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Waterfowl and their Wintering Grounds in Mexico, 1937-64

by George B. Saunders
Dorothy Chapman Saunders

UNITED STATES
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FISH AND WILDLIFE SERVICE
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Contents

Contents—Continued

Contents—Continued

Contents—Continued

Preface

The U.S. Fish and Wildlife Service is pleased to make available, albeit belatedly, some of the previously unpublished investigations of waterfowl and their habitats in Mexico by George B. Saunders and Dorothy Chapman Saunders. These field studies evolved from the activities of the Service's predecessor, the Bureau of Biological Survey, and alarm about the decline of North American waterfowl during the dust bowl era of the 1930's. Broad-based biological surveys of New World fauna were a major undertaking of the Bureau of Biological Survey. Pioneering biological investigations in Mexico were conducted by E. W. Nelson, later to become Chief of the Biological Survey, and his assistant, Edward A. Goldman. Altogether they spent some 15 years (1892-1906), with seasonal interruptions, in Mexico, exploring the biological and geographical zones.

The decline of North American waterfowl because of unprecedented drought and reduction in nesting habitats in the mid-1930's led to increased concern about this valuable resource. It was during that time that many new wildlife conservation programs got under way as the result of reflective and effective efforts of alarmed citizens, including sportsmen. Their efforts gained the support of Congress and President Franklin D. Roosevelt. J. N. "Ding" Darling, then Chief of the Biological Survey, was a principal catalyst. Important waterfowl programs, in addition to the newly accelerated National Wildlife Refuge program, included biological studies of waterfowl in Canada, chiefly for the purpose of providing better information for setting annual hunting regulations and developing other management aids.

In 1936, a waterfowl biologist was assigned to each of the four waterfowl flyways which had been recently identified by Frederick C. Lincoln from his intensive analyses of banding data for waterfowl. Dr. George B. Saunders, one of the original "Flyway Foursome," was assigned to the Central Flyway, and headquartered in Denver, Colorado, in 1937. Saunders' initial assignments carried him into Canada during the spring and summer, and elsewhere in the Central Flyway during the remainder of the year. Saunders recognized that many waterfowl produced in Canada and the United States did not winter in the Central Flyway, or adjacent flyways of the United States, but continued into Mexico and even more southerly climes. Consequently, in 1937 he recommended that winter surveys of waterfowl be initiated in Mexico to supplement E. A. Goldman's earlier biological studies. He made a preliminary study of wintering areas on the northeastern coast of Mexico in 1937-38, and reported that only low-level aerial surveys in combination with ground studies would give an accurate appraisal of the waterfowl present and the extent and value of their habitats.

However, it was not until January 1947, following World War II, that circumstances permitted the first mid-winter aerial survey to be undertaken. Although the first flight coverage was limited almost entirely to coastal areas, it demonstrated the potential value of comprehensive aerial surveys of waterfowl wintering grounds of Mexico. As Saunders describes, the aerial surveys were expanded in 1951 to include the interior Mexican highlands.

In 1939, Saunders was reassigned to studies of the white-winged dove in Texas and Mexico, but whenever possible he continued to gather information on waterfowl wintering in Mexico. He moved from Denver to Brownsville, Texas, to facilitate these investigations. Over the years, he and his biologist wife, Dorothy, a constant field companion, prepared a manuscript from their observations on the winter waterfowl and waterfowl habitats of Mexico. Information was also gleaned from the publications, reports, and field notes of Nelson, the Goldmans, and others. Unfortunately, the voluminous manuscript languished for many years in the Service's files.

Several recent events have redirected attention to this manuscript. In 1975, the United States of America and the United Mexican States embarked on a cooperative wildlife program called U.S.-Mexico Joint Committee on Wildlife Conservation. One project is titled Management of Migratory Birds. Also, the National Audubon Society began a cooperative survey to inventory key Mexican wetlands under the U.S.-Mexico Joint Agreement. Separately, Ducks Unlimited's interest in preserving wetlands in Mexico led to the formation of the Mexican affiliate of Ducks Unlimited (DUMAC), whose goals include monitoring, protecting, and improving major Mexican wetlands of importance to waterfowl. Most importantly, the growing awareness of Mexico to its rich wildlife resources and habitats, spearheaded by the Direccion General de la Fauna Silvestre's expanded programs, emphasized the need to make biological information, such as that provided by the manuscript by the Saunders team, more readily available. Accordingly, the Service decided that their lengthy manuscript should be published. It vividly describes Mexican habitat conditions and waterfowl usage during the years when the Saunderses were afield, and thus serves as a standard against which more current and future observations and studies can be placed in perspective.

It is the Service's pleasure to make some of the invaluable observations of Saunders and Saunders available to those interested in the waterfowl of North America, and their habitats south of the border.

Lynn A. Greenwalt, *Director*
U.S. Fish and Wildlife Service

Waterfowl and their Wintering Grounds in Mexico, 1937-64

by

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Introduction

The U.S. Fish and Wildlife Service has been interested in migratory birds, especially waterfowl, in Mexico for many years. An early period of cooperation in waterfowl administration was culminated in 1937 with the final ratification of the Convention Between the United States of America and the United Mexican States for the Protection of Migratory Birds and Game Mammals, usually referred to as the Migratory Bird Treaty.

Management of waterfowl on this continent is primarily carried out by hunting regulations. Current information on the status of each species must be obtained each year to serve as a basis for any needed modifications in the regulations. In the United States and Canada, wildlife biologists of the U.S. Fish and Wildlife Service and the Canadian Wildlife Service annually make the surveys to obtain this basic information. But the Government of Mexico has made no comparable surveys. Mexicans are not interested in hunting waterfowl to the extent that citizens of the United States and Canada are. As a consequence, Mexico's Department of Game emphasizes activities other than waterfowl management.

Waterfowl, especially ducks, winter in or migrate through Mexico in large numbers, so it is obvious that any continental surveys of the winter population should include Mexico. Some general investigations of waterfowl distribution there were made in 1926 and earlier by E. A. Goldman. He was familiar with much of Mexico because he and E. W. Nelson studied mammals and biota in general there for many years. In the 1930's, because of the greater emphasis on waterfowl conservation and management, more detailed surveys were made of the continental breeding and wintering populations. One of these activities was designated as the midwinter, or January, inventory.

In the early 1940's the senior author, who had been the Central Flyway Biologist since 1937, recommended that the waterfowl wintering grounds in Mexico be included in the coverage of the midwinter waterfowl inventory. This was arranged in 1947, and the first aerial coverage, which only included coastal localities, was made in January–February of that year. The information obtained confirmed the value and advisability of including the Mexican wintering grounds in the annual survey; beginning in 1951 the wintering grounds in the Mexican highlands also were included. The surveys of Mexico were continued, except in 1957, through 1965; after 1965 they were greatly reduced.

Ground reconnaissance and surveys had begun in Mexico with the preliminary work of Goldman in 1926, but quantitative studies were not started until 1937. The ground surveys continued at intervals in various parts of the Republic until 1960. Ground surveys are invaluable for such purposes as securing ecological information, specimens of birds and plants, and historical data about the areas from local residents, but the only satisfactory method of obtaining accurate quantitative information on waterfowl populations and their distribution is by airplane. Consequently, the major emphasis since 1947 has been on the annual aerial surveys. Ground studies were made much less frequently and were carried out mainly to obtain correlative information on the waterfowl foods available, the ecology of habitats, and for liaison with wildlife officials and biologists in Mexico.

An important reason for the surveys of the waterfowl wintering grounds in Mexico was to determine their adequacy for the population of birds using them, and their potential to accommodate additional waterfowl if the wintering grounds in the United States became inadequate and larger flights entered Mexico. Other advantages included providing accurate information to hunters and other interested persons in the United States regarding the waterfowl shooting in Mexico, and determining the current status of these

[1] At the time this manuscript was written, the senior author was on the staff of the Section of Wetland Ecology at the Patuxent Wildlife Research Center. In 1972 this Section was transferred to the Migratory Bird and Wildlife Research Laboratory.

birds and their habitats in that country. Some of these findings were previously summarized by us (Saunders and Saunders 1949; Saunders 1964).

Purpose

This publication is intended for those readers who are interested in waterfowl in Mexico, and especially for Federal, State and Provincial personnel who are concerned officially with waterfowl populations, their distribution, and habitats, fluctuation in numbers, band recoveries, and other information of value to management. This paper summarizes information that has been obtained on migratory waterfowl in Mexico from 1938 to 1965 by personnel of the U.S. Government. The various reports mentioned, plus the field notes and other data prepared by personnel who made the surveys, are in the files of the U.S. Fish and Wildlife Service in Washington, D.C., or at field stations of that agency.

Most readers know more about the waterfowl of Mexico than they do about the physiography, place names, and locations of waterfowl habitats in that Republic. Consequently, the first half of this publication describes waterfowl wintering grounds of Mexico, so that the reader will be oriented to the locations mentioned in the species accounts. The last half of this paper reviews the kinds of ducks and geese found in Mexico and gives information on their Mexican names, distribution, populations, recoveries of banded birds, food habits, and other related subjects.

This is not a general guide to waterfowl, and therefore it does not include color descriptions of the species, or other information except that pertaining to Mexico. For a comprehensive book on waterfowl, with color plates and continental distribution maps, Bellrose (1976) is recommended. Publications of Bent (1923, 1925) are invaluable references for information on migration, courtship, nesting, eggs, young, plumages, food, behavior, and general distribution of waterfowl. For those who have access to a large library, Phillips (1922-26) and Delacour (1954, 1956, 1959) are also excellent references.

For supplementary data on waterfowl in Mexico, Leopold (1959) is recommended. Additional information regarding some of the waterfowl habitats in the interior highlands, especially on their geography, history, and land use, may be found in the publication in Spanish by Arellano and Rojas (1956). The book by Goldman (1951) is an invaluable general reference on the physical characteristics and biota of Mexico, as is that of Beltran (1959).

Field Studies

Most of the survey coverage was by truck or 4-wheel drive vehicle, a considerable amount was by plane, and some was by boat, bus, rail, or afoot.

The aerial surveys began in 1938 with a short trip in a chartered plane over the coastal lagoons, from the Rio Grande Delta south to Laguna Tamiahua, Veracruz. The early flights were chiefly exploratory, for the purpose of learning the extent of individual wintering grounds on the Gulf Coast and the species of birds using them. Although several aerial trips were made during the following winters, it was not until January 1947 that a comprehensive survey of the entire Gulf Coast and of the Pacific Coast was made. All flights were at low level, usually from 30 to 60 m in altitude, so that the waterfowl could be identified by species. The senior author planned these first aerial surveys in Mexico, and together with David L. Spencer, pilot-biologist of the Fish and Wildlife Service, conducted the first two flights in January-February 1947, and January 1948 (Fig. 1). Subsequent flights were made annually by other biologists, except in 1957 when no survey was made (Table 1).

In 1948-49 the authors resumed ground studies in Mexico, and for the first time visited many of the wintering grounds in the highlands and on the Pacific Coast. In each locality, local hunters or other residents familiar with waterfowl were contacted to obtain information on the present and past conditions in the area.

All of the information on the waterfowl areas of Baja California is from other sources, both published reports and correspondence, but chiefly from the aerial survey reports of Robert H. Smith, former Pacific Flyway biologist with the U.S. Fish and Wildlife Service, and his field associates.

Biogeography of Mexico

In general shape, the Republic is like a great funnel with its broad top at its northern boundary with the United States and its neck at the Isthmus of Tehuantepec (Fig. 2). From there the land curves northeastward to form the Yucatan Peninsula. The total area is about 1,987,000 km^2, or about one-fourth that of the United States. The total length of coastline is about 9,730 km, that of the eastern coast is about 2,970 km, and the western coast totals almost 6,760 km. The western coast includes the long, slender peninsula of Baja California, which has more than 2,900 km of shoreline.

Along its northern boundary the breadth of the Republic is about 2,100 km from Tijuana to the Gulf of Mexico at the mouth of the Rio Grande. At the Isthmus of Tehuantepec the continent has a width of only about 220 km. As at the Isthmus of Panama, the course of land is east-west and the shortest route between the oceans is north-south. From Tehuantepec,

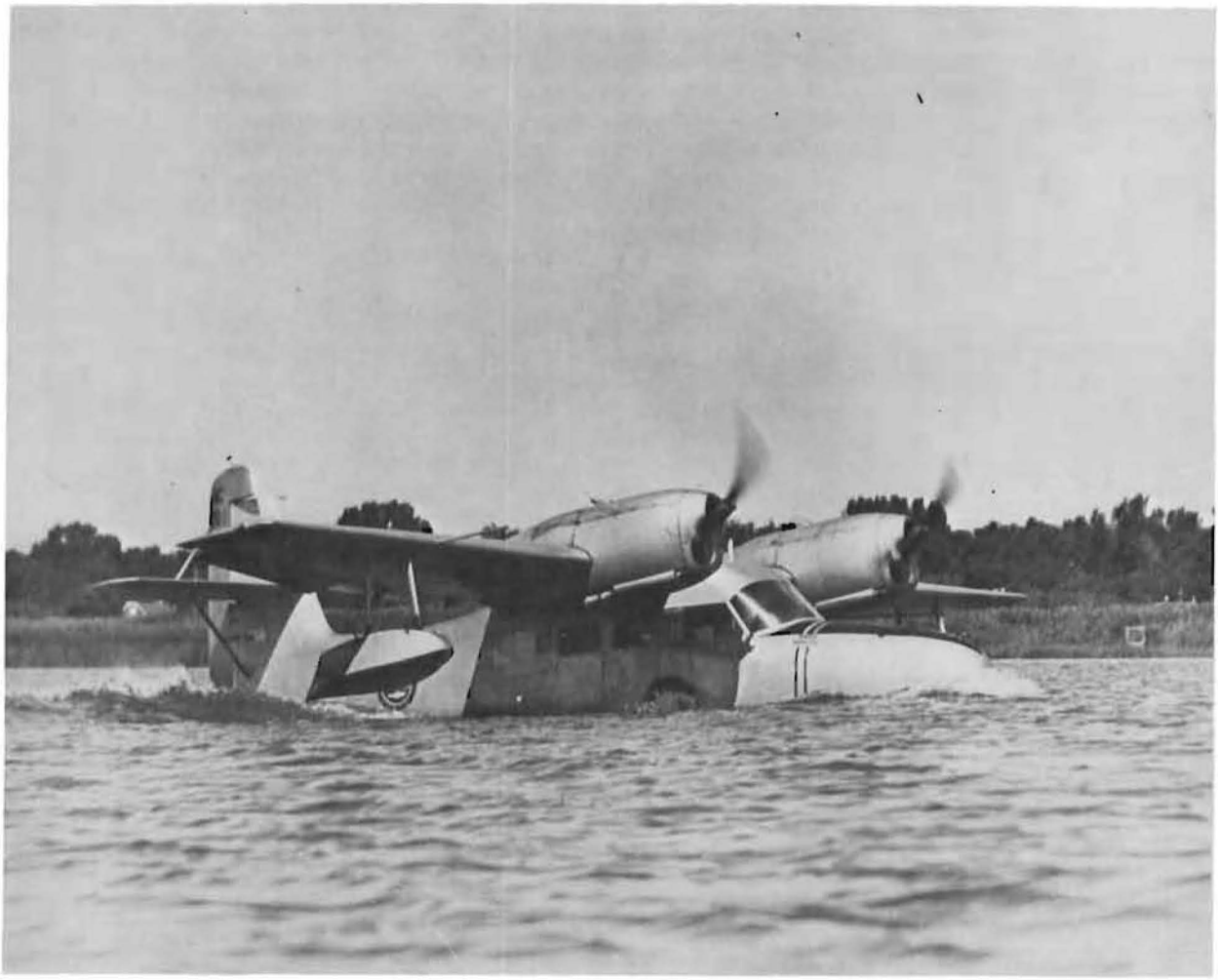

Fig. 1. The midwinter aerial surveys of waterfowl wintering grounds and waterfowl populations in Mexico by the U.S. Fish and Wildlife Service have been made chiefly in amphibious planes. Most of the waterfowl winter on extensive coastal waters, especially in river deltas, bays, and lagoons.

there are the five States of Chiapas, Tabasco, Campeche, Yucatan, and Quintana Roo lying to the east and northeast. The northeastern tip of the Yucatan Peninsula is about 3,200 km from the northwestern corner of the Republic. It is about 870 km from the nearest point on the Louisiana coast to the north, and about 180 km from the western tip of Cuba.

The State of Baja California extends southeastward as a long and very narrow peninsula about 1,240 km in length and parallel to the coast of Sonora. A southern continuation of the Pacific Coast Range forms the backbone of the peninsula almost to its tip. Several coastal bays and lagoons of Baja California are important to waterfowl, chiefly to black brant (*Branta bernicla nigricans*).

Much of the Republic is included in a broad, elevated tableland or plateau (Mesa Central) extending southward from the United States-Mexico boundary to its apex in the region of the Valley of Mexico. This high plateau declines northward from an elevation of about 2,620 m south of Mexico City to 915 to 1,220 m along the northern boundary.

Most of the plateau is a rolling, arid plain, broken by scattered masses and ranges of foothills and low mountains which rise like islands, some to elevations of about 3,000 m. Formerly there were many natural lakes, but most of these, and especially the largest *bolsones* (sump basins), have been dry in recent years, due to a variety of causes. Widespread agricultural development in many localities has resulted in the construction of irrigation reservoirs. Hundreds of these reservoirs have been impounded, and a few are many thousands of hectares in extent.

Those waterfowl that journey southward along the

Table 1. *Personnel of January aerial surveys of waterfowl wintering grounds in Mexico.*[a]

Year(s)	Gulf Coast and Caribbean	Northern Interior Highlands	Pacific Coast and Central Highlands
1938-41	G. Saunders (limited coverage)		
1947	G. Saunders, D. Spencer	G. Saunders, D. Spencer	G. Saunders, D. Spencer
1948	G. Saunders, D. Spencer	G. Saunders, D. Spencer	G. Saunders, D. Spencer
1948	R. Smith, D. Spencer		R. Smith, D. Spencer
1949	R. Smith, F. Thompson		R. Smith, F. Thompson
1950	R. Smith, J. Ball		R. Smith, J. Ball
1951	W. Crissey, J. Ball	R. Smith, A. Leopold,[b] A. Miller[c]	R. Smith, A. Leopold, A. Miller
1952	W. Crissey, E. Wellein	R. Smith, A. Leopold, W. Freeman[d]	R. Smith, A. Leopold, W. Freeman
1953	E. Wellein, J. Stoudt	R. Smith, H. Hansen, R. Hanson	R. Smith, H. Hansen, R. Hanson
1954	E. Wellein, J. Stoudt	R. Smith, H. Jensen, R. Hanson	R. Smith, H. Jensen, R. Hanson
1955	E. Wellein, J. Stoudt	R. Smith, H. Jensen, W. Fleming[e]	R. Smith, H. Jensen, W. Fleming
1956	E. Wellein, J. Stoudt, W. Jennings[f]	R. Smith, H. Jensen, R. Salter[g]	R. Smith, H. Jensen, R. Salter
1958	E. Wellein, J. Stoudt	R. Smith, H. Jensen, V. Oglesby[h]	R. Smith, H. Jensen, V. Oglesby
1959	F. Glover, J. Matlock	R. Smith, H. Jensen, J. McKeen[i]	R. Smith, H. Jensen, J. McKeen
1960	F. Glover, E. Chamberlain	R. Hanson, J. Matlock	R. Smith, H. Jensen, D. Smith
1961	E. Chamberlain, J. Matlock	F. Clever, R. Hanson	R. Smith, H. Jensen, E. Chattin
1962	E. Chamberlain, R. Hanson	R. Hanson, E. Chamberlain	R. Smith, H. Jensen, E. Chattin, F. Glover
1963	A. Brazda, R. Hanson, J. Smith	R. Hanson, A. Brazda, J. Smith	R. Smith, H. Jensen, F. Glover
1964	A. Brazda, M. Smith	R. Hanson, J. Smith	R. Smith, H. Jensen, R. Hanson

Pacific Coast only

[a]U.S. Fish and Wildlife Service employees, unless otherwise noted.
[b]University of California, Berkeley.
[c]California Department of Fish and Game.
[d]Montana Fish and Game Department.
[e]Arizona Game and Fish Department.
[f]Texas Game, Fish, and Oyster Commission.
[g]Idaho Fish and Game Department.
[h]Nevada Department of Fish and Game.
[i]Oregon State Wildlife Commission.

Central Flyway from western Texas, New Mexico, and eastern Arizona find a very limited number of lakes scattered over this highland. The important central lake district lies chiefly in the States of Guanajuato, Jalisco, and Michoacan, about 1,370 km by direct flight from the border at El Paso, Texas. The Valley of Mexico, about 240 km farther east and south from these lakes, has become relatively unattractive to waterfowl in recent years because of continued drainage.

To the east and west the tableland is flanked by great mountain ranges, the Sierra Madre Oriental and the Sierra Madre Occidental. The latter is the southern extension of the western cordillera in the United States. These ranges reach heights of more than 3,960 m on the east and 3,200 m on the west, but as seen from the plateau they attain their elevation so gradually in most places that they do not appear to be that high.

The Sierra Madre Occidental is the backbone of Mexico. With an average width of about 160 km, it is a group of mountain chains, more or less parallel, rising one above the other from west to east. The plateau, together with the flanking mountainous terrain, make up most of the area of the Republic. From each of the two main sierras there is an abrupt drop to the adjacent coastal plain.

The gently sloping coastal plains vary in width from one locality to another, but in general they are about 30 to 160 km wide. The coastal plain on the east averages much wider and is less broken by mountains. Many rivers rise in the mountains and traverse the plains more or less at right angles to the coast. Their seasonal flooding of the low country near their courses, and especially of their deltas, has created a series of coastal lagoons along both coasts. These lagoons and saltwater bays provide the principal wintering grounds for migratory waterfowl in Mexico.

The interior plateau has its apex in the Valley of Mexico. Near there, the two ranges meet in a complex mountain mass which extends southward and forms the western flank of the Isthmus of Tehuantepec. Geologically, this is the southern end of North America. Beyond is the low saddle of the Isthmus, which reaches an elevation of only 245 m at the pass. To the eastward, the mountains of Central America rise steadily to form a high backbone across the State of Chiapas, with an outlying series of high peaks and foothills near the Pacific Coast. There is a coastal plain with many lagoons from the vicinity of Tehuantepec to

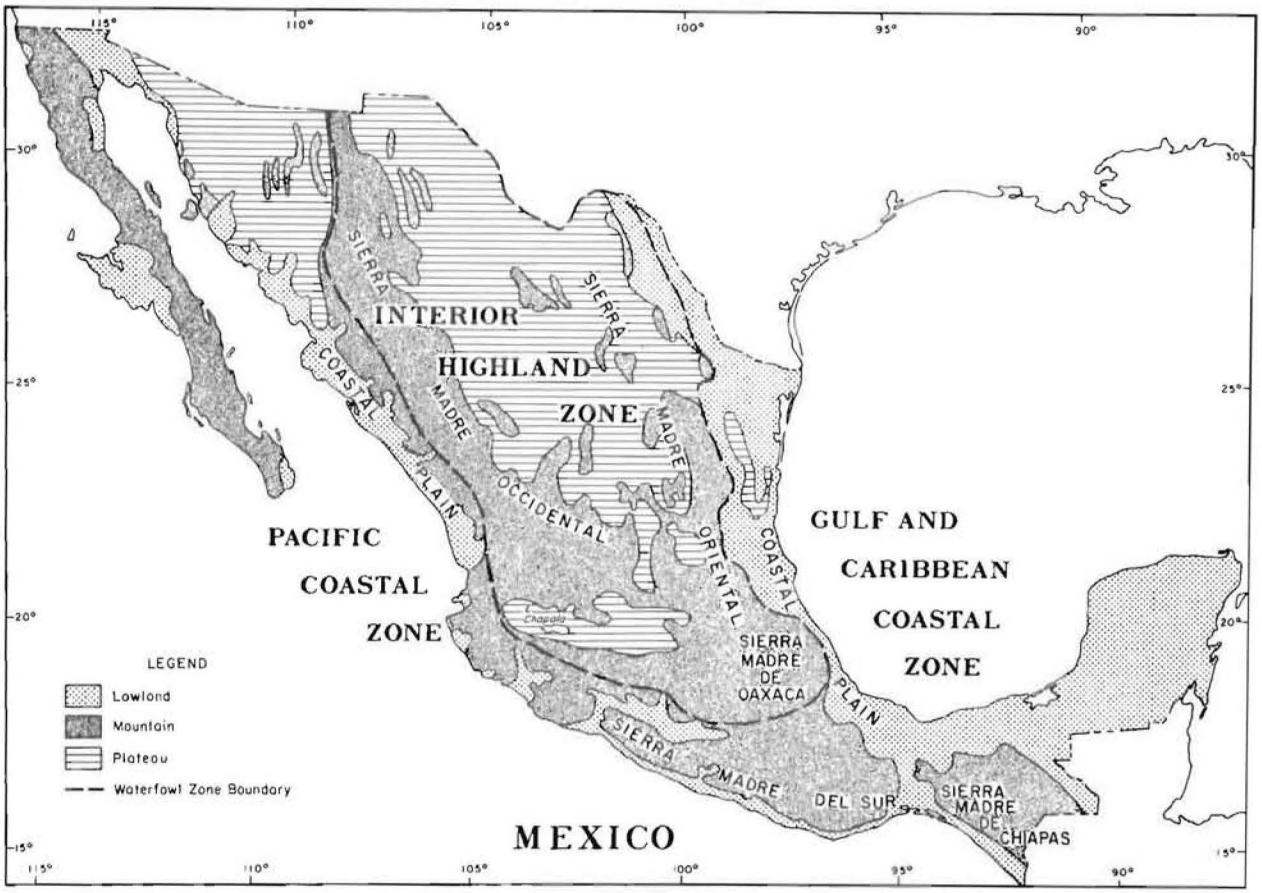

Fig. 2. Surface configuration and waterfowl habitat zones of Mexico.

near the Rio Suchiate, which is the boundary at this point between Mexico and Guatemala.

To the north and northeast of the mountains there is an abrupt descent to the Gulf coastal plain of Tabasco and the low, flat limestone peninsula of Campeche, Yucatan, and Quintana Roo. Tabasco is largely a delta area of swamp, marsh, and lagoons drained by rivers that originate in the highlands of Chiapas. To the east the Yucatan Peninsula extends like a thumb toward Cuba. It has no appreciable surface water except along its coast; its interior drainage is underground. The narrow lagoons on its northern margin are among the most strategically located in Mexico, and many waterfowl and other water birds, migrating from the Mississippi Delta southward across the Gulf of Mexico, stop there regularly.

Rainfall

There are wide differences between the rainfall in various regions of Mexico. Annual averages range from 5.6 cm at Mulege, Baja California, to 396.7 cm at Teapa, Tabasco.

On the Pacific Coast, it is arid in the lowlands of Baja California and along the coast of northern Sonora. As one progresses southeastward the rainfall increases. For example, Guaymas has an annual average rainfall of 28.2 cm, Culiacan 54.1 cm, Mazatlan 76.4 cm, Manzanillo 92.2 cm, and Acapulco 137.9 cm. In the Isthmus of Tehuantepec sector, Salina Cruz is drier, with 97.8 cm, because most of the rainfall is on the north side of the divide. Coatzacoalcos, opposite Salina Cruz on the Gulf Coast, has about 287 cm annually. Eastward from Salina Cruz on the Pacific slope, Tapachula, Chiapas, which has higher mountains nearby, has an annual average of 169.4 cm.

On the Gulf Coast, as on the Pacific, the precipitation increases as one progresses southward. At Brownsville, Texas, the annual average is 68 cm. Southward the averages are Tampico 114.3 cm, Veracruz 155.9 cm, and Minatitlan 287.5 cm.

On the Yucatan Peninsula, the rainfall is heaviest at its base near the mountains and lightest along its northernmost coast. At Teapa, which is near the mountains and at the southern edge of the marshes, the annual average is 396.7 cm, but at Merida, Yucatan, it is only 87.6 cm.

Hurricanes

Hurricanes can sometimes have a devastating effect on waterfowl habitat, but in other instances they can be beneficial. They have been especially destructive in parts of the Yucatan Peninsula, as on the northern coast of Campeche where there were so many severe ones during the 1930's and early 1940's. Some of the coastal lagoons have never recovered from the effects of these hurricanes, and countless thousands of dead mangroves are mute evidence of the damage. The powerful scouring action of several successive hurricanes almost eliminated all visible vegetation except the tree trunks in some localities along this coast.

The heavy flooding also can be very destructive because it drowns the emergent vegetation and deposits excessive quantities of soil and other material. A beneficial action of the flooding under some circumstances is that its scouring force may clean large amounts of silt from the lagoons and old channels and increase their depths. The force of the flooding also may flush out pest plants, such as water hyacinth (*Eichornia crassipes*), water lettuce (*Pistia stratiotes*), and water velvet (*Azolla mexicana*), and in that way may clean out lagoons which have been closed. Comments on the Tampico and Laguna Madre areas give information on the effects of flooding by a hurricane.

Hurricanes often are accompanied by heavy rains that cover a wide sector. At times such rains have been responsible for refilling thousands of freshwater lagoons, ponds, and marshes which had been low or dry before the general rains.

Readers who are especially interested in the history of hurricanes that have affected coastal areas of Mexico are referred to the series, "Pilot Chart of the North Atlantic Ocean, No. 1400," published monthly by the U.S. Naval Oceanographic Office, Washington, D.C. These charts show the tracks of hurricanes and give further details on the most destructive ones.

The description of the wintering grounds is arranged in two parts. The first is a brief, general description of the important localities used by waterfowl. The description begins with those wintering grounds on the Gulf Coast, proceeds to the interior highlands, and concludes with those on the Pacific Coast. The second part is a year-to-year summary of their general habitat conditions, condensed from reports written by personnel who completed the annual aerial surveys. In most instances the latter reports are not quoted, but pertinent information has been abstracted. Full credit for this latter material goes to the biologists of the U.S. Fish and Wildlife Service who made these surveys.

Waterfowl Wintering Grounds of Mexico

Gulf and Caribbean Coast Zone

The waterfowl wintering grounds of this zone are of most importance to the birds of the Central and Mississippi flyways. The major habitat types range from tidal bays and lagoons, brackish and saline landlocked lagoons, brackish and saline flats, freshwater lagoons and marshes, and tropical swamps, to offshore waters of the Gulf.

Ducks that cross the Rio Grande and follow the Gulf coastal plain of Mexico southward have a series of wintering places to choose from: the Rio Grande Delta, Laguna Madre, and other lagoons of Tamaulipas, Tampico lagoons and marshes, Laguna Tamiahua, Papaloapan Delta including Laguna Alvarado, Tabasco lagoons and marshes, and the coastal lagoons of Campeche and Yucatan. There are also other less important wintering places distributed along the way.

When the littoral of this zone is scouted from the mouth of the Rio Grande to the southern boundary of Veracruz, there are only narrow beds of sea grasses in the shallows. But from the Rio Coatzacoalcos, Veracruz, northeastward to Yucatan, this marginal zone is broad and has an abundance of shoalgrass (*Diplanthera*), manateegrass (*Cymodocea*), turtlegrass (*Thalassia*), and a variety of marine algae yet to be identified. The littoral zone of this part of the Yucatan Peninsula is gently shelving and mostly of firm sand, except near the mouths of streams in Tabasco and northwestern Campeche, where a great deal of alluvial silt has been deposited. During most of the year, the prevailing winds are offshore from the southeast, which makes a favorable condition for the growth of this marine vegetation. From the air, one can see the bordering zone of green plants that extends from near the low tide line seaward for a distance of 100 m or much farther.

Some migrating waterfowl used this zone. Flocks of several species were observed in fall, winter, and spring; pintail (*Anas a. acuta*) and lesser scaup (*Aythya affinis*) were the most numerous. Blue-winged teal (*Anas discors*) were frequently sighted there also, some of them observed in flight several kilometers out at sea.

The species most often seen feeding offshore was the lesser scaup. Along the northern coast of Yucatan, pintail and American wigeon (*Anas americana*) also fed

offshore, and along the coast of Tamaulipas red-breasted merganser (*Mergus serrator*) were present in small numbers. Unlike the Pacific Coast of Baja California and Sonora, there were no black, white-winged, and surf scoters (*Oidemia nigra americana, Melanitta deglandi, M. perspicillata*); bufflehead (*Bucephala albeola*) were rare on the Gulf and Caribbean coasts of Mexico.

Two of the major differences between the Gulf and Caribbean coastal plains in Mexico and that of the Pacific are that the former is wider (on an average) and receives heavier rainfall and more runoff than does the Pacific coastal plain. As a result of its greater width, the Gulf plain has a broader band of freshwater lagoons and marshes, and longer river deltas than does the Pacific, but the Pacific has more large coastal bays. The greater precipitation in the Gulf and Caribbean drainages also is largely responsible for the more extensive inland freshwater areas, such as those of Tabasco and southern Veracruz.

The water levels and habitat conditions at some Gulf and Caribbean coast localities are primarily dependent on local rainfall. In other places, such as in the Tampico and Papaloapan deltas, however, habitat conditions are much more dependent upon the amount of rainfall in the mountains and elsewhere upstream, which brings periodic flooding of the tributaries of the large rivers.

The Gulf and Caribbean coasts do not have extensive grain-raising districts of rice and wheat comparable to those of Sinaloa and southern Sonora on the Pacific Coast. There is an important area of grain sorghum in northern Tamaulipas which is of local value to waterfowl, but in general all the major concentrations of ducks on the Gulf and Caribbean coasts depend upon wild foods. Major shifts of the waterfowl population are usually caused by local changes in the relative abundance of natural food, such as the drastic effect of the decline of shoalgrass in Laguna Madre on the distribution of redhead (*Aythya americana*), or the decline of preferred mollusks in Laguna Tamiahua on canvasbacks (*Aythya valisineria*).

The vast Tabasco swamps and marshes offer a combination of habitats that is not available on the Pacific Coast, except to a very limited extent in parts of Sinaloa, Guerrero and Chiapas.

The relative attractiveness of these different wintering grounds depends on the species of duck, and on the current habitat conditions as determined by water levels, food production, weather, and other factors. In general, most of the dabblers prefer the delta marshes and shallow freshwater lagoons, whereas the divers and pintails choose the broader, deeper coastal lagoons.

The major areas are described in the following accounts and are listed in sequence from north to south

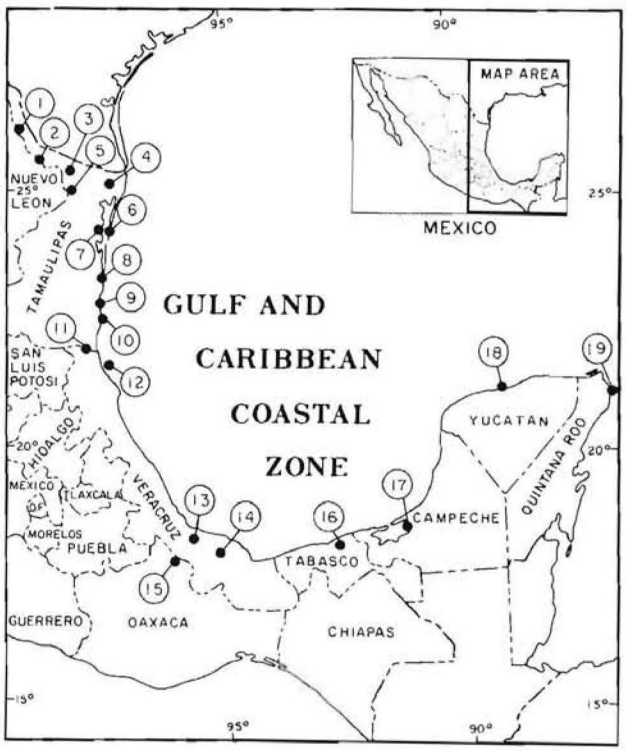

Fig. 3. Waterfowl wintering grounds of the Gulf and Caribbean coasts of Mexico.

along the coast from Tamaulipas to Yucatan and Quintana Roo (Tables 2 and 3; Fig. 3).

Fig. 3 (and Figs. 10 and 16 that will be presented later) show the location of many waterfowl wintering areas; more than 50 are in the highlands, 34 in the Pacific zone, and only 17 in the Gulf zone. These ratios should not be interpreted to indicate the relative importance of each zone to waterfowl nor should the individually numbered localities be assumed to be of comparable value to these birds. Most of the highland localities are small, some only a few hundred hectares or less. There are no large areas of good waterfowl habitat in the highlands. In contrast the coastal zones have many large wintering grounds, especially along the Gulf. On the Pacific Coast there are many lagoons that have been numbered, but along the Gulf the coastal plain is much broader and wintering grounds average much larger. Some of them, such as Tampico, contain scores of lagoons, and two other areas, Alvarado and Tabasco, have thousands of individual lagoons. For this reason only the general sectors have been numbered. This difference in value of numbered localities can be misleading to readers who are unfamiliar with Mexican geography. Although there are only 17 localities numbered on the Gulf Coast, the total area of waterfowl habitat there exceeds that of the Pacific Coast and highlands combined.

Table 2. *Important waterfowl wintering areas along the Gulf and Caribbean coasts of Mexico.*

Name	Description	State	Figure 2 index number
Falcon Reservoir	A large reservoir on the Rio Grande, north of Mier.	Tamaulipas	1
El Azucar Reservoir	A large reservoir southeast of Mier.	Tamaulipas	2
Culebron Reservoir	A reservoir about 30 km westnorthwest of Matamoros.	Tamaulipas	3
Rio Grande Delta	The delta area from the Rio Grande south to Laguna Madre; also several reservoirs upriver, including the following four.	Tamaulipas	4
Ensenada Reservoirs	A group of small reservoirs from 32-48 km west-southwest of Matamoros.	Tamaulipas	5
Laguna Madre	Laguna Madre and the nearby freshwater lagoons and marshes on the mainland.	Tamaulipas	6
Rio San Fernando	Delta of the Rio San Fernando with its lagunas, marshes, and flats to the west of Laguna Madre.	Tamaulipas	7
Soto la Marina	Lagunas and marshes near the mouth of the Rio Soto la Marina.	Tamaulipas	8
Laguna Morales	Coastal laguna for 14 km south from mouth of Rio Soto la Marina.	Tamaulipas	9
Laguna San Andres	The next large coastal lagoon south of Laguna Morales; it is about 42 km long.	Tamaulipas	10
Tampico Lagoons	The deltas of the Rio Tamesi and Rio Panuco, as far upriver as Ebano, San Luis Potosi.	Tamaulipas, Veracruz, and San Luis Potosi	11
Laguna Tamiahua	Laguna Tamiahua and the adjacent ponds and marshes.	Veracruz	12
Alvarado Lagoons	Laguna Alvarado, Laguna Camaronera, and the adjacent vast freshwater deltas of several large rivers, especially the Papaloapan and the San Juan.	Veracruz	13
Lago de Catemaco	The deep mountain lake east of San Andres Tuxtla.	Veracruz	14
(Presa M. Aleman) Temascal	A very large reservoir on a tributary of the Rio Papaloapan.	Oaxaca	15
Lagoons of Tabasco State	Tropical lagunas, marshes, and swamps from the lower Rio Coatzacoalcos, Veracruz, across Tabasco to the lagunas of Campeche.	Tabasco	16
Lagoons of Campeche State	The coastal lagunas and marshes of Campeche, especially Laguna de Terminos and the saline coastal lagunas south of the boundary with Yucatan.	Campeche	17
Lagoons of Yucatan	Lagunas and bays of the northern coast.	Yucatan	18
Lagoons of Quintana Roo	Lagunas, bays, and salt flats of the eastern coast.	Quintana Roo	19

In the accompanying lists of localities, those marked with an asterisk are reservoirs; they are man-made and are not to be confused with lakes which may have had a control structure added to increase their size and to allow some management of their water. Lake Yuriria, Guanajuato, for example, is in a natural basin, but its size was increased greatly by dikes built by Augustinian friars during the 16th century. In general, the reservoirs listed were created by damming river valleys.

The aforementioned figures do not show all of the localities where waterfowl are found in Mexico during winter, but they include all of the more important wintering grounds. Many small lagoons, marshes, and reservoirs that may have had ducks were not included. This is especially true of the highlands. The localities mapped include almost all of those listed in the annual reports of the January waterfowl survey of Mexico by the U.S. Fish and Wildlife Service up to 1965.

Falcon Reservoir (1)[2]

Falcon Reservoir on the Rio Grande, 40 km above Roma, Texas, and Ciudad Mier, Tamaulipas, is above the delta, but its birds are included in the total for the

[2]Number in parentheses corresponds to the index number that designates on Fig. 3, Page 7 the location of the listed wetland(s).

Table 3. *Waterfowl seen (in thousands) during January surveys of the Gulf and Caribbean coasts of Mexico, 1948–62.*

Species	1948	1949	1950	1951	1952	1953	1954	1955	1956	1958	1959	1960	1961	1962	Avg.
Mallard	—	—	—	—	—	—	—	—	—	—	[a]	[a]	[a]	[a]	[a]
Mottled duck	2	1	—	[a]	—	[a]	[a]	[a]	—	[a]	[a]	[a]	1	[a]	[a]
Gadwall	286	62	67	57	41	29	58	24	49	13	14	15	46	18	56
Wigeon	245	96	52	39	19	56	103	34	326	142	47	42	230	39	105
Green-winged teal	51	22	16	6	53	3	6	24	2	8	22	10	6	20	18
Blue-winged teal[b]	59	152	180	147	164	136	125	178	211	200	79	63	161	39	135
Shoveler	44	27	38	19	3	14	23	20	9	6	15	5	4	2	16
Pintail	408	153	55	55	389	147	364	197	144	184	182	43	235	56	187
Redhead	219	111	21	30	58	99	94	58	105	100	241	44	6	2	85
Ring-necked duck	52	23	11	11	7	2	3	4	1	1	[a]	1	[a]	2	8
Canvasback	39	20	13	5	9	2	2	1	2	5	5	3	4	3	8
Lesser scaup	445	297	136	69	242	333	236	250	213	321	138	229	75	191	227
Goldeneye	—	[a]	—	[a]	—	—	—	—	—	—	—	—	—	—	[a]
Bufflehead	[a]	[a]	[a]	—	—	—	—	—	—	—	—	—	—	[a]	[a]
Ruddy duck	14	8	6	2	3	8	10	1	3	2	1	2	2	—	4
Mergansers	[a]	—	—	—	—	—	—	—	—	—	—	—	—	—	[a]
Unidentified ducks	15	25	23	15	—	315	255	64	162	65	57	11	7	52	76
Total ducks[c]	1,879	997	618	455	988	1,144	1,279	855	1,227	1,047	801	468	777	425	926
Geese	14	8	9	4	12	21	8	10	5	10	23	3	6	17	11
Total waterfowl	1,893	1,005	627	459	1,000	1,165	1,287	865	1,232	1,057	824	471	783	442	937
Coots	3,878	938	479	283	915	464	1,113	484	812	510	482	333	595	513	843
Total birds	5,771	1,943	1,106	742	1,915	1,629	2,400	1,349	2,044	1,567	1,306	804	1,378	955	1,780

[a]Fewer than 1,000 birds.

[b]Also includes cinnamon teal.

[c]Does not include fulvous whistling duck, black-bellied whistling duck, and muscovy duck.

delta. It is a large impoundment with a capacity of more than 5,000 million m^3. It is of increasing value to waterfowl as it becomes older and has more aquatic food plants.

El Azucar Reservoir (2)

El Azucar (Marte R. Gomez), a large reservoir with a capacity of 1,080 million m^3, is southwest of Camargo, Tamaulipas, and Rio Grande City, Texas. It is on the Rio San Juan, a tributary of the Rio Grande, and is outside the delta, but its irrigation water is used in the upper part of the delta near Reynosa. Its surface area, when the water level is at the spillway, is about 16,200 ha. Except for some of its coves and shallows at the upper end, its depth is too great to attract many ducks other than divers and roosting geese. The fluctuation of water level has been so great that little submerged aquatic vegetation has been present. In recent years, an increasing number of geese have used this reservoir and fed at nearby agricultural fields.

El Culebron Reservoir (3)

El Culebron (or El Control) Reservoir is upriver about 40 km west-northwest from Matamoros. When it was first scouted in the winters of 1938–44, its maximum area was about 2,025 ha. The reservoir had an average depth of less than a meter, but much was shallower, and most of its shoreline was gently sloping and grassy or wooded. There was a good supply of duck food, chiefly widgeongrass (*Ruppia maritima*), and a daily population of ducks that ranged from several hundred to several thousand, including pintail, blue-winged teal, American wigeon, gadwall (*Anas strepera*), a few black-bellied whistling ducks (*Dendrocygna autumnalis*), and, on at least one occasion, a European wigeon (*Anas penelope*).

Rio Grande Delta, Tamaulipas (4)

The part of this delta of most value to waterfowl extends from the Rio Grande southward to Laguna Madre, from the Gulf shore westward a few kilometers beyond the Matamoros–San Fernando Highway. This is an area of more than 2,000 km^2, about 360 km^2 of which are in basins either intermittently or permanently supplied with fresh, brackish, or salt water, depending on the amount of rainfall, flooding by the river, and inundation by Gulf storms. During recent years, most of these surface waters have been temporary, but a few are permanent and regularly frequented by migrant and wintering water birds.

This area was an attractive and important wintering ground in former years, especially before 1930, when almost every year floods spilled across the flat delta

and replenished the lagoons and extensive marshes. Levels were stable enough then in many lagoons, ponds, and marshes to maintain excellent feeding conditions. But with the construction of a system of levees and floodways, the building of large reservoirs upstream, and the diversion of flow for vast irrigation projects, the lower delta changed in the extent and value of its waterfowl habitats, and in the number of waterfowl using them. The lagoons of the delta are now largely dependent on local rainfall since many reservoirs and other control structures have been built upstream, and the former extensive marshes have disappeared.

These changes have reduced the district from one of the finest waterfowl wintering grounds in North America to one of minor rank and highly variable carrying capacity. Since about 1947, few of the lagoons have remained attractive to waterfowl. Because of the shallowness of many basins, winds have subjected them to heavy bottom scouring and turbidity, with a consequent loss of much of the aquatic vegetation. However, the deeper, more protected parts still provide widgeongrass and muskgrass (*Chara* sp.). Regardless of these changes, during years when water levels are good the delta will attract large numbers of field-feeding ducks and many geese.

Even in the years of frequent flooding there have been few permanent freshwater lakes that were larger than 30 ha, but some of the brackish lagoons have been as large as 30 km^2 or more. The largest and most important of the natural freshwater lagoons is the Laguna de San Juan, usually about 800 ha, and located directly adjacent to the Rio Grande 25 km east of Matamoros. The lagoon's size has fluctuated with the incidence of floods on the river and with droughts. In some winters it has been an important lake for redheads, which make daily round-trip flights from Laguna Madre in Texas to drink and rest at San Juan. Many other waterfowl have also gone there from saltwater bays, chiefly in years of drought when the smaller lakes were dry or saline. The principal foods there are widgeongrass, muskgrass, and dwarf spikerush (*Eleocharis parvula*).

Permanent freshwater lakes are more numerous near the Rio Grande than farther south in the district. Many are old oxbow lakes (*esteros*) formed by the river, from which they receive some of their water supply during floods. Most of the basins located to the south and southeast of Matamoros are fed by *resacas* (former channels of the river), chiefly the Gomeno, Pita, and Tigre. A high flood stage or heavy rainfall is required to fill these *resacas*; consequently there are relatively few permanent lakes along their courses.

There are hundreds of small basins in this district that have water only in wet years (or formerly at times of floods on the Rio Grande). Some of these shallow basins are devoid of vegetation, but others have a heavy growth of grasses, saltwort (*Batis maritima*), spikerushes (*Eleocharis* spp.), and other foods. Grainfields near the river are inundated at times of flood and then become temporary feeding headquarters for ducks in the vicinity. The common vegetation in the flooded flats and basins nearer the coast is halophytic, and includes saltgrass (*Distichlis* sp.), sea oxeye (*Borrichia frutescens*), tomatillo (*Lycium carolinianum*), glasswort (*Salicornia* spp.), saltwort, and associated species.

The common submerged aquatics in the lagoons are muskgrass and widgeongrass. Dwarf spikerush is frequently found on some of the shores and mudflats. Other plants palatable to Canada (*Branta canadensis*), white-fronted (*Anser albifrons frontalis*), and lesser snow geese (*Anser c. caerulescens*) also occur along the shores, flats, and higher ground. Some of these lagoons have a fine food supply of copepods and other crustaceans, the larvae of midges and brine flies (*Ephydra* sp.), and other animal foods utilized by waterfowl.

At the small, open lakes the common ducks were pintail, baldpate, gadwall, blue-winged teal, Northern shoveler (*Anas clypeata*), and mottled duck (*Anas fulvigula maculosa*); some green-winged teal (*Anas crecca carolinensis*), and a few cinnamon teal (*Anas cyanoptera septentrionalium*) also used the lakes. On the small brushy or grassy lakes and ponds, blue-winged, American green-winged, and cinnamon teal, shoveler, and mottled duck were more common than on the open waters. Several mottled ducks shot at such ponds had fed exclusively on small fishes.

Before landowners began planting large acreages of grain sorghum south of Matamoros in the late 1950's, Canada geese fed along the ridges covered with buffalograss (*Buchloe dactyloides*), whereas the snow and white-fronted geese usually fed on the saltwort, tomatillo, and glasswort on the coastal flats. All three species of geese were fond of the dwarf spikerush found on some lagoon shores. In the decade 1954-64, the delta became relatively more popular with geese than with ducks, because of the grainfields.

As one would anticipate from the changing conditions, this wintering ground is highly variable from year to year in its attractiveness to waterfowl and other water birds. In the wet years of the 1930's and 1940's, it sometimes had an estimated winter population of 500,000 ducks and 50,000 geese. In some dry years, the wintering population dropped to no more than 50,000 ducks and 8,500 or fewer geese.

Since the 1940's, the January survey figures on ducks have ranged from a low of 900 in 1956 to 192,000 in 1959, and averaged about 36,000. In 1953, the delta was dry and no birds were seen in their usual places on the day of the survey.

The average percentages of waterfowl present by species in the Rio Grande Delta have been as follows: pintail, 47; shoveler, 11; gadwall, green-winged teal and geese, each 9; wigeon, 6; blue-winged teal, 5; lesser scaup, 1; and whistling ducks (fulvous whistling duck, *Dendrocygna bicolor*, and black-bellied whistling duck), mallard (*Anas p. platyrhynchos*), mottled duck, redhead, ring-necked duck (*Aythya collaris*), canvasback, ruddy duck, and hooded (*Mergus cucullatus*), common (*M. merganser americanus*), and red-breasted (*M. serrator*), mergansers, less than 1 each. Among the ducks reported on all the aerial surveys of waters of the Gulf and Caribbean coasts, the Rio Grande Delta has averaged about 36,000 or 3.3% of the total.

In the past several years, there has been a big increase in the waterfowl numbers reported for the delta over those of the 1950's (except 1959). Formerly, the counts of geese were very inadequate, because of the limited surveys of the grainfields and small reservoirs. Residents of the area told us many times that the number of geese present was much larger than the figures in our aerial survey reports during the 1950's. Recently, water conditions have been very good in the delta, and the total numbers of ducks and geese were about 156,000 in 1964 and 75,000 in 1965. Of the waterfowl totals, the percentage of geese was 27.5 in 1964 and 29.0 in 1965. This was a great change from former years when the percentage of geese was much smaller; in fact, the average over many former years had been about 9%. It seems likely that in addition to the recent finding of more geese as a result of better survey coverage, there has also been an overall increase in the wintering population of these birds. The loss of some wintering habitat farther north seems to have caused more Canada geese to come to Tamaulipas, and the increase in acreage of grain sorghum evidently has shortstopped some of the white-fronted geese which otherwise would have flown on to the interior highlands.

The spectacular increase since 1963 has been chiefly in white-fronted geese, but there has also been some gain in Canada and snow geese. Most of the feeding flights are to fields west of the Matamoros–San Fernando highway, about 30 km south of Matamoros, and from there south to grainfields on and near the Rancho Canelo. Many of the Canada geese are the so-called lesser Canada goose (*B. c. parvipes*) and they have increased in numbers there in the past several years. Most of the birds spend the night on the irrigation reservoirs, or at Laguna de San Juan and other broad coastal waters, and at dawn they fly to the fields to feed.

Ensenada Reservoirs (5)

The most recent important additions to the reservoir system in the area are those near Ramirez and Ensenada, that begin about 55 km west-southwest of Matamoros and extend southwestward. They also have attracted an increasingly large number of waterfowl, including geese, because of their strategic location near extensive grainfields, and their proximity to the coastal flats and lagoons. In 1964 and 1965, most of the birds were reported to be in this locality at the time of the surveys.

The reservoirs mentioned irrigate a total of more than 275,000 ha, but very little of this cropland is attractive to waterfowl except in places where waste irrigation water accumulates in pools and playas. The grain sorghum fields are not a part of the irrigated section.

The district has a sparse human population, except in the vicinity of Matamoros and in the farming areas that extend upriver and toward San Fernando. With few exceptions, the coastland beyond is used only for ranching. Before the 1950's, most of the limited waterfowl shooting was done to supply birds to the restaurants in Matamoros and Reynosa that specialized in game dinners for American tourists. Until the 1960's, the entry of American hunters was a complicated procedure that discouraged many who otherwise would have crossed the border to shoot ducks and other game birds. These regulations have been liberalized and during the past several years the number of visiting hunters has been increasing considerably.

Laguna Madre, Tamaulipas (6)

For many years before 1960, Laguna Madre was an especially important wintering ground for several hundred thousand redhead and pintail, and in some seasons also for many lesser scaup and several other species. At that time this district usually had more wintering and migrant waterfowl than all other lagoons from the Rio Grande south to the Tampico Delta. Over the years, pintail and redhead have been the most numerous winter residents and migrants in this area, because of the vast beds of shoalgrass in Laguna Madre. As recently as the January 1947 survey, 447,000 redheads and 379,000 pintails were observed there, but since 1949 their numbers in the area have declined greatly. During the January 1961 survey, 6,000 redheads were recorded; in January 1962 there were only 2,000. These numbers have been small since then because of the lack of food in the Laguna.

The population of ducks, other than redhead, lesser scaup, and pintail, that winter in this district depends largely on the conditions of the freshwater lakes on the mainland. In some localities (e.g., east of Loreto) there have been some good freshwater lakes even during very dry years. But many of the smaller ones have had water only during those years when there has been an average or greater amount of rainfall (Fig. 4).

On these freshwater lakes the common ducks are

Fig. 4. Laguna Madre, Tamaulipas, January 1945—Many of the redheads that winter on Laguna Madre (Mexico) fly daily to freshwater ponds and lagoons nearby on the mainland to drink and rest. Shallow waters of this type attract many species of ducks, herons, shorebirds, and other water birds, and are the winter home for those that require a freshwater habitat. Laguna Madre is in the background.

gadwall, wigeon, shoveler, pintail, redhead, ruddy duck (*Oxyura jamaicenses*), and green-winged, blue-winged, and cinnamon teal. Many of the redhead and pintail fly to nearby Laguna Madre late each afternoon, where they feed, rest, and spend the night, returning inland early the next morning. The Canada geese and lesser snow geese usually fly to the laguna in late afternoon after spending the day at freshwater lakes, shallow marshes, and meadows where they feed and rest. The other ducks remain on the lakes throughout their stay.

The district is sparsely populated and all except a very small portion of the open country is ranchland. Almost all the place names shown on maps of the district are those of ranches. Considering the size of the area, the amount of duck shooting is small, usually near Boca Jesus Maria (Eighth Pass), El Porvenir, La Carbonera, and the fishing village of La Pesca on the Rio Soto la Marina.

