAGEMENT PRACTICES

For refuges or wildlife management areas in the coastal marshes, management techniques involve either manipulation of water or manipulation of the marsh vegetation itself. Manipulation of water is accomplished by creating shallow water impoundments, placing water control structures (weirs) in drainage systems, using earthen plugs in drainage systems, and by using artificial potholes. Marsh vegetation is manipulated by burning, tilling, treatment with herbicides, or planting (Chabreck 1975).

WATER MANIPULATION

Marsh Impoundments.--The primary goal of impoundment construction is management for waterfowl (Chabreck 1960). Impoundments are either permanently flooded or alternately drained and flooded to allow germination of annual grasses and to make the seeds of these grasses accessible to ducks (Chabreck 1960). Impoundments may also be beneficial to alligators, crawfish, and deer (Chabreck 1960, Perry et al. 1970).

Chabreck (1960, 1975) has discussed construction of impoundments and problems associated with maintenance of levees. Impoundments are usually constructed by digging canals and using spoil for levees, incorporating existing levees when possible. Soil characteristics influence the frequency of maintenance, i.e., subsoils in southeastern Louisiana are generally too fluid for levee construction. Allowances must be made for shrinkage of levees because of moisture loss, decay of organic matter, and subsidence caused by the weight of levee materials.

Chabreck et al. (1974) determined duck usage of brackish and fresh water impoundments within the brackish marsh zone over a 2-year period (Table 1). Densities within the impoundments were compared with two control areas in natural marsh. Duck densities were highest in freshwater impoundments, while brackish water impoundments supported numbers similar to nonimpounded control areas.

Weirs.--In areas where levee construction is not feasible, some control over water levels can be gained by placing low sill dams (weirs) at strategic points in marsh drainage systems. The crest of these dams is generally set 6 inches below the marsh surface. The immediate effect of such a structure is to prevent complete drainage of marshes at low tide and to reduce tidal fluctuations. Water salinity is not significantly affected by weirs (Chabreck 1967), except during dry periods when salt water would normally enter the marshes. Likewise, turbidity differs only slightly between ponds and lakes in natural marsh areas and those in areas affected by weirs.

Secondary effects of weir construction include an increase in the production of certain aquatic plants, notably widgeongrass (*Ruppia maritina*). Whether this increased production is related to

Table 1. Duck usage of management units on Rockefeller Refuge, 1970-72 (from Chabreck et al. 1974)

| Month | Brackish water impoundments | | Freshwater impoundments | | Control areas | |
|---|---|---|---|---|---|---|
| | 3 | 4 | 8 | 10 | 1 | 2 |
| 1970-71 | Ducks per acre | | | | | |
| Aug. | 0.01 | 0.03 | 0 | 0 | 0 | 0 |
| Sept. | 7.03 | 0.91 | 0.34 | 0.06 | 0.08 | 0.03 |
| Oct. | 0 | 0.01 | 0.75 | 0.01 | 0.45 | 0 |
| Nov. | 6.91 | 0.10 | 17.40 | 26.02 | 0.51 | 12.50 |
| Dec. | 1.27 | 1.03 | 4.08 | 9.20 | 0.16 | 2.60 |
| Jan. | 0.41 | 2.12 | 8.25 | 0.57 | 0.15 | 13.00 |
| Feb. | 0.22 | 0.35 | 8.45 | 4.82 | 0.04 | 0.65 |
| March | 0.41 | 0.20 | 15.03 | 6.86 | 1.00 | 0.19 |
| April | 0.04 | 0.01 | 3.03 | 1.19 | 0.02 | 1.08 |
| May | 0 | 0 | 0.44 | 0 | 0 | 0 |
| June | 0 | 0 | 0.35 | 0.01 | 0 | 0.03 |
| July | 0 | 0 | 1.50 | 0 | 0 | 0.24 |
| Average | 1.36 | 0.40 | 4.97 | 4.06 | 0.20 | 2.53 |
| 1971-72 | Ducks per acre | | | | | |
| Aug. | 1.89 | 1.70 | 0.08 | 0.15 | 0.01 | 0 |
| Sept. | 0.01 | 0.10 | 0 | 0 | 0 | 0 |
| Oct. | 0 | 0.01 | 0.03 | 0.05 | 0 | 0 |
| Nov. | 0.19 | 0.30 | 34.60 | 3.51 | 0.40 | 0.40 |
| Dec. | 4.24 | 1.10 | 0.87 | 0.46 | 0.01 | 0.25 |
| Jan. | 0 | 1.93 | 5.63 | 2.27 | 0.09 | 0.09 |
| Feb. | 0.23 | 3.72 | 1.85 | 2.39 | 0.06 | 0.25 |
| March | 1.14 | 1.45 | 0.93 | 2.52 | 0.04 | 0.04 |
| April | 0.01 | 0.05 | 0.38 | 0.44 | 0 | 0.02 |
| May | 0 | 0 | 0.20 | 0 | 0 | 0.02 |
| June | 0 | 0.01 | 0.25 | 0.01 | 0 | 0.01 |
| July | 0 | 0 | 0 | 0 | 0.02 | 0.01 |
| Average | 0.64 | 0.86 | 3.74 | 0.98 | 0.05 | 0.09 |