The laguna basin, which begins about 55 km south of the mouth of the Rio Grande, has an area of about 2,030 km² and a length of almost 160 km. It is about 30 km wide at its broadest part near the northern end, but becomes increasingly narrow toward its southern end. The entire body of water is reported to be shallow, and probably averages less than 1.3 to 1.6 m deep.

From about 1909 to 1960, Laguna Madre was reported to have had one or more direct connections with the Gulf of Mexico. It had almost the same salinity as that of the sea, or was slightly higher in salt content because of evaporation. During the 1940's, when many of these studies were made, the salinity ranged from

about 1.05 to 1.40 times that of the Gulf. Its shallow northern and southern ends were usually the most saline.

In shallow places where the bottom is clay or silt, the water is usually turbid and there is no vegetation except marine algae. Where the bottom is sandier and the depth from 15 cm to 1.3 or 1.6 m at low tide, especially along the eastern side to leeward of the barrier islands and in the vicinity of the passes, there were extensive beds of shoalgrass until about 1960. The shallowness of most of the laguna, the softness of much of the bottom soil, and the frequently strong winds, all combined to reduce the area of these plants and most other aquatic vegetation. The protection from the winds afforded by the barrier islands and other islands in the laguna probably was the principal reason for the more abundant shoalgrass beds along the eastern side of the laguna when it was open to the Gulf.

The southern end of Laguna Madre is of little value to ducks. It is very shallow and lacking in food; the prevailing strong southeasterly winds at times blow all of the water northward from this part of the basin.

The shore in most places is broad and gentle in slope, and is barren or has only sparse vegetation except for encroaching saltgrass, sea oxeye, saltwort, glasswort, and other low halophytes.

The barrier islands between the laguna and the Gulf are low and, for the most part, either barren or only partly covered with halophytes. Near the southern end of the laguna the cover is taller, including some shrubs and trees, the latter chiefly mesquites (*Prosopis juliflora*).

At the times of the low-level aerial surveys during the 1940's, it was estimated that from 25 to 35% of the bottom of Laguna Madre was covered with aquatic vegetation. Identified plants included shoalgrass, which was the principal food, and also halophila (*Halophila engelmanni*), *Acetabularia* sp., and several other kinds of algae. There were extensive beds of widgeongrass and dwarf spikerush near the outlet of the Rio San Fernando.

The best shoalgrass, with longer leaves and abundant rhizomes, was found at depths of 1.3 to 1.6 m. In shallower water the shoalgrass was less luxuriant and often was coated heavily with algae.

In addition to plant food, there was an abundance of animal food in parts of the laguna. At the north end where the bottom soil was thickly crusted with alkali, there were countless larvae and pupae of brine flies, some of which were eaten by pintail, lesser scaup, shoveler, mottled duck, and other species.

The small mollusk *Anomalocardia cuneimeris* was abundant locally and was fed upon chiefly by lesser scaup. There were also many small isopods, crustaceans, and aquatic insects that provided food for wintering waterfowl.

Hundreds of circular spots, close to a meter in diameter and barren of vegetation, were visible on the lagoon bottom from the air during the low-level aerial surveys. Local fishermen reported that these bare spots were made by black drum (*Pogonias cromis*) around their nests.

During the greater part of the past century, Laguna Madre has been open to the Gulf of Mexico at Boca Jesus Maria, the famous Eighth Pass. In its earlier times, Laguna Madre went dry shortly after 1900, according to old-timers among the fishermen. One of them said that the drying was correlated with the hurricane of September 1900, which devastated Galveston, because the storm conditions in the Gulf closed all of the passes of Laguna Madre. The long drought at about that time caused the drying of the laguna. He said that storms reopened some of the passes about 1909, and that one or more had remained open until 1960. In 1937 there were at least four passes open.

During the 1940's and up to the mid-1950's, Eighth Pass was about 0.5 km wide, and its channel 6 m deep. By the winter of 1959-60, it was almost closed by the deposition of sand from the Gulf and the reduced flow from the laguna. As a result of these conditions, the salinity, at a point on the western shore opposite the Eighth Pass, was 50% above that of the Gulf on 18 December 1959. There had been a serious drought on the mainland and very little flow in the Rio San Fernando during that year. High evaporation and lack of circulation caused the excessive salinity, which killed most of the shoalgrass, mollusks, and other foods, and seriously reduced the commercial fishery (Galtsoff 1954). There is no mystery about the cause of the disappearance of most of the waterfowl from the laguna at that time—there was too little for them to eat. The pass closed in 1960, and the bay has been landlocked most of the time since, until Hurricane Beulah opened many passes in 1967. As a result of the closed passes and the lack of runoff from its tributary streams, Laguna Madre became increasingly saline until 1967.

A water sample taken from the main part of the laguna early in 1961 by Vincent H. Stevenson of Brownsville, Texas, and analyzed by Dr. Henry Hildebrand, University of Corpus Christi, had "a chlorinity of 95,600 parts per million and a total salinity of 175,000 parts per million or pretty close to pure brine" (letter of 3 October 1961 from Hildebrand to Stevenson).

On 10-11 September 1961, Hurricane Carla, one of the most destructive in Texas history, hit the coast. At the same time, torrential rains fell on northern Tamaulipas. Stevenson informed us that 30 cm of rain fell at Montemayor, Tamaulipas. He also reported that, as a result of the accompanying storm tides, the

high-water level of the laguna was about 1.3 m above normal. Boca San Antonio, north of Eighth Pass, was opened into Laguna Madre, but the flow was only at high tide. Another former pass located about 8 km south of the Eighth Pass also was opened, but it was only 46 m wide and had a small flow, according to Stevenson. All this fresh water from the rains, plus some circulation from the Gulf, temporarily improved conditions in the laguna.

As of December 1965, Mr. Stevenson reported (personal communication) that the bay was "dry again and white with salt. . . . The first three passes have been open, but have been very shallow and I do not believe any bay grass has grown . . . behind them." His references were to shoalgrass and to passes north of Eighth Pass. He added that, as of late December 1965, there were few ducks on the laguna, but that there were as many or more ducks on the mainland lagunas as there were the previous winter.

The restoration of Laguna Madre as an attractive waterfowl wintering ground and fishery area will depend on the reopening of the Eighth Pass or an equivalent channel which will provide adequate circulation of water between the Gulf and the laguna.

On the mainland, west of the laguna and north of the Rio San Fernando, the upland habitat is chiefly mesquite-grassland. The elevation, especially in that sector from El Mesquite to La Reforma, is higher than that of the coastal flats of the Rio Grande Delta. There are clay bluffs which face the laguna. Much of the coastal plain is covered with brushy chaparral or heavier woodland, and mesquite is the most common tree. In the delta of the Rio San Fernando and southward the woodland is much heavier and includes some fine stands of ebonies and associated trees. There are many small freshwater lagoons, most of them of only a few hectares, but in and near the delta of the San Fernando there are several much larger ones. Most of these contain aquatic vegetation, chiefly widgeongrass, with some muskgrass and naiad (*Najas* spp.). Around the shores of several are margins of dwarf spikerush, bulrush (*Scirpus* spp.), glasswort, saltwort, lycium, and other associated species. There are only a few ponds on the barrier islands, most of which contain no submerged vegetation of value to waterfowl.

The January 1966 aerial survey crew reported that they saw no open passes between the Laguna Madre and the Gulf. Waterfowl were absent from the laguna; most of them had shifted to freshwater lakes and lagoons on the mainland. The majority of the few redheads were seen on Laguna Morales, south of the mouth of the Rio Soto la Marina. That river, which supplies water to brackish Laguna Morales, then had only a narrow opening to the Gulf.

The average percentages of waterfowl present by species have been as follows: redhead, 62; pintail, 22; lesser scaup, 5; wigeon, 3; gadwall and white-fronted goose, each 1; and Canada goose, lesser snow goose, whistling duck, mottled duck, green-winged teal, blue-winged teal, shoveler, ring-necked duck, canvasback, bufflehead, and ruddy duck, less than 1 each.

Laguna Madre and other Tamaulipas lagoons to and including San Andres have averaged about 187,000 ducks or 17.2% of the total population of ducks reported by the aerial surveys of waters of the Gulf and Caribbean coasts.

Rio San Fernando, Tamaulipas (7)

The Rio San Fernando (Fig. 5), also known as the Rio Conchos, is the only stream of any size to enter Laguna Madre. It has some of its headwaters in the Sierra Madre Oriental near Linares, and others in the lower mountains nearer the coast. Until about 1953 there was a good flow of water in this river, but with the great increase in the irrigation of croplands upstream on most of its tributaries, the volume has continued to diminish except during wet years.

When we first saw the delta of the San Fernando on a low-level aerial survey in 1938, it was an outstanding place for waterfowl, with its many distributary channels spreading water over the alluvial fan that extended far out into Laguna Madre. There were small lagoons and marshes as well as mudflats covered with spikerushes and other food plants. The best concentrations of birds were where the streams of fresh water entered the saline laguna. There the assemblage included large numbers of pintail and lesser snow geese, and smaller flocks of wigeon, gadwall, teal, redhead, lesser scaup, and other species. Coot (*Fulica americana*) were there in great rafts. Most of the ducks, other than redhead, pintail, and lesser scaup, were found on the inland fresh water, and were most numerous in the years when the river flooded and overflowed into the adjacent lagoons and marshes.

The delta was building out into the laguna and may eventually divide it into two parts, just as the Rio Grande Delta has divided the former great laguna that extended from near Corpus Christi, Texas, to south of the Rio Soto la Marina, Tamaulipas, and formed two lagunas, both called Laguna Madre. On the aerial survey of 22 January 1947, the following were seen on this delta, exclusive of the lagoons farther upriver: pintails, 70,000; gadwalls, 3,500; wigeons, 2,500; lesser snow geese, 1,200; and Canada geese, 850. Out in the laguna near the delta was a raft of 235,000 redheads, the largest group seen that day. At freshwater lagoons upstream, such as Laguna Anda la Piedra, more than 50,000 other ducks were seen, mostly pintail, gadwall, and wigeon, but there were also 3,500 ruddy ducks, 500 canvasbacks, 11,000 lesser scaups, and 30 buffleheads.

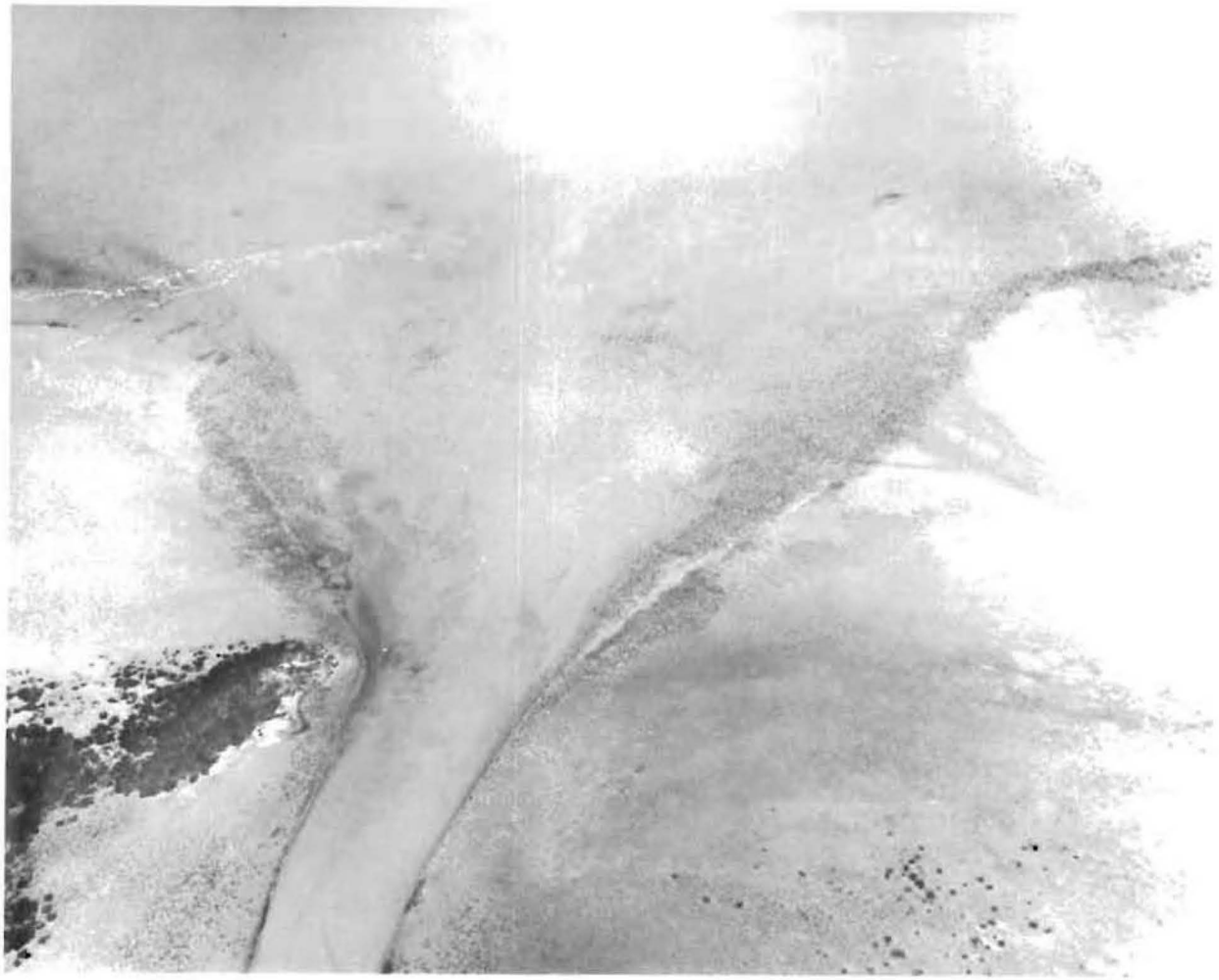

Fig. 5. Rio San Fernando Delta, Tamaulipas, 1948—An aerial view of the principal outlet of the Rio San Fernando in January 1948, when there was a good flow of fresh water entering Laguna Madre. Most of the ducks shown are pintails and redheads; a flight of lesser snow geese can be seen at the upper left. They gathered here and in other parts of the delta to eat, drink, and rest.

On 5 January 1948 a low-level survey of the delta resulted in the following list of waterfowl: pintail and redhead each 35,000; snow geese, 2,400; Canada geese, 600; and other species in small numbers. There was no great concentration of redhead offshore because they were rafted near Boca Jesus Maria, over shoalgrass beds along the lee side of the islands. It is not possible to give the figures from subsequent aerial surveys, because those reports combined all the waterfowl estimates for the Laguna Madre area into one total.

In recent years this delta and the lagoons farther upriver have been a very pale shadow of their former excellence, and the much smaller number of birds there attests to the change. A combination of water diversion upstream and the occasional droughts has left little flow for this lower San Fernando river and its delta. Hurricane Carla brought more water in 1961, and subsequent better conditions, but the improvement was only temporary.

With the upstream agricultural developments increasing steadily, there is no reason for optimism regarding this delta and its waterfowl habitat.

Soto la Marina, Tamaulipas (8)

This waterfowl habitat is a series of freshwater lagoons and marshes on each side of the Rio Soto la Marina above the village of La Pesca. During years of regular flooding when satisfactory water levels are maintained, these lagunas have an abundance of food and are very attractive to ducks and coots. Widgeon-

grass, naiad, coontail (*Ceratophyllum demersum*), and many other species are then plentiful, as are animal foods.

This fine river has undergone many changes in recent times. Formerly it had a strong, well-sustained flow, and although it usually carried very little silt, except at times of flood, its delta built across the lower end of Laguna Madre and cut off the part now called the Laguna de Morales.

Since 1953 there has been a great reduction in the flow of this river near its mouth. This reduction has seriously affected these freshwater lagoons and marshes in many years by lowering their levels. It is the flooding of these basins that maintains satisfactory water levels for the production of food and for its utilization by waterfowl. During some years the flow was so reduced, by a combination of water diversion and drought, that the river was closed at its mouth by sand from the Gulf.

On almost all the aerial surveys, the numbers of waterfowl seen at and near the mouth of the Soto la Marina were combined with the totals for Laguna Madre, or they were listed under the general heading of Tamaulipas Lagoons. For that reason we cannot give the separate tabulations for Soto la Marina for most years. However, on the aerial survey of 1947, the following ducks were seen there: pintails, 15,000; redheads, 7,100; and gadwalls, 3,000. In January 1948, when conditions were better at these lagoons and marshes, there were 10,200 lesser scaups, 1,725 ruddy ducks, 500 green-winged teal, 375 wigeons, 350 redheads, 250 gadwalls, 9,000 unidentified ducks and 96,000 coots.

Laguna Morales, Tamaulipas (9)

This coastal laguna extends southward from the mouth of the Rio Soto la Marina for about 14 km. It is slightly more than 1.6 km wide in its broadest part and is very shallow. In many winters its surface area is much smaller than these dimensions.

The laguna's source of fresh water is the Rio Soto la Marina, as well as some runoff from the mainland to the west. There are several small, short streams which enter it from the nearby mainland foothills. In the 1930's and earlier, before so much water was taken for irrigation use from the tributaries of the Soto la Marina, floods were much more frequent and the water level and extent of Morales usually were good. In recent years, however, with so much irrigated land along the Rio Purificacion and other tributaries, the flow was often insufficient to keep the mouth of the Rio Soto la Marina open to the Gulf. Often when this river was landlocked, the basin of Laguna Morales was only partly full.

The laguna basin formerly was about 26 km long, but siltation at times of flooding and sand from the Gulf have been filling it, especially in its shallower southern end. Now there are seasons when it has water only in the northern half, or less, of its basin.

Most of the western shore of the laguna is wooded with a type of thorn forest. There are very few small freshwater lagunas on that part of the mainland except in the vicinity of the Rio Soto la Marina.

As at Laguna Madre, its best duck food is shoalgrass, but its beds of this plant have not been as extensive and luxuriant in recent years as they were in the 1930's and earlier. A higher salinity, lower water levels, and poorer circulation in Laguna Morales undoubtedly are the reasons for this difference. When the mouth of the Soto la Marina is open to the Gulf, tidal action puts sea water into Morales. In the 1930's and earlier and in some subsequent years, this exchange of tidal water resulted in fine beds of shoalgrass in the northern end of the laguna. Through the early 1940's, there were always a few thousand or more redhead ducks, plus thousands of lesser scaup and pintails; and there were much larger numbers of shorebirds, herons, gulls and terns, pelicans, and other water birds.

On the aerial surveys, the numbers of waterfowl seen on Laguna Morales have been combined with those of Laguna Madre, often under the heading of the Tamaulipas Lagoons, so they are not available separately. On the 1947 survey, the following numbers of ducks were seen on Laguna Morales: pintails, 15,500; redheads, 7,100; and gadwalls, 3,000. In January 1948 the numbers were 56,000 redheads, 9,200 lesser scaups, and 1,025 pintails. During the past several years (1964) when the extreme salinity of Laguna Madre had killed the shoalgrass, some of its redheads moved to Laguna Morales.

Laguna San Andres, Tamaulipas (10)

Laguna San Andres is the next large coastal lagoon south of Laguna Morales, and the next north of Tampico. It is about 42 km from north to south and 1.6 to 2.4 km at its broadest part. When it is full its northern end is several kilometers north of the Punta Jerez lighthouse.

This lagoon usually has one broad pass into the Gulf that is called Chavarria, and also several tributary streams from the mainland, the only large one of which is the Rio Tigre, or Cachimbas. Most of the laguna is shallow (less than 2 m deep) but it has some deeper parts. Some of the small islands, especially those in its southern part, are covered with red mangroves (*Rhizophora mangle*). This is the northernmost lagoon on the western shore of the Gulf of Mexico to have stands of mature mangroves. Some bays farther north have some young mangroves, but they are killed periodically by severe winter cold.

The general topography of the mainland adjacent to San Andres is that of a level plain. At times of flooding

from very high tides or storms, many square kilometers of the coastal flats are inundated, and they are then temporarily attractive to waterfowl and other water birds. Along the streams and on higher ground there is a much heavier deciduous woodland and more palms than are to be found to the north. The barrier ridge and islands have vegetation of a more mesophytic type than do those farther north on the coast of Tamaulipas.

The principal duck food in the laguna is shoalgrass. During years when conditions are favorable, there are extensive beds of this plant in the lee of the barrier island, especially near Barra Chavarria. Because of this abundant food, many redheads wintered there when their numbers were greater, and fore the late 1940's there were usually large rafts of these ducks present. The aerial survey in 1947 revealed the following numbers of ducks: redheads, 26,800; lesser scaups, 26,500; and pintails, 3,000. In January 1948 there were 21,250 redheads and from 1,000 to 2,000 each of pintails, gadwalls, and wigeons. On later surveys, the numbers seen were combined with those of other Tamaulipas lagunas.

Inland from San Andres, there are a few small freshwater lagoons and ponds which attract some waterfowl. All of those we visited had an abundance of duck foods, of both submerged and emergent types.

The irrigation of lands on the headwaters of the Rio Tigre and nearby streams has reduced their flow. This, and periodic drought, at times have had a serious effect on Laguna San Andres. We have had reports that once or twice recently the pass at Chavarria has been closed by Gulf currents, due to a lack of flow from the laguna. Such closure, like that at Laguna Madre, can have a disastrous effect on the shoalgrass.

Some duck shooting is done here, mostly by hunters from Tampico; however, there is so much waterfowl habitat nearer Tampico that it is only an occasional group that shoots at San Andres. The local human population is very sparse, made up mostly of ranchers and fishermen.

Tampico Lagoons, States of Tamaulipas, Veracruz, and San Luis Potosi (11)

These very extensive freshwater lagoons and marshes are near, and chiefly west of, Tampico. They are in the northernmost big delta on the Gulf Coast that is within the tropical zone. This delta is very important to migrant and wintering waterfowl and other water birds, because it affords the northernmost extensive freshwater habitat on the eastern coast of Mexico. The lagoons constitute one of the best wintering grounds in the Republic, but habitats were much better and had many more birds before 1948 than in subsequent years. The tributary Tamesi and Panuco rivers drain large areas in Tamaulipas, San Luis Potosi, Veracruz, and beyond, and periodically they flood parts of this rich double-delta and supply the maze of lagunas and marshes with water. This flooding was more frequent in earlier years before development of extensive irrigation projects upriver.

The area includes about 4,035 km^2, of which, during periods of favorable water levels, probably more than 540 km^2 are lagoons and marshes. In wet years, much more of the region, especially that near Mendez, Chijol, Ebano, and nearby localities, is suitable for ducks and geese. During dry periods, the area of good habitat is reduced greatly.

The water levels and food conditions in the Tampico lagoons are not necessarily correlated with the seasonal rainfall there, but rather with the rainfall in the upper parts of the watersheds of the two major rivers. During some years when rainfall has been deficient at Tampico, there have still been floods on these rivers.

The principal lagoons and marshes lie in a broad basin which is bounded by ranges of low hills (Fig. 6). The Rio Tamesi enters this delta from the northwest, and the Rio Panuco from the southwest. Their confluence is at the western edge of the city of Tampico. From there, the Panuco flows past and turns northeastward the several kilometers to the Gulf. The lower Tamesi, from its junction with the Panuco upstream to a point about 65 km inland, is the boundary between the States of Tamaulipas and Veracruz. Because of the location of this boundary, some of the lagoons are in Tamaulipas, most are in Veracruz, and a few farther west are in San Luis Potosi.

A good perspective of the vastness of the lagoons and marshes is given by the view from the western side of the residential district of Tampico Alto, especially from the hill of Colonia Aguila. The western panorama, when visual conditions are good, is one of water and marshes stretching away to the horizon. Anyone arriving in Tampico by plane in clear weather also has a fine view of this waterfowl wintering ground.

Most of the principal lagoons are adjacent to one of these rivers which meander widely across the delta and are supplied with water during flood stages. Their courses formerly were marked for much of the distance by woodland growing on the natural levee banks, but in recent years most of the trees have been cut. The lagoons on the periphery of the delta are bordered by higher ground, and woodland lies beyond, except where it has been cleared for agricultural uses and for fuel. The lagoons and marshes in the interior of the delta are open and are devoid of trees.

The lagoons with the richest delta soil are margined by luxuriant beds of sawgrass, southern bulrush, cane, and associated plants. The surfaces of the smaller lagoons that are protected from excessive wind action are covered with a variety of aquatic vegetation, in-

Fig. 6. Tampico Lagoons near Altamira, Tamaulipas, 1948—An aerial view of another part of the Tampico lagoons in the vast delta of the Panuco and Tamesi rivers. The island vegetation is chiefly bulrushes and sawgrass; on the marshy shores are spikerushes, smartweed, and other food plants. Submerged vegetation includes widgeongrass, naiad, and several other fine foods. The dark bands of trees seen in the background are on the banks of the Rio Tamesi; beyond are more lagoons, including some along the Rio Panuco.

cluding several species of waterlilies, floating heart (*Nymphoides* sp.), and many kinds of submerged plants. Many of the larger lagoons lack submerged aquatic vegetation except at their margins, because of the inhibiting effect of the excessive turbidity of the water. Some of the largest lagoon basins have been filled with silt; at times of low water thousands of hectares of relatively flat shore are exposed, much of it vegetated with dwarf spikerush, a common food of ducks, geese, and coots.

There is an abundance and variety of aquatic plants for food in Tampico when conditions are favorable. There is a surprising difference in the kinds of plants present from one lagoon to another, depending on water depth, size of the area, protection from wind, bottom soil type, water circulation, frequency of flooding, presence of weed species, and other conditions.

One factor that makes the delta so attractive to waterfowl is the tremendous number of small segments into which some of the larger lagoons are divided. The islands and peninsulas of tall emergents, such as bulrush, sawgrass, cattail (*Typha* sp.), cane, and other plants, partition off many of the basins into protected pools which are used by many species of ducks.

Since 1947, there has been a decline both in habitat and in the number of wintering waterfowl. During the winter of 1946–47 there was an especially good duck and coot population in Mexico. More than 833,000 ducks were estimated in the Tampico area on the January survey that winter, without any allowance made for more than half of the area that could not be scouted because of the lack of time. The subsequent decrease has not been steady, and in some years there have been spectacular rises in the local duck population. For example, after a decline to about 68,000 ducks in 1951, the population was up to 370,000 in 1952.

Most of the waterfowl species found in Mexico occur in the Tampico area. The most common wintering species are dabblers, of which wigeon, pintail, gadwall, the three teals, and shoveler are most numerous. Small numbers of mottled, whistling, and muscovy ducks winter in the marshes. Diving ducks are much fewer than dabblers, their numbers varying according to conditions in this district and on nearby Laguna Tamiahua. Lesser scaup are the most numerous; numbers of ring-necked, ruddy, and canvasback ducks are smaller.

There are three localities in the delta that attract canvasbacks, all of which have excellent but small stands of banana waterlily (*Castalia flava*). No more than several thousand canvasbacks frequent these areas; the big concentration of this species was formerly at Laguna Tamiahua. Coots are numerous and many are shot for food, which lessens the hunting pressure on ducks.

In the early years of the exploratory aerial surveys made by the senior author on parts of the Gulf and Caribbean coasts of Mexico (1938–42), more than half of the waterfowl in this district were found on the Tamesi lagoons and marshes. A progressive decline in habitat conditions has occurred there since the early 1940's. To a great extent, this change has been due to the reduced flow of the Rio Tamesi, which was caused by water impoundments and diversions upstream for the irrigation of crops. The very extensive agricultural development near Mante has left much less water for the Tampico lagoons. Since the 1940's, lagoons there have received much less water from flooding, except at times of tropical storms.

Laguna Champayan (Altamira), formerly a favorite concentration place for waterfowl, is a few kilometers northwest of Tampico and adjacent to the town of Altamira. Its history is typical of much of the delta. At the present time its basin has a length of about

22 km and an average width of 5 km. On some older maps the laguna is shown as one body of open water, whereas on others it appears as a vast marsh. In recent years, the siltation and the encroachment of emergent vegetation have divided it into many lagoons, some containing 100 ha, plus hundreds of pools separated by small islands and peninsulas of tall vegetation, chiefly sawgrass, cattail, southern bulrush (*Scirpus californicus*), cane, and spikerush.

Before the large flood of 1933, caused by torrential hurricane rains over a wide area of the Tamesi drainage, natives living near Laguna Champayan reported that it had an abundance of submerged aquatic vegetation, and ducks and coots were said to be very numerous. The floodwaters destroyed a great deal of this vegetation, but within several years a fine growth of food plants had again become established in many places. In some lagoons much silt was deposited by the floods.

When this laguna was first scouted in 1938 the water level was below normal, but conditions were satisfactory and waterfowl food was abundant. Many of the pools had large quantities of widgeongrass, bushy pondweed, coontail, water star grass (*Heteranthera dubia*), muskgrass, waterlilies, floating heart, and other foods. On some shores there were fine stands of jointed spikerush (*Eleocharis interstincta*); on others there were broad expanses of dwarf spikerush.

The effects of a severe drought were studied during the winter of 1939-40. At that time there had been less rainfall for the previous 2 years than for any similar period since 1917 and 1918. The last floods on the Tamesi and Panuco rivers, which spilled over into the adjacent lagoons and marshes, had been in the autumn of 1936. As a result of this extreme water shortage, the Tampico lagoons were about as low as at any period the old-timers could recall. Large lagoons, such as the Champayan, had receded so much that many kilometers of mudflats, plastered with dried aquatic vegetation, surrounded the shrunken water areas.

Even with this great reduction in water area and feeding grounds, the waterfowl that wintered there had no difficulty finding enough satisfactory food, chiefly in the lagoons adjacent to the Rio Panuco. We found no limiting factor present in the entire sector that reduced the carrying capacity below that of the numbers of ducks accustomed to using the area. During 1938-45, all of the species of ducks that occurred in the Tampico area were observed on Laguna Champayan. Teals, wigeon, gadwall, and pintail were especially numerous, and more mottled duck were there than on any other lagoon of the sector west of Tampico.

Along the shore of the laguna, in the vicinity of Altamira, ducks and coots were much more numerous during the night and very early morning. Coots and many of the dabblers came up on shore to feed on spikerushes, water star grass, bermuda grass (*Cynodon dactylon*), and other vegetation. After feeding, many, especially gadwall, wigeon, and teals, flew farther out into the lagoon and marsh. The presence of many natives who came during the day to the shore to fill water containers accounted in part for the ducks' feeding schedule.

The bottom of Laguna Champayan was an unusually finely divided, gray silt left by floods. An oar could easily be thrust full length into it without meeting any appreciable resistance. Because of this silt, and the shallowness of most of the pools, wind action kept the water turbid during most of the time and eliminated favorable growth conditions for aquatic vegetation; thus the laguna was barren of plant food.

At some of the large lagoon basins farther up the Rio Tamesi, such as Salinas, Corcovado, and Tortuga, aerial reconnaissance in December 1951 revealed no appreciable duck food available. Almost the entire basins were of barren mud bottom, with only occasional clumps of dead cattail and southern bulrush, and some areas were overgrown with catclaw and acacia (*Acacia* sp.). The absence of ducks was obviously due to the lack of food.

The principal habitats for waterfowl during that winter (1951-52) were in the Rio Panuco drainage, chiefly from Tamos to Panuco and Ebano. In previous years, many of these basins had relatively few birds, but that winter, due to high water levels and flooded meadows and crops, they had the best feeding. Tens of thousands of ducks, especially pintails, were found in the flooded croplands. In contrast, there was relatively little flooded cropland along the lower Tamesi near Tampico, because most of the cleared lowlands adjacent to the lagoons were grassy pastures.

The consensus of hunters in the Tampico area was that there were fewer ducks present in 1951-52 than during the preceding winter, but they were unaware of the shift of birds from the Tamesi Delta to the Panuco lagoons, which are farther from the city and less frequently visited by hunters.

The results of the January 1952 inventory confirmed further that the Panuco and Tamesi basins vary from year to year in their relative value to waterfowl. Because of differences between the two systems in their drainage areas, frequencies of flooding, and volumes of siltation, one of them may provide excellent waterfowl conditions in its delta when conditions in the other are poor.

The three hurricanes in September 1955 that devastated the Tampico area had a disastrous effect on the lagoons and marshes of the Panuco and Tamesi deltas. The area inundated was reported to have been 6,400 km^2. The crest of the flood registered a level of 5.8 m

above the mean high tide in the port of Tampico, and surpassed by 1.3 m the previous maximum level during the hurricane of 1933. The precipitation during September was about 91 cm. The effect of this flooding on the lagoons and marshes was largely destructive, but it did flush out a tremendous quantity of water hyacinths and other pest plants, and scoured much of the excess silt from many basins. The long period of deep flooding killed many of the beds of useful emergent plants and left great masses of rotting vegetation scattered over the delta. In some lagoons, such as those in the Chila area, the siltation from this flooding almost filled their basins and caused them to be choked with emergent vegetation or left as relatively barren mudflats. Unfortunately, no habitat studies were made in the Tampico lagoons during 1952–59; consequently, no detailed account can be given of ecological changes during those years, which included the 1955 hurricanes.

A good supply of duck food was available when Laguna Champayan was scouted near Altamira in the winter of 1959–60. Dwarf spikerush was common on the shores and in the shallows up to 15 cm deep. Coontail, floating heart, white waterlily (*Nymphaea odorata*), and dotted waterlily were common to abundant and widely distributed; banana waterlily was scarce and local in occurrence. Water star grass was common, but it was scattered in distribution on the shore and in the shallows. Other foods available in parts of the laguna were widgeongrass, wild millet (*Echinochloa* sp.), sawgrass, bushy pondweed, smartweed (*Polygonum* sp.), and southern bulrush. The waterfowl carrying capacity of Laguna Champayan and many other lagoons of the delta was many times greater than was being utilized.

Before 1940, the Laguna Pueblo Viejo wintered large populations of ducks of several species, and before 1938–40, its south end, where the Rio Llave enters, was a favorite place for canvasbacks. Farther up that small stream there were broad meadows that were among the preferred feeding grounds for Canada geese. Since then, in most years, there have been relatively few waterfowl on the lagoon, and the canvasbacks, except for a few stragglers, have disappeared from the vicinity. The Canada geese still come in small numbers in some winters.

The floating pest plants, water hyacinth, water lettuce, and salvinia (*Salvinia* sp.), have grown in the delta for many years. Another pest that occurs in the delta, but which has not been a serious problem to date, is alligator weed (*Alternanthera philoxeroides*). In 1960, it was found on some of the muddy shores, but it did not give serious competition to such duck food plants as spikerushes and grasses that were there.

Before 1920, and especially in the early days of the oil drilling activity in the Tampico Delta, there were serious instances of oil pollution that killed many waterfowl. At some wells before the completion of the pipeline system, the use of "slush pits" or small diked reservoirs for oil was common. At night, when flocks of migrant waterfowl arrived at the delta, some of them alighted on these pools of oil, and that was their last flight.

In 1939, J. L. Friedman of Brownsville, Texas, who had worked for oil companies at Tampico for many years after 1900, told us that one locality in which the duck mortality was tremendous was near Panuco, Veracruz, where hundreds of hectares were diked to make earthen reservoirs for oil. A series of pipelines filled these reservoirs, and electric lights strung along the dikes illuminated them at night. These glistening lakes of oil were deathtraps for the ducks, and he believed that hundreds of thousands perished there. The volume of bodies and feathers became so great that the company decided not to use the oil because of the amount of debris which would have to be removed. After that, no large reservoirs were constructed and these were drained.

During 1938–52, little oil pollution was observed in the delta. Temporary breaks occurred in pipelines, but reports indicated no serious mortality of birds from that cause. During the past several years, the aerial survey crews have reported increased oil pollution in the vicinity of Ebano, which has seriously affected waterfowl and habitats there. No ground studies, however, have been possible to assess the extent of mortality.

There are also several saltwater wells in the delta that have flowed for years (one in the middle of Laguna Tortuga). These have a local effect in determining the nearby plants, such as spiny naiad (*Najas marina*) and widgeongrass, but within 100 m or less there is an abundant growth of southern bulrush, coontail, waterlilies, and associated species.

All recent indications are that, for at least several years, the lagoons, marshes, and meadows of the lower Rio Panuco may afford the best habitats in the Tampico Delta. The presence of a much greater acreage of agricultural crops, which are attractive to pintail, wigeon, and coot, should also augment food for the population of wintering waterfowl. The Panuco lagoons include many which have not yet been affected by heavy silting, and whose aquatic food plants are therefore more abundant.

Since 1948, the average percentages of waterfowl present, by species, have been as follows: pintail, 27; gadwall, 19; lesser scaup, 13; blue-winged teal and wigeon, each 10; green-winged teal, 8; shoveler, 4; whistling duck, ring-necked duck, canvasback, and ruddy duck, each 2; white-fronted goose, 1; and Canada goose, lesser snow goose, mottled duck, and

redhead, less than 1.

Since the aerial surveys began, the Tampico area has averaged about 247,000 ducks, or 22.6% of the total number reported for waters of the Gulf and Caribbean coasts. The percentage has been considerably less since 1952; the average was only 89,000 ducks for 1961-65.

Laguna Tamiahua, Veracruz (12)

This relatively narrow coastal laguna extends from near the suburb of Tampico Alto southward to Galindo Pass, which is beyond the village of Tamiahua, a length of about 100 km. Its north end is narrow, but widens near the north end of Juana Ramirez Island and for 55 km has an average width of about 10 to 13 km. Near Tamiahua village it narrows to a channel only a few hundred meters wide. A few kilometers farther south this estuary opens into the Gulf at Galindo Pass, an opening which was dredged during the peak of the oil activity in the district.

Much of the lagoon is shallow, but local fishermen report that many parts have a depth of 2.5 m or more. Bottom samples, chiefly taken within less than 100 m of the western shore, were largely sand.

There are a few marshy areas adjacent to the laguna on the west, but most of the mainland has an elevation of 1 m or more above high tide level, and in places low hills front on the lagoon. The principal meadows and marshes are west and north of the village of Tamiahua.

The southeastern shore of the laguna is swampier, especially from near Tantalamos to the latitude of Cabo Rojo. The best marshes are near the southern end of the laguna west of and opposite to the Isla del Idolo (Island of the Idol). Usually several thousand dabbling ducks, several hundred or more lesser snow geese, and smaller numbers of other geese are found there.

In scouting the western part of the lagoon north of San Geronimo, we visited some small freshwater inshore ponds. Several had good supplies of duck food, including naiad, coontail, and duckweed (*Lemna* sp.). Flocks of ducks from the laguna, chiefly teals and whistling ducks, often fed and rested there. However, waterfowl frequenting the southeastern part of the lagoon were mostly on the open water.

Silt Deposition.—The silt deposition in Laguna Tamiahua from 1938 to 1960 was much slower than that in the Tampico Delta because the few small tributaries have very limited drainage basins and flow mostly through wooded country. It may be a long time before silt is a problem, unless the watershed is cleared of its cover. A lack of silt is advantageous for the growth of small mollusks, which are abundant in parts of the lagoon and provide much food for the diving ducks.

No large river comparable to the Panuco or Tamesi of the Tampico Delta enters Laguna Tamiahua. The available maps do not accurately show the relative sizes of the streams in this district, but the Rio Cucharas is the largest of the few small freshwater tributaries, most of which enter from the southwest. The relative freshness of the lagoon is largely dependent on the volume of flow of these small streams. At the times of our several visits, the water was always clear; however, when many oil wells were drilled in nearby fields to the west, oil pollution was very serious.

Oil pollution.—The tremendous amount of oil pollution in 1909, and for several years thereafter, is said to have greatly changed the biology of the lagoon. In 1939, J. L. Friedman told us that he was in the Tamiahua district at the time of the famous Dos Bocas well "blowout" in 1909. The entire surface of Laguna Tamiahua was covered with oil, because the well flowed at least 100,000 barrels a day. Other blowouts, and broken pipelines in early years, sent tremendous quantities of oil and sludge into the laguna.

Being an inveterate hunter, Friedman was dismayed to see "hundreds of thousands and probably millions of dead ducks" covered with oil; many had come ashore and died on the beach. Oil pollution was at its worst then, but it continued to be bad for many years, especially in the vicinity of San Geronimo and other oil centers near the western shore of the laguna.

Mr. A. F. Hubbard, a foreman for a major oil company in Tampico and who was at Tamiahua for more than 20 years, also gave us a great deal of information in 1939 about the ducks there. In commenting on the oil pollution and duck mortality from the famous Dos Bocas blowout, he said that this well was probably the world's worst blowout. Before it was brought under control, it flowed millions of barrels of oil, much of which went into the Rio Carbajal only 1.6 km above its mouth, so that this part of the laguna was the most heavily polluted. Hubbard said that 90% of the dead ducks he saw along this shore were "bluebills" (lesser scaup) and some canvasbacks; the heaviest waterfowl mortality occurred for several winters after 1909.

Mr. Hubbard also said that during the winters of 1921-22 and 1922-23 there was heavy mortality among ducks on the west side of Laguna Tamiahua, between the mouths of the Cucharas and Carbajal rivers, due to the soaking of their plumage with oil sludge. Along this 11-km shoreline there was an almost continuous drift of basic sediment and *chapapote* (asphalt-like sludge) from the oil wells and breaks in pipelines. Fortunately, very little oil pollution has occurred at Laguna Tamiahua in recent years.

Salinity.—The changes in the relative salinity of Laguna Tamiahua from year to year are not known. Before the dredging of the Chijol Canal, which connects the north end of the laguna with the lower Rio Panuco, and the opening of Galindo Pass to the Gulf

south of the village of Tamiahua, the laguna was reported to have been fresh. With these two channels providing an active tidal circulation of salt water, the relative salinity of the laguna varied according to the volume of fresh water received from rainfall and its tributary streams. At times of hurricanes, the lagoon became very fresh, but during long periods of drought it was so saline that the foliage of duck food plants was killed. In years when food supplies in Tamiahua were poor, waterfowl shifted to the Tampico Delta or journeyed farther south.

According to reports from local residents, the hurricane of 1933 brought such a deluge of rain and excessive flow from the several tributary streams that for the first time in many years the lagoon was entirely fresh. During the following several years, the growth of aquatic vegetation must have been very heavy, because when we first visited the locality in 1938 there were luxuriant beds of widgeongrass, naiad, and other plant foods all along the western side, the northern end, and in the shallower parts of the main lagoon. Aerial reconnaissance indicated that at least half of the bottom of the lagoon had aquatic vegetation. Tremendous rafts of coots then wintered there, especially near and to the south of Isla Juana Ramirez. Single rafts containing more than 100,000 coots were observed during the winters of 1938–40.

During the 1940's, drought prevailed and the lagoon gradually became saltier, the vegetation less luxuriant, and the waterfowl population smaller. Large rafts of coots continued to be seen as late as the winter of 1946–47. Aerial photographs of the coots look like patches of black velvet, with a broad band of discolored water downwind because of the drift from their feeding activity.

During the winter of 1949–50, the salinity was 50% of seawater strength, red and brown algae were the dominant plants in the lagoon, and along many kilometers of the western shallows not a plant of widgeongrass could be found. Waterfowl were scarce except for lesser scaup. Mollusks were abundant, including several genera well liked by scaup and other divers. It was undoubtedly the presence of extensive beds of these small mollusks, especially pelecypods, that attracted the large numbers of scaup during most winters.

By the winter of 1951–52, the food conditions had changed very little from those of 1949–50. The hurricane of August 1951 had brought heavy rains to the drainage systems of the Tamesi and Panuco rivers, but apparently very little to the shorter and more southern streams which supply Laguna Tamiahua. The lagoon had a salinity equal to 33% of seawater strength, but the vegetation continued to be mostly algae, with some increase in widgeongrass.

In December 1959, a reconnaissance was made along the western shore as far south as San Geronimo. Salinity readings at several places were about 20% of sea water. There was much drift of widgeongrass along the shore and a trip by boat across the laguna, just south of Isla Juana Ramirez, and almost to the eastern shore, showed luxuriant widgeongrass present on one-third or more of the bottom. In crossing the lagoon, we saw at least 15,000 ducks, mostly pintails, and others were feeding in a large, mostly concealed cove on the eastern side. Several of the flocks in the open water were feeding where the only vegetation was widgeongrass. In earlier years, the gullets of pintails feeding in this same vicinity were obtained from hunters, and analyses revealed that the principal food then eaten was widgeongrass.

Waterfowl.—Laguna Tamiahua is reported to have been a favorite rendezvous for ducks as far back as old-time hunters can remember. The principal birds there were lesser scaup, wigeon, gadwall, pintail, and canvasback, with great rafts of coot. From the beginning of the aerial surveys in 1938, until the early 1940's, most of the wigeon, gadwall, and pintail were observed to be near the western shore. The lesser scaup and coot were in deeper water, mostly south of Isla Juana Ramirez, and the canvasback were usually north of that island. During 1938–43 this lagoon was a principal concentration place for gadwall and wigeon, and the aquatic plant naiad was abundant in those years.

In 1938, one of the most reliable local observers reported a concentration of canvasback that was several hectares in extent offshore from the Bustos pumping station near the northern end of the laguna. On some of the aerial surveys made by the senior author in the late 1930's, as many as 50,000 canvasback were found in this part of Tamiahua. Experienced hunters contacted in 1938 and 1939, who knew the locality, said that large numbers of canvasbacks had wintered there for many years. It was the only wintering place on the Gulf and Caribbean coasts of Mexico that attracted a large number of these divers.

The examinations of the gullets and gizzards of several canvasbacks shot near the north end of the laguna indicated that their favorite food was the *Macoma* clam. The disappearance of almost all these ducks from the northern part of the laguna in the early 1940's may have been caused by the beginning of a decline in these clams, probably because of changes in salinity. But because there was no comparable increase (50,000 to 60,000) in canvasbacks elsewhere in Mexico, their great decrease may also have been caused by habitat and population losses on the breeding grounds in Canada, or by a shift back to wintering grounds in Louisiana and Texas.

In December 1951, dredged bottom samples taken in the northern arm of the lagoon, where large numbers of canvasbacks formerly wintered, produced only a few living *Macoma.* In December 1959, a stop was made at

the Bustos station, but only 200 canvasbacks were present in that locality. During the January 1960 aerial survey only about 1,900 were seen on the laguna, and there were 4,391 estimated in January 1963.

The changes in the numbers and distribution of dabblers at Laguna Tamiahua from year to year have been due largely to the great variations in kinds and abundance of food. During periods of higher salinity, marine algae (mostly red and brown forms) replaced the widgeongrass, naiad, muskgrass, and associated food plants. These changes caused a striking decrease in the local waterfowl population.

In January 1939 there were more than 2,000,000 waterfowl on the laguna of which about 1,700,000 were coots and the ducks were mostly gadwall, wigeon, scaup, pintail, and canvasback; in January 1947, 684,000 birds were observed, of which 550,000 were coots; in January 1951, 27,875 birds were noted, of which 3,100 were coots; in January 1953, 245,400 birds were estimated, of which only 1,100 were coots. In 1963 there were 42,640 scaup; the total of all ducks was 72,844, and there were 10,000 coots. It is apparent from these records that there has been a great decline in the number of coots in this area since the 1940's. If adequate data were available for the Gulf and Caribbean coasts of Mexico for the past 30 years, they would undoubtedly show a spectacular decrease in this species.

Since 1948, the average percentages of waterfowl present by species have been as follows: lesser scaup, 77; gadwall, 5; pintail and wigeon, each 4; canvasback, 3; blue-winged teal, 2; shoveler, 1; and Canada goose, white-fronted goose, lesser snow goose, whistling duck, mottled duck, green-winged teal, redhead, ring-necked duck, and ruddy duck, less than 1. Among the total numbers of ducks recorded on the Gulf and Caribbean coasts surveys, Laguna Tamiahua had an average of about 85,000, or 7.8%.

Alvarado Lagoons, Veracruz (13)

Laguna Alvarado and Laguna Camaronera, with the vast Papaloapan Delta, form a complex area of waterfowl habitat which spreads over about 5,380 km² of coastal lowland lying mostly south of Alvarado, Veracruz (Fig. 7). In survey reports this area usually has been listed only as Alvarado, but the figures represent the combined totals of birds in this extensive region of southern Veracruz. Except for Laguna Alvarado, which is connected broadly with the Gulf at Boca de Alvarado, the delta lagoons and marshes are almost entirely fresh except after tropical storms and hurricanes, when the outer margins may be flooded with brackish or salt water. The presence of green beds of water hyacinths and water lettuce in the marshes adjacent to Laguna Alvarado attest to the present freshness of the water.

Several major rivers supply the broad delta, chief among them being the Papaloapan and the San Juan. The flooding of these rivers for centuries has replenished the water levels of the adjacent lagoons and marshes. This flooding has also served to flush countless tons of floating vegetation, mostly such pest plants as water hyacinth, water lettuce, and water velvet from many areas. From the late 1940's to the late 1960's, several dams were constructed which greatly reduced the river flow into this basin, the largest being the Presa Aleman project on the Rio Tonto, a tributary of the Rio Papaloapan. Floods still occur in parts of the delta, but there is no longer as much flushing action, and many more lagoons are now overgrown with pest plants.

In spite of the reduction and elimination of much waterfowl habitat, it is probable that sufficient water, food, and cover still remain to accommodate all the waterfowl that winter on the Gulf and Caribbean coasts of Mexico.

Waterfowl numbers there declined greatly in the 21 years after the first extensive aerial reconnaissance was made in 1947. Although some localities were first scouted in 1939, the earliest comprehensive aerial survey was made in January 1947. In the 1947 survey, about 110,000 ducks were seen, and on the basis of an estimated 20% coverage, it was believed that the duck population present was about 500,000. In addition, several hundred thousand coots were present. By comparison, in January 1965, the estimate of birds present was 53,000 ducks and 76,900 coots. The annual average has been about 150,000 ducks.

The principal species in most years was the widgeon, pintail, gadwall, blue-winged teal, shoveler, green-winged teal, ruddy duck, and cinnamon teal, usually in that order of abundance. During some years there was a much greater percentage of teals, especially blue-winged teal, and in addition there have been rafts of lesser scaup on Laguna Alvarado, plus small numbers of ring-necked duck, and canvasback. Back in the marshes there were many small flocks of whistling ducks, chiefly black-bellied, but with some fulvous, and a few muscovy duck. Many or most of these last three species are overlooked on aerial surveys, because they are hidden in the marsh vegetation or by swamp shrubs and trees.

Lesser snow geese, white-fronted geese, and Canada geese are observed in the delta; lesser snow geese are most common. Some of the wet pastures on the southern margin of the delta provide the best feeding grounds for geese.

There is a great variety of waterfowl habitat in this delta. Lagoons are mostly shallow and have a soft mud bottom and dense marsh vegetation around the margins, but they range from large areas with much open water and a heavy growth of submerged aquatics

Fig. 7. Lagoons and marshes of the Papaloapan Delta, Veracruz, 1948—An aerial view of a few of the thousands of freshwater lagoons and marshes in the vast tropical delta of the Rio Papaloapan, near Alvarado, Veracruz. This was formerly a most important wintering place for North American waterfowl; in recent years it has had relatively few, although habitat and food conditions could support large numbers of ducks and geese. This is the southernmost locality on the Gulf Coast where geese were observed regularly, but their recent population was always small.

to those that are covered with a continuous growth of waterlilies. Some of the tiny pools have a solid green cover of duckweed, and all too many have a continuous cover of hyacinth, water lettuce, or water velvet. Whistling ducks and coots are observed occasionally on such closed lagoons, the ducks eating the seed pods of floating heart and the coots often snipping off the tender young leaves of hyacinth.

Some shores are dense with weed species, but many have a marginal vegetation of sedges, grasses, spikerushes, water star grass, pennywort (*Hydrocotyle* sp.), and other food plants. Other shores are covered with southern bulrush, pickerelweed (*Pontederia cordata*), smartweed, arrowhead (*Sagittaria* sp.), and their associates. Important foods include widgeongrass, naiads, spikerushes, muskgrass, coontail, "cormlike nutlets" found in duck gizzards that may be from a species of *Sagittaria*, bulrushes, floating heart, wild millet, and other grasses.

In addition to the wealth of plant food there is an abundance of animal food, especially insect larvae and several species of small snails, many of the latter attached to the aquatic vegetation. There is also a variety of other small mollusks and many kinds of crustaceans.

Laguna Alvarado is irregular in shape, about 18 km long, excluding its eastern extension that is more like a river in its narrowness. The main body near Alvarado

is about 5 to 6 km wide, and on its seaward side there is the high barrier peninsula of dunes that extends from each side of the pass to the Gulf. On the landward side of the laguna, the vast delta of freshwater lagoons and marshes reaches as far as one can see. Except at times of flooding on the rivers, the water is clear and its circulation with the Gulf is excellent.

The salinity of Laguna Alvarado varies with the chosen location, the volume of flow from the rivers, and the direction of the tide. A sample taken on 31 January 1952, in the pass near the entrance to the lagoon was 71% of seawater salinity. Several taken in the northern part of the lagoon, both at the surface and on the bottom at 1.1 m of depth, were 20-25% of seawater salinity. On 8 January 1960, a sample taken near the eastern shore, 1.6 km northwest of Alvarado in shallows 0.3 m deep, tested almost fresh at 4%, but outward from there near the middle of the north lobe, where the depth was reported to be more then 4 m, the salinity was almost 30% that of the Gulf. Another sample taken 5 km closer to the end of the bay was 30% of seawater salinity.

Widgeongrass grows in many parts of the laguna. On 8 January 1960 this plant was found at all stations sampled, and it was especially luxuriant and seeding well in protected coves. Large numbers of tiny snails were on its leaves. The bottom ranged from sand, sand and shell, sand and mud, to mud; but even the mud was fairly firm except very near the mouths of the rivers and near mangrove-bordered shores. The currents seemed to be sufficiently strong so that much or most of the flocculent silt was swept out to sea. Silt did not cover the bottom in the many shallow parts of the lagoon where samples were taken, except near mangrove shores.

With the relatively firm bottom in so many places, much of it sand, there was a good supply of small mollusks available for diving ducks. On several aerial surveys, rafts of lesser scaup were seen in the deeper parts of the lagoon, especially in the northern lobe, where they were probably feeding on snails and pelecypods. Mollusks collected there in January 1960 included the following: *Arca umbonata, Bulla striata, Cerithium algicola, Donax denticulata, Nerita antillarum, Neritina meleagris, N. usnea,* and *Tagelus plebeius.*

The Papaloapan project, which includes the Temascal Reservoir (Presa Aleman) near Temascal and Tierra Blanca, Oaxaca, is primarily hydroelectric in development, with emphasis on flood control. Unlike the major reservoir projects in Sonora and Sinaloa, the Papaloapan project did not bring an appreciable increase in irrigated acreages planted to grain. To date, very little gain in any agricultural production of value to waterfowl has occurred in the district. This part of the Gulf Coast has a sufficient rainfall so that there is no need for irrigation as in the arid coastlands of Sonora and northern Sinaloa. Two of the major crops to show a great expansion in acreage have been sugarcane and pineapples, and their increase has eliminated some good waterfowl habitat.

Since 1948, the average percentages of waterfowl species seen have been as follows: pintail, 31; blue-winged and cinnamon teals, 22; wigeon, 13; gadwall, 12; lesser scaup, 11; whistling ducks, 3; white-fronted goose, green-winged teal, and shoveler, each 2; and lesser snow goose, redhead, ring-necked duck, canvasback, and ruddy duck, less than 1.0. Among the total number of ducks reported on the aerial surveys of the Gulf Coast wintering grounds, the Alvarado-Papaloapan area has averaged about 153,000, or 14.0%. During the past 10 years the average has been much less. This fine wintering ground could accommodate many times this number of waterfowl.

Lago de Catemaco, Veracruz (14)

This mountain lake in the Sierra de las Tuxtlas of southern Veracruz has an elevation of about 335 m. It is about 11 km long from east to west, and slightly more than 8 km across in some places from north to south. Its western side is about 10 km east of the town of San Andres Tuxtla. It is very deep, and the only aquatic vegetation present is in the shallows very near the shore.

Few waterfowl frequent this high lake, because their usual flight routes are over the lowlands from the Papaloapan Delta eastward across the marshes and swamps to the lower reaches of the Rio Coatzacoalcos, or offshore along the Gulf Coast.

At the time of the January 1947 survey, the only ducks seen on the lake were 150 scaups. A ground survey of the western side of the lake on 14 February 1960 revealed 410 scaups, 35 ruddy ducks, and 620 coots. The divers were well offshore in deep water. In the shallows there were many small plants of muskgrass and young water hyacinths. The latter had been fed upon, probably by the coots, because we have seen them eating young leaves of this plant in many localities.

Temascal (Presa M. Aleman), Oaxaca (15)

This large, deep, and irregularly shaped reservoir on the Rio Tonto, a tributary of the Rio Papaloapan, is about 104 km south-southwest of Veracruz. According to the navigation chart of 1963, the dimensions of its water surface are roughly 40 km from northwest to southeast, and 19 km from northeast to southwest, which gives it an area of about 823 km^2. When the reservoir is full, it is reported to have a capacity of 8×10^9 m^3 of water.

Temascal has been scouted only once by plane, at which time a few diving ducks and coots were found.

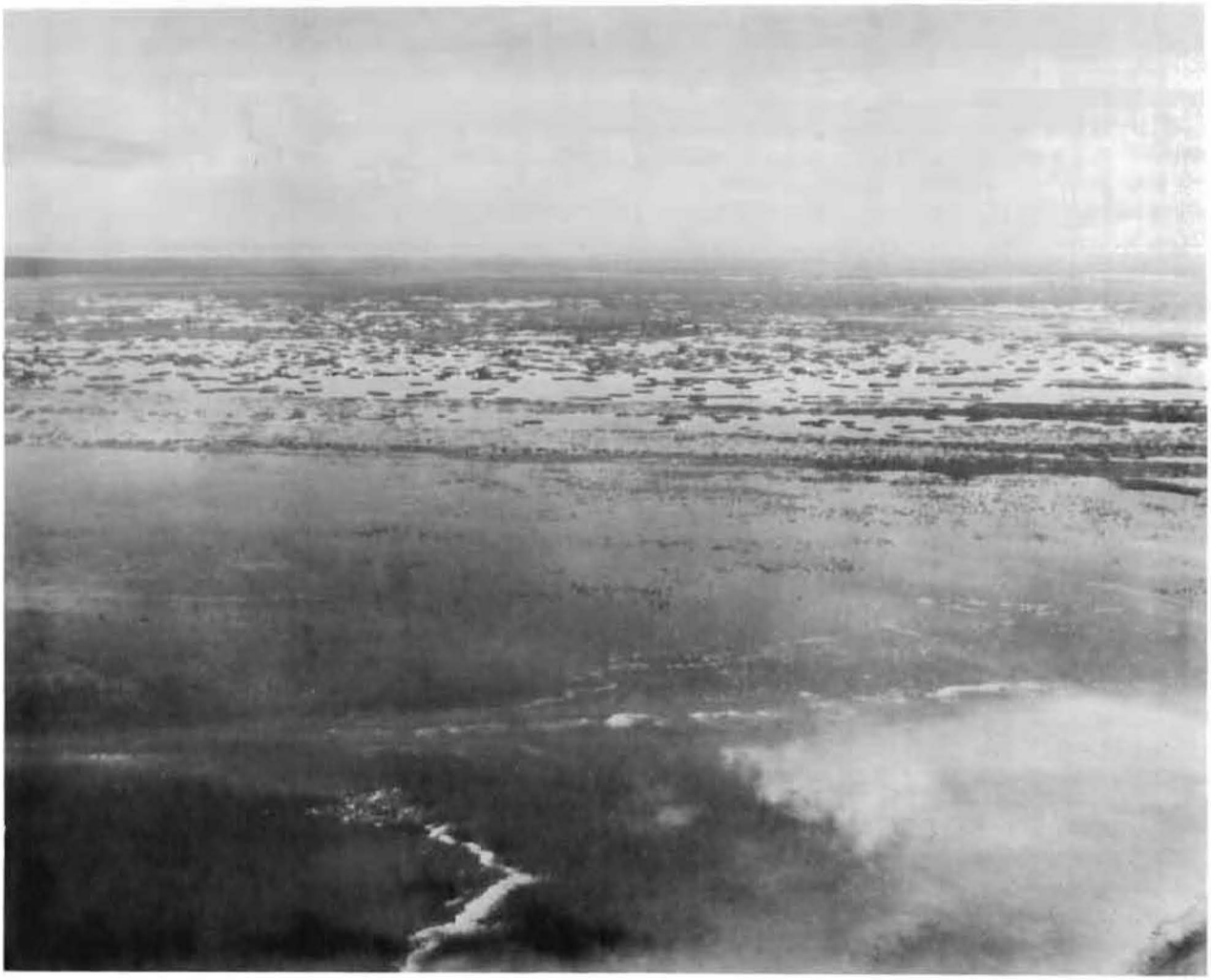

Fig. 8. Lagoons and marshes of Central Tabasco, 1947—An aerial view of a small part of the vast Tabasco lagoons, marshes, and swamps. This area includes the floodplains of several major rivers and provides the most extensive and isolated freshwater waterfowl habitat in Mexico. Although ducks seldom are concentrated there, the aggregate waterfowl population in winter is large. The human population in this vast area is very small.

When it was visited by R. Andrews and the senior author during a ground survey on 9 January 1960, no ducks were seen on the lake from the dam and its approaches. There is too much fine waterfowl habitat in the coastal lowlands for this deep reservoir to be attractive. Perhaps in future years some of its shallower bays may have more vegetation and be of more value to water birds.

Lagoons of Tabasco State (16)

The lowlands of Tabasco include several thousand square kilometers of swamps, marshes, and lagoons. Across these lowlands many streams, with sources that are in the mountains to the south, meander across the vast floodplain to reach the Gulf of Mexico on the north (Fig. 8). The principal rivers are the Grijalva and Usumacinta, but there are many others that form a maze of connecting channels and countless lagoons across this rich alluvial delta.

This district includes two general areas, one of swamp forests, lagoons, and overgrown marshes in western Tabasco, and the other of lagoons, swamps, and more open marshes chiefly in the north central and eastern parts of the State. Near the Gulf there are some small coastal lagoons, but they attract few ducks, judging from aerial observations.

The western part of the Tabasco waterfowl habitat extends from the Gulf Coast on the north to about latitude 17°45′ S, and from about longitude 93° W on the east to the Tabasco–Veracruz boundary (Rio Tonala)

on the west. Most of the inland area is covered with dense, tropical swamp forest, and there are relatively few bodies of open water. The fact that only 641 ducks were observed in the several hundred kilometers of reconnaissance in January 1939 was evidence of the small use of this district by ducks. Most of those observed were black-bellied whistling ducks, in flocks on forest-bordered lagoons. The lack of suitable water areas and of duck foods, the frequency of floods, an overabundance of pest plants, and other adverse factors seemed to be primarily responsible for the small numbers of waterfowl there.

The eastern sector of the Tabasco lagoons extends from the Gulf southward to about latitude 17°45′ N, and from about longitude 93° W almost to that of Carmen on the east. This entire area is the vast delta of the Usumacinta and Grijalva river systems, and it includes most of the lagoons of the State.

On this flat alluvial plain, the rivers and other streams often change their courses at flood stage by taking shortcuts across loops in their channels, leaving the bypassed loops as oxbow lagoons. There are thousands of such relict channels in the Tabasco marshes, many of them with their ends silted and with their water more or less filled with or covered by vegetation. From the air, these waters are noticeably darker than the active streams. During the rainy season, the rivers rise sharply, overflowing their banks in much of the low country and refilling the lagoons before the arrival of migratory waterfowl. E. A. Goldman (1951:257) wrote of this:

> From Frontera to Monte Cristo the rivers flow through low country much of which is overflowed during the rainy season. Here and there the banks rise in gentle undulations to a height of 10 or 15 feet above high-water mark, and occasional ridges near Monte Cristo reach 100 to 200 feet above the river. The Rio Usumacinta varies from 40 to 50 feet between high- and low-water marks at Monte Cristo. About 40 miles in a straight line above Monte Cristo the Usumacinta comes out of a gap in the mountains and from there to the sea has a steady current of 2½ to 3 miles per hour in the dry season; in the wet season the current is considerably accelerated. The rains begin in the mountains of this region soon after the middle of May, and the river began to rise at Monte Cristo about May 20 the season we were there. . . .
>
> Along the way up the river the forest was rather low and irregularly distributed in belts and patches, usually fringing the river banks and occupying the higher ground, thus outlining grassy plains and marshes that are under water during the wet season.

With the exception of the tidewater coastal lagoons the water areas are all fresh. According to government charts, the rainfall in the district is from 152.0 to 305.0 cm or more a year, with even more in the mountains beyond, which accounts for the heavy seasonal flooding. Government records during one period of study show that rain fell on more than 150 days each year and that some of these rains were torrential.

There is relatively little heavy timber in the eastern district as compared with that to the west of Villahermosa. In the almost countless lagoons and open marshes adjacent to the Rio Grijalva and eastward, waterfowl are much more numerous. South of this lowland region rises the high mountain cordillera of Chiapas, which probably serves as a barrier to migration in that direction.

Ducks usually are sparsely but widely distributed in this region. Seldom have they been observed in concentrations, but in the aggregate the number wintering is large. On the flight of January 1947, only 3,325 ducks were seen, but it was calculated that only 4% of the maze of lagoons was covered. During some later years, several hundred thousand waterfowl were estimated to be in the delta. Pintail, black-bellied whistling duck, blue-winged teal, and lesser scaup were the most common ducks observed on recent surveys. Two other common birds of interest were the limpkin (*Aramus guarauna*) and the Everglades snail kite.

The wide fluctuation of water levels, overabundance of pest plants including algae, and other unfavorable conditions greatly lessen the abundance of duck foods and the attractiveness of the area to these birds. Because of the shallowness of most of the waters, the richness of the soil, the year-round growing season, and the abundance of fresh water, there is no lack of marsh and aquatic vegetation, but undesirable species seem to be dominant in many localities. Mats of algae are especially abundant and choke out plants which are more useful to waterfowl. Clumps and islands of pickerelweed, cattail, reedgrass (*Phragmites* sp.), and mimosa; masses of floating hyacinth, water lettuce, and water velvet; and vast beds of bladderwort (*Utricularia* sp.) have been recorded during ground surveys near Villahermosa. Duck foods are common locally, chiefly smartweed, spikerushes, naiad, *Panicum* and other marsh grasses, sedges, water star grass, and duckweed.

Many of the small lagoons near Villahermosa that were studied in 1950 and 1960 have a shore zone of *Panicum* and other grasses and sedges, then a ring of water hyacinth, and farther out some pickerelweed extending into the shallow water. Beyond them is a zone of water velvet; bladderwort is the most common submerged plant.

Some of the pools and lagunas near Villahermosa that are protected from wind action by trees or tall marsh vegetation are completely covered with water lettuce, water hyacinth, or a thick mat of algae. Some shores, especially those grazed by cattle, are covered with bermuda grass, and in some places there are stands of smartweed on the muddy banks. No pondweeds or widgeongrass have been found in the several lagoons studied, but the plants of this vast maze of

waters and marshes are less known than those of any wintering ground on the Gulf and Caribbean coasts. It would require a small plane on floats, or better yet a helicopter on floats, to make an adequate survey of the waterfowl foods of Tabasco.

Animal foods are abundant in these tropical waters, including many kinds of aquatic insects, crustaceans, and small snails. The bottom soils are mostly mud, but some are firm and a few contain gravel. Several of the small lagoons studied have bottoms which are too soft for wading, and they average 1 m or more in depth; the water is clear even on windy days.

The human population in the district is extremely small. Excepting Villahermosa, the population of most of the State averages less than 1 per km^2. The shooting of waterfowl in the State is negligible. The commercial hunting and the sale of waterfowl and other game birds occur on a very small scale at a few places in Tabasco, mainly at and near Villahermosa, the capital. Elsewhere the demand is reported to be too slight to justify the considerable effort and cost required to obtain the birds.

On 24 February 1935, E. A. Goldman wrote in his field notes (U.S. Biological Survey [USBS] files):

> Four species of ducks were observed (near Villa Union and Villa Hermosa, Tabasco). These were, in order of abundance, lesser scaups, pintails, and blue-winged teal, all of which were seen in flocks consisting of hundreds and aggregating several thousands, and spoonbills which were noted in several flocks of 20 to 50. Our canoe men were market hunters. All of the ducks appeared to be remarkably wild, due no doubt to the fact that here they are hunted more or less persistently for the market. Our men informed us that the hunters operate largely in the daytime, where the water is about waist deep. A common method is to pile several of the large floating water hyacinth plants, on top of each other, forming a blind and convenient rest for their guns. The movable blind being pushed before them to within gunshot. The hunters reported that white-fronted and snow geese formerly visited the section but none had been seen in the last two years. According to the hunters at Villa Union fewer ducks than usual have visited the region this season, and they have been decreasing for several years.
>
> Visiting the market at 6 o'clock in the morning we found at a single stand, 27 pintails, 6 black-bellied tree [whistling] ducks, and two lesser scaups on sale. All of these were brought from Villa Union.

On 3 February 1960, Ralph Andrews and the senior author visited the public market at Villahermosa and found 24 blue-winged teal and 2 black-bellied whistling ducks on sale.

The heavy flooding during the rainy season sweeps great quantities of floating pest plants from the lagoons into old channels, the rivers, and on to the Gulf. The ferries that cross the Rio Grijalva near its mouth at Frontera are good observation stations from which to see these green islands of hyacinths and other pest plants nearing the Gulf. On any aerial survey of Tabasco, one sees countless lagoons, pools, and old stream channels clogged with these weeds, but always there are countless others that afford open water and food for many times the number of ducks that go there.

Unlike several other important wintering grounds on the Gulf Coast, the Tabasco area does not have periodic droughts. There is always sufficient rainfall in the basin to maintain adequate water levels.

There is some oil pollution in Tabasco, chiefly in the northwestern part of the State near the boundary with Veracruz, where oil fields have been developed in recent years. To date, no serious effect on the lagoons used by waterfowl has been observed, but more effective pollution controls should be required there. Another locality with oil fields is Ciudad Pemex, east-southeast of Villahermosa. In that area, pollution should be well controlled, because the streams and lagoons in that vicinity are important to fish, waterfowl, and other wildlife.

Since 1948 the average percentages of waterfowl species seen on the aerial surveys have been as follows: blue-winged teal, 33; lesser scaup, 18; wigeon, 17; pintail, 16; whistling ducks, 9; ring-necked duck, 2; gadwall, 1; and lesser snow goose, green-winged teal, shoveler, redhead, canvasback, and ruddy duck each less than 1. Among the ducks reported on the aerial surveys of the Gulf Coast wintering grounds, the Tabasco sector has averaged about 126,000, or 11.6% of the total.

Lagoons of Campeche State (17)

The principal body of water in the State is the Laguna de Terminos, the main part of which has an average width of more than 19 km and a length of more than 64 km. It is on the coast and is connected with the Gulf of Mexico by two broad passes, the Boca del Carmen and Boca del Puerto Real. The Isla del Carmen is the barrier island between the Gulf and the Laguna.

Most of the reconnaissance of this area was by plane; consequently, no adequate information on the depth of the lagoon and its aquatic vegetation was obtained. It is known that the laguna is saline to brackish because of its broad connections with the Gulf at Carmen and Aguada. On the south side, there are three conspicuous bays into which rivers flow, and the great volume of water from these sources results in a local reduction of salinity. Vincent Stevenson of Brownsville, Texas, who operates a fishing camp at Aguada, informed us that the strong tidal flow into the laguna forces salt or brackish water into the lower reaches of the Palizada, Champan, and Candelaria rivers, which are the largest tributaries to the laguna.

The average depth of the lagoon is not known, but much of it is little more than 1 m. Most of the aerial

reconnaissance took place within 0.8 km of the north and south shores, where it is shallow. Along much of the southwest shore, the forest extends to the water's edge and there is no beach. Farther eastward, and especially beyond the Rio Champan, there is a sandy or muddy beach backed by a thin fringe of trees beyond which there are occasional grassy marshes. There, in the shallows of the southern shore, most of the dabbling ducks are seen. Very extensive plant beds, probably widgeongrass, cover the bottom.

The northern side of the laguna is very shallow and bounded for most of its length by a broad, low barrier beach which is broken only by the passes at Ciudad Carmen and Aguada. Westward from the pass at Carmen, the peninsula lying between the Gulf and the lagunas is mostly swamp woodland, divided by a series of grassy marshes and small lagoons parallel to and between the larger bodies of water.

In many places along the northern side of Laguna de Terminos, hundreds, and sometimes thousands, of herons were observed standing only knee-deep in water as far as 0.8 km offshore, but there were deeper holes throughout the zone. Much submerged aquatic vegetation, which probably included shoalgrass and widgeongrass, was visible in scattered but extensive beds. Herons, shorebirds, gulls, and pelicans were much more numerous near the north shore than elsewhere. Undoubtedly feeding is better there, especially near the passes. Judging from aerial observations, more dabbling ducks used the southern edge than other parts of the lagoon, but the largest numbers of waterfowl observed usually were scaups rafted in deeper water. Widgeongrass, shoalgrass, and many beds of small mollusks were available there.

The narrow bay, which extends northeastward from Laguna de Terminos for about 30 km, at times had a much greater concentration of ducks than had the main lagoon. In January 1939, for example, more than 43,000 ducks, mostly scaup, blue-winged teal, pintail, and ringnecked, were observed there at the time of the aerial survey. On other surveys, few waterfowl were seen there; in January 1947, the only ducks recorded were 1,650 blue-winged teal. Since the subsequent aerial surveys lumped together the numbers of ducks recorded in the coastal waters of both Campeche and Yucatan, separate figures for those in the former State cannot be given for most years. Usually almost all the ducks in this combined total are seen in Yucatan waters. On the January 1955 survey, there were 3,600 ducks and 46,400 coots seen on Laguna de Terminos; on the ground survey 1 February 1960, two rafts of lesser scaup totaling almost 5,000 birds were observed 1.6 km east of the dock at Isla Aguada. There was no opportunity at that time to survey the laguna by boat. Offshore in the Gulf, and several kilometers northeast of Aguada, rafts of scaup were seen feeding that same day. In the lagoons and in the shallows of the Gulf, there is adequate food for many times the number of waterfowl that frequent this locality.

Northeast of the city of Campeche, the coastal lagunas, marshes, open swamps, and shallows of the Gulf are similar in some respects to those of the coastal district of Yucatan, but apparently they were much more seriously damaged by the hurricanes which swept across the peninsula in past years. Those storms of the early 1930's were especially destructive. The skeletons of hundreds of thousands of dead mangroves stand in some of these shallow coastal lagoons and flats, beginning a few kilometers north of the city of Campeche—mute reminders of the destructive force of these hurricanes.

North of these desolate coastal waters, there are lagoons and mangrove swamps of normal appearance that have flocks of waterfowl and large numbers of wading birds. The aquatic plants are mostly shoalgrass and widgeongrass in the more open lagoons, muskgrass in the mangrove-fringed pools, and with them an abundance of small aquatic animal life. Offshore, in the Gulf shallows, there are broad beds of shoalgrass and associated marine grasses, lying in a band parallel to the shore.

The part of Campeche to the west and south of Laguna de Terminos is a complex of marshes, swamps, and lagoons similar to that of eastern Tabasco. The lagoons are chiefly in two series. The first is near the coast to the west of Laguna de Terminos and includes Laguna de Atasta and Laguna del Pom (the latter called Laguna del Corte on some maps). The only aquatic vegetation found when their northern shores were scouted on the ground in 1950 and 1960 was a coarse, broad-leaved form of wild celery (*Vallisneria americana*). Although there is no proof based on stomach examinations, it is probable that the fruits of this plant are utilized by waterfowl, and that coots feed on the younger leaves here as they do near Tampico. Between these larger lagoons and the Gulf there are many narrow marshes and small, shallow lagoons which are utilized chiefly by teal, whistling ducks, coots, and wading birds.

The second series of lagoons is southwest of Laguna de Terminos and includes mainly those in the basin of the Rio Usumacinta, between Palizada and Balancan. They almost always have more waterfowl than do those in the first series near the coast, and their vegetation appears to be similar to that of eastern Tabasco.

The principal waterfowl foods are unknown, because no ground studies have been made of this region. The foods are, however, probably the same as those in the nearby lagoons of Tabasco and include grasses, sedges, spikerushes, naiad, smartweed, duckweed, waterlilies, water star grass, and associated species. There is undoubtedly also an abundance of animal foods that includes aquatic insects and their larvae, crustaceans, and mollusks (especially small snails).

Fig. 9. Coastal lagoons of Yucatan. The brackish coastal lagoons of northwestern Yucatan are very attractive to wintering and migrating ducks, coots, and other water birds. Thousands of lesser scaup, wigeon, teal, other ducks, and coots are in this aerial photograph. Extensive beds of widgeongrass can be seen in the background, and beds of muskgrass are in the foreground. The coastal mangrove forest is in the distance, and beyond it lies the low peninsula of Yucatan.

The lesser scaup, ring-necked duck, and teals probably utilize these animal foods, as they do near Villahermosa, Tabasco.

Lagoons of Yucatan (18)

These wintering grounds differ from the other extensive waterfowl areas on the Gulf and Caribbean coasts. They are very narrow and limited to the immediate vicinity of the coast. The Yucatan Peninsula is a porous limestone formation and, except for a few *aguadas* (shallow sinkholes) and many *cenotes* (deep, round, straight-sided sinkholes), there is no surface water in the interior, and the drainage is underground. Some of this underground flow wells up in the coastal lagoons or percolates through the strata to freshen the saline water. Much of it extends beneath the Gulf as an aquifer, and there are places where it wells up offshore. In one of the saline coastal lagoons east of Progreso, an artesian flow of fresh water rises above the surface in a very conspicuous column. A review of the geology and hydrology of this peninsula is given by Robles Ramos (1959).

Many maps do not show the long series of narrow lagoons, marshes, and swamps that exist along the coast. Only recent maps, based on aerial photographs taken when the angle of light was favorable, give the extent of these waters (Fig. 9).

These coastal lagoons extend from the boundary with Campeche eastward to the boundary with Quintana Roo. The best, judged by waterfowl use, are those

from the Bahia or Laguna de Celestun to a few kilometers beyond Progreso. Farther than this point the lagoons become wider, more windswept, more saline, and contain less waterfowl food.

Those lagoons between Celestun and Progreso are, in general, of two types: (1) long, narrow, relatively open, parallel to the Gulf shore, and inside the barrier ridge; and (2) mangrove swamp lagoons, many of which are small and round. All of them that were visited were relatively shallow, most of them no more than 1.3 to 2 m deep.

The narrow coastal lagoons have clear water that ranges from brackish to more saline than the Gulf. The relative salinity varies from year to year, depending on the inflow of fresh water, but it does not always correspond to the amount of rainfall of the preceding rainy season. The limited ground studies in 1950 and 1960, plus information from local hunters and fishermen, indicate that there is always good feeding for waterfowl in some of these lagoons. In January 1960, healthy widgeongrass was common in many places at lagoons whose salinity was 33% higher than that of the Gulf and much of it had seeded heavily; muskgrass also was plentiful. During a previous survey in 1950, these lagoons had averaged 40–60% seawater salinity and had more extensive beds of these plants.

In the principal lagoons, such as the one near Progreso, there is little food variety; widgeongrass, muskgrass, and mollusks and other animal food are the main items. In other lagoons, nitella and other algae are present, and some shallows and shores have sedges, grasses, and other emergents. Many lagoons have muddy shores, with mangroves and a low ground cover of halophytes, including saltwort, glasswort, and saltflat grass (*Monanthochloe* sp.)—all of little value to ducks. Many shallows have dense windrows of small snails, most of them alive.

All of these open coastal lagoons have a bottom that is sandy, or of sand and shell, except that some of the shores, especially those with mangroves, may be muddy from the accumulated organic matter. The small lagoons scattered through the mangrove swamps may have mud, mud and sand, or sand bottoms, depending on their size and location. They have much more organic debris, and the water usually is stained from mangrove and other organic dyes. Their principal aquatics are muskgrass and other algae, but in places the bottom is covered with a heavy drift of mangrove leaves. The aggregate quantity of muskgrass is great, and it is of vigorous growth. When plants are pulled from the bottom and washed clean, many small, round, white tubercles called bulbils are evident. These bulbils average 2-3 mm in diameter. They were commonly found in the gullets and gizzards of the blue-winged teal, pintail, wigeon, and lesser scaup which were examined.

Based on all the ducks of these four species examined, the three most important foods are widgeongrass, muskgrass, and small mollusks. Minor items are the seeds of grasses and sedges, including sawgrass and bulrushes. Ducks which were shot in the coastal lagoons had fed chiefly on widgeongrass and small snails, and those at the mangrove lagoons had eaten mostly muskgrass. An especially large number of widgeongrass seeds were taken, and many of those birds that had eaten muskgrass had sought out the small white bulbils. Some gullets examined contained more than 50 bulbils. When we inquired of the natives regarding the food of ducks, they mentioned two kinds of seeds, one black and the other white. We knew the black one was widgeongrass, but did not realize until later that the white "seeds" they described were these bulbils of muskgrass. For a review of the vegetation of this coast, as well as of inland localities, see Miranda (1959) and Standley (1930).

The largest numbers of ducks during most of the January surveys were found on the lagoons near Progreso and Sisal and in the bay at Celestun. The most common species usually were lesser scaup, blue-winged teal, pintail, and wigeon; there were fewer numbers of shoveler, ring-necked duck, and green-winged teal. During some years, a few canvasback, gadwall, and whistling ducks were recorded. Black-bellied whistling ducks usually are common in the mangrove lagoons slightly farther in from the coast, but usually they are not seen from the air.

On the first survey in January 1939 we found about 362,000 ducks in this sector, most of them from Celestun to Progreso. Estimates from subsequent flights ranged from a few thousand to more than 600,000. In the years when small numbers were seen, it is likely that many ducks were distributed among the maze of mangrove lagoons that are difficult to scout from the air. It is apparent from the larger numbers of waterfowl usually there, and from the heavy flights of migrants that stop for brief periods, that these coastal lagoons are highly important and strategically located. Fortunately, large quantities of waterfowl foods are available, and they are species-adapted to the wide variation in salinity. The muskgrasses evidently are able to tolerate severe drought, because there are local reports of frequent droughts in some of the mangrove lagoons from May to mid-September.

More information is needed regarding the extent to which the ducks feed offshore on shoalgrass and other foods in the Gulf shallows. Local hunters reported heavy flights of pintail, wigeon, and lesser scaup to and from the Gulf. An aerial reconnaissance offshore from Progreso showed a broad band of aquatic vegetation in the shallows for a great distance along the coast to the west and south, and possibly all the way to western Tabasco. Beachcombing near Progreso re-

vealed heavy drifts of turtlegrass and shoalgrass leaves on the shore. It may be that the choice rhizomes of shoalgrass are utilized by some ducks throughout the winter, but it is possible that offshore feeding increases as the large numbers of birds deplete the food in the larger lagunas. The first time we saw the lagoon at Progreso it had relatively little widgeongrass remaining, but there were many thousands of ducks and coots there. These ducks may have been feeding in the Gulf. At such times these offshore beds would provide an invaluable supply of emergency food.

On 27 January 1960 several experienced hunters reported a raft of several thousand ducks offshore about 16 km northwest of Sisal. The birds were too distant for identification, but they were probably scaup. We have also seen many scaup feeding in the Gulf near the pass at Boca Jesus Maria, Tamaulipas.

From Progreso eastward, there are lagoons and estuaries that total many hundreds of square kilometers in water area, but they usually have few waterfowl. Several brackish lagoons just east of Progreso often have more birds than the others. Some of the largest near Dzilam de Bravo, San Felipe, Rio Lagartos, and Yalahau probably lack food, because they are very open, shallow, and windswept. The scouring action of high winds, and in some instances excessive salinity, may be the principal factors inhibiting plant growth. On the laguna at Dzilam, when it was scouted by plane in January 1947, the salinity was so high that lines of white foam covered its surface, and small commercial saltworks were being operated in this district. It was amazing to see so much coastal water and so few waterfowl, but there were thousands of herons, cormorants, shorebirds, gulls, and man-of-war birds. In at least two places not far east of Dzilam de Bravo, great fountains of fresh water welled up 52 m offshore in the Gulf, the outlets of springs of underground water from the mainland.

Since 1951 the average percentages of waterfowl species present in the Yucatan lagoons have been as follows: lesser scaup, 43; blue-winged teal, 20; wigeon, 18; pintail, 16; gadwall and ring-necked duck, each 1; and whistling ducks, green-winged teal, shoveler, redhead, canvasback, and ruddy duck, each less than 1. These figures also include the waterfowl seen in the coastal lagoons of Campeche, because the totals for the two States usually have been combined in the annual reports of the aerial surveys. Usually, more than 90% of the birds are seen in Yucatan waters.

Among the total number of ducks reported by the aerial surveys of Gulf Coast waters since 1948, the Campeche-Yucatan area has averaged about 256,000, or 23.5%.

Lagoons of Quintana Roo (19)

Around the point of Cabo Catoche and southward, there are even fewer birds than in the northeastern lagunas of Yucatan. From that cape to the boundary with British Honduras, fewer than 100 ducks were seen along the coast during each of the January aerial surveys of 1947 and 1948. Slightly larger numbers were observed on the lagoons farther inland, especially to the northwest of Chetumal, but in general waterfowl were conspicuous by their scarcity. Because of this lack of waterfowl, almost all subsequent aerial surveys did not extend beyond Cabo Catoche, the northeastern cape of Quintana Roo.

From opposite Cabo Catoche, south to beyond Puerto Morelos, the coast is low and has many mangroves, salt flats, and savannas, and there are some small muddy lagoons backed by heavier woodland toward the interior. A few kilometers south of Puerto Morelos, the coast is of thick limestone outcroppings well above the level of the water. The bays are beautiful, mostly of the color of translucent malachite and turquoise. Several small *cenotes* can be seen a few hundred yards inland, and in several places the ruins of small Mayan temples show conspicuously on the edges of the rocky coastland. Some very large bays are crossed, and although there were many white ibis (*Eudocimus albus*), herons, cormorants, brown pelicans (*Pelecanus occidentalis*), and man-of-war birds, the only waterfowl seen were a few black-bellied whistling ducks.

From Chetumal inland to the Laguna Bacalar, most of the terrain is a low, saline flat, very little above sea level, and consists of a maze of shallow channels and countless small mangroves. The only other vegetation seen during the surveys was almost entirely halophytes, and the only ducks observed in the area on the 1947 flight were four canvasbacks in one of the small lagoons. At Laguna Bacalar, the only waterfowl sighted were 950 lesser scaup, which were feeding in open water. This lagoon has heavy forests down to the shore along its western side and a thin marsh on the east.

To summarize, the coastal waters of Quintana Roo have negligible numbers of wintering waterfowl. Some flights of migrants, and perhaps many, especially of blue-winged teal, pintail, and lesser scaup, must pass over it. They may not stop in these waters, but continue instead southward to other wintering grounds on the Caribbean coasts of Honduras, Nicaragua, or beyond.

Interior Highland Zone

Although aerial reconnaissance has proved that most of the waterfowl wintering in Mexico frequent the coastal areas, some, and especially those from the Central Flyway, winter at lagunas, lakes, reservoirs, and other waters of the interior highlands. Conditions

favorable to waterfowl in these highlands have declined greatly, as has already been mentioned. Many of the finest wintering grounds were in the large lake basins called *bolsones*, which had no outlets. One of the principal reasons for the radically changed ecological conditions has been the deforestation of so many mountain and valley slopes in the drainage areas which formerly were well wooded. The loss of so much forest, followed by the destruction of herbaceous cover by serious overgrazing, has added erosion to an earlier problem of excessive runoff. Then, with the reduction of flow caused by upstream reservoirs and other diversions, most of the *bolson* lagoons and marshes, which were formerly such important waterfowl wintering grounds, have been reduced to low value or are of only negligible worth because of the losses of water and food resources. Some are now classed as arid *playas*.

The great decline of so much of the waterfowl habitat in the highlands is correlated directly with the great density of the human population there, in contrast to the much lower human density on the coastal plains. The pressures that result from more people and their demands for water, food, lumber, electricity, living space, recreation, and other needs, have affected almost all the streams and other bodies of water in the highlands.

There continue, however, to be some attractive wintering grounds in the interior. The central lake and lagoon district in the States of Michoacan, Jalisco, and Guanajuato, which includes the waters of lakes Chapala, Patzcuaro, Zacapu, Cuitzeo, and Yuriria (Tables 4 and 5; Fig. 10), as well as the many small lagoons and reservoirs of the Bajio area, has the largest waterfowl population in the highlands. In the following pages many of the wintering grounds of the highlands are briefly described. In the following text the wintering grounds of the Interior Highlands are discussed in approximately north to south sequence, within each State.

Fig. 10. Waterfowl wintering grounds of the Interior Highlands Zone of Mexico.

Laguna de Guzman, Chihuahua (20)[3]

This laguna is 32 km northwest of Laguna Santa Maria and about 95 km south-southeast of Columbus, New Mexico. It is a *bolson* or sump lake whose basin is about 8 by 14 km in size. At the time it was visited on 19 January 1935, by U.S. Game Management Agent B. W. Randel, there were only two small pools, or springs, of water in the area and no waterfowl were present.

For those years of the aerial surveys when Laguna de Guzman had water, the number of ducks seen averaged about 300. It was first visited on an aerial survey of 23 January 1949, and was entirely dry at that time. It was dry when surveyed in 1965.

[3]Number in parentheses is the index code that designates on Fig. 10 the location of the listed wetland(s).

Laguna de Santa Maria, Chihuahua (21)

E. A. Goldman (1951) wrote the following concerning the visit he and E. W. Nelson made in September 1899.

> Lake Santa Maria was a saline body of water about 8 miles [13 km] long and 6 miles [10 km] wide at the time of our visit. Low but rugged volcanic hills and mountains rise a few miles away in three directions. The lake basin is separated from that of the Laguna de Guzman, the saline sink of the Rio Casas Grandes, a short distance to the northwest, by a divide not more than 200 feet [60 m] high. The desert mountains near Lake Santa Maria bear grasses and a few shrubs on their slopes but are devoid of timber. Cottonwoods, willows, and mesquites grow along the Rio Santa Maria. On the vast open grassy plains, clumps of the low-growing type of mesquite here and there are mixed with acacias, the creosotebush (*Covillea tridentata*), the ocotillo (*Fouquieria splendens*), and a few cactuses.

L. J. Goldman (USBS files) wrote in 1942:

> These two large shallow lakes (Santa Maria and Guzman) are in the sinks of the Casas Grandes and

Table 4. *Important waterfowl wintering areas in the Interior Highlands of Mexico.*

Name	Description	State	Figure 3 index number
Laguna de Guzman	A desert bolson, usually dry, about 256 km southsoutheast of Columbus, New Mexico.	Chihuahua	20
Laguna de Santa Maria	A desert bolson southeast of Laguna Guzman.	Chihuahua	21
Casas Grandes	Two small reservoirs east of the Casas Grandes airport.	Chihuahua	22
Laguna de Los Patos	A small desert bolson near Ahumado.	Chihuahua	23
Laguna de Babicora	A large bolson in a grassy valley near the mountains, about 184 km northwest of the city of Chihuahua.	Chihuahua	24
Laguna de Encinillas	A desert laguna west of Lagunas.	Chihuahua	25
Laguna de los Bustillos	A bolson on the high plains 64 km west of Chihuahua.	Chihuahua	26
Laguna de los Mexicanos	A bolson southwest of Laguna Bustillos; occasionally dry.	Chihuahua	27
Presa Madero	A reservoir on the Rio San Pedro southwest of Chihuahua.	Chihuahua	28
Lago Toronto (Presa de la Boquilla) and Presa de Colina	A fairly large, deep reservoir about 120 km southeast of Chihuahua. Presa de Colina is a small reservoir downstream from Lago Toronto.	Chihuahua	29
Laguna de las Palomas	A desert bolson in the southeastern corner of the State; dry some years. This is the Palomas occasionally included in the aerial survey.	Chihuahua	30
Lago Don Martin (Presa Venustiano Carranza)	A fairly large reservoir in the northeastern part of the State, northeast of Monclova.	Coahuila	31
Lago de Mayran	A vast bolson east of Torreon; now dry, but formerly a great waterfowl lake.	Coahuila	32
Presa Cardenas (El Palmito or Rio de Oro)	A mountain reservoir of the Rio Nazas, 136 km west of Torreon.	Durango	33
Laguna de Santiaguillo	A double reservoir in a broad valley about 70 km north of Durango; at times almost dry.	Durango	34
Villa de Cos (El Salado)	Groups of small reservoirs from 48 km to 72 km northeast of Zacatecas.	Zacatecas and San Luis Potosi	35
Presa Calles	A mountain reservoir about 32 km northwest of Aguascalientes.	Aguascalientes	36
El Languillo	Several small reservoirs between Encarnacion de Diaz and Ojuelos de Jalisco.	Jalisco	37
Laguna de Magdalena	A bolson reservoir about 43 km northwest of Guadalajara.	Jalisco	38
Laguna de Cajititlan	A laguna about 27 km south of Guadalajara.	Jalisco	39
Lago Chapala and La Barca (Lerma Delta)	The largest lake in Mexico, about 35 km south of Guadalajara and Rio Lerma delta.	Jalisco and Michoacan	40
Laguna de Atotonilco	A narrow, shallow laguna west of Lago de Chapala.	Jalisco	41
Laguna de San Marcos	A shallow bolson southeast of, and adjacent to, Atotonilco; occasionally dry.	Jalisco	42
Laguna de Sayula	A large bolson-playa about 14 km southwest of Lago de Chapala; often dry.	Jalisco	43
Laguna de Zapotlan	A small laguna near Ciudad Guzman.	Jalisco	44
Lagos de Moreno	Several reservoirs near Lagos de Moreno.	Guanajuato	45
Leon	Several small reservoirs near Leon.	Guanajuato	46
Irapuato	Reservoirs near Irapuato.	Guanajuato	47
Laguna de Yuriria	A fairly large laguna adjacent to Yuriria and southwest of Celaya.	Guanajuato	48
Acambaro (Presa de Solis)	A large irrigation reservoir east of Acambaro.	Guanajuato	49
Lagunas de Zacapu	A series of lagoons about 160 km northeast of Zacapu, and the small reservoir adjacent to that town.	Michoacan	50

Table 4. Continued.

Name	Description	State	Figure 3 index number
Laguna Cuitzeo	A large bolson-laguna 29 km north of Morelia.	Michoacan	51
San Isidro (Presa Tepuxtepec)	A reservoir east of Solis on the Rio Lerma.	Michoacan	52
Lago de Patzcuaro	A fairly large lake in the mountains, adjacent to Patzcuaro and southwest of Morelia.	Michoacan	53
Laguna de Metztitlan	A laguna near and north of the town of that name, and about 62 km north of Pachuca.	Hidalgo	54
Tepeji del Rio (Tula)	The reservoir north of Tepeji and south of Tula.	Hidalgo	55
Laguna de Zupitlan	A small laguna near Tulancingo.	Hidalgo	56
Lagunas Tultengo and Tecocomulco	The remnants of a fine laguna in a high valley, about 21 km south of Tulancingo.	Hidalgo	57
Lagunas de Apam (Apan)	The remnants of a fine waterfowl lagoon west of Apam.	Hidalgo	58
Presa de Huapango	A reservoir on the Rio Timilpan, about 80 km northwest of Mexico City.	Mexico	59
Laguna de Zumpango	A laguna near the town of Zumpango, 40 km north of Mexico City.	Mexico	60
Upper Lerma Valley	The upper valley of the Rio Lerma from its source near Almoloyo del Rio north to near Ixtlahuaca; includes a series of small reservoirs and lagunas.	Mexico	61
Lago de Texcoco	The shallow alkaline remnant of the famous laguna at the northeast side of Mexico City.	Mexico	62
Laguna Oriental (El Carmen) and Laguna Alchichica	A large playa-laguna about 64 km northeast of Puebla. Laguna Alchichica is a small crater-lake about 96 km eastnortheast of Puebla.	Puebla	63
Presa Valsequillo (Camacho, Rio Atoyac)	A reservoir in the mountains about 19 km southeast of Puebla.	Puebla	64
Laguna Tequesquitengo	A laguna near Puente de Ixtla and about 32 km south of Cuernavaca.	Morelos	65
Laguna Miacatlan (El Rodeo)	A small laguna near Miacatlan and about 19 km southsouthwest of Cuernavaca.	Morelos	65
Laguna Coatetelco	A small laguna near Coatetelco and about 4 km southwest of Laguna Miacatlan.	Morelos	65
Laguna Tuxpan (Iguala)	The small laguna to the east of Iguala.	Guerrero	66

> Santa Maria rivers. Formerly celebrated as wintering grounds for geese, cranes and ducks, they have in recent years been much reduced in superficial area by water diversion, and during periods of dry cycles by the effects of drouth. . . . Lesser snow geese predominate, with some white-fronted geese. During the spring and fall migration periods, gatherings of transient ducks utilize the localities as resting and feeding grounds. Migrants winter in these districts, and local species are present throughout the year.

This laguna is about 104 km southwest of El Paso, Texas. When it was visited by Deputy U.S. Game Warden B. W. Randel in January 1935, he estimated that there were only 486 to 607 ha of water and grassy marshes in the basin. According to his map, the deep water was limited to several spring-fed pools surrounded by grassy marshes in the northern part of the *bolson*. The waterfowl he saw were 750 teals, 400 wigeons, 350 canvasbacks, 300 mallards, 300 scaups, 200 redheads, 150 buffleheads, 150 pintails, 50 shovelers, 1,500 Canada geese, 50 lesser snow geese, and 7 whistling swans.

During the years of the aerial surveys, very few waterfowl were seen there. In those years when the lake had water, the largest number of ducks recorded was about 5,000, but the average was less than 300. It was first visited on an aerial survey on 23 January 1948. The water area at that time was very small, and the birds seen were 50 gadwalls, 4,600 shovelers, 35 green-winged teals, 350 unidentified ducks, and 1,075 lesser snow geese. Our general impression of the basin was of a vast alkaline *playa* of sand and clay, buff brown in color, and devoid of vegetation, except for its margin of thin grass.

The January 1965 survey report said of the only

Table 5. *Waterfowl seen (in thousands) during January surveys of the Interior Highlands, Zone of Mexico, 1951-62.*

Species	1951	1952	1953	1954	1955	1956	1958	1959	1960	1961	1962	Avg.
Mallard	—	[a]	—	[a]	[a]	—	—	[a]	2	11	[a]	1
Gadwall	18	44	42	14	39	26	29	22	15	15	3	24
Wigeon	27	30	36	93	22	51	53	82	43	26	10	43
Green-winged teal	47	45	23	52	71	85	57	144	55	103	10	63
Blue-winged teal[b]	11	20	26	16	37	30	14	209	46	27	80	47
Shoveler	51	66	64	53	139	109	110	84	53	76	56	78
Pintail	119	105	195	263	325	473	239	454	228	164	56	239
Redhead	6	1	4	[a]	1	1	—	[a]	[a]	[a]	[a]	1
Canvasback	15	10	17	32	18	44	10	2	15	4	2	15
Lesser scaup	6	1	7	6	5	15	2	16	6	3	6	7
Ring-necked duck	[a]	—	—	—	[a]	—	—	—	—	[a]	—	[a]
Goldeneye	[a]	—	[a]	—	—	[a]	[a]	—	—	[a]	—	[a]
Bufflehead	[a]	[a]	—	[a]	[a]	—	[a]	[a]	—	[a]	[a]	[a]
Ruddy duck	2	1	[a]	1	3	8	1	2	1	4	1	2
Merganser	2	[a]	—	—	—	—	—	—	[a]	[a]	[a]	[a]
Unidentified ducks	—	6	118	6	3	—	—	—	1	12	13	14
Total ducks[c]	304	329	532	536	673	842	515	1,015	465	445	237	536
Swan	—	—	—	—	—	—	—	—	11	—	—	[a]
Geese	20	31	16	17	22	20	8	23	18	21	20	20
Total waterfowl	324	360	548	553	695	862	523	1,038	483	466	257	556
Coots	53	22	62	29	24	81	14	55	35	52	37	42
Total birds	377	382	610	582	719	943	537	1,093	518	518	294	598

[a]Fewer than 1,000 birds.
[b]Also includes cinnamon teal.
[c]Does not include Mexican duck, fulvous whistling duck, and black-bellied whistling duck.

habitat at Santa Maria: "A small spring-fed reservoir remained with only a few acres of overflow water . . . in the sump adjoining."

Casas Grandes, Chihuahua (22)

There are two reservoirs in this vicinity which are named Dubland and Fierros (Arellano and Rojas 1956). They are east of the town of Nuevo Casas Grandes at about latitude 30°23′ N and longitude 107°51′ W, and are fed by the Nuevo Casas Grandes river. Laguna Fierros, the reservoir to the southeast, is square in shape, and about 1 km². Laguna Dubland, to the northeast and nearer Nuevo Casas Grandes is circular and has a diameter of about 3 km. The elevation of the nearby Casas Grandes airport is 1,480 m. According to the aeronautical chart of 1963, the basin of Fierros is about 3 km long and 2 km wide; that of Dubland is 3 by 1.6 km in size.

The two reservoirs are surrounded by levees; consequently their water area remains fairly constant. Laguna Fierros is the deeper of the two (Arellano and Rojas 1956), but both fluctuate considerably in depth because of water use for irrigation and for municipal and industrial purposes. On 8 February 1955 Arellano and Rojas (1956) found neither submerged nor emergent aquatic vegetation present in either reservoir.

The average number of ducks recorded on the aerial surveys was about 3,700. The common species were the pintail, green-winged teal, wigeon, mallard, and smaller numbers of other dabblers. A few flocks of lesser snow geese and occasionally a few Canada geese were seen.

Laguna de los Patos, Chihuahua (23)

In 1942 L. J. Goldman wrote (USBS files):

> From tableland elevations of 3,117 feet [950 m] at El Paso and Ciudad Juarez on the Rio Grande, the highway traverses a long semi-arid plain 230 miles [370 km] southward to Chihuahua City, elevation 4,600 feet [1,400 m]; where a low divide formed by a spur of the Sierra Madre . . . separates the Chuviscar watershed from the valley of the Rio San Pedro; both affluents of the Rio Conchos, the south fork of the upper Rio Grande. Between El Paso and the Rio Chuviscar, are two lagoons . . . worthy of special mention.
>
> The first of these, encountered at Ahumada 80 miles [130 km] south of El Paso, is the Laguna de los Patos, the landlocked outlet of the Rio del Carmen . . . Due to river water diversion for irrigation purposes, this lagoon is frequently without water during the dry season. As the name indicates, in times past, this lake had a reputation as a gathering place for waterfowl.

This is a natural lagoon which has diminished greatly in size and value to waterfowl over the past 50

years. It is about 11 km north of Villa Ahumada and on the east side of the Pan-American Highway, at an elevation of 1,150 m. Its dimensions are about 8 by 3 km, and its long axis is north to south. The area is about 2,400 ha according to Arellano and Rojas (1956). The estimated maximum area at times of heavy rainfall is 5,500 ha. According to the aeronautical chart of 1963, the size of the narrow lagoon is 7.2 by 2.4 km, with a winding, irregular shoreline.

It seems probable that the muddy bottom and the prevalence of high winds keep the water sufficiently turbid to inhibit the growth of any aquatic vegetation. In some years it is almost dry. Heavy grazing prevents the growth of emergent vegetation which would give cover for waterfowl along the shore.

Laguna de los Patos was first visited on the survey of 23 January 1948, when it and the other basins in the vicinity were dry. Since then, observers on the aerial surveys have reported small numbers of waterfowl (about 1,200 ducks) during years when it has had water. At times during the winter, ducks were observed resting on the ice.

In 1965 the survey revealed only one small reservoir in this sump that had any ducks.

Laguna de Babicora, Chihuahua (24)

Laguna de Babicora is about 184 km northwest of the capital city of Chihuahua. It is shown on recent maps as having a length of 19 km and an average width of 8 km. Its extent varies from year to year depending upon the volume of runoff from the adjacent mountain slopes, which rise to elevations of more than 2,440 m.

In 1942 L. J. Goldman wrote (U.S. Fish and Wildlife Service [USFWS] files):

> La Babicora Valley is located . . . in northwestern Chihuahua, at an approximate elevation of 7,000 feet [2,135 m] above sea level. It has a length of 30 miles [48 km], and varying widths of from 15 to 20 miles [24 to 32 km]. The oval mountain basin has no drainage outlet, precipitation averages 22 inches [56 cm] annually, and across the level gramagrass-grown flats of the valley's floor are many sloughs, *cienegas* and a water storage reservoir. This system of shallow lakes and channels in irregular pattern, extends the length and width of the valley; the volume of water and surface area varying with seasonal rainfall.
>
> La Babicora is one of the greatest sandhill crane wintering grounds on the North American Continent. There are also large numbers of migrant geese, mainly of the lesser snow species, with a moderate percentage of the white fronted variety. The rare occurrence of swans is reported. Ducks, of all migratory species known on the northern Mexican Tableland, winter in an aggregate of large numbers in this locality, and resident species are present throughout the year.

When this locality was scouted by plane on the first aerial survey of 16 February 1947, we saw nearly 50,000 lesser snow geese, 120 mallards, 450 gadwalls, 275 green-winged teals, and 28,000 sandhill cranes. The area of surface water was greatly reduced, and most of the ducks were on a laguna about 1.6 km long by 0.8 km wide, but there were many small ponds in the vicinity.

On many of the subsequent surveys, this locality was not scouted. During 1961–65 the ducks seen there ranged in totals from about 9,000 to 80,000, and averaged about 46,000; white-fronted geese ranged from 40 to 2,638, and averaged about 1,600; and lesser snow geese varied from 700 to 34,000, and averaged more than 13,000. For the years it was surveyed, the ducks seen at Babicora averaged about 8.2% of the population observed at highland wintering grounds. The most common ducks have usually been green-winged teal, shoveler, and pintail, in that order, with some mallards and Mexican ducks.

Laguna de Encinillas, Chihuahua (25)

In 1942, L. J. Goldman wrote (USFWS files):

> The Laguna de Encinillas is situated in a depression in the valley, 60 miles [96 km] north of Chihuahua. This lagoon and local drainage basin is separated from the headwaters of the Rio Sacramento, a tributary of the Chuviscar, by a low rise in the nearly level valley floor. The lake has a varying length of approximately 7 miles [11 km], the volume of water depending on seasonal changes. The Laguna Encinillas is the favorite wintering resort of a considerable number of geese, mainly lesser snow, sandhill cranes [*Grus canadensis*], and ducks of various species.

This lagoon is west of the town of Lagunas, at an elevation somewhat less than 1,830 m. It is elliptical in shape and about 6.4 by 4 km, according to the aeronautical chart of 1963. Its longer axis is from northwest to southeast, and its average water area is about 1,010 ha. Like Laguna de los Patos, it is a sump with no natural outlet. According to Arellano (1956), its surface area sometimes increases at least 10 times in size during wet years. Judging from aerial observations, as well as from the comments of Arellano and Rojas (1956), there is neither submerged nor emergent vegetation present. The bottom is muddy, with occasional outcroppings of gravel. Arellano reported that on 11 February 1955 the water was turbid and coffee-colored. At the time of his visit no waterfowl were observed, but our January aerial surveys have sometimes recorded a few ducks.

Long-time hunters of Chihuahua told us in 1950–51 that this lagoon formerly had extensive marginal beds of tall bulrushes, but that reduced runoff and drought finally had killed all of the emergent vegetation. Grazing probably was also a factor, especially in preventing the regrowth of plants. With the decline of duck food, almost no waterfowl have used this lagoon except for the few that made rest stops during migration. The only recent aerial survey records of ducks on

this lagoon was in 1961 when 50 wigeons, 70 unidentified ducks, and 185 lesser snow geese were seen.

Laguna de los Bustillos, Chihuahua (26)

This oval-shaped lagoon is 65 km west of the city of Chihuahua, its elevation is about 1,950 m according to the aeronautical chart of 1963, and its dimensions are about 16 by 6.4 km. Some maps show it as being larger, with a maximum area of about 14,580 ha. Its long axis is from northwest to southeast, and as is true with so many basins in Chihuahua, it is a natural sump or *bolson*. Tributary streams enter from the northwest and southwest. The word *bustillos* in Spanish is equivalent to "crane" in English and refers to the popularity of the locality with wintering sandhill cranes.

Most of the lagoon is very shallow and its deepest part is said to average only 2 to 3 m. In drought years it is much shallower and smaller than average. According to Arellano and Rojas (1956), the bottom was muddy and no aquatic flora was observed at the time of their visit in January 1955. The water was dirty grey and had a pH of 8.0 on 13 February 1955. They said that the cellulose factory adjacent to this lagoon was under construction at that time, and that water for this plant would be obtained from a well, and the waste would be released into the lagoon. They commented further that an analysis should be made of the water turned into the canal leading to the lagoon, in order to know what contamination would result. Before the cellulose factory was built, the water from the lagoon was used to some extent for irrigation, but that use is probably impossible now because of its chemical content.

Regarding some past history of this lagoon, E. A. Goldman wrote in 1926 (USBS files):

> In Chihuahua there are a number of lakes, especially on the high plains near the eastern base of the Sierra Madre, of which Bustillos Lake west of Chihuahua City is a typical example. Some of the larger lakes, as Bustillos Lake, 10 or 15 miles [16 or 24 km] in length by about 5 miles [8 km] in width, are surrounded by an abundant growth of sedges and grass, and afford excellent nesting places for some ducks and other waterfowl, and resting and feeding places for large numbers of migratory waterfowl that resort there during the winter. Many other lakes or ponds in the general region afford resting places for migratory waterfowl, but owing to the fact that they have been closely grazed by domestic stock to near the edge of the water, they afford little or no cover for nesting birds. Since the recent revolutions, however, domestic stock have greatly decreased in number, and there is a more abundant growth of grass in general than was formerly the case, but in many places there is still sufficient stock to keep the borders of such water areas closely cropped. Some ducks, such as mallards found near Bustillos Lake, are said to nest there in considerable numbers, and may nest also in Durango where conditions are similar.

The comment regarding nesting probably applied to both the mallard and the Mexican duck (*Anas platyrhynchos diazi*). Little or no nesting cover is available there now.

Experienced hunters who were familiar with Laguna Bustillos told us in 1951 that the geese there averaged about 70% lesser snow, and 30% white-fronted. Canada geese were said to be scarce. Formerly, the best duck hunting had been of pintails, but in 1951 the bags were more varied and contained more teal. Much of the hunting occurred at adjacent small lakes and ponds which were surrounded by fields of oats and corn.

During the January surveys of Bustillos, the estimates of ducks seen in some typical years were 1,055 in 1951, 5,040 in 1944, 20 in 1960, and 920 in 1965 (average, 4,290). The number of snow geese present ranged from zero some years to 12,000 in 1952, and an average of about 4,000. White-fronted geese were fewer; none were seen in some years and up to 3,000 were seen in 1951; the average was about 650. This laguna was first visited during an aerial survey on 16 February 1947, when the following were recorded: lesser snow geese, 9,500; gadwalls, 110; pintails, 425; green-winged teals, 250; wigeons, 40; shovelers, 50; and unidentified ducks, 450. Other birds of interest were 42,000 sandhill cranes and 350 long-billed curlews (*Numenius americanus*). In 1965, only 1,060 ducks and about 2,000 geese were found there.