Source: R. H. Chabreck, R. K. Yancey, and L. McNease. 1974. Duck usage of management units in the Louisiana coastal marsh. Presented 28th Ann. Conf. SE Assoc. Game and Fish Comm., White Silver Springs, W. Va.

slightly lowered turbidities or reduced tidal flushing or some combination of factors is not clear from published research (Chabreck and Hoffpauir 1962, Chabreck 1967).

Chabreck (1967) reported changes in marsh vegetation behind some 9-year-old weirs. He reported a noticeable decline in black rush (Juncus romerianus) and an increase in spikerush (Eleocharis sp.) in high, well-drained marsh affected by the weirs. No changes in marsh vegetation were noted in low marsh behind 9-year-old weirs.

Spiller and Chabreck (1975) found duck and coot populations to be about 4 times higher in ponds behind weirs than in similar ponds not subject to control by weirs. Chabreck (1967) reports observations of greatly increased duck usage of such areas. This may be related to increased widgeongrass production, which provides food for some species.

De la Bretonne and Avault (1971) studied movement of brown and white shrimp over weirs. Weirs are apparently not significant barriers to shrimp movement though they often have the effect of concentrating shrimp populations. Herke (1971) reported that weirs may delay emigration of very small juvenile brown shrimp. He found a similar effect on white shrimp emigration. Brown shrimp abundance is apparently not adversely affected by an increase in aquatic greater weights in semi-impounded marsh in the Biloxi W.M.A., while white shrimp attained greater weights in semi-impounded marsh on Marsh Island.

Burleigh (1966) found a significant effect of weirs on the landward distribution of blue crabs. Larger crabs were concentrated immediately landward of weirs, while smaller crabs were concentrated .4 to .2 km landward of weirs.

Burleigh (1966) analyzed distribution and abundance data for several fish species in relation to weirs. Results are given in Table 2. Fish for which statistically significant effects were seen were concentrated either landward or seaward of weirs (see Table 2). Some species showed a tendency to concentrate in the immediate vicinity of weirs though results were not statistically significant.

Herke (1971) discusses the results of a study concerning the effects of semi-impoundment on five species of fish. Spot showed a faster growth rate and attained greater weight in semi-impounded areas. Atlantic croaker and menhaden showed delayed emigration to the Gulf, and menhaden, in addition, were scarce in areas with much aquatic vegetation. The bay anchovy showed reduced numbers in areas with abundant aquatic vegetation. Harke also points out that these effects are only indirectly the result of weir construction, and that factors such as migration patterns, habitat affinities, and food distribution interact in determining ultimate effects.

Table 2. Fish distributions affected by weirs (Burleigh 1966)

*Spotted gar (Lepisosteus oculatus)
behind weirs
Alligator gar (Lepisosteus spatula)
behind weirs
Ladyfish (Elops saurus)
seaward of weirs
Skipjack herring (Alosa chrysochloris)
concentrated near weirs
Largescale menhaden (Brevoortia patronus)
near weirs
*Sea catfish (Arius felis)
seaward of weirs
Largemouth bass (Micropterus salmoides)
behind weirs
Bluegill (Lepomis macrochirus)
behind weirs
*Redear sunfish (Lepomis microlophus)
behind weirs
*Spotted sunfish (Lepomis punctatus)
behind weirs
Spotted seatrout (Cynoscion nebulosus)
concentrated near weirs
Black drum (Pogonias cromis)
seaward of weirs
Red drum (Sciaenops ocellata)
apparently concentrated near weirs
Sheepshead (Archosargus probatacephalus)
seaward of weirs
*Pinfish (Lagodon rhomboides)
behind weirs

Table 2. Continued.

Southern flounder (Paralichthyes lethostigma) concentrated near weirs)

*Statistically significant effect.

Source: J. G. Burleigh. 1966. The effects of wakefield weirs on the distribution of fishes in a Louisiana saltwater marsh. Master's thesis, Louisiana State University, Baton Rouge, La.