Laguna de los Mexicanos, Chihuahua (27)

This lagoon is south-southwest of Laguna de los Bustillos and about 100 km southwest of the city of Chihuahua. It is a shallow, closed basin, or *bolson*, and has a relatively small drainage area. The basin is about 10 by 7 km, and has a water area of about 4,050 ha when full. Its elevation is somewhat below 2,135 m. This lagoon formerly had extensive beds of bulrushes, but severe droughts killed most of them, and the remainder could not survive the excessive grazing by livestock. The effects of the droughts were increased by the extensive agriculture in the vicinity and the reduced runoff into the basin. The laguna was dry at the time of several of the surveys.

On the January surveys of Laguna de los Mexicanos, the estimates of ducks seen in recent years were 16,400 in 1959, 11,525 in 1960, 2,020 in 1961, 1,235 in 1962, 2,015 in 1964, and 1,060 in 1965 (average, 5,709). The most common species observed there have been pintail, green-winged teal, and mallard.

Presa Madero (Las Virgenes, Delicias), Chihuahua (28)

This reservoir, also known as Las Virgenes or Presa Gertrudis, is on the Rio San Pedro, southwest of the city of Chihuahua and 17 km southwest of Meoqui. Its elevation is slightly above 1,280 m, and its dimensions

are about 19 by 5 km; its long axis runs in a southwest to northeast direction, as does the flow of the river. The large area of cropland irrigated by this reservoir is called Delicias and lies to the east of it. Some geese are present there each winter.

Presa Madero has been listed in only a few aerial survey reports since 1961, and then by the name Gertrudis. The numbers of ducks seen have ranged from 100 to about 8,000. Ruddy ducks were the most common species in 1965, accompanied by lesser numbers of pintails, green-winged teal, and shovelers, plus 165 lesser snow geese and 150 white-fronted geese.

Lago Toronto (Presa de la Boquilla, Conchos) and Presa de la Colina, Chihuahua (29)

This reservoir is about 120 km southeast of the city of Chihuahua. The original name was Laguna de los Conchos. It is irregular in shape and its long axis runs east to west. According to the navigation chart of 1963, it is 29 km long by 7.2 km wide at its broadest part, but most of it is narrower. Arellano and Rojas (1956) reported that it normally has a length of 38 km, but as of January 1955 it had not reached its maximum level for 10 years. The area estimated on that date (1955) was about 7,500 ha.

The reservoir is supplied by tributaries of the Rio Conchos, an important part of the Rio Grande system. The elevation of the dam is 1,318 m. In January 1955, Arellano and Rojas (1956) found that the water was a clear coffee color. Because the water from this reservoir is used for hydroelectric and irrigation purposes, its level fluctuates greatly. The only important area of marsh is in the delta at the upper or western end, and the best waterfowl feeding is found there.

The lake and its vicinity are used by small numbers of dabbling and diving ducks and by lesser snow and white-fronted geese. On the January surveys, the estimates of ducks seen in some representative years were 6,435 in 1951, 2,499 in 1955, 3,145 in 1960, and 1,460 in 1965; the average was 4,503. The most common ducks usually are shoveler, pintail, gadwall, green-winged teal, mallard, lesser scaup, and small numbers of redhead, canvasback, and ruddy duck. The numbers of lesser snow geese ranged from 50 to 1,450 and averaged about 600; white-fronted geese ranged from 12 to 500 and averaged about 150.

Experienced hunters in Chihuahua told us that, in addition to the hunting at Toronto, the part of the Rio Conchos below the lake is a good duck area and has a great deal of food.

Presa de la Colina is a reservoir about 3 km downstream from Lago Toronto and west of the village of San Francisco de Conchos. It is also called La Rosetilla. Its elevation is slightly less than 1,310 m, according to the aeronautical chart. It is roughly elliptical in shape and its long axis is northwest-southeast. According to Arellano and Rojas (1956) its dimensions are 1 by 3 km, the water is clear, its bottom gravelly and rocky, and its depth varying from shallow to very deep. The reservoir is maintained at a relatively constant level by the water from Lake Toronto. There are beds of bulrushes and cattails in some of the shallows and in the section of the river between the reservoir and Lake Toronto.

Laguna de las Palomas, Chihuahua (30)

This laguna is in the southeastern corner of the State, just north of the vast Bolson de Mapimi, a broad interior basin that is now dry. The village of Carrillo and a railroad are near the northern end of the laguna. When it is full of water, Palomas is reported to be about 11 km long and 4 km wide at its broadest part. Some years it is dry and often very shallow.

On the January surveys, the estimates of ducks seen at Palomas the past several years were 1,400 in 1961, 2,147 in 1962, 1,289 in 1963, and 6,555 in 1965 (average, about 2,800). The common species there are the ruddy duck, gadwall, pintail, shoveler, green-winged teal, redhead, and ring-necked duck.

Lago Don Martin (Presa Venustiano Carranza), Coahuila (31)

This reservoir is in the northeastern part of the State, close to the boundary with Nuevo Leon and about 105 km west of Nuevo Laredo. It has an elevation of about 150 m. Several tributaries, including the Rio Sabinas, supply its water. When full, the reservoir is irregular in outline, and covers about 18,225 ha, but usually it is much smaller. The depth is variable, but the area of shallow water is large. The pH is reported to be slightly alkaline. Below the dam, the stream is called the Rio Salado, and the area irrigated is between 17,010 and 20,250 ha.

Don Martin is sufficiently distant from other lakes, so that it has not been included in the coverage of most of the aerial surveys. It was first scouted on 24 January 1948, when almost 20,000 ducks were seen. The most common species were the gadwall, shoveler, and wigeon, and much smaller numbers of pintail, lesser scaup, teals, canvasback, redhead, and ruddy duck. There were also 350 common mergansers, 350 Canada geese, 430 white-fronted geese, 200 lesser snow geese, and almost 170,000 coots.

It was not revisited on an aerial survey until 1961, but each time since then it has had several thousand or more waterfowl. The locality is especially important for geese.

This lake has been a famous fishing center for many years, but some duck and goose hunting has also been done there for the past 30 or more years. Many of the 47 banded waterfowl shot in Coahuila through 1962 were taken at Don Martin.

Laguna de Mayran, Coahuila (32)

This great *bolson*, which lies east of Torreon, although now of little value to waterfowl and then only at times of flooding, was formerly a most important wintering ground and stopping place for migrants. Because of this past history, some excerpts from the files and early publications are given.

Writing of Laguna de Mayran and the Torreon sector, L. J. Goldman said in 1942 (USFWS files):

> The Rio Nazas is the main source of permanent water supply and with widely spreading tributaries drains the greater part of the eastern slopes of the Sierra Madre in the State of Durango. This river after passing the last outlying mountain barrier down a canyon separating the Cerro de Raymundo and the Cerro de las Cuevas, debouches on the level plains of Coahuila and until recent times found outlet in the sinks of Lake Mayran, known also as the "Lago de las Habas."
>
> The copy of a map prepared in 1731 defining in part the boundaries and natural landmarks associated with the Mayorazgo de San Miguel de Aguayo clearly names and indicates the channels of the rivers, but the lake depository of the Nazas is not shown, nor is there mention of such lake in the land grant description of the property and boundaries. The Spanish cartographer fixes the course of the Nazas as west of the Cerro de Santiago, and for this reason the lake outlet was not within the boundaries of the Mayorazgo, the natural bed of Lake Mayran. Obviously in 1731 the Rio Nazas discharged the flood waters either into Lake Tlahualilo or the depressions south of the Sierras del Venado and Sobaco. . . .
>
> An account of the region published in a report prepared by S. Mallett-Prevost for the Compania Industrial Colonizadora Limitada del Tlahualilo under date of September 1, 1908, affords much information relative to the status of Lake Mayran at that time, and records the date of the change in the Nazas channel resulting in the diversion of the river waters from the Tlahualilo outlet to Lake Mayran as of 1839.

The following excerpts are from Mallett-Prevost (1908).

> Available maps by the engineer Federico Wulff prepared in great detail of the Laguna district and published under date of April 6, 1914 clearly show the position of Lake Mayran, Viesca and the river channels. In 1914 the western margin of Lake Mayran is mapped as having receded to the railroad station of Benavides. A sketched-in map by the engineer places the lake margins during the height of flood water periods, during the approximate time of the "Eighties," as extending from the outskirts of the Pueblo of San Pedro eastward to the railroad station of Madero, with Benavides midway of the lake area. In 1887 the lake surface of Mayran varying with seasonal influences had a maximum length of 50 miles. . . .
>
> Prior to 1839, the Nazas, after entering the "Laguna," turned northward; and, as there were at that time neither canals nor cultivation, it poured its entire volume into "Lake of Tlahualilo," as it was then called. But, like the Egyptian Nile, the Nazas carries great quantities of silt which it brings from the mountains and which it deposits, here and there, according as the velocity varies. During past ages, this must have resulted in repeated changes in the course of the river, as is evidenced by the character of the "Laguna" valley, which appears to have been formed by the deposit of river silt. Be this as it may, in the year 1839 the river left its former bed, almost immediately after it had entered the "Laguna," and flowed eastward to another part of the valley, where it formed a new deposit, known as "Lake Mayran," or sometimes as "Lake de las Habas." The ancient lake of Tlahualilo, left forty miles away, gradually dried up, and for lack of moisture became in time a barren desert.
>
> During the early part of the last century, the "Laguna," then known as "Rincon de los Pastores," was inhabited by Indians. These were driven out by bandits, who made the place a favorite rendezvous; and who, in turn, were expelled by troops from Nuevo Leon and Coahuila, which at that time constituted a single state.
>
> It was not until 1849 or 1850 that the valley began to be cultivated. At or about that time, the first dams, known respectively as "San Fernando" and "Santa Rosa," appear to have been constructed. Both of these were near the entrance to the "Laguna"; San Fernando (which today belongs to the Tlahualilo Company) being in the upper, and Santa Rosa the lower. It is not clear which of these two was built first; and indeed, it is even possible, though not likely that the Calabazas Dam, a little lower down, may have been constructed at about the same time, or may even have antedated the other two. . . .
>
> In 1888, at the time when the Tlahualilo concession was granted, there was a great surplus of water going to waste. This surplus was sufficient to form a lake of from 3 to 4 meters in depth, covering an area of 354 sitios or say 621,856 hectares [10 to 14 feet deep and more than 2,300 square miles in area]. That lake had existed from the year 1839 when the Nazas River changed its course making Mayran its terminus instead of Tlahualilo. Today the lake has disappeared and all the water of the river, except such as escapes in brief periods of great floods, is utilized.

Returning to L. J. Goldman's notes of 1942 (USFWS files):

> With the lapse of time this method of water diversion has been progressively developed in supplying the needs of the steadily increasing agricultural acreage, and proportionately less volume of water has reached the river outlet in Lake Mayran. At the present time the lake is practically dry and the most recent occasion when the sump collected water in considerable quantity was in the year 1938.
>
> Today Lake Chapala is the largest lake in Mexico. At the time of the Conquest the lake system of the Valley of Mexico rated a close second. Lake Mayran or the "Lago de las Habas," now dry or nearly so, within the memory of man was greater than either.

Presa Cardenas (El Palmito or Rio de Oro), Durango (33)

This reservoir is referred to in some of the aerial survey reports as Rio de Oro, and it is also called El Palmito. It is on the Rio Nazas, and stores irrigation water for the Laguna district, which is the very important cotton-growing area near Torreon, Coahuila. Presa Cardenas is 135 km west of that city, and its ele-

vation at flow line is about 1,580 m. The water from this river system formerly fed the great *bolson*-lagoon and marshes of Mayran, but as a result of these diversions that famous basin is now dry, except in very wet years.

El Palmito is long and winding in outline, about 43 km in length, and varying from 1.6 to 4.8 km in width, according to the aeronautical chart of 1963. Its water storage capacity is 3×10^9 m^3, which makes it one of the largest reservoirs in the Republic. There is a great fluctuation in water level, due to its heavy use for irrigation. Arellano and Rojas (1956) reported that at the time of their visit on 25 February 1955, the water was a clear green color, had a pH of 7.0, and contained no aquatic vegetation other than algae.

This mountainous area is a difficult one to scout by plane at low level, and at times of adverse weather conditions it has not been possible to make the January aerial survey.

On the survey in 1961 the estimate of ducks seen was 1,005; pintail and green-winged teal were the most common species. There were also 780 lesser snow geese and 176 white-fronted geese. The geese and some of the ducks rested there but fed in agricultural fields to the east.

Laguna de Santiaguillo, Durango (34)

This laguna, the southern end of whose basin is 70 km north of the city of Durango, usually is important to migrant and wintering waterfowl. It was especially good in past years when water and food conditions were more favorable. With the great extent of deforestation in the drainage area, the number of small reservoirs put upstream on its tributaries, and the volume of water drained off to irrigate crops, the amount of water left in the basin in winter months has been highly variable from year to year. In some years it has been dry. The principal tributary stream is the Rio Tinajuelas.

This elongated natural basin, which lies in a northwest-southeast direction, has an earthen dam across its middle which separates it into two main parts. The one to the northwest still is called Santiaguillo, and that part to the southeast is locally known as Guatimape. The former was dammed years ago to control its water level for purposes of irrigation, but the project was reported to be unsuccessful. According to the navigation chart of 1963, the basin of Santiaguillo then was 19 by 6.4 km, but the little water it contained when photographed was a shallow, elliptical lagoon only 1.6 km wide and 5.6 km long. The basin of Guatimape measured 21.6 by 8.8 km, and was entirely dry when photographed. At times the double basin contains three bodies of water, one at the north end, one in the main sump, and one in the southern end. The general elevation of the basins is about 2,010 m.

The village of Guatimape is west of the narrows separating the two basins. According to the engineering reports cited by Arellano and Rojas (1956), the extent of the water area before its diversion was about 16,000 ha. When they visited the locality on 29 February 1955, Santiaguillo was dry, but they described Guatimape as nearly square, and said it measured 4 km on each side, with an area of 1,600 ha. They reported the maximum depth as 2 m, said the water was turbid and coffee-colored, and found no submerged or emergent vegetation. The bottom is muddy and the laguna is often swept by winds; the excessive turbidity probably inhibits the growth of vegetation.

Often in Mexico the names of the lagunas may change. The southern part of Santiaguillo, which Arellano and Rojas (1956) called Guatimape, was known by other names to L. J. Goldman, Pacific Flyway biologist, who visited it occasionally in the 1930's and early 1940's. He says of this basin (USFWS files):

> The Lagunas of Santiaguillo and Canatlan are both situated at the northern end of the Guadiana Valley in Durango. The latter is 5 miles [8 km] to the south of the former, and is also known as the Presa Desta Lucia. . . . Both lakes have been made into reservoirs with dikes at their southern outlets. . . . This lake district has a water area 30 miles [48 km] in length. Contiguous along the shores are wide grassy meadows, below the outlets are marshy flats, and adjacent are extensive cultivated fields of corn and oats, notably on the land of the Mennonite colony where grain is grown on an extensive scale. Southward from the lakes are many miles of grass-grown valley lands, with . . . sluggish tributary streams of the Rio Sauceda. . . .
>
> The setting is typical of the goose and sandhill crane wintering ground of Chihuahua and Durango. Here the birds gather in thousands; the geese mainly of the lesser snow variety; and ducks well represented by groups and small gatherings of the various migratory and local species.

The aerial surveys have reported a great fluctuation in conditions and numbers of birds at Santiaguillo. The lake was evidently in poor condition in 1951-53, but had more water in 1954. In 1955, there were only small areas of water but in 1956 the levels were good. The year 1958 was dry and no birds were seen there; in 1959, however, its levels were high and there was an excellent population of waterfowl, including 92,000 ducks and 5,450 geese. Since then its levels have dropped and then risen again. In 1963, the southern part was dry except for two pools, and the northern part was so shallow it appeared that fishermen could walk anywhere in it. In 1964, the water conditions were good and, in 1965, even better.

On the January surveys of Santiaguillo, the estimates of ducks seen ranged from 400 in 1953 to almost 93,000 in 1959; some other estimates were 5,630 in 1951, 13,750 in 1955, 4,922 in 1960, and 17,850 in 1965 (average, 16,458).

To illustrate the composition by species, in 1959

there were 31,750 pintails, 24,950 green-winged teal, 19,550 shovelers, 8,600 blue-winged and cinnamon teals, and smaller numbers of wigeons, gadwalls, and divers. There also were 4,400 snow geese and 1,050 white-fronted geese. The average number of ducks seen on the aerial surveys was about 2.9% of the total seen on highland wintering grounds.

The numbers of the lesser snow geese ranged from 6,570 in 1952 to 400 in 1953, and averaged 3,470. Among white-fronted geese, the range was from 2,595 in 1962 to 240 in 1954 and an average of 1,315.

Villa de Cos (El Salado), States of Zacatecas and San Luis Potosi (35)

Groups of small reservoirs east of Villa de Cos and from 48 to 72 km northeast of the city of Zacatecas are combined under this name in the reports of the aerial surveys. The streams that supply them appear to be in a closed basin.

On the several aerial surveys that included this area, the average number of ducks seen was about 1,400. The common species were the shoveler and pintail, accompanied by small numbers of the green-winged teal and gadwalls, and from a few hundred to more than 1,100 white-fronted geese.

Presa Calles, Aguascalientes (36)

This reservoir is in the mountains (Sierra de Pabellon) about 32 km northwest of the city of Aguascalientes. Arellano and Rojas (1956) gave the following information regarding it: The dimensions when full are 4 by 3 km, and its area is about 1,200 ha; its level fluctuates greatly because of the water used for irrigation; the pH on 5 June 1955 was 7.0; its elevation is 2,040 m; the only aquatic vegetation they saw was algae.

This mountain lake cannot be surveyed satisfactorily by plane, and because it has negligible use by waterfowl, it has been omitted from the survey coverage.

El Languillo, Jalisco (37)

This name applies to a series of small reservoirs in the valleys of the tributaries of the Rio Verde, between Encarnacion de Diaz and Ojuelos de Jalisco.

On the few aerial surveys which included this area, the average number of ducks seen was about 1,500. The common dabblers were represented, but the pintail, shoveler, gadwall, and green-winged teal were the most frequently seen species. There were also a few diving ducks, chiefly the canvasback and bufflehead, and small numbers of white-fronted geese.

Laguna de Magdalena, Jalisco (38)

This lagoon, near Magdalena, Jalisco, is about 43 km west-northwest of Guadalajara at an elevation slightly below 1,525 m. It has varied greatly in extent, depth, and attractiveness to waterfowl during recent years. According to maps of the 1920's and earlier, and to local hunters, the water area used to cover many square kilometers during wet cycles before so much of its water was used for the irrigation of crops. It formerly extended from the railroad right-of-way of the Nacional de Mexico near Etzatlan north to the right-of-way of the Sud Pacifico de Mexico at Magdalena, a distance of about 19 km. It was about 6.5 km across at its broadest part near the southern end.

Although it is a natural lake, it has been dammed for agricultural purposes, and in years of low rainfall little or no water remains in it for waterfowl. At the time of our visit on 25 March 1960, local observers said that the past 2 years had been wet ones, but that the preceding 3 years had been very dry. In spite of the past 2 years of abundant rainfall, the drawdown for irrigation had been so heavy by late March that the lagoon consisted of only two small bodies of water, each not more than 4 ha, surrounded by a solid mat of water hyacinths. The only other plants were several small clumps of southern bulrushes. In the outlet canal and adjacent tiny pools there were spikerushes, bladderwort, water hyssop (*Bacopa* sp.), and algae. The laguna had been much deeper earlier in the winter before heavy irrigation occurred.

We were told by local hunters that in 1950–51 about 500 snow geese were wintering there, along with several thousand ducks, but we were unable to scout the lagoon at that time.

Laguna Quemada, located a few kilometers to the northwest, was dry in 1960. In past years it often had water and enough waterfowl to attract hunters from Guadalajara.

Laguna de Cajititlan, Jalisco (39)

This lagoon is about 27 km south of Guadalajara. It is about 11 by 3 km and somewhat below 1,525 m in elevation. In one or more survey reports, the number of ducks seen at this laguna, together with those on the small reservoirs near the Guadalajara airport, were listed together under the collective name of El Zapote, a nearby village. Cajititlan is included chiefly because of its proximity to Guadalajara and its interest to people in that locality.

On 25 March 1960 the lagoon was scouted by Ralph Andrews and Venustiano Aguilar. Andrews reported:

> Very windy today and water quite turbid. Unable to examine lake by boat. Water level very high (it borders on stone walls at the village). Relatively small amount of hyacinth. Lake said to be about five to six meters deep. Some *Panicum* sp. encrusted with algae, growing in shallow water, heavily grazed. Small islands of bulrush . . . especially along west side; very little cattail. Shore is very rocky. Algae marks on rocks indicate water has been three feet [1 m] higher. Some ducks ob-

Fig. 11. Lake Chapala, Jalisco, and Michoacan, 17 January 1948—Many thousands of pintail, shoveler, green-winged teal, wigeon, and other dabblers, as well as a few divers, were feeding and resting near the eastern end of this largest of Mexican lakes during the waterfowl survey. The total number of ducks observed was about 142,000. In recent years fewer waterfowl have wintered there.

served. There are corn fields (now fallow) nearby, and some fields of irrigated wheat (nearly ripe).

This laguna and the nearby reservoirs have been surveyed on very few flights. In 1952, the tally, which was typical, included the following: shovelers, 2,300; gadwalls, 2,200; wigeons, 1,850; pintails, 800; blue-winged teals, 760; and canvasbacks, 380.

Lago Chapala and La Barca (Lerma Delta), States of Jalisco and Michoacan (40)

This lake, the largest in Mexico and in earlier years perhaps the most important to waterfowl in the Republic, is 35 km south of Guadalajara, Jalisco, the second largest city in Mexico. It was about 75 km long and 20 km wide near its center. Its long axis is east to west, and it extends from latitude 20°7′ to 20°20′ N, and from longitude 102°41′ to 103°27′ W. It is fed chiefly by the Rio Lerma, but also receives the waters of the Duero, La Pasion, and Zula rivers, all of which enter near its eastern end. The outlet is near Ocotlan, which is several kilometers to the north of the delta.

Lake Chapala is an important locality for recreational hunting and fishing (Fig. 11). More hunting and fishing would be done, but the best parts of the lake are made almost inaccessible during some years by the vast beds of water hyacinths.

E. A. Goldman wrote (1926, USBS files) the following general comments about this locality:

> Lake Chapala . . . lies in a basin at the lower end of an extensive valley . . . or gently sloping plain. This plain as a whole includes western Guanajuato and Queretaro, part of eastern Jalisco, and northern Michoacan. It has an altitude of about 5,000 feet [1,525 m] in the lowest part and rises a few hundred feet at the upper end. On the borders are low hills and mountains that encroach here and there, giving the valley an irregular outline but nowhere breaking its continuity. Lake Chapala, however, is closely bordered, especially toward the western end, by hills and low mountains, which, like most of those about the great valley, are of volcanic origin. The valley forms the southwestern part of the Mexican tableland, and is traversed by the longest river of Mexico. This river, with sources in giant springs at more than 8,000 feet [2,438 m] altitude in the interior valley of Toluca, takes a northwesterly course as the Rio de Lerma, to the eastern end of Lake Chapala. At Ocotlan, only a few miles away, it leaves the lake again as the Rio Grande de Santiago, which enters the Pacific a short distance north of San Blas, Nayarit.
>
> The upper part of the valley includes some of the more arid interior sections of the country where irrigation is necessary to produce crops. Rains are more frequent near Lake Chapala, but even there irrigation is utilized, especially below reservoirs to supplement the usual summer rains from the first of June to the last of September. Heavy winter rains sometimes occur during January and February. For the most part, however, the winter season is dry. Immediately along the shore of the lake and the adjacent slopes of hills frosts are almost unknown, but elsewhere they occur every winter, although not very severe.
>
> The vegetation near the shore of Lake Chapala and on the southern slopes of hills where frost is absent or rare includes a silk-cotton tree, wild fig, guava, tree morning-glory, *Bursera*, *Erythrina*, *Lantana*, and a large organ cactus. More generally distributed are the mesquite (*Prosopis juliflora*), huisache (*Acacia farnesiana*), and the guamuchil (*Pithecollobium dulce*). Bald cypresses, willows, a species of ash and *Baccharis* grow along streams.

The depth of the lake has decreased considerably during the past 50 years, due chiefly to the vast amounts of sediment brought in by the rivers and to the erosion of the surrounding mountain slopes. In 1937 the maximum depth reported by Matsui was 13 m, according to a quotation by Arellano and Rojas (1956); the latter also reported that between 1943 and 1954 the lake level dropped 4.3 m. Much of this decrease was caused by the damming of the Lerma River at several points upstream, and several huge irrigation reservoirs left only a small flow for Lake Chapala. In addition to this, the outlet stream has been used to generate power at Ocotlan.

Because of the importance of this lake and its delta to waterfowl, especially in past years, the following accounts of some of its history are of interest. They are from E. A. Goldman (1951:172-178).

> La Barca is a town at about 5,000 feet [1,525 m] on the Rio de Lerma, a few miles above the outlet, in the east end of the Lago de Chapala. On January 7, 1903, we moved from Ocotlan to La Barca, where we spent 3 days in the great marshes then existing near that place. I revisited the locality during three separate periods in connections with winter investigations of migratory waterfowl in Mexico. . . .
>
> These areas in the delta of the Rio de Lerma were, when first visited by Nelson and me (1903), probably the largest and most important freshwater marshes in all Mexico. There were two main divisions; the Cienega de Guarache, which extended from near La Barca to the lake, and another large marsh, the Cienega de Cumuato, to the southward, near the southeast corner of the lake. The two marshes covered a number of square miles and formed the wintering ground for hundreds of thousands of geese and an equal if not greater number of ducks, coots, and many other kinds of waterfowl. The marshes contained a rank growth of aquatic vegetation of many kinds, of which perhaps the most important was an aquatic grass or grasslike plant, locally known as camelote [*Eleocharis*], that had a tender succulent base much sought by the geese. Along the borders of the marshes were extensive areas over which cattail flags, called tules, grew to a height of 10 or 12 feet [3 to 3.6 m] and furnished material for an extensive local industry in the making of mats. These tules were also used in the construction of picturesque habitations by fishermen.
>
> During the period from 1909 to 1912 advantage was taken of a low stage in water level to build a dike as a government project across the lake, thus reclaiming 20,239 acres [49,991 ha] of delta land, including the marshes described. At the same time the channel of the Rio de Lerma was diked on the southern side, confining the stream against the north bank to prevent the water from spreading into the delta. The length of the two sections of dikes is said to be a little over 30 miles [48 km]. The dike when built was 30 meters wide at the base, 4 meters wide at the top, and had a height of 4 meters. Twenty thousand men, mainly Indian laborers, were employed, and all the material in the great earth fill was carried and dumped in place by men using baskets.
>
> As the water evaporated much good agricultural land was exposed and, at the time of my second visit in 1926, was cultivated to corn, wheat, garbanso, and various other crops. The exclusion of water had obliterated the great marshes I knew in 1903. The camelote, the favorite goose food, appeared to be entirely gone, and the tules were reduced to insignificant patches. In the vicinity of springs within the diked-off area, however, spreading water maintained marshes of varying sizes up to 100 acres [40.5 h] or more, affording considerable open water and feeding and resting places for waterfowl, while the neighboring grainfields supplied additional food. As a result many ducks and some geese were present, but it was significant that the geese in the former great numbers were gone. The reduction in geese especially was due to the apparent extirpation of the camelote.
>
> At the time of our visit in 1935 most of the small marshy areas had disappeared. Thousands of acres in the diked-off area had been planted to corn, but the soil appeared to have lost much of its fertility. The land had been extensively invaded by Bermuda grass and was being used mainly for grazing purposes. On revisiting the locality in February 1936 we learned that about September 1935 a break in the dike led to the flooding of the entire area within it. Thousands of acres of corn were already in the ear, and the flooding resulted in a total loss. There was a very decided tem-

porary gain for waterfowl, mainly ducks, however, of which we estimated the number at 500,000, where we had estimated 100,000 the year before.

When first visited in 1903 the Lerma delta near La Barca was undoubtedly the greatest winter waterfowl concentration area in Mexico and was especially favorable for geese, owing to the abundant growth of the aquatic plant camelote. The construction of the dike, affording water-level control, would have further increased its value for waterfowl if it had been administered for that purpose; and it still is of outstanding potential value for waterfowl. The suggestion of the desirability of creating here a great federal refuge was made to the game department, but although the land in 1935 appeared to have lessened fertility its value for agricultural and grazing use will probably always preclude the carrying out of any such plan for the creation of a refuge. The land was originally reclaimed under government auspices but we understood it was subdivided and parceled out to agrarians under the new land system in vogue in the country. We were informed that plans were being made to close the breech in the dike and thus again provide for the recovery of land through evaporation.

Another reference in literature that illustrates the former greater importance of this wintering ground is by Nordhoff (1922:64-65), who visited there in 1909.

> The fresh water marshes of Lake Chapala, in the state of Jalisco (and Michoacan), Mexico, form another haven for waterfowl. At one end of the lake there is a great area of flooded land cut by a veritable labyrinth of sluggish channels, 400 square miles [1,036 km²], I should say. The far interior of this swampy paradise, reached after three days' travel in a native canoe, is a vast sanctuary for wildfowl, a region of gently-rolling, damp prairies, set with small ponds, and traversed by a network of navigable channels leading to the great lake. I saw as many geese, white-fronted (*Anser albifrons*) and Snow (*Chen hyperboreus*), as I have ever seen in the Sacramento Valley, and the number of ducks was past belief, with some interesting species, like the Masked and Florida Black or Dusky (Mexican Duck), to lend variety. A more thorough investigation of this field would be worth while, for I have reason to believe that several species of northern ducks breed there, and breed at a much later season than in our country. On November 20 I found a brood of young Shovellers (*Spatula clypeata*) unable to fly, and the natives told me that hundreds of ducks nested there, among them Gadwall, Dusky, Sprig, Shoveller, and Cinnamon Teal.

Not only has the diking and drainage of the delta lagoons and marshes (Fig. 12) greatly reduced the waterfowl habitat and use at Chapala, and the much curtailed flow of the Rio Lerma has dropped the water level of the lake, but also the great spread of water-hyacinths has had a disastrous effect some years. This pest plant was reported to have been in the lake before 1900, but apparently it was not a serious menace until recently. By March 1960 hyacinths covered many square kilometers at the eastern end and eliminated most of the good feeding grounds for waterfowl by shading out the submerged plants. They also prevented fishermen and hunters from entering much of the lake. The latest reports indicate that the situation is better and that in 1965 hyacinths covered much less of the lake. In spite of this improvement, the recent use of this lake by waterfowl shows an unbelievable decline from its former great numbers.

On the first aerial survey there in 1948 the numbers of ducks seen were 32,020 shovelers, 30,375 pintails, 26,075 green-winged teal, 10,575 gadwalls, 8,115 lesser scaups, and small numbers of several other species. The total was 128,210. The estimates of ducks seen on some of the later January surveys were 56,030 in 1951, 99,675 in 1955, 21,727 in 1960, and 17,402 in 1965 (average, 56,970). This average is 10.2% of the total average number of all the ducks seen on the aerial surveys of the highland wintering grounds during the years 1951–65.

In January 1965 the principal species were green-winged teal (2,930), Mexican ducks (1,326), and pintails (1,080); total ducks about 17,000, including about 6,000 unidentified. These were very small numbers compared to the vast flocks of earlier years.

As recently as 1956 the number of white-fronted geese seen in the delta was 1,310, but since then the largest number was 190 in 1960, and the average for the past 6 years was only about 45. Snow geese are even less numerous, and during the past 8 years the only record was of 50 birds seen in 1962. No Canada geese have been observed there since 1948, when 115 were seen on the first aerial survey.

Important duck food plants include several species of pondweeds, naiad, widgeongrass, muskgrass, and coontail; valuable emergents include bulrushes, sedges, smartweeds, and grasses. Further data regarding the lake are given by Arellano and Rojas (1956).

Lagunas de Atotonilco and San Marcos, Jalisco (41 and 42)

These shallow lagoons about 14 km west of Lake Chapala were originally one, but sedimentation and declining water levels have separated them. Atotonilco is west and northwest, and San Marcos is southeast of Lake Chapala. Their elevation is about 1,350 m. The Atotonilco basin is about 25 by 5 km and has two principal lobes which are now separated by about 4 km of slightly higher ground. The northern lobe, which is adjacent to the villages of Atotonilco and Tizapanito, is about 13 by 5 km; the southern one, now dry in many or most years, is about 11 by 2 km in dimensions, as shown on the aeronautical charts. The basin of the San Marcos lagoon is about 13 by 4 km, but it is dry most of the time.

They are very shallow and highly alkaline lagoons, without aquatic vegetation, either submerged or emergent, except for a few clumps of southern bulrushes. The water has at times been used for irrigation, but be-

Fig. 12. Drained marshes of Lake Chapala—For miles above its place of entry into Lake Chapala, the Rio Lerma is channelized and bordered by levees. A part of the former vast marshes of the delta that were so important to waterfowl, now drained and farmed, is seen beyond the river. The village of Brisenas is in the foreground; the river flows to the right (west).

cause of its salinity it is not suitable for municipal purposes (Arellano and Rojas 1956).

The shore vegetation is very sparse due to the highly alkaline soil and to overgrazing by livestock. Waterfowl food is largely limited to the larvae of insects and to crustaceans, including the small shrimp called *acociles*. In March 1960, its salinity was about 15% of that of sea water. The maximum extent of these lagoons in wet years is about 7,200 ha (Arellano and Rojas 1956).

During some years, Atotonilco has had several thousand ducks and several hundred geese at the time of the January surveys. These birds have found it a safe roosting place, but have fed elsewhere unless they were satisfied with insect larvae, crustaceans, and plankton. Atotonilco is also a favorite place for thousands of migrant and wintering shorebirds, including many American avocets (*Recurvirostra americana*).

On the January surveys of Atotonilco, the estimates of ducks seen in some representative years were 6,520 in 1951, 2,048 in 1955, 28,675 in 1959, 2,759 in 1960, 890 in 1962, and 1,985 in 1965; the average was 5,122. The most numerous species usually are the pintail and shoveler.

Laguna de Sayula, Jalisco (43)

This laguna is a large alkaline *playa* 14 km from the southwestern corner of Lago de Chapala. It is 25.6 km long and 6.4 km wide at its broadest places and 3.2 km across at the narrows near its midsection. Its northern end is about 13 km south of the southern margins of the Lagunas de San Marcos and Atotonilco and about

25 km southeast of the town of Zacoalco. This laguna is in a sump which has no outlet, but its basin is so shallow and the evaporation is so high that in drought years it is partly or entirely dry.

When it has water, the principal duck foods are several kinds of insects (chiefly their larvae), tiny shrimp (*acociles*), and other small crustaceans. The seeds of a variety of upland plants, including *Helianthus, Argemone, Bidens, Pithecellobium,* and many others, are carried into the laguna by the runoff from the adjacent slopes, and they occur in drifts in the shallows. The margin of the basin is relatively barren of vegetation except for patches of short, heavily grazed grasses.

When the laguna was visited on 19 March 1960 much of the basin was dry, and no submerged aquatics were found in the water along its southeastern side. No ducks were seen, but there were large numbers of shorebirds. It is a very important feeding place for them, as it is for some wintering and migrant ducks in wetter years.

During 1951-65, the number of ducks seen on the aerial surveys ranged from none in 1962, when it was dry, to almost 53,000 in 1959 (average, about 19,000). This average is 3.4% of the average number of all of the ducks seen on the aerial surveys of the highland wintering grounds during 1951-65. The principal species usually are the shoveler, green-winged teal, pintail, blue-winged teal, and gadwall. Occasionally small numbers of diving ducks are also observed.

Laguna Zapotlan, Jalisco (44)

Laguna Zapotlan near Ciudad Guzman, Jalisco, is about 15 km² in area, with an elevation of about 1,510 m. It is a good duck lake, is about 1 m deep, and has an abundance of submerged and emergent vegetation. Duck foods include widgeongrass, spikerushes, southern bulrush, many sedges, and grasses. There are extensive beds of cattails, some of which, along with bulrushes, are cut by residents for the weaving of mats (*petates*).

Ducks observed here have included flocks of all three teals, gadwall, wigeon, shoveler, fulvous whistling duck, and Mexican duck. On 19 March 1960, several hunters armed with muzzle loaders were seen driving coots to obtain a better group shot on the water. One hunter queried had bagged only a woodpecker.

On the January aerial surveys of Zapotlan, the estimates of ducks seen in some representative years were 5,160 in 1951, 14,450 in 1955, 2,600 in 1960, and 335 in 1965; the average was 5,369. The common species of ducks are the shoveler, gadwall, and pintail. Small numbers of white-fronted geese occasionally winter in the vicinity.

Lagos de Moreno, Guanajuato (45)

The estimates of waterfowl in this area are of the birds seen on the reservoirs north and south of the city of Lagos de Moreno. These reservoirs are chiefly on the tributaries of the Rio San Juan de los Lagos. The largest impoundment is called Cuarenta and has a capacity of 30 million m³.

The average number of ducks seen in this locality on the aerial surveys of 1961-65 was 3,240. The principal species are the green-winged teal, pintail, Mexican duck, and several other dabblers, as well as the canvasback, ruddy duck, and ringneck. A few white-fronted geese also winter there.

Leon, Guanajuato (46)

This name is given to the series of small reservoirs south of the city of Leon on tributaries of the Rio Lerma. On the few aerial surveys of this area, the numbers of ducks seen averaged about 600; the Mexican duck, pintail, and green-winged teal were the most common species.

Irapuato, Guanajuato (47)

This name applies to the reservoirs southwest and northwest of the city of Irapuato, and to the tributaries of the Rio Turbio, which in turn flows into the Rio Lerma. The largest reservoir is about 24 km southwest of the city.

The numbers of ducks seen on the aerial surveys in this area ranged from about 2,000 to 24,000, and averaged about 11,000. The most common species were the green-winged teal, pintail, and Mexican duck; smaller numbers of the shoveler, blue-winged teal, and others were also present. Among the diving ducks the ring-necked duck and redhead were seen most often. Usually several hundred white-fronted geese also are observed.

Laguna de Yuriria, Guanajuato (48)

This laguna is adjacent to the village of Yuriria, in a setting of semiarid, rolling terrain, northwest of Acambaro and southwest of Celaya. Its name has been shortened from the Indian name of Yuririapundaro (lake of blood). It was formerly an extensive marsh which became flooded in wet years, but in 1548 a feeder canal was constructed by Augustinian friars to connect it with the Rio Lerma. A system of levees was also built to maintain the reservoir, and the cultivated fields in the adjacent valley of Santiago were irrigated with this water. Arellano and Rojas (1956) gave a detailed account of this lake, including its history, geography, and water depths. They reported that the pH of the water on 11 September 1954 was 7.0.

With the reduction of the water supply from the Rio Lerma, due to the construction of reservoirs upstream and because of other diversions, Laguna Yuriria now receives little, if any, flow from there. In recent years,

a canal was dug from the northeastern corner of Lake Cuitzeo to the western end of Yuriria, which are about 21 km apart. At times of high water in Cuitzeo there is a gravity flow to the lower elevation of Yuriria. Unfortunately, Cuitzeo now often has too little water for its own basin.

The dimensions of Yuriria are about 16 by 6.5 km, and its long axis is from east to west. Its altitude is about 1,740 m; it is oblong and has an irregular outline, some islands, and many shallow bays. The area reported for it in September 1954 (Arellano and Rojas 1956) was 8,600 ha. Because of the heavy use of water for irrigation, its level has fluctuated greatly. In parts of the lake the water is a turbid coffee color, but where aquatic vegetation is common it is clearer. Water hyacinths cover much of its surface. Most of the marsh is at the eastern end of the basin.

On 15 March 1960, when R. Andrews and V. Aguilar scouted the southeastern part of the lagoon, they found no submerged aquatic vegetation, but only southern bulrush, smartweed, and water hyacinth. Much of the bulrush had seeded heavily. Ducks seen at that late date included 25 Mexican ducks, 40 green-winged and blue-winged teal, 25 cinnamon teal, 30 wigeons, and 4 gadwalls.

Much of this lagoon is very shallow and often windswept. The fine silt is kept in suspension much of the time, and even when there is very little wind the water is a muddy coffee color. Several places on the western shore, near the mouth of the stream from Moroleon and along the southern shore to near the southeastern corner, were examined in 1960 for drifted vegetation. The only plants found were great masses of hyacinth, mostly winter-killed or left stranded by a receding water level, and occasional pieces of smartweed. There were no snails or any insect larvae observed.

In 1960 a local shepherd told us that in 1957 all of the eastern part of the laguna was dry, and that most of the bed was then planted in wheat, cantaloupes, and watermelons. During the previous year (1956), he said, the dam at the southeastern end had washed out, so there was no water control, and the fishermen in this part of the lake had to go elsewhere. Evidently the dam was repaired, because since 1958 there has been enough rain for the level of the lake to be fairly high. This level was actually so high in 1958 that some landowners had to move irrigation pumps away from adjacent fields that became flooded, and at the southeastern corner of the lagoon the water extended across the highway near kilometer 18.

There has been a great fluctuation in the number of waterfowl seen here at the times of the aerial surveys. On 18 January 1948, when the first survey of the lake was flown, only 3,355 ducks and 16,050 coots were recorded. This population was the smallest number of ducks seen there on any aerial survey. Since then the totals have ranged from 3,875 in 1953 to 71,290 in 1955. Some other figures were 7,750 in 1951, 17,065 in 1960, 10,803 in 1965; the average was 27,998. In 1955 the most numerous species were shovelers (32,100), pintails (31,235), gadwalls (4,850), ruddy ducks (1,490), Mexican ducks (1,050), and smaller numbers of other species. There were also 915 white-fronted geese in the vicinity.

This is a popular lagoon for duck hunters, but in recent years the continued spread of extensive beds of cattails and of water hyacinths has complicated the hunters' access by boat and has discouraged shooting in some of the former favorite places. Several experienced hunters told us that there were relatively few ducks there in the 1940's, but that as conditions at Laguna Cuitzeo declined, more birds shifted the few kilometers to Yuriria. This may have been true at the time, but during 1951-65, if waterfowl numbers were low at Cuitzeo, they were not particularly high at Yuriria. In most years, Cuitzeo had large numbers of birds, even when all or most of its western basin was dry.

Acambaro (Presa de Solis), Guanajuato (49)

This large irrigation reservoir on the Rio Lerma is very near, and to the east of, the city of Acambaro, and it is listed in the aerial survey reports under that name. The reservoir capacity is 8×10^6 m^3 and the water is used to irrigate a very large area of croplands in the Lerma Valley to the northwest of Acambaro city. The shape of the lake is very irregular and there are several arms of considerable size. Its principal part is in the Lerma Valley, and has a length of about 22 km from the dam to the upper end of the impoundment. Another arm extends to the northeast in the valley of a tributary.

Presa de Solis would undoubtedly be of greater value to waterfowl if the reservoir's shallow areas were not covered with water hyacinth. These pest plants are abundant in the upper Lerma Valley, and periods of high water flush them downstream into the series of reservoirs. Hyacinths, plus the great fluctuations in water level caused by irrigation uses, greatly limit the establishment and growth of good food plants for waterfowl. Because of this condition, almost all the birds, except coots, use Solis only for resting and do their feeding in the fields and small marshes of the valley during the day.

The records of aerial surveys during 1951-65 show some birds each January. Some representative totals are 1,220 in 1951, 3,100 in 1955, 24,684 in 1959, 8,105 in 1960, and 4,414 in 1965 (average, 5,028). In 1959, the composition of the population was 10,900 wigeons, 8,000 blue-winged and cinnamon teals, 4,050 gadwalls, 1,160 pintails, 570 Mexican ducks, and 4 lesser scaups. These are small numbers for the large size of this reservoir, but the lack of food is the apparent limiting factor.

Lagunas de Zacapu, Michoacan (50)

These include the reservoir adjacent to the city of Zacapu and several lagunas about 16 to 19 km to the northeast. Arellano and Rojas (1956) cited Ordonez and Prado Tapia (1902) as saying that the lagunas are in a basin which was formerly an enormous lagoon, and that the remaining marshes were being drained then to make more agricultural lands. Quiroz Martinez (1931) said the name of the lagoon at Zacapu was Zipimeo. Water from these reservoirs is used for irrigation, and the one at the town of Zacapu is largely for municipal and industrial use. The altitude at Zacapu is about 2,000 m.

Arellano (Arellano and Rojas 1956) stated that the lagoon near Zacapu was 1.75 by 1 km and more or less oval with an area about 197 ha. He reported that vegetation in the lagoon included bulrushes, cane, smartweed, and many arales. Among the submerged aquatics were milfoil and green algae. He added that the establishment of a cellulose factory in Zacapu threatened to cause serious pollution of the lagoon.

The lagoons to the northeast have an elevation of about 1,986 m. According to the latest navigation chart (1963), the largest of the two principal lagoons is about 4.5 by 2.9 km.

These two lagoons were first scouted by plane on 17 January 1948, and the following waterfowl were seen: shovelers, 45,000; pintails, 40,000; gadwalls, 6,000; lesser scaups, 3,500; cinnamon teal, 3,000; green-winged teal, 2,500; unidentified ducks 19,000, and Canada geese 65 (total about 119,000). On the later January surveys of Zacapu, the estimates of ducks seen some years were 20,150 in 1951, 37,485 in 1955, 22,705 in 1960, and 35,895 in 1965. The smallest population was 6,800 in 1958, the largest was 76,900 in 1959, and the 1951–65 average was 41,110.

This average is 7.6% of the total average number of all of the ducks seen on the aerial surveys of the highland wintering grounds during 1951–65. The principal species usually are the pintail, shoveler, gadwall, wigeon, and teals.

Laguna Cuitzeo, Michoacan (51)

This lagoon is in the sump basin into which the Rio Morelia flows, in the northern part of the State about 29 km north of the capital city, Morelia, and very near the boundary with Guanajuato. Its elevation is slightly less than 1,830 m. In past years, Laguna Cuitzeo was reported to have had a large population of wintering waterfowl; however, with its great decline in water level and the loss of much of its food, fewer birds have come there in recent years.

The lagoon's principal sources of water have been reduced greatly by upstream impoundments and other water diversions for irrigation use. With the shrinkage in volume and the high rate of evaporation, its water has become increasingly alkaline. The shallowness, soft muddy bottom, and the prevalence of high turbidity have reduced the submerged aquatic growth in the western bay to a small amount. The eastern bays, with their greater depth and better foods, continue to winter many ducks and some geese.

Arellano and Rojas (1956) quoted Quiroz Martinez (1931) as saying that the area of the Cuitzeo basin was 45,400 ha and that it was covered with water in 1928. Arellano said that its dimensions in 1955 were 50 by 7 km, without counting the extent of its north bay, and he added that the limit of permanent waters in 1955 was only 6,250 ha, which was only about 14% of the area listed in 1931. Although the lagoon is now in a closed basin, during periods of high water it has overflowed into the Yuriria basin. A few years ago an irrigation canal was cut from the north bay to supply water to lands north of Cuitzeo and at the western end of the Yuriria basin, but because of high alkalinity its value for crops was greatly reduced. According to the latest navigation chart (1963), the length of the main body of the basin, from east to west including the southeastern bay, was 36 km, and from north to south it was 7.4 km. The northeastern lobe was 22 km long and 6.4 km wide.

When this lagoon was surveyed on 18 January 1948, the northern bay was dry and the western arm was very low. Many of the ducks and most of the white-fronted geese were seen near and on the southeastern shore, where the Rio Morelia and another stream enter. There are springs and seeps in this locality, as well as an area of meadow and marsh. Ducks were scattered over the eastern bay and around the small, rocky islands. Many of the shovelers and other dabblers were in the shallows of the western bay feeding on plankton.

In the winter of 1949–50 at the time of the ground survey, the western arm of Cuitzeo was dry for some distance to the east of the causeway, but when the lagoon was revisited by car on 15 March 1960, the entire basin had water. Local fishermen said there had been some water in the shallow western arm for the past 4 years.

At the time of the 1950 visit the principal duck food plants in the eastern bays of the laguna were widgeongrass, muskgrass, coontail, and pondweeds. In the shallow, and sometimes dry, western arm of the laguna aquatic plants were not found in the part adjacent to the causeway. Water hyacinths were massed in the shallows, and a wiry variety of bermuda grass, heavily grazed, grew along the shore. In places in the shallows there were small patches of cattails. The only duck food seen there consisted of insects, insect larvae, and small crustaceans in some of the shallows. It was not possible to visit the far western end.

On the 1948 aerial survey the total number of waterfowl observed was 89,980, of which 87,400 were ducks and 2,580 were white-fronted geese. Ducks, by major

species, were shovelers (28,450), pintails (16,610), green-winged teal (11,300), gadwalls (4,425), wigeons (3,975), and cinnamon teal (2,600). Due to poor light conditions during portions of the survey, 28,000 ducks were unidentified.

Other duck estimates during some of the January surveys at Cuitzeo were 63,700 in 1951, 94,700 in 1955, 55,225 in 1960, and 23,765 in 1965 (average, 59,542). This average is 10.6% of the total average number of all the ducks seen on the aerial surveys of the highland wintering grounds.

San Isidro (Presa Tepuxtepec), Michoacan (52)

This reservoir is in the northeast corner of the State and on the Rio Lerma to the east of Acambaro (Presa de Solis). In the few aerial survey reports which list it, the entry is under the name San Isidro, a nearby town.

This reservoir was not visited during the ground surveys, and we have no firsthand information regarding it. The Presa is primarily for hydroelectric use and has wide fluctuations in its water level, which interfere greatly with the growth of aquatic duck food plants. According to the 1963 navigation chart, this reservoir has four long, finger-like bays, the longest of which extends about 13 km from northwest to southeast.

The numbers of ducks seen on the aerial surveys during 1954–65 ranged from a high of 21,680 in 1958 to 930 in 1962, and averaged 6,827. The principal species usually were pintail, green-winged teal, and shoveler, and small numbers of the wigeon, canvasback, gadwall, and Mexican duck.

Lago de Patzcuaro, Michoacan (53)

Patzcuaro has been a fine waterfowl lake for a long time, and it continues to be a favorite wintering ground for many of the species (Fig. 13). It is 38 km west-southwest of the city of Morelia, and is adjacent to the town of Patzcuaro, which has an elevation of 2,174 m. The lake fluctuated in depth and area in recent years due to variable rainfall and increased siltation. In 1943 its dimensions were 15 km from east to west and 17.5 km from north to south; in 1955 it was 10.5 km by 14.5 km (Arellano and Rojas 1956).

We first saw this beautiful lake in its lovely mountain setting in the winter of 1948–49. The concrete pier at the Patzcuaro boat landing was mute evidence that the lake level had dropped several meters since the structure had been built, because it was high and dry above the water and no longer useful for its original purpose. The marks of old shorelines on some of the adjacent hills also are clear evidence of the distance the lake has dropped during this century.

It is very irregular in shape and has three principal parts: one to the northeast known as Seno (Bay) Quiroga, which is connected to the second part, Seno Erongaricuaro, to the southwest by means of a neck, and a third bay to the southeast known as Seno Ihuatzio. The deepest parts are in Seno Quiroga. According to several authors (Waitz 1943; De Buen 1945) cited by Arellano and Rojas (1956), Patzcuaro is now in a phase of regression after having been a much larger lake that formerly was a part of the Rio Lerma system.

The principal source of water is runoff from the immediate basin and from the Chapultepec and Guani rivers; other watercourses are the Tinajas, Quiroga, and Turipan. Arellano and Rojas (1956) quoted De Buen (1944) as saying that the lake had an area of 111 km^2, or 11,100 ha in 1942.

Aquatic vegetation is abundant in the shallower parts of the lake; it extends commonly to a depth of 4 to 5 m, and in some places to 6 m. The shallow bays are margined by wide bands of emergent vegetation, except in places where the cultivated fields have been extended down to the water's edge.

Although at the time of our several winter visits the water was clear, Arellano and Rojas (1956) reported that it sometimes took on the color of the clays and microorganisms in suspension, especially during the rainy season; they (page 217) quoted Osorio Tafall as saying thato various plankton organisms gave it a definite green color. In the bays the bottom soils are deep muds, but in the deeper parts of the lake the deposits are much thinner. One of the most serious problems affecting Patzcuaro is the great extent of erosion, much of it due to the widespread deforestation of most of the lower mountain slopes within the basin. In addition, agricultural fields have been cleared on nearby slopes that are much too steep for them, with increased erosion resulting from this practice.

On 17 March 1960, R. Andrews and V. Aguilar made a reconnaissance by boat, from the channel nearest the Limnological Station at Patzcuaro to the bay to the east and southeast (Ihuatzio). They found many of the food plants growing in more than 3 m of water. Illinois pondweed, for example, was growing from 1.5 to 1.8 m to much greater depths. Although this bay southeast of Patzcuaro appeared to be shallow because of the clumps and islands of southern bulrush and other vegetation in it, these plants were actually growing at depths of 1.5 m or more. Because of the clarity of water, fertility of the soil, and other favorable conditions, the plant growth was extremely abundant.

The silty-clay soil in many places along the shor 'as a varied marsh flora. In some places it is southern bulrush, elsewhere narrow-leaved cattail, spikerushes (one species is 5 to 10 cm, others are up to 45 cm in height, the latter heavily grazed), and mixed herbaceous species, including smartweeds, sedges, rushes, and others. The southern bulrush and cattail are near and along the shore; beyond them in shallow water are arrowheads and banana waterlily, and in deeper waters there are pondweeds, naiad, muskgrass, coontail, and other submerged aquatics.

Fig. 13. Lake Patzcuaro, Michoacan, January 1948—This intermontane lake is important to migrant and wintering waterfowl. It has had fewer ducks in recent years because of its declining water level, increasing siltation, and resulting ecological changes. There has also been a reduction in the number of waterfowl wintering in the Mexican Highlands. The island in the upper left background is Janitzio. This aerial view is toward the ENE.

In the deeper marsh it is impossible to wade with hip boots because of the soft, deep mud and the frequency of holes. Almost all of this marshy shore has a broad band of water hyacinths. If it were not for the frequency of the high winds that sweep the lake, hyacinths probably would soon cover a much greater part of the surface. Winter frosts also may do much to control this pest plant.

Formerly, much of the shoreline along the bases of the adjacent foothills was steep, but with the considerable drop in water level during recent years most of the littoral zone is now shallow, with a gradual descent to the deeper parts. The southern bays, from Erongaricuaro across to Jaracuaro, to Copujo, and to the head of the bay northeast of Patzcuaro, are largely shallow and contain an abundance of submerged aquatic vegetation. These parts of the lake are most attractive to the dabbling ducks, for they provide extensive beds of some favorite food plants, an abundance of insects and their larvae, snails, and small crustaceans. Rafts of divers, predominately canvasbacks, congregate in Quiroga Bay. An examination of its eastern shore revealed many shells of a small pelecypod and of small snails.

On the senior author's first aerial survey of the central highlands in January 1948, the following ducks were seen: gadwalls, 4,900; pintails, 4,300; lesser scaups, 3,355; green-winged teal, 2,435; shovelers, 1,370; wigeons, 670; canvasbacks, 295; and ruddy ducks, 205 (a total of 17,530). The following winter, on a survey by car and boat, the January 1949 duck population was 61,510. In January 1950, it was 63,930. At the time of the 1949 survey by boat, the ducks were

Fig. 14. Tarascan Indian hunters using *atlatls* (throwing sticks) and spears near the marshy shore of Lake Patzcuaro. Duck hunters use shotguns there now, but in early years the natives relied on these spears to kill coots and ducks. Some of the Indians continue to use spears on crippled waterfowl. The dugout canoes are hewed from logs at the lake by the Tarascans.

distributed as follows: the bay near the town of Patzcuaro, 26,600; from there to Erongaricuaro, 22,510; San Andres bay, 2,600; and the north bay and main channel, 9,800. About 76,000 coots were distributed generally over all of the bays, but especially along the southern shore.

On 17 March 1960 during a ground survey there, the number of ducks on the southern half of the lake was estimated at 12,000, including 7,500 gadwalls and wigeons, and about 1,500 each of teals, lesser scaups, and canvasbacks. An abundance of duck food remained in the lake at that late date.

The aerial surveys of the highland wintering grounds were resumed in 1951 and continued until 1965. Some representative estimates were as follows: 16,890 in 1951, 118,930 in 1955, 22,705 in 1960, 4,945 in 1965, and an annual average of about 46,400. The 3 years of 1963–65 all had less than 5,000 ducks, and these small numbers were correlated with the reduced waterfowl population throughout the highlands. The food resources at Patzcuaro were adequate for many times the number of ducks that wintered there.

Lago de Patzcuaro is one of the very few localities in Mexico where the natives commonly hunt ducks. In earliest years, the weapons used were throwing spears of an *atlatl* type locally called *tiraflechas* (Fig. 14). These were replaced later with muzzle-loading shotguns, but the cane spears continued to be used for killing cripples. More recently modern types of shotguns are being used by an increasing number of hunters. During the 3 days of scouting on the lake in January 1949, from 8 to 14 dugout canoes were observed, each with one or two Tarascan Indians hunting waterfowl. All those we talked to were armed with old muzzle-loading shotguns and long cane spears, tipped with three-pronged metal heads (*fisgas*). The Indian in the stern would paddle quietly toward a raft or flock until a bird was within range (usually only coots allowed them to approach that near). Then the hunter who was crouched in the bow would make the shot, and a cloud of black-powder smoke would pour from the antique gun. If the bird was only crippled, the spear was readied and thrown at distances up to 27 m; a hit was usually scored after one or more attempts. Their bags

averaged about 20 coots to every duck. The largest kill on any day we were there was Thursday, 27 January, because Friday is the principal market day in Patzcuaro. Most of the birds shot on this Thursday were cleaned, parboiled, and taken to market, where 250 coots and 15 ducks, mostly ruddy duck and cinnamon teal, went on sale early Friday morning.

Considering the concentration of ducks wintering on this lake, the kill from this type of hunting is negligible, and coots bear the brunt of this very limited shooting pressure. Few outsiders come to hunt there; we saw none except Tarascans during our several days there in 1949 and 1950. In 1952 we saw one party of three visiting Mexican hunters armed with modern shotguns. Since then, hunting by visiting sportsmen has increased, but we are told that it continues to be relatively light.

In 1935, E. A. Goldman wrote the following in his report (USBS files) regarding the hunting at Patzcuaro:

> I was told by Senor Roberto Carrillo, the head of the game section of the Mexican Forestry, Game and Fish Department, that on the 28th day of October of each year the Tarascan Indians make a special organized duck hunt in accordance with a religious observance to provide food for their departed relatives. The birds are cooked and placed on the graves where they are left for a day or two, and at the end of this time the relatives are supposed to have partaken of food and anything that is left may be carried off and eaten by the people.

Laguna de Metztitlan, Hidalgo (54)

This lagoon is near the center of the State and about 13 km northwest of the town of Metztitlan, at an elevation of somewhat below 1,525 m. It was created during the last century by a major landslide that blocked the Rio Metztitlan. In 1888 it was reported to have a depth of 40.4 m and a length of 20 km. Since then it has continued to shrink and on the 1959 aeronautical chart was shown with a length of about 5 km.

Cantu Trevino (1953) mentioned that it was visited by a variety of waterfowl, but the laguna was a sizeable distance from the aerial survey route and was not included in the coverage.

Tepeji del Rio (Tula), Hidalgo (55)

There are two principal reservoirs and several smaller ones in the vicinity of this town, which is about 2,135 m in elevation. One of the two main reservoirs, Presa Endo, is between Tepeji del Rio and Tula on the Rio Tula. It is very deep and steep-walled, and has a water capacity of 182 million m^3. The other, Presa Requena, is on the Rio Tepeji, about 11 km southwest of Tepeji del Rio. It has a storage capacity of 70 million m^3.

Both of these reservoirs, and some smaller ones, irrigate crops in that part of Hidalgo. There are small numbers of ducks in this locality, but there are no specific figures for waterfowl reported from the aerial surveys.

Laguna de Zupitlan, Hidalgo (56)

This lagoon is about 6 km north of Tulancingo. Its elevation is reported to be 2,120 m. It is about 1.0 by 0.5 km, and its long axis is from northwest to southeast. Although it is a natural body of water, it has been modified for irrigation purposes by the construction of a levee and connecting canals.

The Tulancingo Club, a group of hunters, leased shooting rights there. They reported that the laguna's greatest depth was 15 m. There was considerable shallow water with an abundance of aquatic vegetation, and much of the shore was a dense marsh. The bottom was of grey mud and rich in organic material. Most of the shore was very boggy with a great deal of southern bulrush and cattail and an abundance of hyacinth. Growing near the shore was coontail, some muskgrass, naiad, and pennywort. Spikerushes were common in the wet meadows, and out in the boggier parts were bulrushes, sedges, grasses, and cress.

Arellano and Rojas (1956) reported that on 24 August 1954 the pH of the water was 8.0. He also said that on a visit by Dwain W. Warner and technical personnel of the Department of Game on 19-20 December 1953, 63 waterfowl of 9 species, including the 3 teals, pintail, shoveler, wigeon, redhead, lesser scaup, and ruddy duck, were examined in the bags of hunters.

Lagunas Tultengo and Tecocomulco, Hidalgo (57)

On old maps (edition of 1888) these lagoons are divided into two parts; laguna Tecocomulco (sometimes Tecomulco) is to the north and Laguna Pueblilla to the south. The village of Tecocomulco, about 21 km south of Tulancingo, was near the northeastern corner of the basin, and the village of Tultenco, formerly called Pueblilla de San Isidro, was at the southwestern corner. A road was shown crossing the basin between the two parts. Since the 1930's, however, the southern or lower part has usually been referred to by hunters as Lake Tultengo.

This basin is located at latitude 19°52' N and longitude 98°24' W, at an altitude somewhat below 2,745 m. Its shape is a long ellipse and the bottom is relatively flat, with deep alluvial deposits. Arellano and Rojas (1956) reported that the basin was about 17 by 8 km in size, and the aeronautical chart of 1947 showed the lagunas were 11.2 by 3.2 km. When R. Andrews and the senior author were there on 9 March 1960, we were told that the rapid spread of bulrushes had left relatively little open water in the basin. This basin had no natural outlet, but it was partially drained by a canal dug at its southern end to supply irrigation water southwestward to the vicinity of

Tepeapulco. The drainage ditch and irrigation canal were under construction from about 1944 to 1953, primarily to increase the acreage of irrigated cropland and pasture in the valley below, and also to reduce the probability of local flooding at the village of Tultengo (Tultenco).

Before the construction of the canal, the level of the laguna varied from year to year, according to the amount of rainfall in the vicinity. In 1939, for example, it was reported to have been without any surface water, except in channels and pools. During wet years the higher water level joined the two lagoons and temporarily flooded the adjacent lands, and pressure from some of these landowners was part of the basis for the drainage project.

With the drastic lowering of the water level in the basin by drainage, the islands of southern bulrush spread very rapidly so that within the past few years (1960-64) the lagoon has been converted largely into a vast marsh with very little open water. As a result, its use by waterfowl has greatly declined. From an agricultural standpoint, the reduced lake level, caused by digging the canal, was reported locally to have been more of a loss than a gain, due to the drying of the former croplands adjacent to the lake basin because of the lowered water table. With the drainage of the laguna, the first ducks that stopped using the area were the redhead and lesser scaup. When the water level dropped, dense stands of *Scirpus* became established and gadwall and baldpate that used the lake also declined in numbers.

According to hunters who shot there regularly for many years, the lagoon depth was about 0.6 m in 1941. In 1944, which was the peak of water depth, the lagoon was 2.4 to 2.7 m deep and mostly open water, with countless patches of bulrushes. Fifteen species of ducks, including several kinds of divers, were reported to have been shot there. Ruddy ducks were common in the openings of clear water. By 1959-60, as a result of the low water level and the spread of bulrushes, the duck population contained almost all blue-winged teal and redheads had not been seen for 3 years. Day (1949:270-273), who went on a hunting trip to this lagoon, described the conditions which prevailed at that time.

Tultengo still has a good supply of aquatic food plants, but they were formerly much more abundant when there was more open water and less drainage. The principal foods are pondweeds, widgeongrass, naiad, muskgrass, duckweeds, and spikerushes. Animal foods include small snails, aquatic insects, insect larvae, and crustaceans.

All of the migratory species of dabblers and divers that have been recorded as far south as the Valley of Mexico have been shot at Laguna Tultengo. Before the drainage project, it was also a popular habitat for Mexican ducks.

Lagunas de Apam (Apan), Hidalgo (58)

Some maps and reports use the names Apam and Apan interchangeably, but the postal guide lists Apam, and almost all hunters who speak of this locality use the latter name.

The 1963 navigation chart shows a group of three small lagoons west and northwest of the town of Apam. They are the parts of the lagoon basin that had water in them several years earlier, when the aerial photographs were taken for making this chart. On 9 March 1960, when R. Andrews and the senior author visited this locality, the three bodies of water were about as shown on the chart. Local farmers who were cutting hay in the basin said that the western part was called El Caracol, and the others were known as El Valle.

The topographic map prepared by the Mexican Government in 1888 and published in 1894 showed this laguna as one body of water measuring 5,900 m from southwest to northeast, and 4,100 m from north to south. In those years the water area was at least 15.5 km^2.

Arellano and Rojas (1956) said that there were two parts to the laguna, and that the larger was 2 by 1 km and the smaller 1.5 by 1.0 km. They added that the water area was estimated to be 350 ha and that the depth in places was 1 m.

The great decline of this lagoon was caused by deforestation, overgrazing, haying, and drainage. Years ago a canal was dug, which diverted the water from the Apam basin to a reservoir near Tlanalapan, about 16 km northwest. Still in operation, this drainage is undoubtedly the principal factor in the recent decline of the lagoon.

Apam has a great reputation as a waterfowl lake, and for many years it has been a favorite place for some hunters from Mexico City. However, Laguna Tultengo has two hunting clubs and Apam has none. Also, Tultengo has vast beds of tall bulrushes which afford excellent cover for hunters, but the tules and cattails at Apam grow mostly around the margins, and the open water has little emergent vegetation.

The fishing at Laguna Apam was formerly important to many people in three nearby villages. This food source has been largely lost as a result of the diversion of water and the resulting low lake levels.

Apam was also noted not only for the large numbers of birds, but also for the variety of species; it was especially attractive to dabblers, but many redhead, canvasback, ring-necked duck, and ruddy duck were there until 1948. Small numbers of buffleheads, hooded mergansers, and Mexican ducks also were present. Large flocks, chiefly of pintail and green-winged teal, continue to come to Apam when water and food conditions are satisfactory. In 1959, the estimate of ducks was 130,000, including 54,100 pintails and 56,800 green-winged teal. The only divers seen

were 1,100 lesser scaups. On 9 March 1960, the ducks seen at the northern lagoon included 30 wigeons, 30 lesser scaups, 15 gadwalls, 15 shovelers, 12 Mexican ducks, 6 pintails, and 4 ruddy ducks.

Arellano and Rojas (1956) wrote that the marginal vegetation was principally composed of smartweed, and possibly *Glyceria*. When R. Andrews and the senior author visited it on 9 March 1960, the shore vegetation was made up mostly of scattered beds of southern bulrush, cattail, rushes, a small spikerush, dock (*Rumex* sp.), and grasses (including *Glyceria* and perhaps *Muhlenbergia*). Many of the remaining beds of bulrushes and cattails had been cut near the ground or water level by local people for use in making mats, and much of the other vegetation had been harvested for hay. Many grazing animals, especially sheep, were closely cropping the other plants. The principal submerged aquatics seen at the northern lagoon were naiad, pondweeds, widgeongrass, coontail, and muskgrass.

On the January surveys of Apam the estimates of ducks seen were 6,650 in 1954, 11,300 in 1955, 51,775 in 1956, 12,700 in 1958, 128,350 in 1959, 36,735 in 1960, 8,150 in 1961, 8,200 in 1962, and 6,950 in 1965; the annual average was 30,090. The principal species there now are the pintail; green-winged, blue-winged, and cinnamon teals; shoveler; gadwall; and lesser scaup.

Presa de Huapango, Mexico (59)

This reservoir on the Rio Timilpan is about 80 km northwest of Mexico City and 35 km west of Tula in the State of Mexico. Its water capacity is 120 million m^3, and the reservoir itself is relatively narrow and about 11.2 km long.

Its duck population as reported by the aerial surveys ranged from 1,250 to about 23,000, and averaged about 12,000. This average is 2.1% of the total average number of all of the ducks seen on the aerial surveys of the highland wintering grounds during 1951-65. The most common species were pintail, gadwall, green-winged teal, shoveler, and wigeon; smaller numbers of the lesser scaup, blue-winged teal, and cinnamon teal were also seen.

Laguna de Zumpango, Mexico (60)

This freshwater laguna is 40 km north of Mexico City near the town of Zumpango, at an altitude of about 2,290 m. According to Arellano and Rojas (1956), the dimensions of the lake were 5 by 3.5 km, and the area was 1,750 ha. They said the deepest parts were 2 m but many parts of it were shallow. The lake level varies considerably because of the heavy demands made for irrigation water. Much of the lake is surrounded by a levee in which control gates have been placed for the release of irrigation water.

This lagoon, which is owned by the Federal Government, provides hunting and fishing for the local populace. Native fishermen with hand nets dip for small fish (*charales*), shrimp, and axolotls while wading in the shallows. Other fishermen, in homemade boats, use trident-pointed spears to obtain their catch. Local duck hunters roll and bind oval forms made of cattails, bulrushes, and pondweed to fashion their own duck decoys.

There is a great deal of aquatic vegetation, especially in the eastern part of the laguna. The bottom is muddy, and during high winds the water becomes very turbid, except where submerged vegetation is dense. There are extensive beds of cattails and water hyacinths, especially in the northwest part of the lake.

The eastern shore is gently sloping. When Ralph Andrews and the senior author visited it 7 March 1960, its bermuda grass and saltgrass were heavily grazed. The lake is very shallow along the eastern shore and has no emergent vegetation but an abundance of submerged aquatic plants of which pepperwort (*Lepidium* sp.), muskgrass, pondweeds, floating heart, naiad, and algae were the most common. Floating heart appeared to be the most widely distributed plant, but a sampling of the bottom vegetation indicated that naiad was the most abundant waterfowl food. Sago pondweed (*Potamogeton pectinatus*) was also widely distributed and locally very common. Hyacinth was present in extensive masses toward the northwest corner, but much of it had been winter killed and the surviving plants were of small to medium size. It was gratifying to see that despite the water hyacinth, most of the lake surface was open, and there were thousands of clumps of floating heart. Seeds of floating heart are relished by several species of ducks. Hyacinth, floating heart, spikerushes, and bulrushes were being grazed by wading cows.

We also scouted the northern third of the lake, going by boat from east to northwest. The densest vegetation was in the western two-thirds and especially the western third of this part of the lagoon. There were many crustaceans, insect larvae, and small snails.

Zumpango is a good duck lagoon because of its food and its strategic location in the Valley of Mexico. It is attractive to both dabblers and divers. Recently it was selected by the Mexican Department of Game as the site for a waterfowl management program to make it even more attractive to these birds and to provide more shooting for hunters living in Mexico City.

Upper Lerma Valley, Mexico (61)

Most of the flow of the Rio Lerma from the great springs of Almoloya del Rio has been diverted via a tunnel through the mountains to Mexico City. Consequently, this upper valley near Toluca has been vastly changed. Many changes had occurred earlier with the

Fig. 15. A part of Lake Texcoco, near Mexico City, in January 1935. Most of this lake has been drained and the value to waterfowl greatly reduced. (Photo by E. A. Goldman)

drainage of the marshes and channelization of the river, but this major loss of water supply makes an enormous difference in the volume of flow down the valley.

The remaining habitat for waterfowl is in the groups of small reservoirs and marshes scattered down the valley. Hunters who are familiar with the vicinity say that the principal duck lagoons near Toluca are San Mateo, about 1.6 km in length, narrow, and shallow; Santa Cruz, about 2.4 by 0.8 km and very shallow; and several other smaller marshy areas northeast of Toluca and south of Lerma.

On the January surveys of the upper Lerma Valley from near Toluca to Ixtlahuaca, the estimates of ducks seen in some representative years were 23,950 in 1954, 11,800 in 1955, 87,500 in 1956, 95,150 in 1958, 21,500 in 1959, 39,350 in 1961, 6,250 in 1962, and 8,682 in 1965, and an average of about 37,000. Of the wintering grounds that were included in the aerial surveys, the upper Lerma Valley has averaged about 6.6% of the ducks seen in the highlands. The principal species of ducks there usually are the pintail, green-winged teal, shoveler, blue-winged teal, cinnamon teal, and wigeon. Smaller numbers of the gadwall, Mexican duck, and divers were also seen. Diving ducks, including redhead, canvasback, and ring-necked duck, were numerous when the lagoons and marshes were deeper.

A number of sportsmen from Mexico City shoot ducks at these lakes, and some groups lease season hunting rights at a specific marsh. In March 1960, we were told that not more than 100 hunters from the city shot there that season.

Lago de Texcoco, Mexico (62)

This lake (elevation about 2,239 m) is adjacent to, and northeast of, Mexico City near the site of the old Aztec capitals of Tezcuco and Tenochtitlan (Fig. 15). In Aztec times it was an extensive lake and undoubtedly was a very important waterfowl wintering ground. Its dimensions on the maps of 1889 were 19.5 by 10.6 km. A detailed discussion of the lake and its relation to Mexico City was given by Tamayo (1949:2:175–187) and Terry (1947), and more recent comments regarding its changes as they affect waterfowl were made by Arellano and Rojas (1956:197–200) and Goldman (1951:138–139).

Partial drainage of this basin was begun by the Aztecs, continued by the Spaniards, and completed during the regime of President Diaz. The deep Gran Canal carries most of the water of Texcoco to the Rio Tula, but some remains in the sump, the amount depending on the season's rainfall. It was thought in earlier years that drainage would allow agricultural cultivation of much of its basin, but the salinity and

alkalinity of the soil have proved to be too great for this. For years efforts were made to use the incoming runoff from the adjacent hills to wash the salts from the soil, but the amount of this water was far too inadequate for the purpose.

Goldman (1951:138-139) wrote:

> Several lakes at slightly differing levels formerly formed a notable feature of the Valley of Mexico, and have had an important bearing on its history. The principal ones were Lake Xochimilco, Lake Chalco, and Lake Texcoco. The water that formerly filled these rather large lakes had one of its main sources in giant springs in Lake Xochimilco, from which the water passes to a lower level in Lake Chalco and on the larger Lake Texcoco, which occupied the lowest part of the valley and had no outlet. The water of Lake Texcoco was heavily charged with mineral salts, commonly referred to by the people as "tequisquite". . . .
>
> At the time of the Conquest and for many years thereafter the City of Mexico was frequently threatened with inundation from Lake Texcoco, and there was no satisfactory way of disposing of the sewage of the city. In order to relieve this constant menace the cutting of the Gran Canal was begun in 1879. The canal leads from near the City of Mexico northward out of the valley and through a long tunnel to the watershed of the Rio de Tula, an affluent of the Rio Panuco which enters the Gulf of Mexico at Tampico. The canal was finally completed in 1900 and was regarded as one of the engineering triumphs of the Diaz administration. The Gran Canal has served its purpose admirably in carrying away the city sewage and has drained an estimated area of 600 square miles [1,554 km²] of former lake bed, but like many other drainage projects this one has not proved to be an unmixed blessing.
>
> Lake Chalco has been almost entirely drained, and much of the former bed of Lake Texcoco is now a nearly bare plain with a whitish soil and friable surface. When the wind blows, great clouds of dust are carried into the city to the great discomfort of the people. Much of the bottom of Lake Chalco was planted to corn for a time, but the limited fertility of the soil is soon exhausted. On much of the bed of Lake Texcoco mineral salts in the soil are so concentrated that no field crops can be grown. Shallow water still remains on the lowest part of the bottom in the southeastern part of the lake basin.
>
> The lake and marsh areas in the Valley of Mexico formerly afforded extensive and very favorable wintering grounds for migratory waterfowl, especially ducks, that visited the valley in hundreds of thousands. . . . The drainage of some 600 square miles [1,554 km²] of marsh and water area in the Valley of Mexico has, therefore, had an adverse effect on the wintering of North American waterfowl.

In the eastern part of the lake basin, there remain several lagoons, bounded by levees, which are visited by migrant and wintering waterfowl. Although the numbers of birds are only a small fraction of the former concentrations and fluctuate greatly with local conditions, the vicinity continues to be of value to waterfowl.

According to Arellano and Rojas (1956:198), since 1953 the government has modified the Texcoco project to allow the planting of trees in the basin in order to improve conditions for nearby housing developments and to reduce the blowing of dust. They reported that the area of impounded water then was 3,000 ha, and the average depth was 0.6 m.

Lago Texcoco is doomed as a waterfowl area by the rapid expansion of Mexico City, which is building out on the old lake bed; probably within 15 to 20 years there will be no lake. The main body of water is already restricted to the southern part except after heavy rains. Most of the lake is hardly more than knee-deep. The deepest and most open part is that to the northwest, adjacent to the Caracol, a chemical plant. The water is highly alkaline and the chemical industries in and adjacent to the basin are extracting these salts. Part of the laguna has some islands of bulrush, but most of the emergent vegetation is along the ditches and dikes that enter the eastern and southern sides of the lake. The bottom is fairly firm clay in most places.

The principal basin and waters of Lake Texcoco are owned by the Federal Government, but most of the present shoreline is controlled by the local villages (*ejidos*). Groups of Mexican and U.S. hunters rent, from the villages, exclusive hunting rights to part of the water area and obtain the services of natives to pole the boats and retrieve the ducks. These natives also build blinds at the beginning of the season and tend the decoys. Hunters can drive within 1.6 to 3.2 km of the shooting places.

Arellano and Rojas (1956) cited Ramirez Cantu (1939) who gave a list of the marsh and aquatic plants collected at Lake Texcoco. Included are smartweed, pondweeds, bulrushes, sedges, spikerushes, grasses, duckweed, coontail, and others.

On the January surveys of Texcoco, some of the estimates of ducks seen during 1951–65 ranged from 83,750 in 1956 to only 3 shovelers in 1962; the average was about 39,000. This average is 7.3% of the total average number of all the ducks seen on the aerial surveys of the highland wintering grounds.

As an indication of the relative numbers by species, the 62,400 ducks reported in the 1955 survey included 30,500 green-winged teal, 12,400 cinnamon and blue-winged teal, 10,050 pintails, 5,700 shovelers, 3,500 canvasbacks, 150 gadwalls, and 100 wigeons. In 1961, the composition was 9,700 pintails, 2,250 green-winged teal, 1,100 shovelers, and 20 wigeons.

Lagunas Oriental (El Carmen) and Alchichica, Puebla (63)

This large lagoon, also known as El Carmen, is in the same vicinity as the Llanos de San Juan. At an elevation of about 2,360 m, its northern margin is adjacent to the railroad near the stations of El Carmen and Oriental, which are about 60 and 68 km, respectively, northeast of Puebla.

Because of the flatness of its basin, the surface area of water fluctuates greatly with the variations in seasonal rainfall. Arellano and Rojas (1956) gave the area of permanent water at about 1,600 ha and the marsh in general at about 3,200 ha, but the latter varied greatly with the rainfall. According to the latest air navigation chart (1963), the dimensions of this basin are 27 km from northeast to southwest and 11.2 km from northwest to southeast. In pre-Conquest times, and before the forests on the nearby mountains were cut, this lagoon was undoubtedly a magnificent waterfowl wintering ground.

In addition to the rainfall within the basin, there are three springs of relatively constant flow which feed the lagoon. Alvarez del Villar (1949) reported that each spring had different chemical characteristics; one was fresh water, a second brackish, and the third contained traces of hydrosulphuric acid.

Judging from the weather records at the City of Puebla since 1878, the annual rainfall there shows relatively much less variation than in most parts of Mexico. The mean has been about 84 cm, the minimum 56 cm, and the maximum 127 cm. How much the rainfall at Oriental, only about 64 km from Puebla, varies from these figures is not known.

From this information one would conclude that the principal reason for the lower levels of Laguna Oriental in recent years has been the increased agricultural use of the lands surrounding it and the diversion of its tributary drainage for a variety of purposes. The lagoon has the most water at the end of the rainy season in September. From then until the next rains begin, there is a high loss from evaporation and a drop in lake level.

The principal foods in the lake, according to our surveys, were widgeongrass, muskgrass, naiad, several species of bulrushes (especially alkali bulrush, *Scirpus paludosus*), duckweed, and pennywort. There also were several species of sedges, spikerushes, pondweeds, and foods of lesser value. Animal food was provided by insect larvae, crustaceans, mollusks, and small fishes. Drift along the shore contained many seeds of a mint, pine (*Pinus* spp.), and cactus (*Opuntia* sp.).

When D. W. Warner and personnel of the Mexican Department of Game visited the lake in the winter of 1953–54, about 30,000 waterfowl were seen, most of them shovelers (Arellano and Rojas 1956).

On the aerial surveys of Oriental, the estimates of ducks seen were 2,650 in 1953, 22,285 in 1954, 77,310 in 1955, 85,600 in 1956, 83,200 in 1958, 181,785 in 1959, 33,550 in 1961, 10,750 in 1962, and 17,525 in 1965; the average was 57,180. On 16 February 1960, we saw 18,000 ducks south of the Zacatepec–El Carmen highway, including 10,000 shovelers. The remainder were wigeons, pintails, gadwalls, and ruddy ducks. North of the highway there were 5,000 to 10,000 more that could be seen fairly well, most of which were shovelers, and some teals and wigeons. Farther away there were other flocks too distant to estimate. The principal species usually are the pintail, teals, shoveler, and wigeon. During some years, the Mexican ducks are numerous, as in 1958 when 6,000 were seen. The only geese observed were 150 to 200 white-fronted geese in 1953 and 1955, but experienced hunters from Mexico City, who are very familiar with this area, told us that in 1951 they had seen about 250 of these geese during several previous winters and about 400 sandhill cranes.

Laguna Alchichica is a small, steep-walled crater-lagoon, deeply set below the level of the surrounding countryside, and adjacent to the Puebla–Jalapa highway near Kilometer 253. It is almost circular and according to Arellano and Rojas (1956), who cited Alvarez del Villar (1949), it has an area of 283 ha. The water level is said to remain constant throughout the year and the greatest depth is estimated to be nearly 100 m. Alvarez del Villar (1949) said the water was saline, had a pH of 10.2, and 8,237.6 ppm of dissolved solids.

There is a narrow marginal zone of shallows in Laguna Alchichica. Arellano and Rojas (1956:240) reported there was no submerged aquatic vegetation, but at the time of our visit in 1960 widgeongrass and algae were common in the shallows; however, the longest leaves of the widgeongrass were only about 10 cm. At least 300 coots, 50 ruddy ducks, and 5 scaups were feeding in the shallows; some pools contained water beetles, diptera and other insect larvae, and small fishes.

On the shore of Laguna Alchichica, there was an abundance of small spikerushes of two species and some saltgrass. Judging from the number of waterfowl droppings that contained fragments of these plants, it was obvious that coots and ducks grazed on the spikerushes at night when they were not disturbed by the numerous local women and children who came to get water or to do their laundry.

Presa Valsequillo (Camacho, Rio Atoyac), Puebla (64)

This reservoir, primarily intended for irrigation, is about 20 km southeast of Puebla, on the Rio Atoyac. It is also called the Presa Manuel Avila Camacho. Situated in the mountains, it is very irregular in outline and is about 21 km long. Fluctuations in water level are large, due to the irrigation demands and to wide variations in rainfall. Its elevation is below 2,135 m, and according to Arellano and Rojas (1956), its area is approximately 1,800 ha.

Because of the extreme fluctuation of water level and the steepness of most of its shores, there is no submerged vegetation, but great quantities of water hya-

cinths have floated in from tributary streams. At the times of our visits in 1950 and 1951, ducks were not seen, but there were small numbers of coots.

Laguna Tequesquitengo, Morelos (65)

This lagoon is near Puente de Ixtla. It is elliptical in outline, its dimensions are 3 by 1.5 km, and its area about 450 ha, according to Arellano and Rojas (1956). They reported that on 16 March 1955 the pH was 6.0, and the water was crystal clear. They added that the lagoon had an average depth of 25 m, citing Tamayo (1949), and that there were relatively few shallow places in it. The lagoon is stream fed and remarkably uniform in its water level. There is some irrigation and municipal use of the water, but the flow is adequate to maintain a stable level.

The submerged aquatic vegetation was reported by Arellano and Rojas (1956) to be abundant and to include watermilfoil (*Myriophyllum* sp.), algae, and other plants. The emergent vegetation is found mostly along the west side. They cited Beltran (personal communication) as having observed shovelers there in November and ruddy ducks in December.

This lagoon is a popular resort area bordered by many private homes. Its great depth limits its value for most ducks to the shallower areas, and even where shallow its use is further reduced by boating and other recreational activities.

Laguna Miacatlan (El Rodeo), Morelos (65)

This oval-shaped lagoon in the upper Rio Balsas drainage is near the town of Miacatlan. Its elevation is about 1,098 m, or 70 m higher than nearby Laguna Coatetelco (Arellano and Rojas 1956). They said it had an area of 220 ha in 1955, which was its minimum size over a period of years. The principal source of water is the Rio Tembembe, and a dam has been constructed across its outlet to control the flow of water for irrigation purposes. Arellano and Rojas (1956) also said that the water of the lagoon was coffee-colored and turbid, and they quoted Osorio Tafall as saying that the water was alkaline and had a pH of 7.5–8.6.

On 15 April 1935, E. A. and L. J. Goldman visited this lagoon on a waterfowl survey and wrote (USBS files):

> The lagoon is about a mile and a half long and a mile broad. It contained considerable aquatic vegetation and during the winter is said to harbor thousands of ducks. Most of the birds had evidently departed but we counted about 100 spoonbills, 4 canvasbacks, 100 ruddy ducks, and 35 widgeons.

Arellano and Rojas (1956) said that although the dam had been constructed 17 years before their visit in 1955, there was still no submerged aquatic vegetation, and very little emergent cover in which waterfowl could hide. They added that because of the heavy shooting pressure from hunters using motorboats, most of the waterfowl soon left the lagoon to seek safety elsewhere. They also reported that many of the ducks that migrated through the region spent part of the day on Miacatlan, but that in the late afternoon the ducks took cover in the bulrushes of Coatetelco.

Laguna Coatetelco, Morelos (65)

This lagoon (elevation 1,030 m), named for the nearby town of Coatetelco, is 4 km southwest of Laguna Miacatlan (El Rodeo). The lagoon drains into the Rio Balsas, it is elliptical, and reportedly contained 400 ha. Arellano and Rojas (1956) reported that in 1955 the fluctuation of water level was slight because of the local water control system, and because the only irrigation use was on lands adjacent to the lagoon.

The water was clear and aquatic vegetation was abundant along the margins of the lagoon. There were many clumps and small islands of bulrushes that formed a zone several meters in width around much of the lagoon. It was in this dense vegetation that waterfowl found cover and fed nearby.

This lagoon was popular for recreation, and many foreign and local duck hunters were said to shoot there. According to Arellano and Rojas (1956) and others, further restrictions are needed in order to reduce hunting pressure, especially shooting from motorboats.

Laguna Tuxpan (Iguala), Guerrero (66)

This small lagoon is near, and east of, the town of Iguala at an elevation of about 732 m. The lake is natural in origin and is less than 1.6 km in diameter. According to Arellano and Rojas (1956), it had a depth of several meters, but this varied widely because of water use for irrigation. They reported that the bottom was soft and supported a considerable amount of submerged aquatic vegetation, but that it had no emergent plants. The pH of the water was 6.5 on 4 May 1955.

Although this lagoon could be very useful to waterfowl, it was so heavily used by people for boating and other recreational activities that ducks were greatly discouraged from wintering there, although many coots were said to be present. The laguna was declared to be national property in the Federal Official Register of 12 April 1921.

Pacific Coastal Zone

The waterfowl wintering grounds of the Pacific Coast of Mexico are most important to the birds of the Pacific Flyway, but are also of value to some from the Central Flyway. The key areas extend from the Peninsula of Baja California southward to Chiapas, and

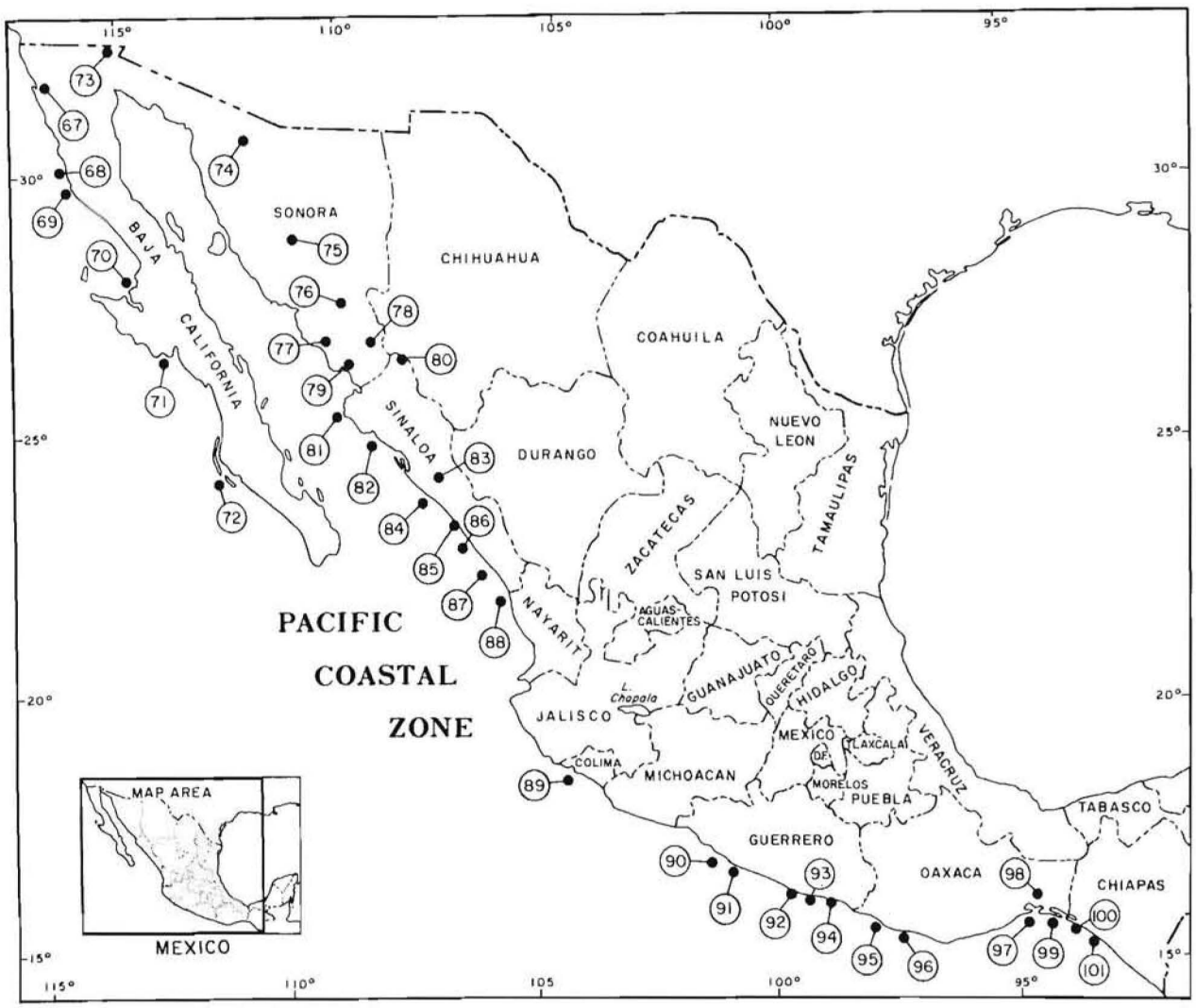

Fig. 16. Waterfowl wintering grounds of the Pacific Coast of Mexico.

include tidal bays and lagoons, brackish and saline landlocked lagoons and *playas*, freshwater lagoons and marshes, agricultural districts mainly growing small grain, and offshore waters such as the Gulf of California (Tables 6, 7; Fig. 16). In the accompanying text, tables, and figures, the areas of Baja California are described first, then the other Pacific coastal areas in approximately north to south sequence.

Food and water for waterfowl in the tidal bays and lagoons are influenced by hurricanes, the closure of passes to the sea by massive deposits of sand or silt, and the effects of diseases on foods of waterfowl. These bays and lagoons provide the principal west coast habitats for diving ducks, black brant, and wigeon.

Other than tidal waters, the remaining habitats of greatest value to waterfowl, as listed by the January aerial surveys, are in five areas: Obregon, Topolobampo, Pabellon, Caimanero, and the Marismas Nacionales. The average waterfowl population in these wintering grounds totals more than 75% of the waterfowl on this coast of Mexico. With the exception of the two last-named localities, the largest waterfowl concentrations are associated with agricultural lands and waste irrigation water, especially where it flows onto the flats and into the salt water of tidal basins and causes fresh to brackish conditions. As new lands are cleared and irrigated and new waste-water outlets to coastal lagoons created, many waterfowl shift there from nearby localities. After the new areas are fully developed agriculturally, the waterfowl population usually stabilizes, unless better feeding grounds attract the birds elsewhere. The latter happened when most of the pintails and many of the geese shifted from

Table 6. *Important waterfowl wintering areas along the Pacific Coast of Mexico.*

Name	Description	State	Figure 6 index number(s)
Ensenada	The tidal lagoon southsouthwest of the Ensenada airport and adjacent to the waters of Bahia Todos Santos, as well as the latter larger bay.	Baja California	67
San Quintin	Bahia San Quintin, a tidal laguna.	Baja California	68
Bahia del Rosario	The coastal waters of Bahia del Rosario.	Baja California	69
Laguna Scammon	Laguna Scammon, Estero de San Jose (Laguna Guerrero Negro) and Laguna Manuela, which are tidal areas surrounded on the landward side by the Vizcaino Desert.	Baja California	70
San Ignacio	Laguna San Ignacio, Bahia Ballenas, and all tidal lagunas from 16 km northwest of Punta Abreojos to Punta Santo Domingo.	Baja California	71
Magdalena	From La Tinaja and Boca de las Animas southward to and including Bahia Almejas, a series of tidal bays about 208 km long, including the large Bahia Magdalena.	Baja California	72
Rio Colorado Delta, Presa Santa Teresa, and Presa Rodriguez	Delta of the Rio Colorado, including that part of the Imperial Valley's agricultural lands in Mexico.	Baja California and Sonora	73,74,75
Obregon and Alvaro Obregon (Oviachic)	The cultivated grain area near Ciudad Obregon, the Rio Yaqui delta, and the coastal lagunas to the southwest and south, Cocoraquito (Tobari) being the principal one.	Sonora	77,76
Laguna Agiabampo and Mocuzari	The lagunas of Agiabampo and Bacorehuis and the smaller mangrove lagunas south to Punta Ahome.	Sonora and Sinaloa	79,78
Topolobampo and Presa El Majone	The delta of the Rio Fuerte, including the adjacent agricultural area of Los Mochis, and the bays of Topolobampo, de Ohuira, and Navachiste.	Sonora and Sinaloa	81,80
Bahia de Santa Maria	The large tidal bay of that name, the southern part of which is sometimes called Altamura, and the adjacent coastal flats and agricultural lands.	Sinaloa	82
Ensenada del Pabellon, Culiacan, and Presa Sanalona	The Ensenada del Pabellon, adjacent freshwater and brackish pools created by waste irrigation water on the flats, and agricultural lands of the Culiacan area.	Sinaloa	84,83
Dimas	Coastal waters between the Ensenada del Pabellon and Mazatlan.	Sinaloa	85
Mazatlan and Laguna del Caimanero	Coastal waters from Mazatlan to and including the mouth of the Rio Baluarte. Caimanero is the name of the principal laguna.	Sinaloa	86,87
Marismas Nacionales	The coastal strip between the Rio Baluarte and San Blas, Nayarit. It contains a vast network of mangrove-bordered lagunas, mud flats, and several river deltas. This area is designated on many maps as Marismas Nacionales.	Sinaloa and Nayarit	88
Laguna de Cuyutlan, Rio Armeria, and coastal waters	Laguna de Cuyutlan and the coastal waters from Zihuatanejo to the Morro de Papanoa.	Colima and Guerrero	89
Lagunas Nuxco, Mitla (Cayaco), and Rio Coyuca	The coastal waters from the Rio Atoyac to and including the Rio Coyuca.	Guerrero	90
Laguna Coyuca	Laguna Coyuca, northwest of Acapulco.	Guerrero	91
Laguna Papagayo (Tres Palos)	Laguna Papagayo and the Rio Papagayo.	Guerrero	92
Laguna San Marcos	Laguna San Marcos and the coastal waters to and including the Rio Nexpa.	Guerrero	93
Nexpa	Laguna Nexpa and the coastal waters to Punta Maldonado.	Guerrero	94
Laguna Alotengo	Laguna Alotengo and the adjacent mangrove swamps and marshes.	Oaxaca	95

Table 6. Continued.

Name	Description	State	Figure 6 index number(s)
Laguna Pastoria to Salina Cruz and Laguna San Mateo	The coastal waters from Alotengo to Laguna Lagartero, and several other lagunas and river deltas to San Mateo del Mar.	Oaxaca	96
Laguna Inferior	Laguna Inferior and adjacent lagunas to the east.	Oaxaca	97
Laguna Superior	Laguna Superior.	Oaxaca	98
Mar Muerto	Mar Muerto only.	Oaxaca and Chiapas	99
Laguna de la Joya	Laguna de la Joya and the swamps between it and the Pacific Ocean.	Chiapas	100
Sesecapa	The coastal waters, marshes, and swamps between Laguna de la Joya and the Guatemala border.	Chiapas	101

Obregon to Topolobampo and Pabellon, as the centers of rice and wheat growing moved southward. New agricultural developments, therefore, may have an important impact on the distribution of migrant and wintering waterfowl. The natural drainage of nutrient-laden streams into landlocked lagunas (e.g., in parts of the Marismas Nacionales) also produces excellent habitat.

In some places along the Pacific Coast there are freshwater lagoons and estuaries behind the beach ridge, or farther inland on river deltas, that are used by waterfowl. On some of these there are only a few ducks and coots; on others there are large flocks of several species, including divers. Some of these lagoons are fringed with mangroves; others have woodlands of mesquite, *guamuchil*, and other thorny trees; some are in relatively open situations flanked by marshes, meadows, or barren flats.

Duck food occurs in most of these waters. In some it is chiefly plants, but in others the insect larvae, mollusks, crustaceans, and other small forms of animal life are the principal fare.

Most of the coastal waters used by waterfowl north of the headlands of Jalisco are saline and connected to the Pacific. Many of those south of Jalisco, and to the Guatemalan frontier, are landlocked or so indirectly connected with the ocean that they contain fresh water. There are, however, several saline lagoons in the Isthmus of Tehuantepec.

The inflow is sometimes sufficiently great at some coastal freshwater lagoons that are fed by rivers, especially during the rainy season, to raise their levels until they break through the barrier beach to the ocean. Then the powerful tidal action pushes salt water into the lagoons. This, more commonly with smaller bodies of water, may greatly affect their aquatic plant and animal life. Most of the larger, landlocked coastal lagoons scouted from Guerrero south, to and including Chiapas, have fresh or only a slightly brackish water, even though some are bordered by mangroves, trees often typical of saline bays and tidal swamps.

On the Pacific Coast few waterfowl were observed offshore, except in the Gulf of California, where thousands of diving ducks, mostly scoters, were usually seen farther out from the survey route along the Sonora Coast between Guaymas and the Colorado Delta. Food along the Sonora Coast is believed to be a variety of animal life, because most of this sector is too deep for aquatic vascular plants. The following species of ducks are usually common between the mouth of the Colorado River and Guaymas: surf scoter, white-winged scoter, lesser scaup, bufflehead, ruddy duck, red-breasted merganser, and a few dabblers.

The offshore waters south of Guaymas, Sonora, were not appraised because the scouting of the bays, lagoons, and other waters inside the barrier beach, and part of the agricultural lands, left no time for offshore coverage. The only exceptions were localities where the mountains extended to the ocean. In those rugged regions there are no inshore waters, except for occasional small influent streams.

The coastal localities southeast of Laguna Cuyutlan, Colima, and northwest of the Isthmus of Tehuantepec, Oaxaca, were not covered during 1953-62. In the field notes made in 1947-50, the population counts for some of these lagunas were combined, so that the data for individual lagoons are not available to us. Most of the summaries and averages are based on the period 1951-65, but for the sector between Cuyutlan and Tehuantepec they are based on the years 1951, 1952, 1963, 1964, and 1965.

The unique peninsula of Baja California has attracted ornithologists for many years, but it was not until the first aerial surveys of its coastal waterfowl habitats were made by the U.S. Bureau of Sport Fisheries and Wildlife that accurate quantitative information was obtainable on the species of waterfowl and

Table 7. *Waterfowl seen (in thousands) during January surveys of the Pacific Coast of Mexico, 1948-62.*

Species	1948	1949	1950	1951	1952	1953	1954	1955	1956	1958	1959	1960	1961	1962	Avg.
Mallard	1	[a]	[a]	[a]	—	—	1	[a]	[a]	[a]	3	[a]	[a]	[a]	[a]
Gadwall	162	28	113	18	76	43	45	45	43	51	92	44	22	32	58
Wigeon	72	62	102	32	34	18	50	48	53	24	62	61	28	65	51
Green-winged teal	28	26	13	123	87	43	74	147	142	97	409	168	170	207	124
Blue-winged teal[b]	37	83	179	84	41	26	9	18	36	26	55	29	61	67	54
Shoveler	342	392	213	228	329	147	286	203	223	186	189	281	175	170	240
Pintail	290	238	220	297	407	304	433	420	167	307	609	569	843	875	427
Redhead	25	39	11	18	25	25	32	25	17	8	43	21	24	11	23
Canvasback	6	1	1	2	1	—	[a]	[a]	1	—	[a]	1	1	[a]	1
Lesser scaup	338	328	159	109	272	182	232	91	91	207	205	53	86	106	176
Ring-necked duck	7	[a]	3	—	1	—	—	—	—	—	—	—	—	—	1
Goldeneye	[a]	—	2	[a]	—	—	—	[a]	1	[a]	[a]	[a]	[a]	[a]	[a]
Bufflehead	[a]	9	—	2	5	3	1	[a]	[a]	[a]	[a]	[a]	[a]	[a]	1
Ruddy duck	82	73	33	36	126	5	[a]	11	39	27	71	24	3	7	38
Scoters	4	8	6	2	25	—	—	—	—	—	1	—	—	4	4
Mergansers	1	[a]	1	[a]	[a]	—	—	—	—	—	—	—	—	—	[a]
Unidentified ducks	14	17	2	—	8	—	[a]	—	—	—	—	—	—	—	3
Total ducks[c]	1,409	1,304	1,058	951	1,437	796	1,163	1,008	814	933	1,739	1,251	1,413	1,544	1,201
Swan	—	—	—	—	—	—	—	—	2	—	1	—	—	—	[a]
Geese	22	27	8	20	14	4	10	1	2	2	9	8	14	6	11
Brant	—	32	73	34	103	87	86	77	53	71	46	83	143	118	72
Total waterfowl	1,431	1,364	1,139	1,005	1,554	888	1,259	1,086	869	1,006	1,794	1,342	1,570	1,669	1,284
Coots	84	422	102	132	103	27	67	53	81	108	76	125	25	107	108
Total birds	1,515	1,786	1,241	1,138	1,657	915	1,326	1,140	950	1,114	1,870	1,467	1,595	1,776	1,392

[a]Fewer than 1,000 birds.

[b]Also includes cinnamon teal.

[c]Does not include fulvous whistling duck, black-bellied whistling duck, and muscovy duck.

their numbers in midwinter. On the first aerial surveys of the Mexican mainland it was not possible to make adequate arrangements for refueling at La Paz, so it was not until January 1949 that some of the important lagoons and bays of Baja California were scouted for the first time.

In 1949, R. Smith and F. Thompson (USBSFW files) wrote the following in their report regarding their first aerial survey of Baja California.

> There are two general areas on this peninsula that, according to the map, appear to have possibilities as waterfowl concentration areas. The largest, just north of La Paz and on the west side includes Bahia Almejas, Bahia Magdalena, and the lagunas extending north to Pozo Grande. The second, beginning about 100 miles [160 km] farther north includes the Laguna de San Ignacio, Laguna Scammon and Laguna de Guerrero Negro.

Due to unfavorable weather and the lack of assurance regarding available gasoline at La Paz, the first area could not be covered in 1949, but the second was surveyed. Smith and Thompson wrote:

> The second area is situated in an extremely arid flat coastal plain—a veritable desert. The upper reaches of the laguna and the landlocked bays are only occasionally flooded by high tides, and are desolate saline flats supporting no vegetation or bird life. Those areas open to the sea and having a reasonable depth of water had vast beds of what appeared to be *Halodule* [ed. note: this proved to be eelgrass] and here we found black brant, buffleheads, and surf scoters, along with thousands of shore birds along the edges. The scoters and buffleheads were scattered over the entire area in singles, pairs and small groups, and the brant occurred in flocks of 10 to 400. We estimated that we saw 11,000 brant, 1,070 buffleheads, and 220 surfscoters on Lagunas Guerrero Negro and Scammon. Figuring our coverage at one-third, this would give us a total population of 33,000 brant, 3,200 bufflehead and 660 scoters. On Laguna de San Ignacio . . . were brant 3,450, buffleheads 335, and surfscoters 275. Coverage was estimated to be one-half which would give an estimated population of 6,900 brant, 670 buffleheads and 550 scoters. Total population for the entire area was estimated to be 39,900 black brant, 3,900 buffleheads and 1,200 surf scoters in round figures. . . .
>
> We believe that these areas would never be important concentration areas for the shoal water ducks, as not a single individual was seen. Probably these pass on the mainland side of the Gulf of California.

In most of the years since 1949, both of these areas, and the other important wintering grounds in Baja California, have been included in the aerial coverage, chiefly to obtain population information on the black brant which is given in the chapter on species.

Ensenada (67)[4]

During the January aerial surveys, some ducks were observed on Bahia Todos Santos at Ensenada and on the tidal lagoon south of its airport. Others, chiefly divers, were seen around the mouths of the tributary streams that reach the coast between Ensenada and San Quintin.

San Quintin (68)

The first important wintering place for waterfowl on the west coast of Baja California, going southward, is Bahia San Quintin and the protected lagoon behind the cape. These waters were attractive to black brant because of the extensive beds of eelgrass. Diving ducks and a few dabblers were also present. Robert D. Jones, Jr. (personal communication) made the following observations in the winter of 1974-75:

> Brant were not feeding on *Phyllospadix* at San Quintin, but were feeding on *Zostera*, including herring eggs attached thereto, and possibly *Ulva* which is quite abundant. I did not have the opportunity to examine stomach samples from brant at San Quintin, but from what I know of brant they were probably taking all the epiphytes available on the eelgrass plus free-swimming crustacea associated as part of the invertebrate community. The ducks I observed in San Quintin are pintails, cinnamon teal, wigeon, lesser scaup, bufflehead, surf scoters, a few common golden-eye, and a few mergansers.

Bajia de Rosario (69)

South of San Quintin, the next locality used by waterfowl was Bahia Rosario, where small numbers of brant were usually seen inshore.

Laguna Scammon (70)

Scammon Lagoon, of gray whale (*Eschrychtrus robustus*) fame, also known as Laguna del Ojo de Liebre (Spring of the Jackrabbit), is about 710 km south of Tijuana and the United States-Mexico border. Adjacent to it on the north are Laguna Guerrero Negro (Black Warrior Lagoon) and Laguna Manuela. Scammon is a broad, saline lagoon surrounded on the landward side by the Vizcaino Desert and open to the Pacific Ocean through a deep channel. At Scammon Lagoon most of the shore is a low, sandy desert with sparse halophytic shrubs on the undulating, barren dunes, many of them backed by larger dunes and bluffs. The shrubs and other vegetation on these bluffs range from little or no cover to dense thickets. The intertidal zone varies in roughness. Some of the rocky shores are characterized by many tidal pools and a heavy drift of marine vegetation.

The depth of the lagoon varies considerably from the many shoals to the deeper channels. At low tide, there is a great deal of shallow water which in places stretches several kilometers from shore, making extensive feeding grounds. Dawson (1962) reported extensive beds of what appeared to be eelgrass in Scammon Lagoon and at other localities in Baja California.

Both Scammon and Guerrero Negro lagoons have passes open to the ocean, and at high tide there is an intricate network of shallow channels between them.

There are vast salt pans on Laguna Guerrero Negro from which thousands of tons of salt are harvested annually.

San Ignacio (71)

The series of coastal lagoons extending from the one northwest of Punta Abreojos southeastward to Punta Santo Domingo is called the San Ignacio area in reports on the January aerial surveys. Some maps show these more specifically as Bahia Ballenas, Laguna San Ignacio, and several unnamed lagoons. They are broad, saline, tidal lagunas, with eelgrass, other marine grasses, and algae as their principal vegetation, and with desert on the adjacent mainland.

Magdalena (72)

The name Magdalena, as given in the survey reports, is applied to a long series of lagoons extending from La Tinaja (Boca de las Animas) southward to Bahia Almejas, a distance of more than 208 km. Almost all these saline tidal waters are protected by a chain of barrier islands which is broken by several passes to the Pacific. Like Ignacio, they have a desert setting. Their principal attraction for black brant is the availability of marine grasses. This area has been surveyed regularly since 1959, and for 1960-65 brant numbers ranged from 19,860 in 1960 to 40,400 in 1961 (average, about 25,000).

Summary: Baja California

Aerial reconnaissance has been conducted on parts of the Peninsula of Baja California almost every January since 1949, but it has not been possible to make ground studies of available waterfowl foods.

Black brant are the principal wintering waterfowl population, and Laguna Scammon and Bahia de San Ignacio are their preferred haunts, primarily because of the vast beds of eelgrass and the natural protection afforded by these isolated waters (Nelson 1921; Leopold 1959).

Most of the continental population of black brant spends the winter in Mexican coastal wintering grounds, several hundred kilometers or more south of the border. At the time of the January 1952 inventory, the black brant seen in Baja California (102,945) and

[4]Number in parentheses corresponds to the index number that designates the location of the listed wetland(s) in Fig. 16, page 60.

California (43,840) made up perhaps 90% of the total continental population. This was the most complete inventory of black brant taken up to that time (Leopold and Smith 1953). In January 1965 the number of brant seen in Baja California was 118,850 and on the mainland of Mexico, 23,315. Few of these birds wintered in California during the past several years; in 1965 only about 23,000 brant were found on the Pacific Coast of the United States and Canada. Further data on this sea goose are given in the species chapter.

Although these peninsular wintering grounds are of the greatest significance because of the brant present, they also have small populations of ducks, mostly divers, which include scoters, bufflehead, lesser scaup, mergansers, and several others.

The aerial surveys of 1952-65 showed the following numbers of ducks: San Quintin area, from 725 to about 20,000 (average, about 5,000); Laguna Scammon, Black Warrior Lagoon and vicinity, from a few to about 8,000 (average, about 2,000); and San Ignacio and vicinity, from 500 to about 15,000 (average, about 4,000). During the aerial surveys of 1961-65 Magdalena had estimated duck populations of about 1,100 to 4,850, and an average of about 2,800.