Spiller and Chabreck (1975) compared distribution and abundance of a variety of wildlife species in weired marsh areas and in similar, nonweired control areas. Nongame birds (wading birds, shorebirds, gulls, and terns) were randomly distributed between the two types of areas except during extremely low water when natural marsh ponds were drained. Muskrats (Ondatra zibethicus) were randomly distributed between semi-impounded and control areas, while Nutria (Myocastor coypus) showed very slightly higher populations in natural marsh. Swamp rabbits were randomly distributed except in a February-March survey when significantly more rabbit scats were seen in semi-impounded marsh. Distribution and abundance of marsh rice rats (Oryzomys palustris) were not significantly affected by weirs.

Earthen Plugs.--The use of earthen plugs in marsh drainage systems is similar to the use of weirs except that the crest of earthen dams is usually high above water level. This prevents tidal exchange and causes runoff to flood across the marsh proper. Chabreck (1967) reports that ponds behind such plugs often have higher salinity than control ponds. He also found that this type of damming affected negligible changes on vegetation. He further states that the effectiveness of earthen plugs is increased when they are used in conjunction with a water-regulating device.

Artificial Ditches and Potholes.--The benefit to wildlife of artificial ditches and potholes has not been well established (Chabreck 1967), although alligators (Alligator mississippiensis) and some furbearing species may be obviously benefited by artificial water bodies during periods of drought. Ditches improve access by boat to remote marsh areas and have long been used by trappers.

## MANIPULATION OF MARSH VEGETATION

Practices such as marsh burning, tilling, use of herbicides, and planting have as their ultimate goal the maintenance of marshes dominated by three-cornered grass (Scirpus olneyi), a preferred food of muskrat, by elimination of competition from other species (cf. McNease and Glasgow 1970, Ross and Chabreck 1972).

Burning of the marsh has been widely applied in coastal Louisiana and when done at certain times of the year gives three-cornered grass a competitive advantage. It is also used to attract snow geese that feed in freshly burned areas. Burning alone, however, is largely ineffective in maintaining stands of three-cornered grass (Chabreck 1975).

Chandler (1969) examined the use of burning and tilling as a means of controlling wiregrass (Spartina patens) and saltgrass (Distichlis spicata) in fresh and salt marshes in southwestern Louisiana. He found that tilling fresh marsh areas reduced wiregrass and increased the annual grasses and sedges, but burned plots were more easily tilled. Tilling salt marsh reduced the amount of saltgrass and wiregrass but was not effective in increasing leafy tree-square (Scirpus robustus). This technique is probably too expensive for use over large areas (Chandler 1969).

Herbicides have been used to control vegetation in marsh areas, but as yet they have not been useful in selective control (Chabreck 1975, Chandler 1969).

Ross and Chabreck (1972) studied survival of artificially planted stands of three-cornered grass (Scirpus olneyi). They found that tilling before planting gave best survival and that burning before planting, though not as effective as tilling, gave much better survival than in stands planted with no site preparation. Planting was most successful in brackish marshes, in 2 to 4 inches of water and at salinities ranging from 10 to 15 ppt.

Planting time was also found to influence survival, December and January plantings showing 100 percent survival. Plots planted in July showed only 47.5 percent survival.