Rio Colorado Delta, Presa Santa Teresa, and Presa Rodriguez, States of Baja California and Sonora (73, 74, 75)

The Rio Colorado Delta is very disappointing as a waterfowl wintering ground. During recent years a combination of factors has so changed the river flow, surface water, marshes, and ecology of the delta that it has few ducks in comparison to its great flights of earlier years.

The former extensive and frequent flooding of the delta, which maintained the fine marshes and lagoons, ended with the completion of a series of great reservoirs upriver and the control of much of its flow for hydroelectric, irrigation, and municipal uses. The upper delta was under extensive cultivation, and there was little surface water except that in the river channels and irrigated fields. Almost no good marshes remained.

The Rio Colorado Delta is roughly triangular; the International Boundary is near the north side, the old channel of the river bounds the east side, and the Sierra de Cocopah fronts it on the west. The southern apex is at the mouth of the river, about 80 km south of the boundary.

In 1905, E. A. Goldman and D. T. MacDougal made studies of the fauna and flora of the Colorado River Delta. They wrote (Goldman, 1951:255)

> Colorado River (20 miles [32 km] south of U.S. boundary) (100 feet): March 28-29, 1905.—An overnight stop on the high Sonora bank of the Colorado River while descending the stream at an unusually high flood stage. At this time the river was flowing along the base of the Sonora mesa, or bluff, bordering the flood plain on the eastern side. Soon thereafter the entire river turned into the Salton basin, where it ran for nearly a year. When finally diverted it did not resume the former channel along the Sonora mesa, but took a new course, probably marked by an old slough, through Volcano Lake, some 15 miles [24 km] or more farther west. Visited by D. T. MacDougal and myself.

In recent years, the main channel has shifted from the western side to nearer the eastern margin. Former marshes are mostly dry and some of them are overgrown with brush and low trees. A large area of the barren lower delta is flooded regularly by the tide, which cuts a complicated network of channels in the mudflats. The alluvial deposits have extended far into the Gulf of California and along the western shore of the peninsula.

For many kilometers inland the lower delta is composed of barren mudflats, and yet farther inland there are bits of marsh. Many parts that were formerly excellent marsh are now dry because of the controlled flow.

Aerial surveys were made there by the U.S. Fish and Wildlife Service from 1947 through 1951, but since then the aerial coverage and estimates of waterfowl present in the Rio Colorado Delta have been made by the California Department of Fish and Game. On the aerial survey of 15 February 1947 the following waterfowl were seen in the delta: 4,935 snow geese, 2,075 green-winged teal, 1,890 shovelers, 1,035 mallards, 975 pintails, 575 gadwalls, 75 wigeons, 20 scaups, and 985 unidentified ducks. On the survey of 5 February 1949, Robert H. Smith and Floyd Thompson estimated the total of all waterfowl present at 28,440 ducks and 23,050 geese.

The number of birds found on more recent surveys has varied greatly. In 1959, there were 76,000 ducks and 340 geese recorded; in 1960, only 13,000 ducks and 300 geese; and in 1964, 22,000 ducks and 400 geese. Annual averages for 1952-64 were almost 2,000 geese, about 25,000 ducks, and about 3,000 coots. Shoveler, green-winged teal, and pintail, in that sequence, were the most numerous species. The ducks were mostly in the flooded fields and on croplands. The lesser snow goose is the most common goose, but there are small numbers of Canada and white-fronted geese.

Most of the snow geese observed in the lower delta were resting on mudflats or sandbars in the river. Those that roost and loaf in this part of the delta have to fly many kilometers inland to reach a source of grit.

The ducks were widely scattered; small flocks were seen in pools on the flats, in the river and on bars, in the remnants of marshes, and in flooded agricultural fields.

Some of the banded ducks and geese shot in the agricultural areas of the delta were killed near Ejido Chiaqua, Colonia Zacatecas, and Lake Cerro Prieto,

Baja California. Undoubtedly many thousands more ducks and geese would winter in this area if conditions were more favorable. Instead, most of the Pacific Flyway birds that cross the border journey farther down this coast of Mexico, going chiefly to the coastal lagoons and agricultural areas from Ciudad Obregon to Culiacan and beyond.

Southward from the Rio Colorado there are no major waterfowl wintering areas until one reaches the Rio Yaqui Delta, but there are some lesser localities which should be mentioned. There are many waterfowl, chiefly scoters, in the offshore waters of the Gulf of California. Information on these birds is given in the species chapter. On the mainland there are some small freshwater lagoons and reservoirs near Guaymas and Bahia Kino. Farther inland there are two reservoirs, one on the Rio Altar and the other on the Rio Sonora. The first is the Presa Santa Teresa or Cuauhtemoc, 35 km northeast of Altar, Sonora, which has a water storage capacity of 45 million m^3, and which irrigates an area of 3,000 ha. The second is Presa Rodriguez just east of Hermosillo, Sonora, which has a water storage capacity of 250 million m^3, and which irrigates 10,000 ha. Both of these reservoirs, and especially the latter, attract small numbers of ducks and some geese, but they are more useful to migrants than to wintering birds.

Obregon and Presa Alvaro Obregon (Oviachic), Sonora (77, 76)

This wintering ground includes the agricultural district adjacent to Ciudad Obregon, the Rio Yaqui Delta, and the coastal lagoons, of which the principal one is Laguna Cocoraquito (Bahia Tobari).

Cocoraquito Lagoon (Tobari Bay) has been very important to waterfowl for many years, but it is less so now because of the reduced acreage of grain crops nearby. Before the agricultural development of the Obregon district, the water from the south branch of the Yaqui River entered this lagoon and provided some excellent marshes adjacent to it. Waterfowl fed either in the lagoon or in the marshes, and only wild foods were available to them. With the extensive cultivation of rice and wheat on the coastal plain, and the impounding of the Yaqui, the fresh marshes were reduced to an insignificant fraction of their former extent. This change also reduced the extent of the submerged aquatic vegetation in the northern part of the lagoon. There has continued to be a fair growth of widgeongrass in the lagoon, but most of the waterfowl that winter in this vicinity are field feeders that rely much less on native foods. Consequently, the percentage of pintails and of geese in this area increased greatly during the years of high grain production, but declined in the 1960's.

The lagoon, located 40 km south of Ciudad Obregon, is about 26 km long and 3 km wide. Its axis is from northwest to southeast and it is connected to the ocean by two wide passes.

The agricultural district of Ciudad Obregon was created by the clearing of a very large acreage of thorn forest and thorn scrub on the coastal plain between the town and the Pacific shore to the south. By the 1930's, a large area had been cultivated and planted to rice and wheat. Letters written then to the Bureau of Biological Survey, by North Americans working in Mexico for U.S. agricultural implement dealers, reported that large numbers of ducks and geese were already utilizing the excellent feeding grounds provided by the rice stubble and fields of young winter wheat.

The first of the reservoirs to be completed for the irrigation of these croplands was La Angostura, which stores the waters of the Rio Bavispe, a tributary of the Rio Yaqui. This reservoir has a capacity of 840 million m^3. The second and much larger reservoir for this district was the Oviachic, or Alvaro Obregon, about 40 km north of Ciudad Obregon on the Rio Yaqui; its basin has a capacity of 3,000 million m^3.

By 1950 there were 141,750 ha of irrigated cropland adjacent to Ciudad Obregon, on which the principal crops were rice and wheat. With the completion of the Oviachic Reservoir, it was estimated that this crop acreage would be doubled. In subsequent years, however, various water and land problems complicated the irrigated farming in this sector. With the great development of water storage and irrigated lands in the Los Mochis-Culiacan, Sinaloa district, there was a rapid increase in grain acreage, which was accompanied by a corresponding decrease in the Ciudad Obregon region.

The largest waterfowl populations in the Ciudad Obregon region were present during the 1940's and early 1950's. During those years the majority of the birds were pintail, along with much smaller numbers of several other species of ducks and geese. The January survey estimates show the trend in waterfowl use there.

Usually the field-feeding ducks and geese roosted on the coastal waters, and early each morning and late each afternoon they flew inland to feed. Typical schedules are shown by the following excerpts from field notes in our report of December 1950.

On 21 December, en route to Tobari Bay, several hundred white-fronted geese were observed feeding in fields of young wheat several miles inland from the bay at 0930. At 1050 a flight of about 3,000 white-fronted geese returned to the coastal flats adjacent to the bay, southeast of Paredon. By 1115 there were at least 5,000 geese present. Two freshwater drainage ditches emptied onto this flat, but instead of flooding it they drained through narrow, winding channels down to the bay. The geese gathered there by the thousands upon

returning from feeding. They stood, walked around, rested, or grouped in small flocks on the alkali flat. The only vegetation was sparse clumps of saltbush (*Atriplex*), which were mostly less than 0.3 m high.

When disturbed by passing natives, these geese flew less than 100 m to another part of the flat. If shot at, they usually flew out into the bay where they alighted on extensive mudflats well beyond gun range. Near the bay, on some of the alkali flats, were halophytes such as saltwort, glasswort, and sea blite; however, geese were not observed feeding on them, probably because of the unlimited supply of rice and young wheat within easy flight distance.

Geese left their roosting place on the bay early each morning, usually soon after 0700, and flew inland to the fields of rice and young wheat. A later flight left the bay at about 0815. Soon after 0800 the first flight returned from feeding and alighted on the alkali flats. At about 1045 to 1115 the later flight returned. In the afternoon, the big flight back to the feeding fields left at about 0300 and late in the afternoon it returned to the bay for the night. There were too many coyotes in the vicinity of the flats for the geese to feel safe on land.

More than 95% of the ducks present in this locality were pintail. During most of the day they rested on the bay, especially on mudflats where the drainage irrigation water reached them. Some were on lagoons of the Rio Muerto and in flooded fields near the coast. Very early in the morning and again near dusk, they flew inland to feed.

Because cutworms cause heavy damage locally to young wheat, farmers usually flood the fields when the plants are about 5 cm high to kill these pests. This flooding makes the field especially attractive to waterfowl. If they are not kept out at night by men or boys armed with guns or homemade firecrackers, the ducks may concentrate there by the thousands. These birds "puddle" the flooded topsoil with their feet and where they have gathered the mud dries with a hard surface. Such spots then have to be replanted. Several farmers reported that at times each had from 40 to 80 ha of young wheat almost destroyed in this manner by feeding ducks, but there was no opportunity to verify these statements. They also said in the autumn when ducks were shot in the grainfields, coyotes came out of the brushlands into the cultivated fields to catch the cripples. Some ducks were shot and left dead in the fields to attract the coyotes. This was a technique the farmers used to frighten the waterfowl away from their fields, because the presence of the hunting coyotes kept some of the ducks away.

By the late 1950's the duck population and number of hunters in this area had declined greatly, due to the reduction in rice acreage. By the winter of 1959–60 there had been an even greater decrease in rice-growing there. This crop was then being grown principally in Sinaloa, and most of the dabblers, especially pintail, were wintering there instead of near Ciudad Obregon. During that winter, the nearest large concentrations of ducks at Ciudad Obregon were on the lagoon at Bacobampo and Huatabampo.

At the same time, it was reported that there continued to be a great deal of aquatic vegetation, presumably widgeongrass, in Tobari Bay, especially where waste irrigation water entered. A small lagoon near the outlet of Rio Muerto, one of the former channels of the Rio Yaqui, was an important concentration place for many flocks. It contained a great deal of native food, including horned pondweed (*Zannichellia* sp.), widgeongrass, and bulrushes. Some ducks in this area rested on the two large reservoirs inland, as well as on the numerous small ones, and on the coastal waters. Their feeding was mostly in the remaining grainfields.

Crop damage by waterfowl will continue to occur in the major grain-producing areas, such as Culiacan, Los Mochis, Navojoa, and Ciudad Obregon, as long as rice and wheat are common crops. Rice matures in the autumn and is harvested during November and December, when the waterfowl are congregating in large numbers. Much of the winter wheat sprouts in November and December. Fields that are harvested late are especially subject to damage by these birds.

In a general survey of the aquatic food plants in the ponds fed by drainage ditches and in irrigation canals during December 1950, the densest and most widely distributed species was horned pondweed; widgeongrass and bacopa were also very common. Along the shores, dwarf spikerush, other spikerushes, and grasses were good sources of food; in some places smartweed, acnida, bulrushes, and several other plants were present. Dwarf spikerush was especially abundant and attractive where waste irrigation waters spilled onto the alkaline flats near the coast. Other plants on these flats were saltwort, glasswort, sea blite, and lycium. Algae were common and were utilized by wigeon, shoveler, and teals.

At Laguna Grande, where concentrations of pintail were observed, aquatic vegetation was not present except for green algae. The bottom mud was soft and very rich in phytoplankton. In Tobari Bay the aquatic vegetation during the 1950's was chiefly widgeongrass, which was most abundant at the southeast end. Small mollusks provided the principal animal food.

On the January waterfowl surveys of this district, the estimates of ducks seen were 357,755 in 1947, 215,000 in 1951, 76,590 in 1955, 55,073 in 1960, and 89,723 in 1965 (average, about 120,000). In 1965 the species composition was 149,300 green-winged teal, 50,000 pintails, 27,400 wigeons, 12,200 redheads, 9,200 shovelers, and smaller numbers of several other

ducks. There were about 8,400 white-fronted geese.

The first black brant observed in this area by the survey crew was in January 1963, when 800 were seen. In 1964 the total there was 50; in 1965 it was 1,100. We do not know the habits of these birds at Tobari Bay.

Laguna Agiabampo and Presa Mocuzari, States of Sonora and Sinaloa (79, 78)

Laguna Agiabampo is on the boundary between Sonora and Sinaloa; part of it is in each State. Its southern end is 48 km northwest of Los Mochis, Sinaloa, and the town of Agiabampo is on the adjacent mainland to the east. Its length from north to south is about 38 km. It is irregular in outline with two principal lobes, one the estuary of Agiabampo and the other the estuary of Bacorehuis. No plants were collected there, but views from the air showed a good supply of submerged aquatic vegetation, probably widgeongrass and marine algae.

Thousands of ducks, most of them lesser scaups and redheads, were commonly present at the time of the aerial surveys. The southernmost flocks of buffleheads and red-breasted mergansers also were usually noted there. Nearer Los Mochis, small numbers of ducks were observed on the waters between the Isla Santa Maria and the Rio del Fuerte; they were mostly redheads, lesser scaups, and wigeons.

This area also includes the irrigated croplands in the vicinity of Navojoa and the very large irrigation reservoir of Mocuzari (Rio Mayo), Sonora. The latter is on the Rio Mayo about 37 km east-northeast of Navojoa. It has a water storage capacity of 1×10^9 m^3 and irrigates 70,000 ha. This extensive district of irrigated fields is very important to several species of waterfowl, especially to pintail and geese.

On the January waterfowl surveys of Laguna Agiabampo, the estimates of ducks seen in some of the years were 21,905 in 1947, 10,400 in 1951, 22,274 in 1955, 11,118 in 1960, and 11,970 in 1965 (average, almost 13,000). The 1959 estimate of 31,700 was typical of the recent species composition: redheads, 19,400; lesser scaups, 8,500; wigeons, 3,400; and much smaller numbers of several other species.

The first black brant seen on the mainland by the January survey crew was a flock of four at Laguna Agiabampo in 1958. In 1964, the total seen there was 120, and in 1965 it was 30. Most of these brant on the mainland were wintering at Santa Maria.

Topolobampo and Presa el Majone, States of Sonora and Sinaloa (81, 80)

This coastal area, located near Los Mochis and designated as Topolobampo in the survey reports, actually includes several bays. The first bay, just south of the mouth of the Rio Fuerte in the delta area, is about 9 by 15 km. The second bay, which extends to the northwest of San Ygnacio light, is about 4 by 18 km. The third bay, and the main one to which the name Topolobampo is applied, extends northeastward. At its upper part it is called the Bahia de Ohuira. The total combined dimensions of these three bays are about 10 by 22 km; they are south, southwest, and west of the town of Los Mochis.

The Bahia de Navachiste is also considered to be a part of the Topolobampo area. This coastal bay is about 24 km southeast of Los Mochis. It is about 18 km at its greatest width and 38 km at its greatest length. The principal part of the bay contains a number of barren islands which separate it from the Pacific Ocean; the Isla de San Ygnacio at its southwest part, and the Isla de Macapule at its southeast end.

The estimated numbers of waterfowl seen on this bay are combined with those observed elsewhere in the vicinity of Topolobampo on the aerial surveys.

This wintering ground also includes the agricultural lands and waters in the vicinity of Los Mochis, which extend from north of that town and east to near Guasave. The principal reservoir in the area is the Presa El Majone on the Rio Fuerte, with a capacity of 2,300 million m^3.

These bays of Topolobampo appear to be mostly shallow, and much of the time they are windswept and turbid. Before the expansion of agriculture in the vicinity of Los Mochis, relatively few waterfowl were observed on these coastal waters, but with the increase in the planting of small grains and other cultivated crops more ducks and geese have stopped there. They feed chiefly in the fields. On the first aerial survey, 14 February 1947, only 325 pintails were seen on the northeastern bay nearest Los Mochis.

On 21 January 1948 there were almost 22,000 ducks in the same locality, most of them pintails. A few small flocks were also seen in the fields nearby. With the great increase in grain acreage and the decline of rice-growing near Obregon, the number of waterfowl has increased spectacularly in the Los Mochis area. The estimated total of ducks was 21,000 in 1951, 80,000 in 1955, 485,000 in 1960, and 743,000 in 1962. The 219,000 average placed Topolobampo in third highest place in number of ducks among the Pacific coastal areas.

The majority of ducks at Topolobampo are pintail; green-winged teal, shoveler, and wigeon are usually in that order of abundance among the dabblers, and redhead and scaup among the divers. In 1962, for example, the report included 670,000 pintails, 66,000 green-winged teal, 2,400 shovelers, and fewer wigeons and blue-winged teal. In 1965, along with the more than 163,000 dabblers, there were 24,200 redheads and 10,300 lesser scaups.

Recently black brant began wintering in the area. In 1959 the aerial survey crew saw 400 in the Topolo-

bampo area; in 1960, 600; in 1964, 4,175; and in 1965, 5,710.

Bahia de Santa Maria, Sinaloa (82)

Bahia de Santa Maria is about 32 km south of the inland town of Guamuchil on the Rio Mocorito, which empties into the bay. The long axis of Bahia Santa Maria is from northwest to southeast; its dimensions are about 18 by 74 km, and the longer dimension is parallel to the coast. There are two broad openings to the ocean; the one nearer the northern end is about 12 km wide, and the one nearer the southern end is nearly 5 km wide. Isla Altamura, about 42 km long, is the barrier ridge between the bay and the ocean. Several smaller streams also enter the bay which extends from about latitude 24°46' to 25°15' N and from longitude 107°58' to 108°23' W.

This large coastal bay has a number of islands, including one named Tachichilte that is about 27 km by 10 km. The water area north of this island is called Santa Maria and that to the south is called Altamura. There are deeper parts with channels of clear water that extend to the passes and these are favorite places for diving ducks, especially redhead. Porpoises were seen there; on one reconnaissance trip two gray whales were sighted.

In many years much of the eastern and southeastern parts of the basin (Altamura) was very shallow or dry, with extensive flats, but from the air a great deal of submerged vegetation was seen. Widgeongrass was common. Some of these broad flats were exposed around the islands, and these were favorite resting places for water birds and feeding grounds for shorebirds. Tens of thousands of shorebirds were observed on the flats at the north end of Isla Tachichilte. White-fronted geese were common on the adjacent mainland.

On the January waterfowl surveys of Santa Maria, the estimates of ducks seen in some sample years were 17,620 in 1947, 7,480 in 1951, 3,181 in 1955, 5,906 in 1960, and 22,945 in 1965 (an average of more than 12,000).

In 1965 the composition of ducks was 13,400 redheads, 4,800 lesser scaups, 3,200 wigeons, and a few green-winged teal, pintail, and several other species.

This area has become the principal wintering ground for black brant on the mainland of Mexico. Following the appearance of four of these geese at Agiabampo in 1958, 958 were seen at Santa Maria in 1959. Since then the numbers have been as follows: 215 in 1960, 4,155 in 1961, 2,400 in 1962, 12,440 in 1963, 18,930 in 1964, and 16,575 in 1965. We do not know whether eelgrass or any other favorite food of these brant occurs at Santa Maria, but obviously they have found adequate food in this locality.

Ensenada del Pabellon, Culiacan, and Presa Sanalona, Sinaloa (83, 84)

The Ensenada del Pabellon, about 34 km southwest of Culiacan, is about 17 by 58 km. Its long axis is parallel to the coast in a northwest-southeast direction. Most of its fresh water comes from the Rio Culiacan, but it has several smaller streams, including one near its north end close to the village of Altata. There is only one pass to the ocean which, on the aeronautical charts, is less than 1.6 km wide.

The northern part of the laguna had the same salinity as that of the ocean at the time it was visited on 5 April 1960. That part had little aquatic vegetation other than algae, but there was an abundant supply of small mollusks which were being eaten by scaup and other divers. There was a great deal of deep water, including channels that radiated from the pass. On several of our earlier visits, rafts of scaup and schools of porpoises were seen. Adjacent to the lagoon there were salt flats and tidal pools, and much of the mainland shore was bordered by mangroves. In places, the shallows were stained red by the organic dye from the mangroves.

The larger southern lobe of Pabellon contained a great deal of shallow water, which was very turbid during periods of high wind. At times of low water, large areas of mudflats were exposed. This southern lobe contained scattered beds of aquatic vegetation, including widgeongrass that had borne a good crop of seed.

Many of the shores were margined with mangroves, but where beaches were present there were spikerushes, sedges, glassworts, bulrushes, and several grasses, including saltgrass and bermuda grass. Most of the waterfowl that wintered in the area were in the southern part of the laguna at roosting time, but the diving ducks were there throughout the day.

The principal submerged aquatic in the small lagoons on the mainland was widgeongrass, but some shallows contained muskgrass and algae. In the smaller, fresher lagoons, naiad was also present, and there also were two species of smartweed, and floating heart, waterlilies, burhead (*Echinodorus* sp.), bulrushes, and several species of grasses.

In years of favorable conditions, large numbers of waterfowl were present, but in dry years the numbers were small, as in 1947 when only 27,000, mostly shovelers, were seen. Some mangrove islands were used as roosts and nesting places by brown pelicans and magnificent frigatebirds (*Fregata magnificens*). The shore was margined by red mangroves; black mangroves were on slightly higher ground beyond.

Local residents reported in 1960 that an increasing number of ducks were using the lagoon during the winter months, but that most of their feeding was in the agricultural fields, marshes, estuaries, and fresh-

water ponds between there and Culiacan. White-fronted geese were common winter residents of the Culiacan sector, often visited the coastal flats, and probably roosted on or near Laguna Pabellon. Small numbers of Canada geese were reported at inland grainfields.

The extensive irrigated lands near Culiacan are a principal part of the Pabellon area in the reports of the aerial surveys. These croplands, including the rice and wheat fields, extend from northwest of Culiacan to south of the town of Costa Rica. Two large reservoirs are in the district: the Presa El Humaya has a capacity of $3{,}150 \times 10^6$ m^3 and the Presa Sanalona (Rio Tamazula) has a capacity of 845×10^6 m^3.

The numbers of ducks seen on this wintering ground on some of the January surveys were as follows: 137,000 in 1951, 365,000 in 1955, 110,000 in 1960, and 560,000 in 1965 (average, 236,000). The average positioned it second among the Pacific coastal areas; the most important wintering area was the Marismas Nacionales.

A comparison of the January survey estimates since 1947 shows clearly that the wintering duck population has increased greatly in the Pabellon-Culiacan sector. As was described in the account for the Ciudad Obregon district, the decrease in grain-raising there and the increase near Culiacan have resulted in more and more of the ducks going to the Pabellon-Culiacan area.

Most of the ducks in the Pabellon-Culiacan area are pintail, along with much smaller numbers of green-winged teal, shoveler, lesser scaup, and blue-winged teal. In 1965, for example, there were 342,450 pintails, 94,400 green-winged teal, 47,800 shovelers, 52,100 blue-winged teal, and smaller numbers of other species.

Dimas, Sinaloa (85)

Dimas is the name given in the survey reports to the series of estuary-like lagoons between the Ensenada del Pabellon and Mazatlan. The first lagoon is a very long, narrow one of irregular shape extending from the mouth of the Rio San Lorenzo to near that of the Rio Elota, a distance of about 60 km. Its widest part, near the village of Santa Maria, is about 6 km. This name is also applied to separated coastal waters between the village of Dimas and Mazatlan.

When water conditions are favorable, these lagoons provide good habitat with an abundance of widgeongrass, but in years of inadequate runoff, much of the basins may be dry and waterfowl use may be slight. On 14 February 1947, on the first aerial survey, water and food conditions were good, and almost 185,000 ducks were seen there. They included 127,000 scaups, 20,700 ruddy ducks, 19,750 redheads, and 7,845 shovelers. On 21 January 1948, water levels were low, and only 11,460 ducks were tallied, most of them scaups.

In subsequent years, Dimas has continued to vary in its attractiveness to waterfowl as habitat conditions have improved or worsened. Estimates of the number of ducks seen on the January surveys have ranged as follows: 3,100 in 1951, 17,000 in 1955, 12,600 in 1960, and 54,300 in 1965 (average, 12,300). In 1965 the following ducks were seen at Dimas: pintails, 14,900; green-winged teal, 8,800; shovelers, 8,000; gadwalls, 6,800; wigeons, 4,800; lesser scaups, 8,000; ruddy ducks, 1,700; and smaller numbers of several other species.

Mazatlan and Laguna del Caimanero, Sinaloa (86, 87)

In the early years of the waterfowl surveys, there were several small lagoons near the city of Mazatlan, including one known as Laguna de Camarones, which was just inside the barrier beach near the old airport. Laguna de Camarones was especially attractive to all species of ducks passing through in migration; although it was small, at times several thousand birds were observed there. Because of its ecological features, a detailed description is given here, based largely on a ground survey. With the growth of the city, suburbs have been built over the filled lagoons and at this writing none of them remains.

In January 1950 Laguna de Camarones, which was hidden beyond the sandy beach ridge and only 90 m from the Pacific shore, was a favorite rendezvous for wintering and migrant waterfowl and shorebirds. As a coastal lagoon it was small, only about 0.8 km long and averaging less than 90 m in width; its long axis was parallel to the ocean shore. The trough in which it lay was formerly much more extensive, but windblown sand had gradually filled in the southern part of the basin, and lessened its general depth elsewhere. Its water level was about the same as that of the ocean at high tide.

The shore toward the sea was more abrupt than the inner one, and the cover of small straggling mesquites and low, copse-like thickets of huisache (*Acacia farnesiana*) in places came almost to the water's edge. Along most of its length the marginal zone was of saltgrass, with occasional clumps and lines of tomatillo. The shore was black mud and sand, on a base of sand.

Because there were several hundred ducks present at the time of our first visit, when ruddy duck, scaup, and coot predominated, the shore was scanned for any fresh drift of aquatic vegetation that could be fed upon in the deeper water, which was then about 0.6 m in depth. No fresh leaves, such as those of shoalgrass or widgeongrass, were seen, so a closer search was made for the food being eaten. At the water's edge a close scrutiny revealed very small particles of floating vegetation, which were short fragments of almost thread-like widgeongrass leaves. The feeding of ducks and

coots along the shore, as well as farther out, left almost no sizable pieces of leaves. Yet the old drift at a higher level, and the root systems in the soil, showed that much of the bottom had been covered with a heavy growth of widgeongrass at the time the waterfowl had arrived in autumn.

At occasional intervals there were small depressions, usually about 0.3 m in diameter, containing hundreds and even thousands of tiny snails of the species found in the gullets and gizzards of the lesser scaup and ruddy duck taken at this lagoon. Many or most of these mollusks were alive, but at the water's edge there were scattered windrows of their empty shells.

A closer examination of the bottom mud along the shore revealed countless numbers of brown tubes that were the cast skins of midge larvae (bloodworms, *Chironomus* sp.). Scattered small plants of *Ruppia* were also found that had leaves less than 1 mm wide and 10-15 mm long. Some plants of shoalgrass were present, and in the debris where drift had lodged on the mud bottom, there were masses of bloodworms. Large numbers of these larvae were found in the digestive tracts of many ducks, including most of the divers killed at this lagoon. One scaup examined, typical of those killed very early in the morning, had several thousand of these larvae in his gullet. The small snails were also eaten by many of these divers.

By the time of the spring migration, green food was scarce in the lagoon, but since widgeongrass seeds, snails, and bloodworms were still available, lesser scaup and ruddy duck were the principal visitors.

During the growing season, the old rhizomes and the countless seeds of *Ruppia* which sank into the mud produced new plants. They supplied a good crop of succulent greenery and of seeds, plus a better habitat for the bloodworms and snails. Thus the cycle repeated itself, until the lagoon was filled by builders and covered by a new section of Mazatlan.

The collective name Caimanero is used in the aerial survey reports to designate all coastal waters from Mazatlan to and including the Rio Baluarte. The principal waterfowl area is the Laguna del Caimanero, the northern end of which is about 24 km southeast of Mazatlan. It is situated between the delta of the Rio del Presidio and that of the Rio del Baluarte, and measures about 32 by 9.6 km. Its longer axis is parallel to the coast in a northwest-southeast direction. The lagoon has two lobes, and the neck between them is less than 1.6 km wide. According to the aeronautical charts, there is no pass to the ocean; however, it appears that at times of very high water there is a distributary that enters near the mouth of the Rio del Presidio and another one near the mouth of the Rio del Baluarte.

Caimanero Lagoon is shallow and the bottom is soft mud. Its extent varies greatly from season to season, depending on the amount of runoff from the adjacent foothills. The principal waterfowl food in 1950 was widgeongrass, which was thriving in the brackish-to-saline water of its upper end; even in periods of low water there seemed to be a high production of seeds. There were also some green algae and small mollusks of several species. In some shallows along the shore there were great numbers of midge larvae that were an important food for water birds.

There were many small freshwater ponds on the narrow barrier peninsula between Laguna Caimanero and the Pacific. The water levels of these varied greatly with the seasonal rainfall. There was no submerged vegetation other than green algae in those ponds scouted, but they were bordered by southern bulrushes, sedges, bermuda grass, and other grasses. Food was very limited, so the ponds' attractiveness to ducks probably was due to the fresh water available for drinking and the sheltered places for resting.

Many cattle used these ponds, and the excessive turbidity caused by their wading and trampling inhibited the growth of aquatic vegetation. They also grazed on the grasses and bulrushes. The peninsula was of a sandy soil covered with a dry forest of varying density. The beach along the outer shore of Laguna Caimanero was of gently sloping clay soil, which had some drifts of widgeongrass and green algae, and scattered windrows of small mollusk shells which included razor clams, snails, and several other species. On the nearby exposed flats and shallows thousands of avocets were feeding, probably on the insect larvae which were abundant. It was in some of these shallows that thousands of scaups were observed in January 1948.

At the time of the first aerial survey of Laguna Caimanero on 13 February 1947 the water and food conditions were excellent, and there was a great concentration of ducks, coots, and shorebirds. The estimate of ducks seen was 507,000 shovelers, 414,000 lesser scaups, 37,500 green-winged teal, 5,800 redheads, and 135 canvasbacks (total, 964,835). Conditions in subsequent years have varied greatly, but no comparable concentration of waterfowl has been found there since that year. The next largest population observed was 195,600 ducks in 1958. Figures for several other years were 1,541 in 1951, 110,805 in 1955, 113,920 in 1960, and 85,635 in 1965, and an average of 109,708. The species composition in 1965 was 32,700 shovelers, 21,500 pintails, 9,600 ruddy ducks, 9,100 green-winged teal, 7,700 blue-winged teal, 2,600 wigeons, and smaller numbers of several other species.

Marismas Nacionales, States of Sinaloa and Nayarit (88)

The Marismas Nacionales make up one of the outstanding waterfowl wintering grounds in Mexico (Fig. 17). The Spanish word *marismas* means marshy

Fig. 17. 1948—Green-winged teal feeding in the shallows of the Marismas Nacionales, Sinaloa. Their food in this locality usually was bloodworms, the tiny larvae of midges, which were abundant in the shallow water. The seeds and leaves of widgeongrass also were favorite food. The darker patches in the water were beds of widgeongrass. The Marismas Nacionales comprise a vast and most important wintering ground for Pacific Flyway waterfowl.

lagoon formed by the overflowing of the tide, but this vast network of coastal lagoons, flats, and marshes southeast of Mazatlan is usually supplied by the runoff from tributary streams and the adjacent foothills. It extends from the delta of the Rio del Baluarte southeastward to and including the delta of the Rio San Pedro beyond Tuxpan, Nayarit. Its dimensions are about 26 km in greatest width by 128 km. But during surveys, the lagoon and swamp area that continues south to Punta Camaron, slightly beyond San Blas, Nayarit, was considered as part of the Marismas.

The principal source of fresh water for this area is the Rio de Acaponeta and the smaller streams between the San Pedro and the Baluarte rivers. The only direct opening from the Marismas to the ocean is near Teacapan. The extent of these surface waters varies greatly from year to year, depending on the rainfall and runoff from the adjacent mountains. In some years the basin is filled with water, but in others much of it is dry. Waterfowl habitats range from broad, shallow, saline lagoons to fairly deep mangrove-bordered pools and vast areas of marshes and mudflats (Fig. 18). There are thousands of individual bodies of water within this area; consequently, it has not been feasible to scout the entire area during the aerial surveys. The number of birds seen here each year has been estimated to be about 66% of those present in the area.

The principal duck food observed was generally widgeongrass, but locally muskgrass, naiad, bulrushes, spikerushes, and grasses were important.

Fig. 18. A low-level aerial view of a small part of Marismas Nacionales, the vast and important wintering ground that extends from near Mazatlan, Sinaloa, to San Blas, Nayarit. Some lagoons are bordered by red mangroves, but others by acacias, mimosas, and other leguminoseae. Dabbling ducks, especially green-winged teal and shoveler, like to rest on areas that have open beaches. A small flock of shovelers is in the lower left corner of this photograph. Widgeongrass is the most abundant duck food plant.

Animal foods, such as bloodworms, small mollusks, and crustaceans, were abundant and were heavily utilized in some places.

On the first aerial survey, 11 February 1947, water and food conditions were excellent, and there were large numbers of ducks, coots, and shorebirds in some lagoons of the Marismas. The estimates of those seen in the parts scouted were 306,400 shovelers, 187,800 gadwalls, 71,200 lesser scaups, 53,875 green-winged teal, 23,500 pintails, 17,570 black-bellied whistling ducks, 13,100 wigeons, 7,900 blue-winged teal, 6,150 redheads, and 530,400 unidentified ducks, for a total of 1,217,895. The large number unidentified was due to their distance or the unfavorable angle of light from which they were seen. In subsequent years, habitat conditions and numbers of ducks seen have varied widely. In 1959, the estimate was 678,810, which was the second highest during the survey years. Some other estimates were 129,400 in 1951, 181,570 in 1955, 319,842 in 1960, 345,645 in 1965, and an average from 1951 to 1965 of 286,614.

Southward from the Marismas, there are small waterfowl areas adjacent to Jalotemba on and near the Rio Tomatlan, Jalisco. Between it and the Rio San Nicolas, there are lagoons that are fairly deep in places and cover several square kilometers. At the time of the midwinter survey, there were as many as 59,000 ducks on the lagoons, including 43,000 lesser scaups. From

the Rio San Nicolas, Jalisco, to Manzanillo, Colima, there are no noteworthy waterfowl habitats.

Laguna de Cuyutlan, Rio Armeria, and Coastal Waters, States of Colima and Guerrero (89)

Laguna de Cuyutlan extends from the city of Manzanillo east-south-eastward about 40 km, but siltation has divided its eastern third from the rest of the basin. This division has resulted in one section about 4 by 21 km and the other about 6 by 15 km. Many short, small streams supply fresh water, but there is no large tributary entering the laguna. In earlier times the Rio Armeria entered the southeastern end. Silt has blocked this former connection, but when the Rio Armeria floods, high water extends in both directions from the estuary, and if the level is high enough it also enters the southern end of Laguna Cuyutlan. The southern end is much fresher than the main body of the lagoon, probably due to the seepage from the Armeria drainage. When it was visited 20 March 1960, the brackish water on the river side was 33% as saline as the ocean, so it was much fresher than that of the lagoon. Before the blocking of this tributary, the lagoon probably received more fresh water and had a better circulation. Local fishermen told us that at the time of the hurricane in 1959, the water level of the lagoon rose almost 1.8 m, and the flow from it went out from the pass to the south and at Manzanillo. Cuyutlan has no natural opening to the ocean, but at Manzanillo a cut has been made connecting the laguna with Manzanillo Bay. This cut is the only regular means of circulation with the ocean, except at times of tropical storms when the ocean may flood across the low beach ridge near the southeastern end of the lagoon.

A low barrier ridge separates Laguna Cuyutlan from the Pacific. On the mainland side, foothills rise abruptly in many places, backed by increasingly higher mountains. Much of the lagoon is bordered by mangroves.

In years of favorable water level and circulation, the laguna is an excellent wintering ground for some species of waterfowl, but when its level is very low and circulation is poor, waterfowl foods are in short supply. The bottom in most places is very muddy, and when the water is shallow the wind action and excessive turbidity greatly reduce the food supply.

Beds of widgeongrass and muskgrass were present in some places when the laguna was visited in February 1950, but they were not widely distributed. Along the eastern shore there were many good stands of alkali bulrush and southern bulrush, both of which had seeded heavily. There also were several species of spikerushes, glassworts, and grasses. Duckweeds were common in sheltered pools; in other pools water lettuce was overabundant.

The bottom is a very soft mud rich in organic materials. There are many insect larvae available to feeding ducks, and along some of the shores several species of mollusks are common. The lagoon is also well supplied with small fishes; large schools are at times so conspicuous and dense that they attract thousands of gulls, terns, herons, cormorants, and other fish-eating birds. Specimens taken were identified as *Gobionellus microdon* and *Dormitator latifrons* by Robert R. Miller, Curator of Fishes at the Museum of Zoology at the University of Michigan. Thousands of them measured no more than 5 cm in length, but some were as long as 10 cm. The diving ducks that wintered on this lagoon may have fed on some of these small gobies.

On 20 March 1960 the water samples taken at several places along the northern shore tested 21% more saline than sea water. On this date there were no submerged aquatics seen other than algae, and local fishermen said that recently the lagoon had remained salty and that "no grass grows in it." They added that the ducks there fed on mud (plankton) and mollusks. We observed no drift of aquatics along the shore, other than algae. With a very small volume of fresh water reaching the lagoon, and with the high rate of evaporation, it is not surprising that the water is now considerably saltier than that of the ocean. Our guess is that the diving ducks that have been seen in large numbers in past years were feeding on insect larvae, small mollusks, and crustaceans. Observations at various points on the lagoon shore indicated that animal food provided most of the fare. It was not possible to obtain waterfowl for food habits studies.

At several places along the mainland shore of the lagoon there were small seepage springs, most of which had a strong, sulphurous odor. In these seepage areas there were dense beds of cattails, alkali bulrushes, southern bulrushes, and cane. These seepages supplied the only fresh water to the lagoon. There were dense clusters of small pelecypods on much of the vegetation along the shoreline and on the roots of mangroves and other trees at the water's edge.

On the 1947 survey, there were 177,435 ducks seen on Laguna Cuyutlan, including 46,200 lesser scaups, 41,900 gadwalls, and lesser numbers of several other species. In 1948 the total was 109,450, of which 39,500 were scaups, 14,750 were ruddy ducks, and the remainder was distributed among 11 species, including 2,255 canvasbacks, 500 ring-necked ducks, and 270 redheads. Several thousand black-bellied whistling ducks were there both years. In some of the other years the estimates were 14,790 in 1951, 5,840 in 1955, 17,370 in 1960, 26,850 in 1965, and an average of 31,726. In 1965 the composition by species was 12,700 lesser scaups, 8,600 pintails, 3,100 shovelers, 1,300 blue-winged teals, and several other species in much

smaller numbers. In 1964, 3,200 redheads were also observed.

From the delta of the Rio Armeria as far south as Papanoa, much of the coast is rugged and of no value to waterfowl. In places there are many kilometers of precipitous, rocky headlands that front on the Pacific. There is some heavy forest in the swampy delta of the Rio Balsas. This woodland, and especially that of the foothills, is usually much greener than that to the east from Zihuatanejo to Acapulco and beyond there southward to Tehuantepec. On several small lagoons of the Balsas Delta, flocks of teals, wigeons, shovelers, whistling ducks, and lesser scaups have been observed.

The area called Papanoa in some reports includes the series of coastal lagoons between Zihuatanejo and the Morro de Papanoa, a distance of about 70 km. Along with the lagoons and long, winding esteros, there were some extensive areas of drier marsh farther inland from the coast which appeared to be filled with sedges, cane, and associated vegetation. On the survey in 1947 these waters had almost 50,000 ducks, about half of them pintails, and including 7,000 green-winged teal and smaller numbers of five other species. In 1948 and in many subsequent years, they contained few birds.

Lagunas Nuxco and Mitla, and Rio Coyuca, Guerrero (90)

Southeast of Nuxco and the Rio Atoyac is Laguna Mitla (Cayaco), which is about 37 km northwest of Acapulco. It is a good waterfowl area, especially for divers. Almost 24 km in length and situated just inside the barrier ridge, it is bordered mostly by mangroves, but there is thorn forest on the northern side where the hills come close to it. During some years, the adjacent pools and marshes are more attractive to dabblers than is the main lagoon. Laguna Mitla's aquatic vegetation is similar to that described for Laguna Coyuca, except that it has a more extensive margin of mangroves and contains much more widgeongrass.

An extensive marshy area lies between Laguna Mitla and the Rio Coyuca in which the principal plants are spikerushes, bulrushes, several species of grasses, cane, and cattails. The water is fresh and the pools have waterlilies and floating heart, waterhyssop, saltwort, tomatillo, and spikerushes. When we visited the area on 1 March 1960, much of the cattails and bulrushes had been cut by the natives for making mats.

In 1947 the ducks seen there totaled 6,425, but in 1948 we saw more than 46,000. On 16 January 1948 almost all the ducks in this sector were concentrated on the western half of Laguna Mitla, probably because of better feeding conditions. Mainly ruddy duck were on the small lagoon near the Rio San Jeronimo. Much of this coastal area was in rice production, and rice fields bordered several of the streams. With food in the fields and in the lagoons, this sector was important to wintering and migrant waterfowl. There was probably an even greater gathering of birds there in the fall, when more grain was available.

Laguna Coyuca, Guerrero (91)

Laguna Coyuca is 8 km northwest of Acapulco. It is roughly a half circle; its longest dimension is about 14 km and its width 5 km. There is no direct connection between the laguna and the ocean, but there is a narrow estuary that extends westward to the Rio Coyuca just inside the barrier ridge. No large streams enter the lagoon, and its level and freshness remain more stable than do similar bodies of water having a highly variable inflow. Because of the volume of fresh water entering the lagoon from rains within its basin, it is fresh most of the time. When samples were tested during the winters of 1950, 1951, and 1960, there were no traces of salinity.

Much of the lagoon is fairly deep and relatively little is less than 1.2 m deep. It is margined by tall, dense mangroves along most of the northeastern shore, by cattails, cane, and bulrushes along the northwestern side, and to the south by the low, wet, grassy shores of the barrier peninsula. The submerged aquatic plants observed in the lagoon on 28 February 1960 were chiefly coontail, naiad, and algae. In the shallows along the southern side, bermuda grass was very common; on the southern shores other grasses, spikerushes, and small patches of bulrushes were recorded. Almost all the dabblers seen were in the shallows near the southern and western shore. The deeper water of the remainder of the lake was utilized chiefly by scaup and ruddy duck. Water hyacinths were present in many places along the shore, but they were in a relatively narrow band.

Coontail and naiad were abundant in the channel extending from the lagoon to the river. Along the shores several species of grasses, including two species of *Panicum*, many of them in seed, were available to the ducks. Several blue-winged teal examined there in hunters' bags had been feeding on naiad and widgeongrass, and several scaup and ruddy duck contained small snails.

On 28 February 1960 the sex ratio of 8,000 lesser scaups was estimated to be about 60 females to 40 males. A female scaup shot there was very fat and in her gullet and gizzard were many small snails. We were told that this lagoon is hunted regularly throughout the winter and that most of the hunters shoot from motorboats.

To the westward there is an estuary which was formerly connected with Rio Coyuca, but a dam near its landlocked mouth now blocks any passage by boats. The common aquatic plants were naiad and coontail, which were abundant to a depth of 1.5 m or more.

Inland from this estuary there are a few small lagoons and marshes which attract wigeon, gadwall, fulvous whistling duck, blue-winged teal, and other dabblers. Most of the birds were on a shallow lagoon just south of the river in a locality that contained many small rice fields.

Since 1951 the aerial survey reports have combined the estimates of the waterfowl seen in the area from Laguna Nuxco to and including Laguna Coyuca under the name of Mitla-Coyuca. This actually has combined the waterfowl of six lagoons, as is explained in the following description. On the first survey in 1947 this estimate was divided among six water areas going from north to south, as follows: (1) Laguna Nuxco had 9,100 ducks, including 4,500 gadwalls, 2,800 wigeons, and 1,800 black-bellied whistling ducks. (2) A smaller, more isolated lagoon situated about half-way from there to the Rio Tecpan had 11,650 ducks, including 1,800 gadwalls and 9,850 unidentified ducks. (3) To the east across the Rio Atoyac, there is an unnamed lagoon southeast of the village of Tecpan. There and on the adjacent extensive marshes an estimated 87,000 ducks were seen, including 29,000 shovelers, 21,750 blue-winged teal, 14,000 wigeons, 10,000 pintails, 8,000 green-winged teal, and 4,250 cinnamon teal. (4) The larger laguna Mitla (also called Cayaco) had a much smaller number of ducks, possibly because of the activity of fishermen. The birds seen included 3,050 ruddy ducks, 1,550 pintails, 1,200 shovelers, 225 wigeons, and 150 black-bellied whistling ducks. (5) Beyond Laguna Mitla and west of Rio Coyuca, there is a small, isolated, unnamed lagoon which had a great concentration of waterfowl, including 62,000 wigeons, 38,800 gadwalls, 20,500 blue-winged teal, 2,500 ruddy ducks, and 750 shovelers. (6) Laguna Coyuca had 23,520 ducks, of which 4,720 were on the main lagoon. They included 3,300 scaups, 350 blue-winged teal, 325 ruddy ducks, 195 wigeons, and 550 unidentified ducks. The remainder (18,800) were seen on the marshes and shallow lagoons adjacent to, and north of, the narrow estuary between the main lagoon and the Rio Coyuca. They included 8,500 wigeons, 4,000 gadwalls, 3,500 fulvous whistling ducks, and 2,800 blue-winged teal.

The total number of ducks observed on these six areas in 1947 was 277,595, which was far more than has been seen on later surveys. During more recent years the largest number seen in this area has been 39,875 in 1963, and the average for 1951, 1952, 1963, 1964, and 1965 is 31,726. The species composition in 1965 was 11,700 blue-winged teal, 5,700 shovelers, 3,200 pintails, 2,200 black-bellied whistling ducks, and smaller numbers of several other species.

Laguna Papagayo (Tres Palos), Guerrero (92)

Laguna Papagayo (Tres Palos) is about 14 km southeast of Acapulco, and has a water area of about 6 by 15 km. It is an excellent waterfowl wintering ground, including both deep and shallow water, an abundance of food, and extensive marshes. In some of the shallows examined, the bottom is mud or a mixture of mud and sand, and beds of small mollusks are common in the sandy areas.

The Rio Papagayo enters the ocean several kilometers east of the lagoon, but at times of flooding some of the water pours into the lagoon. There is no direct pass between the lagoon and the ocean.

The principal submerged aquatics are widgeongrass, muskgrass, naiad of two species, and coontail. These plants, and especially widgeongrass, are eaten by both dabblers and divers; the naiad is abundant at depths up to 2 m. In the adjacent marshes the principal foods are bulrushes, smartweeds, floating heart, waterlilies (including banana waterlily), spikerushes, sedges, and several species of grasses. The drier marshes are heavily grazed by livestock, which at times wade into the water to feed on the aquatics. In February 1960 flocks of fulvous whistling ducks were feeding in the protected pools and marshes on its southwest side. One bird that was shot had almost exclusively eaten the seeds of floating heart.

Bennett (1938: 28–29) visited this area, as well as Laguna Coyuca, in 1936 for information on wintering blue-winged teal, and commented on these lagunas and their birds.

Laguna Papagayo is the largest open lagoon between Acapulco and Tehuantepec. During some winters it has been a concentration area for ducks, especially in its southeastern part near the outlet. A total of 63,000 ducks were observed there on 11 February 1947, including 37,575 gadwalls, 8,700 ruddy ducks, 6,420 pintails, and at least 7 other species. On 15 January 1948 the total seen was 82,000 of at least 11 species.

In recent years (1960–64) the number of birds there has declined greatly. In 1963 slightly more than 18,000 ducks were counted on the January survey which included the following: 15,600 ruddy ducks, 2,300 blue-winged teal, 500 scaups, and 10 fulvous whistling ducks. In January 1965 there were only 4,400 ducks. How much of this decrease is due to the dispersal effect of a much heavier hunting pressure by hunters shooting from speedboats under power, and how much is the result of a general decline in the duck population on the west coast of Mexico south of the Marismas Nacionales, is not known.

Laguna San Marcos, Guerrero (93)

Laguna San Marcos, 9.6 km southeast of the town of San Marcos and west of the mouth of the Rio Nexpa, is about 4 by 9 km. Its sources of fresh water are several small streams from the foothills. It has no open pass to the ocean, but at times of high water there is a tem-

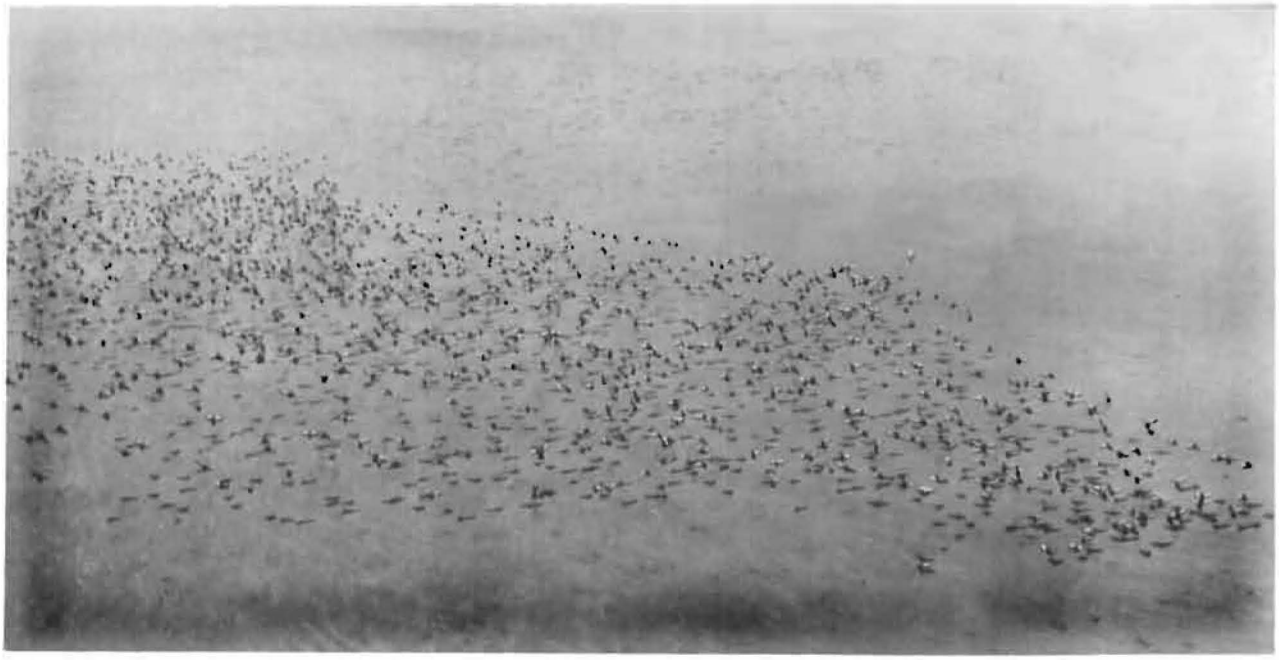

Fig. 19. Black-bellied whistling ducks flying low over a coastal lagoon of Guerrero. These tropical ducks were seen in the marshes and among floating vegetation such as waterlilies and water hyacinths. Often they were not observed until they flew, then their large white wing patches were very conspicuous. This species prefers tropical lagoons and marshes bordered by woodland.

porary channel from its eastern end.

This is another excellent area for waterfowl, because it has both deep and shallow water, an abundance of submerged aquatic vegetation, and broad marshes (Fig. 19). A great deal of the higher ground nearby is savanna and thorn forest. On 11 February 1974 there were 114,000 wintering and migrant waterfowl seen. Although conditions looked equally good on 15 January 1948, the only species that was numerous was the gadwall (32,500) and the total number of ducks was about 40,000. Like Papagayo, its waterfowl population has been much smaller during the past several winters. In 1963 the ducks seen totaled 14,000; in 1965 there were only 8,700.

Laguna Nexpa, Guerrero (94)

Laguna Nexpa is about 6.4 km east of the mouth of the Rio Nexpa and 4.8 km west of the Rio Copala. On some maps it is called the Laguna Chautengo and is about 5.6 by 13 km. There is no natural pass to the ocean, but there are estuaries from each end that function as passes at times of high water.

This is an excellent waterfowl lagoon with many good marshes. Formerly it attracted many birds, especially during migration. On 11 February 1947 few ducks were observed there, because by that date most of them had evidently moved farther northward. The total seen was only 800; but on 15 January 1948 the number tallied was over 50,000, of at least 9 species. In January 1963 only about 6,000 ducks were seen, and in 1965 about 11,500.

Laguna Alotengo, Oaxaca (95)

Laguna Alotengo is about 35 km east of the Guerrero–Oaxaca boundary and 16 km southwest of the town of Pinotepa Nacional. It is long and narrow, about 3 by 14 km, and is an excellent waterfowl area. When the laguna was scouted on 11 February 1947 17,500 ducks were seen, including 1,675 black-bellied whistling ducks, 325 fulvous whistling ducks, and several small flocks of muscovy ducks. Recently the area's duck populations have been much smaller.

When the aerial surveys of coastal waters between Laguna Cuyutlan and Salina Cruz were resumed in 1963, estimated numbers of ducks were combined for the localities from Laguna Alotengo to Salina Cruz. Some of these localities are described very briefly in the following comments on the sector from Laguna Pastoria to Salina Cruz.

Laguna Pastoria to Salina Cruz, Oaxaca (96)

Small lagoons near the Rio San Luis, and in the delta of the Rio Santa Catarina, at times attract a few thousand waterfowl, but the next important area to the south includes a series of swampy lagoons and marshes extending for about 104 km along the edge of

the coastal plain. The area includes the lagoons in the delta of the Rio Verde, the Laguna Pastoria, Laguna Lagartero, and it ends near Punta Escondida. On 11 February 1947 the number of ducks seen there totaled 39,000, including 22,700 wigeons and 10,500 pintails. On 15 January 1948 the total was almost 58,000, of which 16,500 were scaups. Thousands of herons, ibises, and several flocks of roseate spoonbills (*Ajaia ajaja*) were also observed in this sector. Like most of the other localities between Tehuantepec and Acapulco, the waterfowl population has decreased in recent years.

Laguna Lagartero is about 29 km south-southwest of Juchatengo, and measures 1.6 by 8 km, not including an estuary that connects its western end with the Pacific Ocean.

The two lagoons near Puerto Escondido (Chacaqua and Menialtepec) are just inside the barrier ridge, bordered by mangroves, and are used by relatively small numbers of ducks.

From the end of the delta of the Rio Colotepec to within a few kilometers of Salina Cruz, the mountains come abruptly to or near the sea. Water areas are very small and are usually hemmed in by the rugged foothills. Many small streams run down to the Pacific, but most of them are landlocked during the dry season, with tiny freshwater lagoons at their mouths.

Two lagoons around the point west of Salina Cruz were especially attractive to migrant waterfowl when seen in February 1947, probably because of favorable water and food conditions. These shallow, saline *playas* depend upon local runoff, or on an influx of water from the ocean, and in periods of drought they are dry. The birds seen there on 11 February 1947 included 34,200 wigeons, 8,800 shovelers, 3,200 pintails, and 2,500 blue-winged teal. On 14 January 1948 the water levels were low and only 1,165 ducks were seen. When these basins were visited by car in February 1960 they were almost entirely dry, and surface salt was being harvested commercially.

The duck food in these waters consists mostly of insects, crustaceans, and some mollusks. Brine fly larvae and tiny shrimp are believed to be abundant there when the *playas* are flooded. The brine shrimp, *Artemia salina,* and the small mollusks, *Cerithidea hegewischi, Tagelus affinis,* and *Theodoxus luteofasciatus,* were collected from its pools in February 1960. Brine flies were very numerous at that time.

The narrow Laguna de San Mateo is not far inside the barrier ridge from the Pacific, adjacent to the Indian village of San Mateo, which lies east of Salina Cruz. It is described because it is typical of several small but important freshwater lagoons in similar situations in this coastal district. There, and on nearby pools between San Mateo and Santa Maria del Mar, about 14,000 ducks were observed on 7 February 1960. Wigeon were the most numerous, followed by pintail, gadwall, and blue-winged teal.

When full, Laguna de Mateo is more than 1.6 km long, but it averages less than 180 m wide. It is shallow (mostly less than 0.9 m deep) and the bottom is firm sand, but it contains a considerable content of organic matter. When it was visited in 1960 widgeongrass was abundant, dense, and full of seeds, which explained the attraction of the lagoon for ducks. There was also an abundance of small crustaceans and insect larvae, and the water was only 4% of sea salinity. Much of its source of fresh water seems to be from seepage. The shore was open and grassy, and a thorn forest was on some of the higher ground to the northwest of the basin.

It is very doubtful whether Laguna de Mateo and some of the other narrow ones inside the beach ridge are seen at the time of the January surveys, because the coverage at that time is concentrated on parts of Lagunas Superior and Inferior, which are directly to the north of San Mateo. Because of the proximity to the coast of this freshwater lagoon and several others like it, it attracts wintering waterfowl and large numbers of migrants when conditions are favorable.

Laguna Inferior, Oaxaca (97)

The western end of Laguna Inferior is 16 km southeast of the city of Tehuantepec, extending to the east for about 56 km. Its greatest width from north to south is about 13 km near its eastern end.

Laguna Inferior is longer and much narrower than Laguna Superior and has a more irregular shape. The Rio Niltepec flows into it from the north. Like Laguna Superior it is relatively shallow, although reports indicate that parts of it are deeper than Superior. No aquatic vegetation was observed on shore near Santa Maria del Mar, but it was not scouted by boat. The molluscan fauna appeared to be even greater than that of Laguna Superior. Its pass to the Pacific and its connection with Laguna Superior are broad. Its shores are open, with low vegetation, but unlike Superior it has no streams entering from the mainland.

Laguna Inferior, Laguna Superior, and a smaller lagoon to the east, which is fed by the Rio Ostuta, are separated by narrow beach ridges and alluvial deposits.

The average number of ducks seen there during the surveys of 1951–65 was about 22,500. In most years the majority of these ducks are scaup, but in some years there are more dabblers. In 1962, for example, there were 22,200 wigeons, 10,800 pintails, and 4,500 blue-winged teal, as well as 20,000 lesser scaups.

Laguna Superior, Oaxaca (98)

Laguna Superior is about 10 km southeast of Juchitan and 19 km east of Tehuantepec, and extends to the

east and south. It is broad and saline and has several islands in its northern half; its dimensions are about 32 by 18 km and the longer axis runs from northeast to southwest. The low beach ridge that separates it from Laguna Inferior is open toward its southeastern end at a wide pass between the two bodies of water. Several intermittent streams, fed partly by irrigation waste water, enter Laguna Superior from the mainland through fairly deep channels, or *esteros*. The banks of the *esteros* are brushy, and the protected pools are often used by ducks, especially when strong winds are blowing across the laguna. This is probably the windiest part of Mexico, with frequent gales screeching in winter across the low saddle of the Isthmus from the Gulf of Mexico, and ducks have many occasions for taking shelter.

Twice, when the north shore of the laguna was approached by car from near Xandani, the narrow road was impassable because of flooding by waste irrigation water. The broad expanse of the laguna could be seen from an adjacent conical hill, but the high wind made it impossible to see whether any birds were on its surface. Waste irrigation water spilled across the flats from several channels, and small flocks of ducks could be seen on a number of pools.

This lagoon, as well as Laguna Inferior, is reported to be mostly shallow. It was not scouted by boat, and its shore was seen in only one locality. During the dry season in the winter months, it is common for these waters to be bordered by broad mudflats. The shore was not seen at close range, but the *estero* pools had widgeongrass, muskgrass, naiad, and bordering grasses of several species. There was a great variety of mollusks in the lagoon; they and other small invertebrates may provide most of the food for the diving ducks that stop there chiefly in migration.

Several of the islands in the laguna are reported by local fishermen to have fairly dense vegetation, including brush and small trees, that provide nesting cover for birds, including black-bellied whistling duck, white-winged dove (*Zenaida asiatica*), and other doves.

In the flats bordering Laguna Superior, some of the most common trees were *guamuchil, huisache, mimosa, retama,* and *coma.* The flats also had a herbaceous growth of glasswort, saltwort, and sea blite (*Suaeda* sp.), and a variety of grasses and sedges.

The average number of ducks seen there on the aerial surveys of 1951-65 was more than 18,000, most of which were lesser scaups.

Mar Muerto, States of Oaxaca and Chiapas (99)

This long, shallow, coastal lagoon is 12 km west of Tonala, Chiapas. It extends from west-northwest to south-southeast, about 10 by 67 km. Its shape is very irregular and there are scattered islands, especially in the western part. Several small streams from the nearby mountains supply it with fresh water. According to the aeronautical charts, it is connected with the Pacific Ocean by two passes at its southeastern corner.

We have no information on aquatic vegetation or invertebrates of Mar Muerto, but it is reported to average less saline than Lagunas Superior and Inferior. Mar Muerto differs from them by having a heavier, taller border of vegetation, including trees on the mainland site. Scaup are more abundant than other species. We made no ground studies there.

Maps indicate that a channel connects the narrow eastern end of Mar Muerto with Laguna de la Joya, but we have no information regarding the frequency and direction of flow. During the dry season in the winter the water level may be too low for an exchange between the two basins.

The average number of ducks observed there during the aerial surveys of 1951-65 was almost 29,000. In the big year of 1956 the composition of species there was 60,500 lesser scaups, 18,100 blue-winged teal, 10,300 pintails, 7,000 shovelers, 6,400 wigeons, and smaller numbers of others. The total number of ducks was 104,200.

Laguna de la Joya, Chiapas (100)

Laguna de la Joya (Laguna Cabeza del Toro) is about 16 km southeast of Tonala. It is of very irregular shape, and its surface area depends largely on the amount of rainfall for the season. The long axis of the northern and principal part is from east to west, and it measures about 4 by 16 km. Its western end is about 3 km east of the Arista lighthouse. A long arm extends from its eastern end southward and southeastward, following the contour of the adjacent foothills. A railroad skirts the base of these foothills, and a view of the lagoon can be obtained from that route, especially from the station of Mojarras.

Laguna de la Joya differs from the three preceding lagoons in that it is fresh most of the time, according to reports, although storms occasionally have brought high tides of salt water into its basin. When the level of Mar Muerto is high, water reportedly flows from it into la Joya. When the latter was visited during the winters of 1950 and 1960, it contained only a trace of salt. When the water level is low, the laguna has more islands than when the water level is higher. The southern lobe is at right angles to the northern part, and it is about 6 by 2 km. Its islands, and a great deal of swampy land between the laguna and the Pacific, are covered with mangroves; red mangroves are in the lowest places and black mangroves are on the slightly higher ground. Larger mangroves, especially the black species, are the principal trees along the inner shore.

Most of the lagoon is shallow, especially the northern part where much of it cannot be scouted by row-

boat because of shallow water. The bottom is so soft and deep that poling a boat is very difficult in shallow places.

We did not find aquatic vegetation other than phytoplankton and algae. The soil of the lagoon basin was a very soft black ooze, alluvial and mostly organic in origin, and the greenish soupy water, as well as the mud, abounded in plankton. For the thousands of ducks, which were chiefly shoveler with some teals and lesser scaup, food was almost exclusively plankton.

This lagoon usually winters large numbers of shoveler; in 1948 it was estimated that several hundred thousand were there. A more accurate survey could not be made because of high winds.

At the time of our visit on 10 February 1960 there were more than 100,000 ducks on the lagoon, almost all of them shovelers. The shovelers collected contained almost no food other than the plankton-mud. The water was fresh, and had a specific gravity of 1.001. In recent years, when much smaller numbers of shovelers were present and the lagoon appeared to be stagnant, low rainfall and increased salinity of the lagoon may have adversely affected the plankton growth.

The average number of ducks seen there during the aerial surveys of 1951–65 was almost 77,000, most of which were shovelers. In 1963, when the total number of ducks seen was 85,000, the species composition was 47,700 shovelers, 23,200 blue-winged teal, 4,400 gadwalls, 3,800 lesser scaups, 3,500 wigeons, 2,300 pintails, and smaller numbers of several other species.

Sesecapa, Chiapas (101)

In the January aerial survey reports since 1948, all the waterfowl observed in the localities between the southern end of the Laguna de la Joya and the Mexico–Guatemala border were listed as though they were in the Sesecapa area. This sector of coast is about 200 km long, including several series of lagoons and marshes, chiefly the lagunas of Buenavista, Los Patos, Solo Dios (Carretas), and Sesecapa or del Viejo (near Sacapulco). Some of these place names have changed several times in the past 80 years, causing confusion in records. For example, the name Sesecapa applies chiefly to the town and to the river south of Mapastepec rather than to the series of lagoons and marshes in that vicinity. Earlier Mexican Government maps show this river as the Rio San Nicolas. The largest lagoon in the vicinity usually is called the Laguna del Viejo. The principal pass to the ocean is the Boca de Sacapulco (Boca de Soconusco).

The outer coastal plain is low, swampy, and marshy, but in most years there is relatively little open water in proportion to its total area. The levels of these lagoons are determined chiefly by the runoff of streams that have their origin in the nearby Sierra Madre de Chiapas, and which flow the short distance from there to the coast. Many of the high peaks are less than 48 km inland, and it is only a distance of 8–32 km from the coast to foothills of 305 m or more in elevation.

Each river flows into extensive coastal swamps and marshes, as well as lagoons and estuaries. In many years there is insufficient runoff to maintain satisfactory water levels in the lagoons. Most of the marshes are deep and mainly closed by the heavy growth of water hyacinths, pickerelweed, and associated plants.

On the survey in 1947 the water levels were good. Nine individual lagoons of considerable size, and three groups of smaller lagoons, were scouted between the Guatemala border and the south end of Laguna Buenavista. The groups were at Los Patos, Solo Dios (Carretas), and Sesecapa. In addition, there were many small lagoons scattered through the marshes and swamps, but they were so overgrown with pest plants that they contained almost no ducks except for black-bellied whistling duck and some muscovy duck. On 11 February 1947 at the Los Patos lagoons and marshes, which lie south of the village of that name and east of El Malajual, there were 6,600 wigeons, 6,500 pintails, 2,950 blue-winged teal, 1,000 shovelers, 2,250 white-fronted geese, and 15 Canada geese. In recent winters, however, few waterfowl have been observed there.

On the Carretas or Solo Dios lagoons the waterfowl included 5,750 pintails, 1,350 blue-winged teal, 275 shovelers, 15 black-bellied whistling ducks, and 330 coots.

On the lagoons near the Rio Sesecapa the following ducks were seen in February 1947: black-bellied whistling ducks, 1,875; pintails, 1,360; wigeons, 1,245; blue-winged teal, 200; and green-winged teal, 200.

The total of ducks seen throughout the sector in 1947 was almost 32,000. Since then the numbers have varied widely, from a low of 5,222 in January 1965 to a high of 63,025 in January 1958, and averaged almost 33,000.

On the 1958 survey 63,025 ducks were seen, as follows: pintails, 23,200; lesser scaups, 18,550; shovelers, 13,350; blue-winged teal, 5,750; green-winged teal, 1,100; wigeons, 825; gadwalls, 250; muscovy ducks, 1,277; and black-bellied whistling ducks, 2,695. In 1964, the 43,165 total included 18,300 blue-winged teal, 14,225 lesser scaups, 4,200 wigeons, 1,300 shovelers, 600 pintails, 300 redheads, and 4,100 black-bellied whistling ducks.

In 1965 the species composition was 13,100 shovelers, 13,000 blue-winged teal, 5,400 fulvous whistling ducks, 5,200 lesser scaups, 4,600 wigeons, 2,100 pintails, 1,900 black-bellied whistling ducks, 200 gadwalls, and 10 muscovy ducks. The muscovy ducks

are usually in the swamp and, therefore, not visible from the aircraft. From 1948 to 1965 the number of ducks seen in the Sesacapa area averaged 2.6% of the total recorded on the Pacific Coast of Mexico.

The extensive area southwest of Acapetahua is a broad expanse of marsh and savanna, with little open water. There are a few small lagunas with great masses of water hyacinths, and waterlilies are common on the open water.

Between the San Benito lighthouse and the Guatemala-Mexico boundary there are several winding estuaries just inside the beach ridge that are backed by mangrove swamps. About two-thirds of this distance from the boundary there is a pass which connects the estuaries with the Pacific.

Most of the migratory waterfowl that enter Latin America by way of the Pacific Coast of northwestern Mexico do not travel beyond the Mexico-Guatemala boundary. Of those that do, most are blue-winged teal and lesser scaup, and the majority of the former go on to northern South America, but most of the lesser scaup winter on the coastal lagoons of Central America.

Winter Habitat Conditions and Waterfowl Use, 1945-1964

The following summaries are based on the reports of the U.S. Fish and Wildlife Service personnel who conducted the January aerial surveys.

Gulf and Caribbean Zone

1945-51

Many of the streams in Tamaulipas and Veracruz were below normal in flow during 1945-51. As a result the coastal bays, lagoons, and marshes had less fresh water than usual. This condition was especially noticeable in the Tampico district because many lagoons there were much lower than average. Water levels were more favorable in the vast Papaloapan Delta of southern Veracruz. Because of the high rainfall of the Tabasco sector, even in years of subnormal precipitation, the lagoons and marshes usually have had sufficient water. The coastal lagoons of Campeche and Yucatan had favorable water levels and general conditions seemed good for waterfowl during these years.

1952

Water conditions in the Tampico district in January 1952 were much better than in the previous years. The lagoons were well above their average level, and some of the adjacent flooded farmlands, especially near the town of Panuco, afforded additional feeding grounds for waterfowl. The rainfall in the upper drainage replenished this delta and brought an end to the drought that had prevailed since 1945. Water and habitat conditions in Veracruz, Tabasco, Campeche, and Yucatan were satisfactory for wintering ducks.

1953

In January 1953 the Rio Grande was again very dry, dust was blowing from many of the basins, and observers reported no ducks or geese in the usual areas of lagoons and marshes. The Tampico deltas were full of water, thanks to the record rainfall of 1952.

1954

The Rio Grande Delta showed a slight improvement in water conditions, and a few shallow lagoons were renewed. The water levels in the Tampico lagoons were below the 1952 and 1953 levels. Waterfowl were fewer in the Tabasco lagoons.

1955

Due to the heavy rains of the past 6 months, the Rio Grande Delta was extremely wet. There were hundreds of water areas compared with none in 1953 and only a few in 1954. As a result about 30,000 ducks were recorded in the area, where in the previous year only 2,500 were observed. The water levels in the Tampico lagoons seemed to be receding and a substantial decrease was recorded in both ducks and geese.

1956

The Rio Grande Delta was very dry this year in comparison to 1955. Only a few of the larger areas contained water, and few ducks and geese were observed.

The Tampico lagoons and marshes were in the path of the hurricane which struck Tampico in 1955 and caused widespread flooding of the Panuco and Tamesi rivers, which flow through this area. The water still was very turbid and the vegetation showed the effects of heavy flooding. In spite of the turbidity, more ducks, but fewer coots, were observed than in 1955. Few lesser scaup were observed on Laguna Tamiahua, but it is not known whether this was a result of the hurricane. Only 23,000 lesser scaups were recorded in comparison to 167,000 in 1955. As usual, the habitat conditions in the Alvarado lagoons appeared to be excellent and there was an increase in waterfowl over last year. The numbers there, however, continued to be small in relation to the carrying capacity of the area. There was an increase in waterfowl using the Tabasco lagoons, and gains were noted in populations of wigeon, pintail, and lesser scaup.

An increase in the number of ducks was recorded for the Campeche-Yucatan lagoons, due chiefly to an increase in wigeon. As in 1955, Celestun Bay, which ordi-

narily contains large concentrations of waterfowl, had very few. The reason for this shift was not apparent.

1957

No survey was carried out in Mexico this year.

1958

Conditions generally were good throughout the Gulf coastal wintering grounds.

1959

The Rio Grande Delta flooded several times this winter and refilled many lagoons, which restored very favorable conditions for waterfowl. It was impossible to cover the vast inundated area utilized by waterfowl, but an estimated 50% was scouted.

Conditions were good in Laguna Madre and other Tamaulipas lagoons. Except for the divers, about 90% of the waterfowl observed were found on freshwater areas. Extensive rafts of redheads were seen on the west side of Laguna Madre, just south of the Eighth Pass. The number of waterfowl observed in Laguna Madre and other Tamaulipas lagoons was more than twice the total found in any year since 1948.

The Tampico lagoons and marshes appeared to be in very good condition and had high water levels. Extensive flooding was noted west of the village of Panuco and at Laguna Tortuga. However, fewer waterfowl were observed in these marshes than in 1958, but their number was above the recent average. On Laguna Tamiahua, in the vicinity of La Mar and Saladero, additional wintering habitat had resulted from the heavy rains, necessitating survey coverage greater than that of previous years. In the past, large concentrations of scaup have been observed on Tamiahua Lagoon, but the number seen this year was below that recorded in any previous year since the beginning of the Mexican surveys. It is estimated that 10% of the Alvarado lagoons were surveyed this year. Much of the habitat was being destroyed by the invasion of water hyacinth and other pest plants. Major portions of the marshes were also dry. The number of waterfowl seen was slightly more than half of that observed in 1958.

The most important waterfowl area in the Tabasco lagoons and marshes this year was located south of Alvaro Obregon and northeast of Villahermosa. The invasion of water hyacinth into this area has continued, covering many of the lagoons. The number of waterfowl found was below that of 1955 and 1956.

1960

In 1958–59 the Rio Grande Delta was flooded several times, and its surface water was extensive. This year the delta was very dry and many of the more permanent lagoons were at extremely low levels. At Laguna Madre only the nearly closed Eighth Pass provided a tidal connection with the Gulf, and there was no flow from the Rio San Fernando into the laguna. There were great drifts of dead shoalgrass leaves in places, chiefly in the western shallows, as a result of the excessive salinity. The freshwater lagoons on the mainland were low and some were dry, but most of the birds seen in this sector were on these mainland waters.

On the Tampico lagoons, as elsewhere at so many freshwater lagoons and marshes of Mexico, the encroachment of water hyacinth is making the habitat less and less attractive to waterfowl. Pintail, scaup, and blue-winged teal were less numerous than in 1959, but gadwall, green-winged teal, and geese showed a definite increase. However, the overall total was the lowest since 1956. It is estimated that 50% of the area was surveyed. The past surveys at Laguna Tamiahua revealed good numbers of lesser scaup, but the numbers were down in 1959 and even lower in 1960. Gadwall, whistling ducks, and ruddy duck showed a small increase over 1959. Total waterfowl numbers were below those of 1959, which was the lowest recorded for this area since the Mexican surveys were begun. Apparently the Alvarado lagoons and marshes had recovered from the severe drought of 1959, but water hyacinth continued to take over much of the open water. Waterfowl numbers were only about 20% of those in 1959, which was the previous lowest count recorded.

Some additional survey coverage was made in the area on the basis of information given the senior author by local hunters, who had estimated that about 2,000 geese were using an area to the southeast of the regular survey area (beginning near the railroad that runs through El Maguey and crosses Rio Playa Vicente and Rio San Juan) and extending northeast to join the regular survey area. This is a large tract of prairie consisting mainly of open range land, wet meadows, and some agricultural land. It appears to be good goose habitat, closely resembling the prairie land of the western United States and Canada. However, if large numbers of geese had been here, they had left before the aerial survey. The number of waterfowl seen on the Tabasco lagoons was even lower than in 1959; coverage was estimated at 8%.

Some of the Campeche and Yucatan coastal lagoons were utilized heavily by scaup and coot, mostly in the segment between the cities of Campeche and Progreso. This year for the first time considerable numbers of these species were observed in the coastal lagoons and marshes east of Progreso and eastward to Quintana Roo. The total population for the area was about three times that for 1959; most of the increase was in lesser scaup and coot.

The waterfowl populations varied from one survey

area to another. Some were higher than last year and some were lower, but the general trend was a decrease. All of the common species were below the 8-year average. Ruddy duck, gadwall, lesser scaup, and ring-necked duck showed some increases over 1959.

1961

This year, as in 1960, the Rio Grande Delta suffered from drought. The levels of all of its bodies of water were extremely low with the excepton of El Azucar Reservoir, which was considerably higher than last year.

Laguna Madre and other Tamaulipas lagoons were suffering from lack of rainfall in 1960, and the situation was even worse this year. Large rivers, such as the Soto la Marina, were so reduced in flow that they were landlocked. Not a river was flowing into the Gulf between Tampico and the Rio Grande. Furthermore, only one small pass, the Eighth, was open from Laguna Madre to the Gulf, and it had an almost negligible flow. As a consequence, the level of Laguna Madre was low and the salinity extremely high. Very few waterfowl were seen, and the fishing fleets at the several small villages along the western shore of the laguna were tied up. The lack of flow of fresh water into the laguna, coupled with the absence of tidal action from the Gulf, had a disastrous effect on fish as well as on waterfowl food. Far fewer waterfowl were observed than during any previous survey.

There is cause for concern about the future of some of the Tampico lagoons, especially those of the Rio Panuco system. Lagoons and marshes in the vicinity of Ebano are being seriously polluted by oil. Unless some corrective action is undertaken soon, the waterfowl value of this part of the Panuco drainage will vanish within the next 10 years. As noted in 1960, there is some encroachment by water hyacinth, but it is not so pronounced as in some of the other areas, notably the Alvarado lagoons and those of Tabasco.

The situation in Laguna Tamiahua improved in 1961. There were 30,000 scaups, more than had been found since 1955. In the Alvarado–Papaloapan sector there was evidence of severe drought in 1959, but in 1960 it appeared to have recovered and the lagoons seemed to be in good condition except for the continued spread of water hyacinth. In spite of the improved water conditions, populations of all species except coot were fewer than in previous years. The total for coot was the second highest recorded since 1955.

The water levels in the Tabasco lagoons and marshes were extremely high, and waterfowl populations were the highest since 1956. These lagoons were sampled by the transect method because the area is very large. It was impossible to record all of the waterfowl present along the survey lines, because of the great amount of concealing cover, so the estimates were very conservative.

Many of the Campeche and Yucatan lagoons were suffering from lack of water. The one exception, and the one that made the survey of this particular sector outstanding, was Celestun Bay, located near the Campeche–Yucatan boundary, which had an estimated 800,000 to 1,000,000 ducks. This bay is about 24 km long and 3 km wide, and the birds were concentrated in less than half of the bay, making it difficult to obtain a good estimate without striking ducks. This was the highest number of waterfowl for this coastal sector since 1955, and practically all of them were in the one bay.

1962

The Rio Grande Delta, in common with most of the other survey areas, continued to suffer from the lack of water. The only exception was a newly filled irrigation reservoir upriver from Brownsville and Matamoros, which was holding more waterfowl than had been seen in past years. Also, probably due to the rains of Hurricane Carla and better feeding, some of the coastal ponds had more ducks and geese than they have had for several years. As a consequence, the total waterfowl in the delta was the highest recorded since 1959 when the delta was flooded.

At Laguna Madre and other Tamaulipas lagoons there had been an obvious shortage of food and favorable water conditions for the past three or more surveys (1959–61). The rivers had been so reduced in flow, probably from a combination of drought and the use of water for irrigation, that none of them opened into the laguna. All the passes were closed, as they were in 1961, except a very small one through the barrier beach. As a result, the salinity of the laguna was too high to permit the growth of waterfowl food plants, and very few waterfowl were seen there. In 1962 there was a definite increase in waterfowl populations on the lakes inland from Laguna Madre. There, as in the Rio Grande Delta, the increase in wintering waterfowl was attributable to the filling of inland lakes and ponds by Hurricane Carla.

In the Tampico lagoons, as in most of the other coastal localities, there was considerable evidence of drought. The marshes and lagoons bordering both the Tamesi and Panuco rivers provided excellent wintering habitat, and even in their present reduced extent they could winter far greater numbers of waterfowl than had been found there during the past few years. The Panuco area from Ebano downstream was suffering not only from drought, but also from oil pollution. Marsh destruction from the latter cause was more evident than in any year since these surveys began.

Comparatively few waterfowl were found on Laguna

Tamiahua, and even fewer were found from there to Veracruz. It had been common to find fair numbers of birds along the west shore of Tamiahua in the channel between Isla Juana Ramirez and the mainland, around Isla del Toro, and between Isla del Toro and the mouth of the river near Saladero. This year most of the birds were found around Isla del Idolo and in its marshes. Fewer waterfowl were recorded this year on the Alvarado-Papaloapan lagoons than in any of the last 5 years.

On the Tabasco lagoons in 1961 waterfowl populations were the highest since 1956. The 1962 population was even higher, slightly more than half of the total recorded for the east coast of Mexico. This survey unit has had plenty of water most years, and has only occasional evidence of drought, in contrast to the other areas. The reason is that this general area receives an average of from 178 to 381 cm of rainfall annually, depending on the locality. Because of its vast size, and in spite of the fact that large parts of it are choked with water hyacinth, this wintering ground could support many times the present number of waterfowl. This is probably true of nearly all of the survey units.

The Campeche and Yucatan lagoons, in common with all but the Tabasco lagoons, were apparently suffering from a severe drought. The bay at Celestun, where nearly 1,000,000 waterfowl were seen in 1961, held relatively few this year. This loss was not compensated for elsewhere, but some of the shortage was made up by more birds in the mangrove swamps between Celestun and Sisal, and by a large raft of lesser scaups in the lagoon just east of Progreso. The total, however, was the lowest in recent years for these waters.

1963

The Rio Grande Delta was very dry, and its reservoirs held less water than in 1962. In spite of this, duck numbers were more than twice those of last year, and the goose population, chiefly white-fronted geese, was the largest ever recorded.

In 1963 Laguna Madre was again almost devoid of birds because of its high salinity and lack of food, but adjacent freshwater lakes on the mainland and other Tamaulipas lagoons to the south held large numbers, including a raft of 32,000 redheads. This contributed to an increase of about 55,000 birds over those of 1962. Available habitat here, as elsewhere on the coast, appeared to be more than adequate.

At the Tampico lagoons, habitat conditions in the waters and marshes bordering the Rio Tamesi appeared good to excellent. Water levels in the Rio Panuco lagoons were substantially lower, but were sufficient. Oil development is continuing, but apparently at a slow pace. This could be an increasingly serious problem in the future unless proper anti-pollution measures are taken. On Laguna Tamiahua, considerable oil pollution was observed in the northernmost part, and consequently waterfowl were absent. Large numbers of ducks, chiefly lesser scaup, were observed in the vicinity of Isla Juana Ramirez and Isla del Toro. At the Alvarado-Papaloapan lagoons, overall habitat conditions on this extensive delta and floodplain appeared very good and were thought to be similar to those of 1962. Ducks were four times more plentiful than the previous year; blue-winged teal were the primary reason for this increase.

The Tabasco lagoons and marshes made up the largest and most impressive marsh area on the east coast. Potentially, these marshes could support the entire waterfowl population that wintered on the east coast of Mexico. Water levels were low this year, and many areas were covered with water hyacinth, but there appeared to be no shortage of habitat. The Tabasco lagoons contained about 80% of the black-bellied whistling duck observed on the entire coast, as well as about 50% of the wigeon and blue-winged teal.

Observers on the 1962 survey reported a severe drought affecting the Campeche-Yucatan lagoons, and it was apparent that this condition had reached even greater proportions in 1963. Stretches of swamp and marsh up to 40 km in length were dry; only the area from San Felipe to Isla Holbox held much water. The total waterfowl population observed was only 8% of the birds seen in the peak year of 1961.

The 1963 duck survey showed a slight decrease from 1962. Dabblers were up 12% and divers were down 22%; geese were up 102% and coots were down 14%. The impressive increase in geese (33,805 in 1963 from 16,769 in 1962) was largely due to the numbers of white-fronted geese on the Rio Grande Delta reservoirs. The redhead population of about 43,500 returned to the level of 1960, but after reviewing the manner in which these birds shift in and out of upper Laguna Madre (Texas), it probably means only that more of these transients went south of the border. This movement between the two areas has occurred for many years, and is caused chiefly by changes in food supplies and weather conditions.

1964

Overall habitat conditions along the coast appeared to be excellent, except for Laguna Madre. In contrast to 1963, water levels throughout the Rio Grande Delta were high. The total waterfowl population doubled over last year, with the Ensenada-Ramirez area west of Matamoros contributing most of the birds. Goose numbers continued to show an increase; about 30,000 white-fronted geese were observed.

At Laguna Madre and other Tamaulipas lagoons the freshwater habitat appeared adequate, but the saltwater bays continued to deteriorate. All the passes of Laguna Madre were closed, the salinity of the lagoon was extremely high, and there were very few ducks there. Waterfowl numbers showed only a slight drop, but two species, redhead and shoveler, made up 81% of the population. The redhead concentration at freshwater lakes near La Pesca, which numbered 32,000 in 1963, increased to 45,000, which is commensurate with the redhead increases observed along the lower Texas Coast. Eleven swans (six adults and five juveniles) were also observed in a small freshwater lake near Laguna Madre, about 104 km south of Matamoros.

At Tampico lagoons the habitat conditions were excellent and the waterfowl numbers showed a substantial increase of 55%; ducks increased 66%. Oil pollution was evident in many of the small marshes near the Rio Panuco. At Laguna Tamiahua the waterfowl numbers were down considerably, although habitat conditions appeared to be equally as good as those in 1963. The oil pollution observed in the northern part of the lagoon last year was gone, but some was observed on the west side near the Rio Cucharas. At Alvarado lagoons ducks appeared to be at the same level of abundance as last year, but coot increased about 37%. Habitat conditions were very good, as they were in 1963.

Recent heavy rains had flooded the western half of the Tabasco lagoons and marshes. Rivers were bankfull and many lakes and marshes extended far beyond their normal extent. The eastern part of this vast area was in excellent condition and contained most of the birds. Considerable oil pollution was noted in the Rio Uspanapa near Coatzacoalcos, and refinery refuse was being dumped into a large marsh near Minatitlan. As in 1963, this vast area again had about 80% of the whistling ducks and 50% of the blue-winged teal observed on the Gulf Coast.

At the Campeche and Yucatan lagoons the severe drought conditions of 1963 were gone, and the water levels were much improved. Some water was available throughout the coastal basins. The waterfowl populations did not reach their high levels of 1961, but they were 55% higher than in 1963.

Interior Highland Zone

The following summaries are based on the reports of the U.S. Fish and Wildlife Service personnel who conducted the January aerial surveys.

1951

The aerial survey included many small reservoirs in the highlands which had not been inventoried before. Although the water levels were fairly satisfactory, there were almost no ducks using the reservoirs. In the vicinity of Lake Chapala, San Marcos was dry, as was Sayula, except for a little water in its southern end. Santiaguillo, Toronto, Mexicanos, and Bustillos had water and ducks, but almost all the basins in northern Chihuahua were dry. The remaining water of Laguna de los Patos was frozen, and there were 1,200 ducks sitting on the ice. Laguna de Guzman was dry, and Santa Maria was almost dry.

1952

A flyway biologist noted that:

> The highland areas are deteriorating progressively as more and more water is impounded for irrigation purposes. In most cases the reservoirs created are much less desirable habitat than the natural basins and marshes that are disappearing as a result of the impoundments. This is particularly true in the northern more arid sections where interior drainage created large shallow lakes. Most of these have been reduced to a remnant or have disappeared completely. To aggravate the situation a drought of several years standing has further depleted the surface water and subsurface moisture.

Lake levels of Chapala, Patzcuaro, and Yuriria were satisfactory, but that at Cuitzeo was down so much that very little water remained in its western part.

1953

No summary is available on habitat conditions during 1953.

1954

A hurricane which crossed from the Gulf coast into the highlands in September 1953 dumped a tremendous volume of water into many of the basins there. At the time of the January 1954 survey the central interior was still very wet, and even the northern region was improved over January 1953. The Lerma Valley was overflowing from its headwaters near Toluca over all of the long distance to Lake Chapala. The Bajio and nearby Lake Yuriria had good water levels, but Cuitzeo, not having profited from the Lerma floodwaters, had low water. In the northern region, the old *bolsones* were beginning to fill. Santiaguillo and Bustillos were much improved over the previous year, but it will take several consecutive wet years to refill them. Probably even improvement of the desert in northern Chihuahua would have been observed, if it could have been seen through the dust clouds.

1955

The interior highlands varied greatly in water levels, which for the most part were favorable. Sayula was dry, Zapotlan almost dry, and Chapala had receded to its normal level. Patzcuaro was down somewhat from

last year and consequently was in better condition for waterfowl. Cuitzeo had water in the west arm again, but the north bay was dry. Yuriria was normal, but Irapuato was drier than usual. Water was more abundant than last year in the Upper Lerma, Oriental, Apam, and Huapango.

The northern desert areas had more surface water than had ever been encountered on previous surveys. Among the units surveyed regularly, Santiaguillo and Bustillos were in the best condition, and many areas which were dry for the past 5 years contained water. This excess surface water may have dispersed the birds from their normal haunts and left fewer on the regular areas, and it may also have held birds there that otherwise would have gone to other areas. It is also possible that an unknown number of waterfowl was present in the northern desert areas that were not covered in the survey. A complete coverage of all the interior bodies of water would have entailed at least twice the amount of time and doubled the cost of the survey.

1956

The highland basins were literally brimful of water, the most seen during the past 6 years. Exceptionally heavy rains during the previous summer and early in the fall created more surface water than usual. These water levels could affect the numbers present on the regular survey route, but there is no way of determining the extent of this effect. It is obvious that with so much water and the incomplete survey, there were more waterfowl present in the interior than were recorded.

1957

No survey was made in Mexico in 1957.

1958

There was considerable variation in water levels in the interior areas. Zapotlan, Bustillos, and Zacapu were almost dry, Toronto and Upper Lerma very low, Oriental partly dry, and Irapuato, Sayula, Mexicanos, and Santiaguillo dry. However, Chapala was over-full and extended into the adjacent fields; waterfowl were very scarce there and it is possible that their aquatic foods had been drowned out or were too deep to be within reach. Other interior areas appeared to have about normal water levels, but each year there is considerable variation. Each drainage basin is affected by its local weather conditions, which may differ considerably from the amount of rainfall received beyond the next ridge.

Waterfowl populations varied greatly on the interior areas, chiefly due to changes in water levels. Dry or almost dry areas obviously have few or no ducks, as was the situation at Sayula, Zapotlan, Zacapu, Irapuato, Santiaguillo, Mexicanos, and Bustillos. But Chapala and Yuriria probably suffered from too much water, which drowned the aquatic food plants. There were no apparent reasons for the changes in waterfowl numbers at Atotonilco, Cuitzeo, Texcoco, Apam, Huapango, San Isidro, and Acambaro. In the interior areas all the significant changes in the numbers of waterfowl were decreases. These changes probably reflect the poor habitat conditions encountered in most localities.

1959

With one exception the interior areas had more water than in 1958, some to the extent that their habitat conditions were damaged. Lake Chapala, for example, was backed up into the villages on its shore, and the shallows, as well as the marshes at its eastern end, were submerged, which eliminated most of the habitat for dabblers. The water level at Patzcuaro was too high for the best food conditions and in many localities the ducks were in the flooded fields adjacent to the permanent bodies of water. The only area that did not have more water was the upper Lerma, where conditions appeared to have deteriorated because of water diversion to the Valley of Mexico.

Water hyacinths covered the western end of Lake Chapala, thus eliminating that fine canvasback feeding ground, at least temporarily. There were also extensive mats of hyacinths elsewhere on the lake, used only as roosting places and cover for the ducks, and as a minor source of food for coot. Ducks increased on all the areas except where habitat conditions were unfavorable. Patzcuaro, Cuitzeo, and San Isidro were flooded, and the Upper Lerma was too dry. Some of the great increases were at places that were dry or nearly dry last year, including Atotonilco, Sayula, Zacapu, Texcoco, Irapuato, Santiaguillo, Mexicanos, and Bustillos.

The number of Mexican ducks seen decreased from about 10,000 to 3,000. Much of their favorite habitat, emergent clumps of *Scirpus*, had been flooded and other basins drained, so it is probable that there were major population shifts and that most of the birds were not seen on the survey.

1960

Water conditions in the highlands were generally better than average. The survey crew commented on the number of new, small, man-made impoundments, especially in the sector from Queretaro south to Pachuca, Hidalgo, but no time was available to investigate their duck populations. The water levels of the lakes and reservoirs of the central highlands continued to be high, and in some localities (Chapala, Yuriria, and Patzcuaro) too high to be productive of some waterfowl foods. At a few other lagunas, including Ato-

tonilco and Oriental, the surface water was slightly below the levels of 1959, but elsewhere water and habitat conditions appeared to be normal.

One of the increasing threats to many highland waters is the spread of water hyacinth. During the past 10 years this pest has covered some of the smaller reservoirs and almost blanketed Acambaro (Presa Solis). Water hyacinth now threatens Lago Chapala, and is spreading more there each year.

1961

Water conditions south of Chihuahua were much poorer than last year, but the areas north and east of Casas Grandes were as good as last year, and more standing water was noted in the Santa Maria basin than was observed in 1960. This increased water was due to the recent snows and rains in that locality. It is doubtful whether this made the habitat attractive to waterfowl, because most of the water covered only bare, alkali desert flats which were devoid of vegetation. Almost no waterfowl were seen on these large sumps when they were covered by water.

As the survey progressed south of Chihuahua to San Luis Potosi the basins with water became fewer and they held less water. Many areas that had previously had considerable water were dry and the reports by local people indicated a reduction in runoff this year. However, conditions at several areas were better than in 1956 and 1958.

A close look at the small reservoirs which are relatively numerous west and southwest of San Luis Potosi and east of Queretaro indicated that they were mediocre habitat for waterfowl. Most of them had receded so much that no emergent aquatics were available and much of the water was turbid; no submerged aquatics were visible, probably because of the excessive turbidity. A few ducks and coots were in these areas, but usually no more than a few to several dozen were present, and no large concentrations were seen. Those flocks which were there consisted mostly of green-winged teal, shovelers, gadwalls, pintails, and some Mexican ducks. Diving ducks were scarce on all the larger reservoirs.

Most of the important central and southern lakes and reservoirs were somewhat lower than the previous year and were near their normal condition, but Lago Chapala was still so high that some of its bordering villages remained flooded. Water hyacinth continued to be a serious pest in some localities, particularly on Lago Chapala, Acambaro, and several of the smaller reservoirs.

In the northern highlands the concentrations of waterfowl were on the larger bodies of water where aquatic vegetation was available or agricultural crops were nearby. Several desert sump areas with water had sizable numbers of ducks and white-fronted geese. There were no agricultural fields in the vicinity and little or no aquatic food available; thus, these birds probably were migrants using the *playas* only for resting.

More bodies of water were scouted than in previous years, and the number of waterfowl seen was greater than last year, as might be expected. However, the 101,093 waterfowl seen in 1961 was still below the 174,850 seen in 1959 when only five major areas were covered. This year, in addition to those 5, 21 other areas were flown. In 1960 11 areas, including the major 5, were flown. The total waterfowl population that year was 38,871.

The data indicate that 1959 far exceeded the other survey years, either before or since, in total waterfowl populations in the highlands. The larger total in 1959 was mainly due to more dabblers and especially to more green-winged teal, pintail, and shoveler at Santiaguillo. This increase in ducks followed a dry year in 1958. What the status of the area was in 1957 we do not know, because no survey was flown that year. However, the area must have become attractive to waterfowl when duck foods increased. This also probably happened at Laguna Mexicanos, although it was not so pronounced. Some dry basins with favorable soil and moisture conditions produce many food plants and when reflooded they can carry significant numbers of waterfowl.

The speculation made last year, that an extended coverage of the entire highlands would not reveal a great number of birds missed, was substantiated by this year's survey. Of the 101,093 waterfowl tallied in 1961, only 25,000 were from areas not covered last year. Of these, Babicora had 15,000 birds. Outside of the Babicora area only about 10,000 birds were found. The best time to cover additional areas would be when conditions are very dry, because there is the possibility that little used areas may have increased populations then. The Babicora area should be included in the regular surveys because of the large number of birds that may be present there.

1962

The basins in the northern highlands were in general very low or dry. Almost all the water levels had dropped at least 30% from last year. The areas north of Casas Grandes were almost all dry except for Santa Maria and Lago de Patos, and the latter two were further reduced in extent by about 30%. Last year there was water in their open flats and sumps, but this year they were dry. Mexicanos and the reservoir north of it were dry except for a few small stock ponds nearby which had the only ducks and geese noted there. Bustillos was in very poor condition and had only mudflats covered by a few centimeters of water. Babicora appeared to be dry except for a few hectares in a sump,

but when Babicora was scouted, the high winds were blowing dust and alkali so that it was very difficult to see, and flying was too rough to get complete coverage. Indications were, however, that few additional birds could have been present other than those that were recorded.

In 1961, we theorized that in dry years those areas should be surveyed in the northern plateau that in normal years might be unimportant in holding waterfowl. Even in drought years the more important wintering places continued to hold up better than did the lesser areas. Most of the smaller areas were dry this year. In the years of low waterfowl populations it seems unnecessary to fly these additional areas.

Although not all the localities were covered this year that were flown last year, most of those skipped were reported to be dry, and consequently we assumed that the population data were comparable to those of last year. The waterfowl population was down about 50% from last year. Geese decreased 36%, ducks 54%, dabblers 70%, and divers 68%. If the last 5-years' data for the five most important areas are compared, it is apparent that this year's population was about average except at Mexicanos. The latter was practically dry and held very few birds. Mexicanos has a good waterfowl population when water conditions are favorable. In general, the overall population observed in the highlands reflected a decline.

At Santiaguillo the north reservoir was in fair condition. The water level was down somewhat from last year, but it still looked good and was holding an average population of ducks. The middle sump was dry, and the south reservoir was reduced about 33% in area from last year. The reservoirs east and south of Queretaro had water, but most of them had 33% less water. The Leon sumps were dry, as were some of the others such as Villa de Cos, Encinillas, and eastern La Cruz. In some instances areas such as Tarabillas were reported to be dry, and were not censused. The Gertrudis sump areas were dry except for the one man-made reservoir which was 33% lower than in 1961.

Water conditions at the southern interior areas ranged from dry to nearly normal. Sayula and a small reservoir to the northwest of Chapala were dry. The areas with poor water conditions and reduced waterfowl use included Zapotlan, Cuitzeo, Upper Lerma, Apam, and especially Oriental and Irapuato. Atotonilco, Zacapu, Patzcuaro, Chapala, Yuriria, and Texcoco had nearly normal conditions. The reservoirs of San Isidro, Acambaro, and Huapango had levels below flow line. This condition may be normal at this time of year.

The waterfowl populations on the waters of the southern interior region were 46% below 1961, and 61% below the 6-year average. All the areas surveyed showed large decreases from that average, and only the areas around Cuitzeo (Cuitzeo, Acambaro, and Zacapu) had larger populations than in 1961.

All the southern interior areas except Zacapu and Cuitzeo recorded decreases greater than 50% from the 6-year average. Notable downward trends occurred at all the areas around Mexico City, including the Upper Lerma, Texcoco, Apam, and Oriental.

1963

The habitat conditions were poor from south of San Luis Potosi to areas north and west of Chihuahua, except at Babicora. Babicora was the wettest of any years recorded during the surveys there. Casas Grandes appeared to be normal or above, and Guzman had more water than during any year except 1961. Santa Maria was above normal and its habitat was good, but Patos, just east of these watered areas, was almost dry. Bustillos appeared to be down slightly, although it was still holding a good amount of water, but Mexicanos was entirely dry. Last year the large sump of Mexicanos was dry, but there was still a little water in some of the nearby ponds. Laguna de Palomas, north of Torreon, was down about 0.6 m from the 1962 level.

The water areas south and west of Chihuahua were in poor condition. Lago Toronto was down about 3 m from last year. Much of the west end of the reservoir, which previously had a fairly good marsh, was dry. At Santiaguillo all of the southern sump was dry, the middle one was dry as usual, and the northern one was down 33% from last year and was obviously going dry. The natives here were walking in the lake in water only up to their ankles or knees and were catching the few fish still alive. Normally the northern sump is about 1 m deep. The Villa de Cos and Santo Domingo areas were also very dry; all the large sumps were dry, and only a few small stock and irrigation reservoirs contained a small amount of water.

The habitat conditions this year differed from those of other years; there were only a few very good areas and all of the others were very poor. Babicora, as mentioned before, was very good in contrast to most of the areas to the southward, which were very poor. Last year Babicora was almost dry and was blowing alkali dust. Except for the good areas listed, most of the basins on the northern plateau have been losing water gradually since the good year of 1960, probably because of the widespread drought.

Bustillos continued to show the results of pollution from the cellulose plant, and the duck usage of this area has almost vanished. Except for this pollution there appeared to be no other reason for the absence of ducks. Snow geese were still using the area in substantial numbers.

It seems that drought has been the principal factor

in recent years in the drying of the sumps, but upstream the diversion of impoundment of irrigation water has doomed many of these former wetlands. Some will never come back even in years of good rainfall. Quick runoffs may fill the sumps at Guzman and Santa Maria. These areas had plenty of water in 1960 and in 1963, but almost no ducks. Santa Maria had its usual fair population of snow geese, but there were few ducks.

The large increases in waterfowl in 1963 were due chiefly to spectacular gains at Babicora. Because of the dry conditions elsewhere, the excellent water level at Babicora was a great surprise; the surface water had increased at least 10-fold over that of 1962. Survey records for the last 3 years for this basin show that it has had an abundance of birds whenever water was plentiful, but it is not possible to say what condition is average for this locality. With the increases at Babicora, the drier areas could have been expected to show population decreases, but that did not occur. For example, although Santiaguillo and Toronto had lower levels, they maintained their populations. The dry areas, of course, had no birds this year, but the same areas were dry last year. In view of the waterfowl numbers found at Babicora this year, it seems advisable to survey some of these out-of-the-way places each year. If they have water, some of them may have a large waterfowl population. Babicora held 117,000 of the total 179,000 waterfowl seen in the northern highlands survey.

Almost all of the population of 2,121 canvasbacks recorded in the northern plateau were found on two small reservoirs in the Santiaguillo area. None was seen on the main sump, which was so shallow and muddy that they probably could have walked all over it.

Because of the adverse weather and the lateness of the survey, the areas east and west of Mexico City were not flown nor were the areas from Mexico City to San Luis Potosi covered.

The western part of the southern highlands was improved over the previous year. Sayula was about 33% full; last year it was dry and Cuitzeo was 66% full. The other interior areas had adequate water. Chapala and especially Acambaro are still plagued with an abundance of water hyacinth; thus, the value of Acambaro for ducks is very low.

The greatest changes in numbers of waterfowl wintering in Mexico have occurred in the southern highlands and these changes have continued this year. The combined species totals were 36% below those of 1962 and 63% below the average. Increased populations were found at the western areas including Atotonilco, Sayula, Chapala, and Zapotlan. Localities farther to the east, such as Zacapu, Patzcuaro, Cuitzeo, Acambaro, and Yuriria, showed large decreases ranging from 37 to 76%. Decreases from the average were generally from 50 to 75%. All species showed decreases from last year except gadwall and green-winged teal. The dabblers decreased below the average, from 16 to 93%, depending on the species, and diving ducks, as usual, were few.

1964

The first locality visited in the northern highlands, Laguna de Patos, was dry. West of there Santa Maria, Guzman, and Casas Grandes had more water and were in as good condition as in 1963. Babicora also was at least as satisfactory as last year, if not better. The Mexicanos and Bustillos sumps had improved greatly, but neither of them contained the number of waterfowl that they had attracted in some past years.

South of Chihuahua conditions were varied. The large reservoir, Toronto, was better than last year, but still about 6 m below its flow line. Palomas, and most of the area south to Torreon, were dry. Santiaguillo had improved since 1963 and was almost back to normal; its habitat looked good, whereas last year it was nearly dry. The areas south of Torreon, such as Villa de Cos, were dry, but about 96 km northwest of San Luis Potosi, near Salinas and Soldadito, water conditions were improved. Most of this district is normally dry at this season, but this year many of the sumps were 50 to 75% full of water. From San Luis Potosi west and south, water conditions showed the effects of early rains. South of Leon through the Irapuato Valley, the reservoirs were full and water from recent rains stood in the fields.

Water was very abundant in the large valleys between the Rio Lerma and Guadalajara. Rains had replenished the reservoirs, some of them to overflowing. Many of the rivers and other streams were filled; in some places water was standing in the fields. All the big lakes and sumps, such as Chapala, Cuitzeo, Patzcuaro, and Zapotlan, appeared to be normal or above. This year the southern part of Sayula had water with scattered pools throughout its basin, but it was probably the poorest of the sumps in that area. Early rains were reported throughout the mid-central highlands, which made excellent habitat for ducks.

Many of the wetlands had flooded the adjacent harvested fields and other agricultural lands and waterfowl were using them. The hyacinth problem in Chapala was not evident this year, possibly because of the high water. There were floating masses of it at the east end, but the water had backed up and flooded many of the fields. Previously all of the open water at the delta end of the lake and the canals had been choked with the weed. Acambaro was still almost covered with hyacinth, so that it was very poor for waterfowl. The water and marsh at Cuitzeo looked good. In general,

all these mid-central areas were in excellent condition.

Compared with 1963, most duck populations increased. The populations of the northern highlands were down from 1963, but those of the central highlands were up. All of the highlands combined showed an increase of 9.1% in all species over last year, and 34.3% over 1962. It seems that better habitat conditions have attracted increased waterfowl usage in this region. Coot usage was up 41.2% over 1963 and 121.2% over 1962. Duck usage was up 11.2% and 17.5%, respectively, over 1963 and 1962. Geese showed a decline; in snow geese this was mainly due to a reduction of about 15,000 birds in the population of Babicora. When the figures for the highlands are compared with the 7-year averages, those for 1964 show general decreases. For example, the total for all waterfowl is down 39.9% from the long-term 7-year average; ducks are down 46.1%, but coots show an increase of 40.7%.

Certain areas in the States of Mexico, Hidalgo, and Puebla were not surveyed because of the unfavorable weather for flying.

Pacific Coastal Zone

The following summaries are based on reports of U.S. Fish and Wildlife Service personnel who conducted the aerial surveys.

1952

Coastal habitats changed little from January 1951, except for a few places where local drought had reduced greatly the amount of runoff reaching the marshes and lagoons. The Obregon district was relatively dry, but this did not seriously affect its use by pintail and other major species because they are chiefly field feeders in that locality. As long as there are adequate shallow water and mudflats for safe roosting, the ducks use the area. Laguna de Pabellon was almost dry; it had few waterfowl in comparison to 1951. The Marismas Nacionales had excellent conditions and a decided increase in waterfowl. Most of the other areas along the coast, especially that from Laguna de la Joya to Sesecapa and southeastward to the Guatemala frontier, were much drier than in 1951 and in general had fewer ducks.

1953

No summary is available.

1954

The water levels were generally good. The upper half of Laguna Caimanero contained water for the first time in 3 years and as a consequence it had a heavy population of ducks. Surprisingly, the adjacent area, Marismas Nacionales, was drier than usual, although it was only a few kilometers distant. Sesecapa was also rather dry, but other areas along the coast appeared to be normal. Apparently these local variations were caused by great fluctuations in the precipitation in the mountains bordering the coastal plain.

1955

The water conditions along the coast were extremely variable, as would be expected over such a wide area. All the arroyos and intermittent streams in the arid ranges of Baja California had water in many pools and tanks. The desert near Hermosillo was so well watered that it resembled a grassland more than a Lower Sonoran desert.

Between the Rio Yaqui and Mazatlan the major rivers had flooded, inundating a great many square kilometers of fields and mesquite flats. The Rio Fuerto and Rio Culiacan had flooded the largest area and were responsible for most of the damage. Many ducks had moved into the flooded areas and the great extent of flooding, much of it in heavy cover, made it difficult to locate them. Because of this condition some birds were missed. It seems likely that the decrease in populations recorded at Obregon and in the Marismas was due in part to the ducks having moved to the newly flooded areas, not all of which could be surveyed. Caimanero was still full, but the nearby Marismas Nacionales was nearly dry on its landward side. Cuyutlan was the driest we have seen, and consequently contained very few ducks. Sesecapa was also dry on the landward side and most of the lagoons between the beach ridges had disappeared.

The usual wind was screeching through the pass at Tehuantepec, and consequently Laguna Superior was too rough for its ducks to be seen. Only a partial count could be made on Laguna Inferior because of the rough water.

1956

The water levels along the coast varied considerably from last year with the exception of the tidal lagoons, which remained relatively constant. Nontidal areas are dependent on local runoff from individual drainage systems and, even though these may be contiguous, their levels vary considerably from one to another. This contrast was noted particularly between Caimanero and Marismas, because the former was full and the latter was relatively dry on its inner side. All the coastal streams were within their banks and there was no flooding of the flats or agricultural areas. Consequently waterfowl were present in their usual haunts, which made the counting easier and undoubtedly more accurate than in 1955, and also reduced the coverage considerably.

1957

No survey was made in Mexico in 1957.

1958

The tidal waters have changed little from year to year except for man-made modifications or major storms. So far there have been few man-caused changes in waterfowl habitat on the Pacific Coast. Access to tidal waterfowl areas is slowly increasing, new agricultural areas are being developed on adjacent coastal plains, and a salt works with export facilities has been developed adjacent to Laguna Scammon. The principal effect of these changes is to increase the waterfowl hunting pressure in areas that were heretofore inaccessible to hunters.

The hurricane that battered the coast of Sinaloa in 1957 caused some marked changes in waterfowl distribution in the Marismas Nacionales, probably by flooding and by changing its salinity and food supply. The ducks were much more widely distributed and were more abundant than usual. Other areas, notably Dimas, appeared to have been scoured and contained fewer birds, probably because of the decrease in food.

In the other coastal areas there was considerable variation in water levels and in their consequent attractiveness to waterfowl. Pabellon was dry and Obregon and Laguna de la Joya were drier than usual. Laguna de la Joya has had very few ducks for several years and the water appeared to be stagnant.