## WISNER WILDLIFE MANAGEMENT AREA

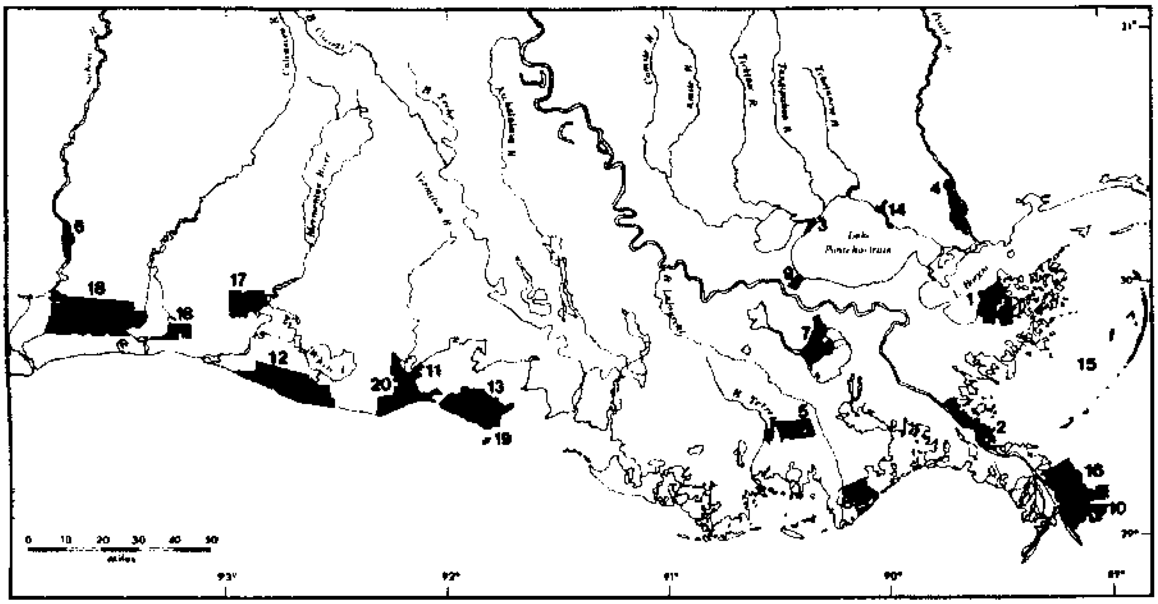
Wisner Wildlife Management Area is located in southern Lafourche Parish and encompasses 22,153 acres of coastal marsh, including about 5 miles of shoreline on the Gulf of Mexico. The predominant habitat type is saline marsh that occupies 11,576 acres. There are 2,485 acres of brackish marsh habitat and 90 acres of high ground. There are 6,345 acres of water in the saline marsh habitat and 1,658 acres of water in brackish marsh. This area is leased by the state and was originally 30,000 acres in total area. Approximately 3,700 acres in the southernmost part of the refuge were relegated to construction of a deep water port facility (Bob Beter, LWFC, personal communication).

The only management technique employed in the Wisner area has been the installation of weirs to create semi-impounded marsh. Construction of weirs began in 1959. At present, 10,388 acres of marsh are semi-impounded.

## SALVADOR WILDLIFE MANAGEMENT AREA

Salvador Wildlife Management Area, located in southern St. Charles Parish, includes 30,604 acres of fresh marsh and swamp forest. It includes some shoreline in the northern portion of Lake Salvador as well as some along Bayou Couba and Lake Cataouatche.

This tract was purchased by the state in 1968 and was opened to the public for hunting and fishing during the 1968-1969 season. Access to the area is by boat only. All privately owned camps and cattle have been removed and overnight camping is prohibited. The area is extensively trapped to control populations of furbearers. After an area is trapped it is wet-burned to remove the dense vegetation and allow regrowth. This occurs from November until February. At the close of the trapping season the trapping ditches are dammed off to control water flow. The ditches are reopened at the beginning of the trapping season. Water hyacinth is sprayed with herbicide before the opening of waterfowl season.




| State Wildlife Management Areas | Acres | Hectares |
|---|---|---|
| 1. Biloxi W.M.A. | 39,583 | 16,019 |
| 2. Bohemia W.M.A. | 33,000 | 13,355 |
| 3. Manchac W.M.A. | 5,261 | 2,129 |
| 4. Pearl River W.M.A. | 26,716 | 10,811 |
| 5. Point au Chieu W.M.A. | 28,404 | 11,495 |
| 6. Sabine Island W.M.A. | 8,103 | 3,279 |
| 7. Salvador W.M.A. | 30,604 | 12,385 |
| 8. Wisner W.M.A. | 22,153 | 8,965 |
| 9. Bonnet Carre Public Shooting Area | 3,789 | 1,533 |
| 10. Pass a Loutre Game and Fish Preserve Hunting Grounds | 66,000 | 26,710 |
| | 255,510 | 103,402 |

| State Refuges | Acres | Hectares |
|---|---|---|
| 11. Louisiana State Wildlife Refuge and Game Preserve | 13,000 | 5,261 |
| 12. Rockefeller Wildlife Refuge and Game Preserve | 86,000 | 34,803 |
| 13. Russell Sage (Marsh Island) Wildlife Refuge and Game Preserve | 78,000 | 31,566 |
| 14. St. Tammany Wildlife Refuge | 1,600 | 647 |
| | 178,600 | 72,278 |

| National Refuges | Acres | Hectares |
|---|---|---|
| 15. Breton | 4,507 | 1,824 |
| 16. Delta | 48,799 | 19,748 |
| 17. Lacassine | 31,765 | 12,855 |
| 18. Sabine | 142,845 | 47,808 |
| 19. Shell Keys | 8 | 3 |
| | 227,924 | 92,239 |

| Audubon Society | Acres | Hectares |
|---|---|---|
| 20. Paul J. Rainey Wildlife Refuge and Game Preserve | 26,161 | 10,587 |

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