The coastal area showed considerable variance in waterfowl populations from 1956. At San Quintin there were too few ducks to be of significance; there was, however, no apparent reason for the large numbers found at Obregon, Pabellon, and Sesecapa. There was also no obvious explanation for the lack of ducks at Mar Muerto, except that this has occurred on several previous occasions. Increases at Marismas and Cuyutlan may have been due to reduced salinity as a result of the hurricane and accompanying heavy rains, while Dimas was less attractive because of scouring. The decreases recorded at Agiabampo, Topolobampo, and Santa Maria were probably due to incomplete coverage on the survey.

Concerning the percentage variation in species between 1956 and 1958, a further interpretation of the figures is advisable. Some species are found in such small numbers that any changes, large or small, have little significance. Along the coast this applies to all geese except brant, and to the mallard, common goldeneye (*Bucephala clangula*), canvasback, and bufflehead.

Along the coast the big changes occurred in pintail and lesser scaup. Both of these species are highly mobile during wintering; thus, the significance of these changes is problematical. This is particularly true of the scaup; one year they are found and estimated, whereas in another year they are not. Yet the continental population, as determined from the breeding ground surveys, does not change much. This suggests that large numbers of scaup often winter south of the localities regularly surveyed in Mexico. On two aerial surveys of Central American waters, many of these ducks were found in the bays, lagoons, and lakes of Honduras and Nicaragua. The decrease in baldpate could be attributed to the poor survey coverage between Obregon and Pabellon. This was definitely true with the redhead, because Agiabampo is the principal area for that species. Observations of unusual interest were of four black brant at Agiabampo, the first recorded on the mainland, and of two whistling swans (*Cygnus columbianus*) at Obregon, the first seen on the coast during an aerial survey.

1959

Topolobampo is now in the process of drastic change because more irrigation water is available, new land is being cultivated, and new drainage ditches are being dug. This sector will have to be resurveyed and re-evaluated for waterfowl use as soon as the agricultural development becomes more nearly stabilized. It can then be determined what waterfowl concentrations have shifted from old established haunts to newly created habitats.

All coastal landlocked areas, except Sesecapa, were full or had better than average water levels. Obregon and Topolobampo now had more waste irrigation water to dispose of, and excessive rainfall had filled Caimanero and the Marismas Nacionales. Pabellon and most of the lagoons of Dimas were better than average, but the most productive areas of Sesecapa were almost dry. In general the higher water levels of most coastal areas greatly improved the habitat, as attested to by the increased waterfowl populations.

The tally of white-fronted geese on coastal areas increased, due almost entirely to large numbers at Obregon. The numbers of snow geese found on the coastal areas are never significant, as are all other species of geese, except brant, that occur on the Pacific Coast of Mexico.

Coots on the coastal areas decreased 30%, but this species often is counted only when the observers are not very busy estimating ducks. When large concentrations of ducks are encountered, coots often are overlooked or omitted for lack of time to record notes. This is particularly true when the ducks flush in a great cloud and the coots remain on the water.

To summarize, black brant decreased 36%, and because this decrease is general throughout its wintering area, the species may be in serious trouble. The Magdalena area was not surveyed so we do not know how many were there. Geese quadrupled, due chiefly to snow geese returning to localities that were dry in

1958. Ducks almost doubled in numbers; the big increases were among pintail, and green-winged, blue-winged, and cinnamon teals.

1960

The only important change in the coastal conditions was caused by an excessive rainfall, and the flooding of the river floodplains from Obregon to Culiacan. The floods were cresting during the aerial survey and vast areas were under water, which required considerably more flying than would normally have been necessary. Waterfowl populations, however, were in their usual haunts rather than on the newly flooded lands. Earlier in the fall a hurricane had battered Laguna de Cuyutlan, but other than the shredding of the mangroves and some downed timber on the adjacent foothills, little conspicuous change was noted. Sesecapa, almost dry last year, was even drier this year and had mudflats exposed in many of the broader lagoons. It was in the driest condition observed during the years of aerial surveys begun in 1947.

Black brant increased on all areas except Santa Maria. The fact that brant were still present on the mainland for the third consecutive year is the important fact, regardless of the minor fluctuations in numbers recorded. On the principal areas of Baja California their increases were considerable. It is significant that before 1960 no more than 6,000 brant were found south of San Ignacio, but during the current survey almost 31,000 of them were counted. These increases south of the border evidently include birds that formerly wintered farther north, because fewer than 4,000 were found in California.

White-fronted geese decreased slightly on the coast, but snow geese increased. As stated in previous reports, the goose figures are not considered to be reliable due to the inadequate coverage. The goose estimates should be regarded as minimum and probably are not comparable from year to year.

Ducks decreased on all the coastal areas except Topolobampo, Dimas, Cuyutlan, Mar Muerto, and La Joya. On Topolobampo the increase, mostly of pintail, was probably due to their shifts from Obregon and Pabellon. The increases at Dimas and la Joya were of only a few thousand ducks each and could be considered as normal fluctuations. The increase at Mar Muerto may have been due to the improved visibility because of less wind, and conversely the great decrease at Laguna Superior may have been the result of high wind and the very poor visibility. Cuyutlan had a thorough flushing from the recent hurricane, and the increase there probably was the result of improved water conditions and more food.

The shoveler was the only common duck to increase on coastal areas; ducks in general decreased 28%. Coots increased 65%, but this may have been due to the reduction in numbers of ducks and the resulting increase in time available for counting coots.

1961

Pabellon was completely flooded in January 1960 and water was all over the coastal plain, but this year the water levels were normal. Caimanero was almost dry at the time of the aerial survey, but 10 days later after numerous heavy rains it appeared to be back to normal. Dimas and the Marismas were much drier than last year, although the heavy rainfall that raised Caimanero undoubtedly improved these areas also. Topolobampo continued to be altered by new outflows of irrigation water that create new habitats and attract pintails at the expense of nearby districts, chiefly Obregon and Pabellon. The water levels in the Sesecapa sector were somewhat better than a year ago, although still low.

The most noteworthy increases were in numbers of blue-winged teal, pintail, and scaup. The blue-winged teal, encountered mostly east of the Isthmus of Tehuantepec, could have been Mississippi or Central Flyway birds from the Gulf Coast that had crossed the Isthmus rather than gone northeastward to Yucatan. Based on past experience, blue-winged teal in these numbers are unusual on the west coast. The increase in pintail resulted from the concentrations found at Topolobampo, and this caused a gain in the overall duck population on the west coast. This seems a paradox after several seasons of poor pintail production. The counts of scaup have not been considered to be particularly significant, because during some years large concentrations are seen in some areas and in other years they are not to be found. This change does not necessarily mean a decrease in the population. Although many more lesser scaup were found this year than in 1960, the total is still 33% below the 5-year average.

The increase in black brant probably was due to a successful breeding season, because 1960 was a good year for all geese. The new wintering population on the mainland continues to flourish and, if this trend continues, a sizable segment of the total population may soon be found there.

1962

The marshes appeared to be about half dry, and several of the lagoons with emergent vegetation had no surface water. The associated marshes and other areas between Obregon and Mazatlan which were supplied by waste irrigation water were in satisfactory condition, except that their water levels were slightly below average. Caimanero, the first area of Mazatlan, was less than full, with some mudflats exposed on the south shore of the southern lagoon. This lagoon was almost dry at the time of the survey in 1961. Other

areas along the western coast were normal, except that Sesecapa appeared to be below its usual level.

Waterfowl populations showed an overall 11% increase over 1961. This gain was general among the dabbling and diving ducks, but geese showed a decrease. Coots increased significantly because of large numbers present this year at Caimanero, which was dry during part of last winter. Black brant showed a 17% increase over 1961 and a 24% increase over the 6-year average. Brant totals for 1959 and earlier were from three areas, whereas the subsequent figures include the extensive coastal lagoons south of San Ignacio. Consequently, one would expect the latter counts to be higher because more brant wintering places were surveyed.

The geese in coastal areas were 55% below the 1961 totals, but only 7% below the calculated 6-year average. The total duck population increased 9% over 1961 and 20% over the 6-year average; however, the diving ducks were 28% below the 6-year average.

Much of this increase in the duck population was due to: (1) the large increase in pintail at Topolobampo which has occurred for 3 years; (2) the increase of ducks at Caimanero because of its much improved conditions; and (3) a significant increase in baldpate, blue-winged teal, and shoveler on the far southern coast at Inferior and la Joya.

1963

This year, for the first time since 1952, the entire Pacific Coast of Mexico was included in the survey. Except for Laguna Cuyutlan, none of the wintering grounds between San Blas and Salina Cruz had been censused since 1952.

Marismas and Sesecapa, and especially the latter, that depend upon their tributary rivers for water, appeared to be below in average water conditions. The other coastal areas, more closely associated with the tidewater, were at or near normal levels. This year's total of waterfowl seen on the west coast of Mexico was 24% below 1962 and 8% below the longer average. The decrease was due to fewer dabblers at Topolobampo, Pabellon, Inferior, and Caimanero. It was partially offset by increases of 50% or more of ducks at Obregon, Marismas, and la Joya. Other areas, even with increases or decreases, could not alter the results greatly because of the small size of their populations. The increases at Santa Maria were the result of brant in numbers far greater than have been previously observed.

The general trend in total waterfowl numbers this year has been a decrease, and dabbling ducks declined 27% from 1962. Among the principal species, the pintail decreased 51% and the green-winged teal 35%. The diving ducks are characterized by more erratic changes and their trend has shown a 70% increase. This is due chiefly to the recording of 70,000 lesser scaups in the Marismas on Laguna de Agua Brava. These may have been ducks ordinarily missed and which this year gave the Marismas and the species a much higher rating than usual. Regardless of this local increase, ducks were 19% below 1962 and 9% below the average. The total, including ducks, geese, brant, and coots, was 19% below 1962 and 8% below the average. Brant estimates were similar to those of last year, and 18% above average. A shifting of brant to the mainland continued and 12,500 were observed at Santa Maria and 800 at Obregon, which is a fivefold increase from last year. Coot estimates decreased about 17% from the average and 29% from the 1962 total.

1964

Habitat conditions appeared to be average except in the following few localities: the abundant rainfall of the past season maintained Caimanero at an optimum level and also caused the dispersal of waterfowl over a much wider area at Pabellon and in the Marismas Nacionales; beyond the Isthmus of Tehuantepec the habitat was drier than usual.

Among the ducks occurring in significant numbers and importance to hunters in the United States, the gadwall, baldpate, shoveler, lesser scaup, and ruddy duck decreased, whereas the pintail, green-winged teal, and blue-winged and cinnamon teal combined, increased. The general duck average was an increase of 21%. All kinds of geese (including brant) and coots increased, with waterfowl in general showing a gain of 26%.

Black brant continued to extend their range and to increase in numbers on the mainland coast. This year they were observed from the east side of Tiburon Island southward to a point about 80 km north of Mazatlan, totaling 25,000 birds; their principal areas were Topolobampo and Santa Maria.

Waterfowl Species Encountered in Mexico

In the discussion of species, the waterfowl are listed in the order used in the Check-list of North American birds (American Ornithologists' Union [AOU] 1957). Latin names used are those recommended by the AOU Committee on Classification and Nomenclature (1973, 1976) in supplements to the Check-list of North American Birds (AOU 1957). For each species the English name and several common Mexican names are listed. Mexican names are usually accompanied by the reference that verified use of the Mexican name. Many are from Martin del Campo 1948 and the list of names he included in Friedmann et al. 1950. Mexican names not accompanied by a reference are names that we

heard used by local hunters. If the name is listed and followed by a State or locality name in parentheses, the name was heard only in that location.

Ranges listed for each species are, unless credited otherwise, based chiefly on the findings of the aerial and ground surveys made by biologists of the U.S. Fish and Wildlife Service.

To present a more specific summary of the distribution of common species of Mexico, the average percentages of the population that have been found in the annual January aerial surveys in the various localities in 1948-62 are listed in descending order of importance.

The summaries of banded waterfowl from the United States and Canada recovered in Mexico were prepared by the senior author from information from the Migratory Bird Population Station of the U.S. Bureau of Sport Fisheries and Wildlife.

Food studies for each species of waterfowl are summarized briefly from much more detailed tabular records. Most of the foods mentioned in this chapter are described elsewhere (Martin and Uhler 1939). The examination of 784 gizzards of waterfowl was made by James A. Kerwin of the Patuxent Wildlife Research Center in 1964-65. The examination of 776 gullets was made in the field and laboratory by the senior author. The brief summaries are of principal items, excluding minor ones, so in many instances the percentages do not total 100.

The comments on hunting pressure are based on observations during field surveys and on information obtained from other biologists and local hunters.

Whistling Swan (*Cygnus columbianus*)

Mexican names: cisne, cisne chiflador (Friedmann et al. 1950)

This swan is very rare in extreme northern Baja California, Chihuahua, and Tamaulipas; formerly it was less rare in these States. It was recorded at San Rafael and Laguna Hanson (Sierra Juarez) in Baja California (Grinnell and Storer 1928; Friedmann et al. 1950). Three fresh specimens from Laguna Hanson were brought to the San Diego Natural History Museum by hunters, one in 1923 and two in 1924 (Huey 1926). It was also recorded near Colonia Diaz, Chihuahua, by J. H. Gaut in 1904 (USBS files) and in Chihuahua by Sgt. J. S. Brown (see Francis Harper 1917, USBS files), who saw large flocks at Laguna Guzman in December 1916 and small numbers near Ascension, Chihuahua, in October 1916. He and other members of the expedition under General Pershing shot several of the swans. A specimen, killed locally, was seen in the museum at Silao, Guanajuato, in 1896 by E. W. Nelson (USBS files).

E. A. Goldman wrote in his report for 1926 (USBS files):

> Whistling Swan—According to Professor Carlos Lopez, swans occur as far south as Lake Chapala in severe winters only. In Chihuahua I was informed by William Craft, an old resident, that swans visited the various lakes in the vicinity of Chihuahua in former years, but none have been observed by him very recently. Similar information was furnished me by Raul Madero of San Pedro, Coahuila, who stated that swans formerly visited the Laguna de Meyran, but that none had been seen by him in recent years. Edward Brittingham of Gomez Palacio says that swans sometimes still appear in small numbers on lakes near Torreon, southwestern Coahuila, and near Durango in the State of Durango, but none were observed by him this year.

No recent records were reported until the January aerial surveys found the following: northern Baja California, 2 in 1956 and 1 in 1959; Lake Santa Maria, Chihuahua, 4 in 1951, 11 in 1960, and 4 in 1965; and Laguna Madre, Tamaulipas, 11 (6 adults, 5 immatures) on a small freshwater lake 104 km south of Matamoros, 11 January 1964.

Trumpeter Swan (*Cygnus buccinator*)

Mexican names: cisne, cisne trompetero (Friedmann et al. 1950).

The trumpeter is reported to have been a rare winter visitor in northeastern Mexico. Of the one record from Matamoros, Tamaulipas, on 21 January 1909, Phillips wrote (1911) ". . . a typical specimen of the species and constitutes its first Mexican record." This bird, an immature, is in the Museum of Comparative Zoology collection, at Harvard University.

In recent years, trumpeters have not wintered south of Idaho and Wyoming, so they no longer occur in the southern United States or in Mexico.

Canada Goose (*Branta canadensis*)

Mexican names: ansar, ganso, ganso griton, ganso graznador, gargantillo (Lake Chapala), ganso de cuello negro and ganso de cara blanca (Tamaulipas); ganso de Canada (Friedmann et al. 1950), ganso comun de Canada (Lopez and Lopez 1911), and ansar de corbata (Duges 1869).

At least five races of Canada geese winter in Mexico, judging from the museum specimens available and the information from band recoveries. These races are *moffitti, parvipes, leucopareia, hutchinsii,* and *minima.* Two other subspecies, *interior* and *taverneri,* that winter southward to southern Texas probably also occur in northern Tamaulipas, but no specimens are yet available from Mexico. In these names, Delacour (1954) has been followed in preference to the checklist of the American Ornithologists' Union (1957).

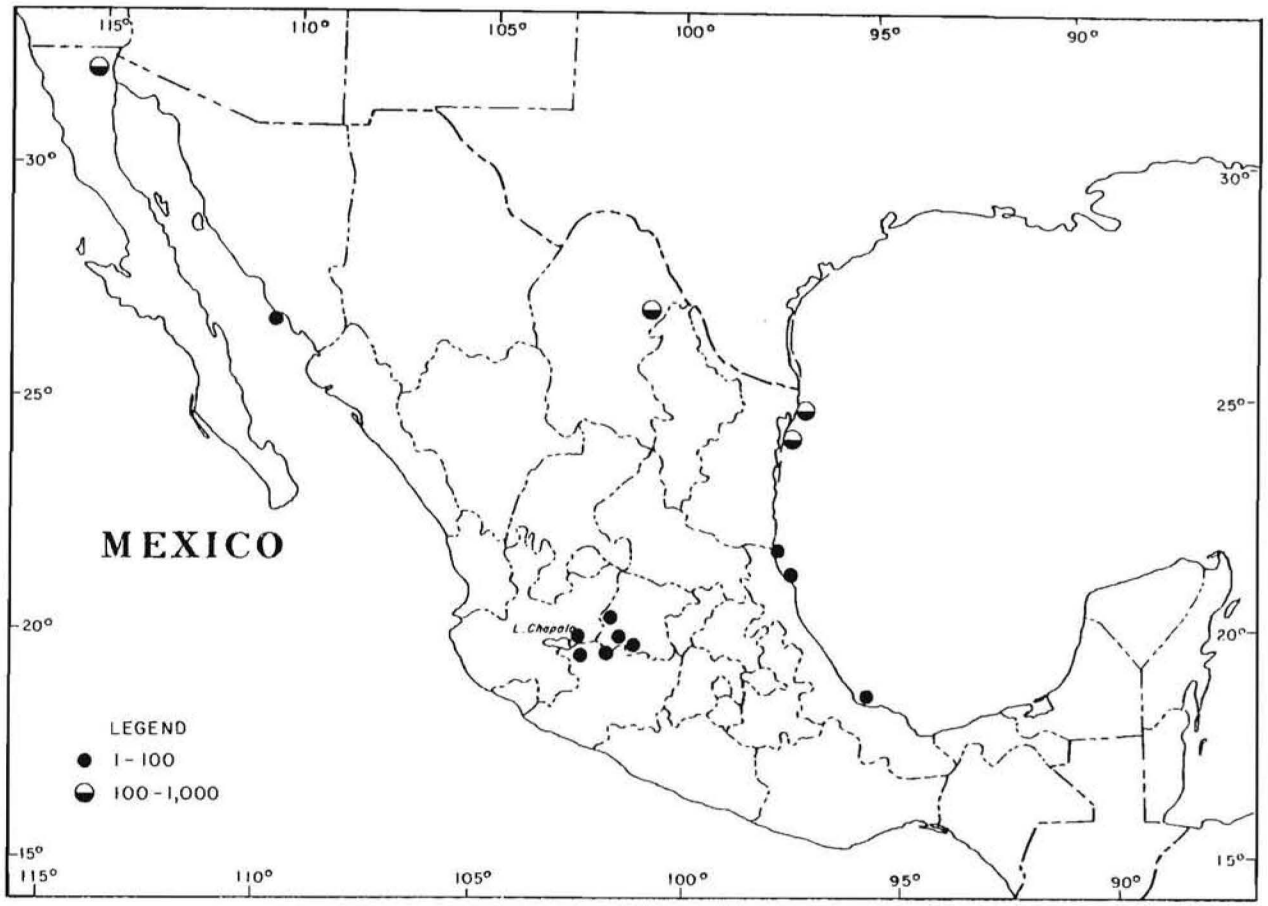

Fig. 20. Average numbers of Canada geese observed during January aerial surveys, 1948–62.

These geese winter in small numbers in many localities of northern Mexico, especially on the coastal plain of Tamaulipas, the delta of the Colorado River, and some lakes of Chihuahua and Coahuila (Fig. 20), but they are fewer in Mexico than the white-fronted and lesser snow geese.

On the Gulf Coast they are regular winter residents also in the Tampico area (Tamaulipas and Veracruz), where small flocks are found chiefly on the dry lake beds and broad coastal flats. A few are usually present each winter in the vicinity of Laguna Tamiahua and as far south as the Alvarado district in Veracruz.

On the Pacific Coast Canada geese are very local in their distribution. The aerial survey reports for 1948–65 indicate that a few hundred honkers wintered in the Colorado River Delta and in the Ciudad Obregon district of Sonora. These figures probably are low, because ground studies made in the latter locality in January 1950 showed several times as many of these geese there as had been noted from the air. Some flocks were missed because the agricultural lands were too extensive to be scouted thoroughly on the aerial surveys.

The species also winters in small numbers near Ensenada, Baja California, and near Culiacan and Los Mochis, Sinaloa. On 11 January 1947 a flock of 15 was observed on the coastal meadows of Laguna Buenavista, southeast of Mojarras, Chiapas. This is the southernmost point where Canadas were recorded. They may have reached that locality from Veracruz by way of the Isthmus of Tehuantepec, because they are ordinarily rare on the Pacific Coast south of Sinaloa.

In the interior they have been observed during the winter in Chihuahua, Coahuila, Nuevo Leon, Durango, Zacatecas, San Luis Potosi, Guanajuato, Jalisco, and Michoacan, but they were scarce in all of these States except Chihuahua. It is reported by oldtime residents of the region that Canadas formerly were very common in the vicinity of the now dry Laguna de Mayran, near Torreon, Coahuila. A few of these white-cheeked geese occasionally winter in the highlands as far south as the meadows and agricultural lands to the east of Lake Chapala, and in the Bajio. In 1966 H. O. Wagner

wrote us that he saw a Canada goose that had been shot at Lake Texcoco, near Mexico, D. F., several years previously.

Very few of these geese were seen in the highlands during the January aerial survey, probably because the survey's route was chiefly over water areas at a time when most of these geese were feeding in agricultural fields. Canada geese are wary and they flush a long distance ahead of a low-flying plane. In agricultural areas of the Bajio (Guanajuato, Jalisco, and Queretaro) and northwest of Lake Yuriria, 440 were observed on an aerial reconnaissance on 18 January 1948. They were found in scattered flocks of from 10 to 185 individuals, mostly in fields. Other flocks were recorded in 1948 as follows: 16 January, Lake Atotonilco near Sayula, Jalisco, 400; 17 January, delta of Lake Chapala, 115; 16 January, Lake Patzcuaro, 65; and 19 January, Lake Magdalena, Jalisco, 30.

Among the early records of this species in Mexico, those based on the notes of Berlandier (Baird et al. 1884, 1:464) are of interest: "Dr. Berlandier . . . speaks of it inhabiting the great plains of Tamaulipas, Mexico. He has seen it in flocks of several hundreds in the grassy marshes between San Fernando and Matamoros, in the vicinity of Soto la Nanine [*sic* Marina], etc. . . . He also met with it in December on the central plateau between the Hacienda of Encarnacion and Aguas Nuevas, near Saltillo." At that time, before the extensive grain-farming on the plains of Texas and elsewhere in the Southwest, more Canada geese probably wintered in northern Mexico than in recent years.

Although the distribution of the species in general has been described, the taxonomy of these geese and the distribution of the several races in Mexico is not adequately known (Aldrich 1946; Hellmayr and Conover 1948; Delacour 1954; Marquardt 1962; MacInnes 1963; Hansen and Nelson 1964). There is a serious lack of specimens from Mexico, and most of the records are based on band recoveries rather than skins. More skins from representative localities are required before the distribution of the races of Canada geese in Mexico can be determined adequately. Some of the information we have on the several races follows.

Great Basin Canada Goose (*B. c. moffitti*)

Friedmann et al. (1950) do not record this subspecies as occurring in Mexico, and some maps of its winter range do not indicate that any go south of northern California, Nevada, and Utah, but many recoveries of banded individuals prove that some winter in Mexico.

There is some disagreement regarding the breeding ranges of *moffitti* and *maxima*. Several of the honkers shot in Mexico were banded as locals in places shown on some maps as the breeding range of *maxima* (Marquardt 1962; Hanson 1965), but *maxima* is considered to be a much more sedentary species than *moffitti*; thus, it seems likely that these Mexican recoveries are referable to the latter race.

More than 32,000 white-cheeked geese were banded from the earliest years and through 1951, most of which were listed as *B. c. canadensis* and *B. c. moffitti*. Among this number only nine recoveries were reported from Mexico and all were *moffitti*. The total banded for all years through 1960 was 128,438, not including experimentals; there were 71 Mexican recoveries of which at least 38 (and probably 50) were of this western race. Through June 1962, 24 *moffitti* were recovered in Baja California, chiefly on agricultural lands in the delta of the Rio Colorado, and there were also 12 in Sonora, 6 in Chihuahua, 3 in Coahuila, and 1 in Colima.

We do not have all the details on the localities of banding and recovery of these birds, but some for which we do have this information follows. Two of these birds were banded during the breeding season at the Bear River Migratory Bird Refuge, Utah. One, banded as a juvenile, was killed the following January near Ciudad Obregon, Sonora; the other, banded as an adult, also was shot in Sonora, about 160 km south of the border, probably in the Rio Magdalena Valley.

Two other recoveries were banded in July at the Bowdoin National Wildlife Refuge, Malta, Montana. They included a first-year immature that journeyed down the Central Flyway to Don Martin Reservoir near Sabinas, Coahuila, and an adult that followed the Pacific Flyway down the coast to Huatabampo, southern Sonora. Five birds banded during the nesting season at Blackfoot Reservoir, near Pocatello, Idaho, were shot in the Rio Colorado Delta, Baja California.

Additional Records in Mexico

Baja California.—Five birds were recovered about 13 km below Ensenada; 11 in the delta of the Rio Colorado, mostly about 96 to 128 km below Mexicali; and 1 from Ejido Chiaqua. Of these birds, seven were banded in Idaho, six in Utah, three in Wyoming, and one in Saskatchewan.

Chihuahua.—Three birds were recovered near Ignacio Zaragoza, 80 km south-southeast of Nueva Casas Grandes and northeast of Laguna Babicora; two near Laguna Guzman, 96 km west-southwest of Ciudad Juarez; and one at Boquilla, 152 km south-southeast of Chihuahua. Of these, three were banded in Colorado, two in Montana, and one in Idaho.

Coahuila.—Three birds were recovered near the Don Martin Reservoir southwest of Eagle Pass, Texas. Two of these were purchased at Jamestown, North Dakota, transported to New Mexico, and released there by the State Game Department; the third was banded in Montana.

Sonora.—Five birds were recovered near Ciudad Obregon and in the Rio Yaqui Delta, three near Huata-

bampo, and two near Caborca. Exclusive of the two from Caborca, four were banded in Utah, three in Montana, and one each in Wyoming, Idaho, and Colorado.

There were 16 recoveries in December and 17 in January. The kill was mostly in those two months.

To summarize, this race has been recorded from Baja California, Sonora, Colima, Chihuahua, and Coahuila, but it also probably occurs in small numbers from Durango south to Jalisco, Guanajuato, and Michoacan.

Lesser Canada Goose (*B. c. parvipes*)

Friedmann et al. (1950) say of *parvipes*, "Veracruz, one record (this type specimen); undoubtedly occurs westward across northern Mexico to Chihuahua, but no specimens yet known." Some of the Canada geese that we examined in hunters' bags in 1949–52 from Tamaulipas, Veracruz, and Chihuahua were of this form. The only additional specimen obtained was a male, U.S. National Museum (USNM) 419691, that we took near San Jose, southeast of San Fernando, Tamaulipas, on 19 February 1939; it was identified by John W. Aldrich.

In 1939 in an official report based on ground and aerial surveys, we estimated 12,550 Canada geese present in northern Tamaulipas between the Rio Grande and Laguna Madre. Several thousand others were on the grassland and marshes west of that lagoon.

The percentage distribution of honkers seen on the northern Gulf Coast of Mexico on 14 aerial surveys through 1965 averaged as follows: Rio Grande, 55.6; Laguna Madre, 40.5; and Tampico-Tamiahua, 3.8. The populations for these areas ranged from 0 during some years to more than 8,000 in 1963; the average was 2,267. If the percentage distribution is computed only for the 5 years of 1961-65, it is Rio Grande, 68.6; Laguna Madre, 30.7; and Tampico-Tamiahua, 0.7. The average annual total for those 5 years was almost 5,000 geese. There undoubtedly has been some increase in honkers in the Rio Grande Delta since the late 1950's. But according to experienced local observers who have seen the goose feeding flights from vantage points on the ground where their numbers could be estimated, even the most recent aerial surveys have sighted and counted only part of the total population. We do not know how these totals would be divided among *parvipes, hutchinsii,* and intermediates between them, and whether other races such as *interior* and *taverneri* were also among them.

Almost all the banded honkers taken in Tamaulipas were migrants marked at Sand Lake National Wildlife Refuge near Columbia, South Dakota, and most were identified as "Little Canada Geese." This designation apparently was given to some *parvipes,* some *hutchinsii,* and many intermediates between the two. Some were banded in Canada, and of this population John W. Aldrich wrote us in 1963, "I have identified the rather good series of specimens taken by MacInnes at McConnell River (Ontario) as *parvipes,* tending to intergrade toward *hutchinsii.*" There are many unanswered questions regarding the relationships of *hutchinsii,* some concerning genetics and taxonomy, and others regarding their ecology and physiology (Linduska et al. 1964).

It is likely that a few individuals of this race winter south of Chihuahua, probably as far as Durango and Michoacan, but there are no known specimens.

On the Gulf Coast, the gizzards were examined from six specimens obtained along the western shore of Laguna Madre, Tamaulipas. Plant food (five items) was 99.9% and animal food (four items) 0.1%. Among the contents, 69.4% was *Lycium,* 19.1% bermuda grass, 11.4% other grasses, and traces of crabs, insects, and bivalves.

The gullet contents of six Canadas from the saline Laguna Madre, Tamaulipas, included 93% plant food and 7% unidentified animal matter. The foods included 20% each of buffalograss and dwarf spikerush, 15% each of bermuda grass and unidentified vegetation, and lesser amounts of three other plant foods.

Aleutian Canada Goose (*B. c. leucopareia*)

The 1931 AOU check-list gave the winter range of *leucopareia* as "northern Washington to northern Mexico." Friedmann et al. (1950) said this race had been recorded in "Baja California (extreme northeast), northern Chihuahua, northern Coahuila, Nuevo Leon, Tamaulipas, and northern Veracruz. Uncertain records from Sonora, Jalisco, and Guanajuato." In the 1930's and 1940's, many or most of the intermediate-sized Canada geese in Tamaulipas and northern Veracruz were thought to be *leucopareia,* but it is now believed that these birds probably were *parvipes.*

The 1957 AOU check-list reported that *leucopareia* winters "from British Columbia to California," thereby restricting its distribution to the Pacific Coast.

The only Mexican specimen of this race in the National Museum collection is USNM 419355, a male which we obtained near Ciudad Obregon, Sonora, on 18 January 1951. It probably also occurs in the Colorado Delta sector of Baja California, other parts of Sonora, and northern Sinaloa.

On the Pacific Coast three of these geese were obtained from rice fields near Ciudad Obregon, Sonora. Their gizzards contained 60% cultivated rice and 40% dwarf spikerush. Most of the Canada geese shot on this coast of Mexico were taken in Baja California and Sonora, chiefly in cultivated grainfields.

Richardson's Canada Goose (*B. c. hutchinsii*)

During 1936–46 almost all of the Canada geese that we observed at close range and in hunters' bags on the coastal plains of northeastern Mexico were of an intermediate size, and at that time they were considered to be *leucopareia* (then called the lesser Canada goose). Rarely was a small honker (*hutchinsii*) seen, but a few specimens were recorded, two of them in hunters' bags at Tampico, Tamaulipas, in December 1939. Another one, obtained at the Tampico public market on 10 March 1940, had been shot near Cacalilao, Veracruz. During the past 15 or more years there has been a progressive increase in the numbers of small *hutchinsii* or *parvipes-hutchinsii* that winter on the coast of Tamaulipas, possibly because of the loss or deterioration of some of their wintering grounds in the United States. During the aerial surveys of 1948–62 a considerable percentage of the Canada geese observed in Tamaulipas probably were of this race, but it was not possible to make an accurate appraisal.

Undoubtedly many of these geese were overlooked, because at the time many of the surveys were made these birds were farther inland, feeding on grasslands or in agricultural fields. Their habit of flushing far ahead of the plane and swinging to one side also reduces the number seen. The relative abundance of small Canadas there is corroborated by the number of banded individuals reported since 1955. Most of these were migrants banded at Sand Lake National Wildlife Refuge, Columbia, South Dakota.

MacInnes (1963) in his studies of Canada geese that winter on the Texas coastal plain just north of the United States–Mexico boundary, wrote:

> It has proved impossible to carry out an aerial inventory of the Canada goose population of south Texas, for, aside from moving about unpredictably, the birds disperse in small bands wherever food and water are available. Thus a ground survey of the Laureles Division of the King Ranch revealed that almost every stock watering pond served as center of activity for up to fifty Canada geese; these small flocks were not seen during an aerial survey of the same area.

The research by MacInnes has provided a great deal of information on these geese, but there still continues to be a considerable difference of opinion regarding the relationship of *parvipes* and *hutchinsii*.

Aldrich (1946:100) identified specimens of *hutchinsii* from Guzman, Chihuahua (female, immature, 9 January 1904), and LaBarca, Jalisco (male, immature, 4 December 1903). Some of the Canada geese that winter on the Central Plateau and in the Bajio, the great interior basin centering in Guanajuato, Jalisco, and Queretaro, are of this form.

To summarize, the "Little Canada Goose" has been recorded from Chihuahua, Jalisco, Tamaulipas, and Veracruz; and probably occurs also in Coahuila, Nuevo Leon, Durango, Zacatecas, San Luis Potosi, Guanajuato, and Michoacan.

In 1961–62, of 8,071 "Little Canada Geese" banded, there were 1,003 recoveries reported, including 21 (1.36%) in Mexico. The total recovery rate was 19.14% but only 0.26% in Mexico.

Twenty of the 21 recoveries were banded in South Dakota; the other recovery was banded in Northwest Territories, Canada, near Eskimo Point. Twenty of them were killed in Tamaulipas, and one in Veracruz. The percentage of recovery in Mexico for those banded in South Dakota was 2.91 and the largest number of recoveries was in December (11). The heaviest kill was in that month; there were only three recoveries in November and two in January.

Recovery records through June 1962 were as follows: "*B. c. parvipes* toward *hutchinsii*," and "*hutchinsii*"; Tamaulipas: six from 56 to 104 km south of Matamoros; three in the northern part of Tamaulipas; three near San Fernando; two southeast of Reynosa near Rio Bravo; one at Washington Beach, Gulf Coast, east of Matamoros; one at Control Lake, northwest of Matamoros; one about 3 km inland from Laguna Madre; and one near Soto la Marina. Veracruz: one near Magozal (64 km south-southwest of Tampico).

It should be emphasized that more Mexican recoveries of Canada geese and lesser snow geese would be listed if experimentals were included. Thousands of these geese have been given colored neckbands and other special markers, but the tabulations used in this report include only wild birds marked with standard aluminum bands.

This little goose has feeding habits in the lower Rio Grande Delta that are similar to those of the other Canada geese there. Formerly it fed chiefly on the grassy ridges of the coastal clay dunes, grazing on buffalograss and other grasses. At times it fed on the coastal flats, especially on the small tomato-like fruits of *Lycium*, called "tomatillo," and on entire plants of dwarf spikerush. Since the late 1950's, local observers have reported that most of the small honkers feed in the stubble fields of grain sorghum south of Matamoros. The partial gizzard contents of a bird shot near Matamoros were made up of widgeongrass seeds.

We believe the hunting of this race of goose is confined chiefly to the Gulf Coast, mostly in Tamaulipas, and mainly between Matamoros and San Fernando, near Laguna Madre, and in the Tampico district. A few are killed in the Palaloapan Delta, Veracruz, and reports from hunters indicate that several have been shot in the northern part of the interior highlands, mostly in Chihuahua.

Cackling Canada Goose (*B. c. minima*)

Friedmann et al. (1950) reports "One record for Baja

California (near San Quintin, November 2, 1934)." A specimen we took from a flock of small honkers at Tobari Bay, near Ciudad Obregon, Sonora, on 29 January 1951, was identified as *minima* by J. W. Aldrich (USNM 419386). We saw two other specimens in hunters' bags in the same locality on 21 December 1950, but we were unable to obtain them. The specimen collected had fed chiefly on the tender leaves of winter wheat, together with rice which was gleaned from the stubble fields.

Black Brant (*Branta bernicla nigricans*)

Mexican names: ganso negro, ganso de collar negro (Friedmann et al. 1950).

Before 1958 this brant was recorded in Mexico only in Baja California, where locally it was a regular and abundant winter resident, and on and near the Colorado River Delta in Sonora (Price 1899). On the January 1958 aerial survey four of these brant were observed at Laguna Agiabampo (Sonora-Sinaloa). This was the first record of them south of the Colorado River delta on the Mexican mainland. Since then their numbers on the mainland increased to about 25,000 in 1964 and 1965, and they were distributed from near Tiburon Island and Estero Agiabampo, Sonora, to Laguna Santa Maria, Sinaloa.

About the January 1952 aerial survey, which Robert H. Smith, A. Starker Leopold, and Wynn G. Freeman made in Baja California, Leopold (1952) wrote:

> The 1952 inventory of black brant along the Pacific Coast was probably the most complete ever made. We found 102,945 brant along the west coast of Baja California and an additional 43,840 on the California coast, from Humboldt Bay to San Diego. A few are known to winter along the northwest coast, as far as Vancouver, but the total of 146,785 brant found on the coasts of California and Baja California represents perhaps 90 percent of the total population. Of these it can be seen that two-thirds are in Mexico, mostly in Scammon Lagoon and San Ignacio Bay. Practically all of the eelgrass bays in Baja California, where the brant winter, are isolated from human disturbance and there is every prospect that they will remain good wintering habitat far into the future.

Earlier aerial surveys had been less complete in coverage, due to a short cruising range or to inclement weather. Totals of this species observed on the west coast of Baja California in preceding years were 32,980 in 1949 (incomplete), 72,985 in 1950, and 34,190 in 1951 (incomplete).

The 1960 January survey showed a 100% gain in the wintering population of this species in the flyway. There was a large increase in Baja California where more than 114,000 birds were observed, but there was a 65% decrease in California. The decrease in brant wintering in California had continued during the past 5 years. California Fish and Game Department observers have noted that this decline has accompanied a continued buildup in human activities along the coast during this period. The latter includes an increase in industry, boating, fishing, and pollution—all of which have made these localities much less attractive to the brant. It is no wonder that they prefer the isolated coastal lagoons of Baja California or the more southern Pacific States of Mexico.

Einarsen (1965:16) wrote, "Dr. and Mrs. Harry G. Plut of Port Townsend, Washington, very familiar with black brant, report seeing a small flock at Acapulco, Mexico, in mid-January 1960." This is the first record for the State of Guerrero and the southernmost one on the mainland.

The estimated numbers of brant seen on all these surveys in Mexico from 1949 through 1965 averaged 72,000, but for the past 6 years the average has been about 131,000 because more of the continental population winters south of the border. The percentage distribution for the past 6 years was as follows: San Ignacio, 41.8; Scammon, 22.1; Magdalena, 19.0; Santa Maria, 6.9; San Quintin, 6.3; Topolobampo, 2.7; and Ensenada, Obregon, and Agiabampo each had less than 1.0. Grinnell and Storer (1928) cited many localities in Baja California where black brant had been recorded.

Among 10,822 black brant banded, there were 1,003 recoveries reported by July 1962, including 106 (10.6%) in Mexico. The recovery rate was 9.3% but only 1.0% in Mexico; all recoveries there were from Baja California. Most of them (95) were of birds banded in Alaska; 6 were banded in California and 5 in the Mackenzie district of northwestern Canada. The percentage recovery in Mexico was highest for those from the Mackenzie district (83.3); Alaska was second (9.7) and California third (7.1).

The greatest numbers of recoveries were 29 in February and 25 in January. Those recovered in December (18) and March (13) were fewer. The earliest recovery record to date from Baja California is 14 November and the latest 18 April.

A serious decline of eelgrass in many places on the California Coast occurred from 1937 or 1938 until the early 1940's (Moffitt 1941*a*, 1943). It was believed to be caused by the fungus *Labyrinthula* and probably other factors, such as higher temperatures and an abnormally heavy deposition of silt in some bays. By 1940–41 there was insufficient eelgrass in the coastal bays of California to feed as many brant as wintered there, so other foods, including surfgrass (*Phyllospadix*) and sea lettuce (*Ulva lactuca*) were utilized to a greater extent (Moffitt 1941*b*). An increasing number of these geese began wintering in Baja California at that time, and they have continued to do so. The reports on the annual black brant census published in

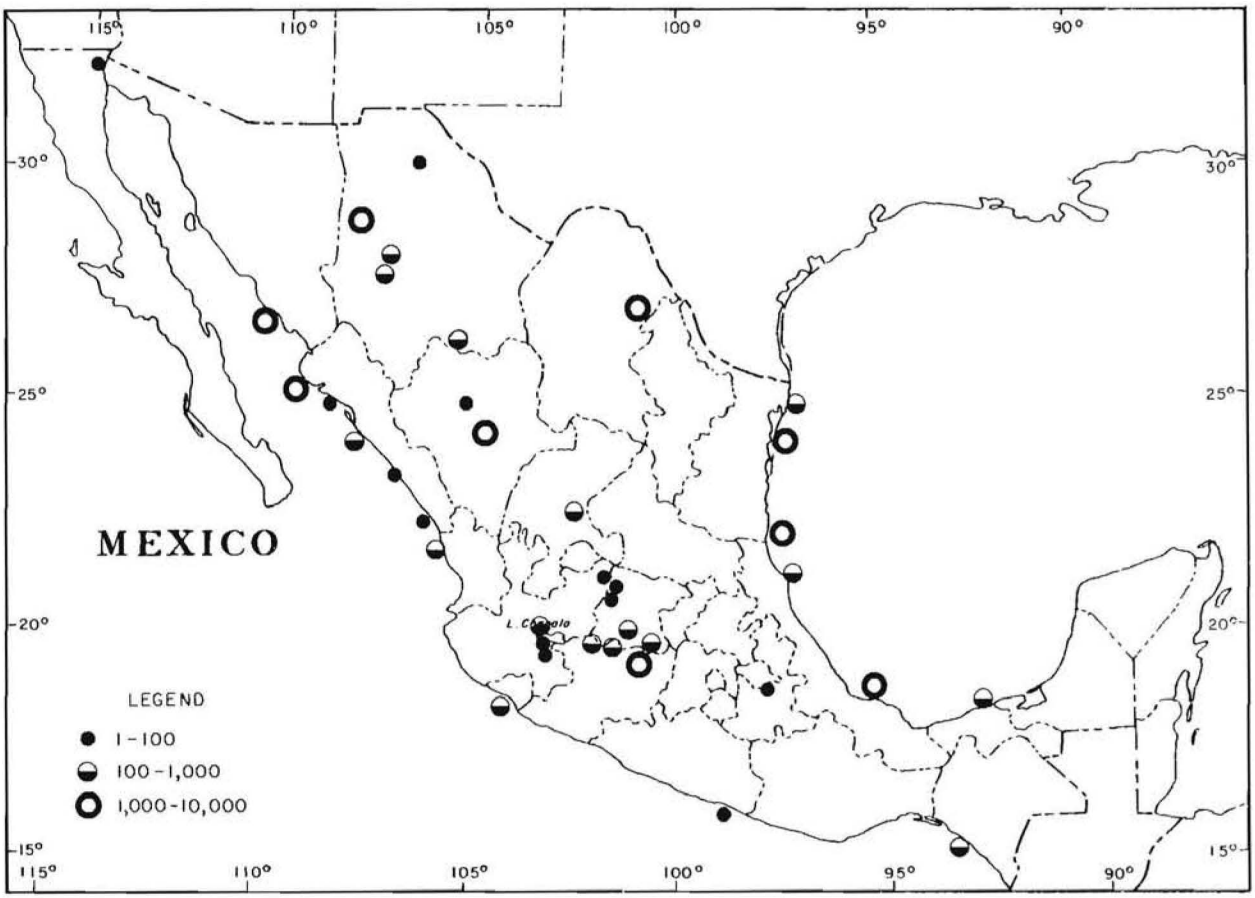

Fig. 21. Average numbers of white-fronted geese observed during January aerial surveys, 1948-62.

California Fish and Game are an excellent source of detailed information on this species in that State.

With the majority of these brant now wintering in Mexico it is apparent that the habitat there, including eelgrass as the principal food plant, is more attractive than the California wintering grounds. Too many adverse conditions have developed in the California coastal bays that outweigh the remaining attractions. We do not know the extent to which eelgrass and other marine grasses and sea lettuce and other marine algae are available and utilized by brant along the Pacific Coast of Mexico.

Most of the black brant shot in Baja California are reportedly taken in the vicinity of San Quintin, but smaller numbers are obtained farther north on the coast, especially near Ensenada. Because the brant have extended their winter range to the mainland, it is likely that a few are killed near Ciudad Obregon, Sonora, and at Laguna Santa Maria, Sinaloa, but we have no definite reports from there. The kill is very light compared with that in the United States, because many of these birds in Mexico are relatively inaccessible to hunters.

White-fronted Goose (*Anser albifrons frontalis*)

Mexican names: ansar; ansar salvaje; oca salvaje; ganso frente blanca; and tlalacatl (Nahuatl) (Friedmann et al. 1950).

This bird, known to many hunters in the United States as speckle-belly or speck, is undoubtedly the most widely distributed goose in Mexico (Fig. 21). It has been recorded in every State except Campeche and Quintana Roo, and there have been band recoveries from 15 Mexican States. All the white-fronted geese in Mexico, except a few among those that winter in Sonora (and probably Baja California and Sinaloa), are of the subspecies *frontalis*. The few exceptions are of the subspecies *gambelli*, the tule goose, which is discussed below.

In former years, the white-fronted goose probably

was outnumbered there by the lesser snow goose, but during the past several years these two species have been seen in almost the same numbers. White-fronted geese are observed in many more areas than snow geese, which are in larger flocks, but in fewer localities. The white-fronted goose is recorded in winter on the Gulf Coast as far south as Veracruz and Tabasco. On the Pacific Coast it occurs from Baja California to Chiapas, but it is most numerous in Sinaloa and Sonora. The recent great reduction in rice and wheat growing in the Obregon, Sonora district, and the heavy increase in these crops in northern Sinaloa, especially in the Culiacan district, have caused most of the geese and field-feeding ducks to shift from the former to the latter locality. This extensive grain-raising sector from south of Obregon to Navojoa, Los Mochis, and Culiacan winters most of this species on the Pacific Coast of Mexico. Those observed during some years in the coastal areas of Chiapas were usually on meadows and marshes between Buenavista and Solo Dios. They may reach this wintering ground via the Gulf Coast and the Isthmus of Tehuantepec.

In the Colorado River Delta the January aerial surveys have recorded from none to 400 white-fronted geese, and the average has been about 50 birds. The largest numbers formerly wintered in the Ciudad Obregon district because of the extensive grainfields there. In 1948, 17,100 were observed there, but beginning in 1960 many more were seen in the Topolobampo-Los Mochis locality than near Obregon. In that year, 2,490 of these birds were observed in the lagoons and grainfields around the latter area and almost 10,000 in the former. Since then the number of white-fronted geese seen in those places has decreased, but the Los Mochis territory has still averaged more birds than Obregon.

South of Topolobampo-Los Mochis, the next important wintering ground is in the Ensenada de Pabellon-Culiacan area. White-fronted geese (560) were observed there on the aerial surveys beginning in 1952. Their numbers varied from year to year, but the trend has been toward increased populations; in 1964 the estimate was 5,200. Southeast of there the next important wintering ground is the Marismas Nacionales, Sinaloa-Nayarit. In January 1964 the count in this area was 755, but the average over the years has been about 200. Small flocks are usually near the Laguna Cuyutlan, Colima, and occasionally on the marshes southeast of Acapulco, Guerrero. The southernmost wintering ground along this coast is in southern Chiapas in the Sesecapa district. The numbers seen here during the aerial surveys have ranged from none to 1,525 (average, about 275).

The percentage distribution of these geese on the Pacific Coast, as indicated by the average of the January aerial survey figures, was as follows:

	1948-65	1961-65
Ciudad Obregon	48.8	18.5
Topolobampo	24.7	42.2
Pabellon	16.7	30.4
Marismas	2.4	3.3
Sesecapa	4.1	2.5
Santa Maria	<1.0	2.0
Cuyutlan	1.8	0.0
Colorado Delta	<1.0	<1.0

White-fronted geese are the most numerous and widely distributed geese in the interior highlands, but they are not nearly as numerous as they were in earlier years before drainage of many marshes and impoundment of rivers. They are regular winter residents in the principal lake areas from Chihuahua and Coahuila south to Durango, in the Bajio (chiefly Jalisco, Michoacan, and Guanajuato), San Luis Potosi, and Puebla.

In Chihuahua, the largest population observed in any locality during the January aerial surveys was about 2,700 at Babicora in 1963 and 1964. Santiaguillo, Durango, had from none in dry years to about 2,600; the annual average was about 1,315, including all years since 1951.

To the southward, the largest numbers recorded on these aerial surveys were at Lake Cuitzeo where the tallies ranged up to almost 4,000 in some years, and averaged about 1,690. This species also was recorded fairly regularly at Irapuato, Yuriria, Chapala, Atotonilco, and Zacapu. The total annual figures on the aerial surveys in the highlands ranged from about 3,500 to almost 10,000 white-fronted geese (average, about 6,500).

The average percentage distribution of white-fronted geese in the highlands, as shown by the aerial survey estimates, was as follows:

	1951-65	1961-65
Cuitzeo	23.6	4.2
Santiaguillo	15.5	31.8
Irapuato	11.9	5.2
Bustillos	9.8	3.1
Babicora	8.6	26.6
Chapala	6.7	0.2

In the above data, only those localities with an average of 5% or more are listed. Thirteen localities were in the less-than-5% category.

On the Gulf Coast, these geese are especially common in northeastern Tamaulipas during the fall migration when some of the flocks bound for the interior, as well as those frequenting the coast, pass that way. Before the 1950's only a few thousand usually wintered in the Rio Grande Delta of northern Tamaulipas, but since then the expansion in acreage of grain

sorghum between Matamoros and San Fernando has increased the numbers of white-fronted geese stopping there. They roost on the coastal bays, reservoirs, and lagoons and fly inland to feed. Small numbers also occur at Laguna Madre, on the meadows of the Tampico sector, and in the Papaloapan basin south of Alvarado, Veracruz. Their southernmost wintering area on the Gulf Coast is in the Tabasco marshes.

The comparative percentage tabulation of all Gulf areas having white-fronted geese is as follows:

	1948-65	1961-65
Rio Grande	40.6	77.8
Madre	15.9	9.4
Tampico-Tamiahua	21.2	10.6
Alvarado	17.5	1.1
Tabasco	4.8	1.1

From the above data it is obvious that more of these geese have been shortstopped in the delta in recent years. Another reason for this increase is the much better coverage of the aerial surveys there since 1963.

There are so many references in the literature to localities in the northern Mexican States where white-fronted geese are numerous that they cannot be cited here. Some of the records for the more southern places, however, include those of Sumichrast (1881), who reported this species at Nopalapan, Veracruz, and Santa Maria del Mar, Oaxaca (east of Salina Cruz); Ferrari-Perez (1886), who recorded it at San Marcos, Puebla (probably near Laguna Oriental); Herrera (1888), for the Valley of Mexico; Duges (1869), for Guanajuato; and Grayson (see Lawrence 1874), for Mazatlan, Sinaloa. In 1935, Goldman and Goldman wrote: "two on sale in the San Juan Market, Mexico City, January 31, 1935"; and "a small flock reported February 12, 1935, near the Coatzacoalcos River," Veracruz, south of Minatitlan (USBS files). They noted a flock of 2,000 at the Presa Los Angeles, 24 km south of Penjamo, Guanajuato, on 16 January 1935. In their field reports for 1935-37, they also reported many white-fronted geese at the eastern end of Lake Chapala. Many thousands of them were reported as wintering regularly before the diking and draining of the delta marshes east of that great waterfowl lake.

The drainage of many wetland areas, especially in the northern highlands, and the development of irrigated croplands in other localities, have had a great impact on the distribution and numbers of these geese in Mexico. Formerly, the largest flocks wintered in the highlands on natural lakes and marshes from Chihuahua south to the Valley of Mexico. The Lerma Delta above Lake Chapala was a favorite wintering ground for them. A larger percentage of white-fronted geese in Mexico now winter there because of the recent great increase in rice and other grains on the coastal plains of Sonora and Sinaloa. In migration they occasionally stop at some of the smaller lakes and reservoirs, and at other waters too small to attract other species of geese.

In personal correspondence dated 17 January 1966, Helmuth Wagner wrote, "White-fronted geese. I saw three which were shot by Indians in January 1964 near Sisal . . . Yucatan . . . I saw them also near Palenque, Chiapas, on the lakes." This is the first record for Yucatan and for that part of Chiapas, to our knowledge.

The gizzards of five specimens shot near Ciudad Obregon, Sonora, in 1950 contained 99% rice, 1% young leaves of wheat, and a trace of animal food (beetles and flies). Food totaled 94% and grit 6% of the contents. The gullet contents of 46 other specimens from the same locality were examined with the following results: rice (grain), 55%; wheat (young leaves), 29.3%; and small amounts of seablite seeds, glasswort, and several grasses.

On the Gulf Coast the gizzards of three birds shot in the Tampico Delta contained almost 100% sedge seeds, except for traces of rice (grain) and other vegetation. Food totaled 80% and grit 20% of the contents.

Until July 1962, of 6,896 white-fronted geese banded, 1,241 recoveries were reported, including 68 in Mexico. The overall recovery rate was 18.0%, but only 5.5% were taken in Mexico. There were recoveries from 15 States in Mexico; the largest numbers were from the interior highlands (43), especially from Chihuahua (6), Durango (7), Zacatecas (9), Coahuila (5), and Jalisco (5). The Pacific zone had 17 recoveries: Sinaloa (8), Sonora (5), Baja California (3), and Nayarit (1). The Gulf zone had 8: Tamaulipas (6) and Veracruz (2).

The heaviest hunting of these geese is in the interior highlands, especially in Chihuahua, Durango, and the other States south to the Bajio. On the Pacific Coast hunting is concentrated in Sonora and Sinaloa. White-fronted geese wintering on the Gulf Coast are killed chiefly near Matamoros and Tampico, Tamaulipas.

Tule Goose (*Anser albifrons gambelli*)

The tule goose, a large race of the white-fronted goose, has been recorded in Sonora, and it probably also occurs occasionally in the Colorado River Delta and in the northern half of Sinaloa.

From 13 December 1950 to 3 February 1951, when we were engaged in waterfowl investigations near Ciudad Obregon, Sonora, white-fronted geese were common there. Their numbers ranged from more than 8,000 during late December to about 6,000 in mid-January. Many were shot by visiting hunters from the United States and in examining more than 100 of those geese we were impressed by the larger size of some specimens. One of the larger individuals, but not the largest seen, was obtained on 18 January, in addi-

tion to the heads of two others. Alden H. Miller of the University of California, in comments on the specimens sent to him for identification, wrote, "I am willing to call your specimen from Obregon and specimen number two, the head, *gambelli* although I wish that a more decisive complete specimen, nonintermediate, were available." Several larger examples were seen during January but were not obtainable as specimens (Saunders 1953).

The specimens of this goose, which were shot near Ciudad Obregon, Sonora, had been feeding on the young leaves of winter wheat. Hunters there shot more than 100 typical white-fronted geese during January 1951, of which we estimated that not more than 5% were these larger tule geese.

Lesser Snow Goose (*Anser caerulescens caerulescens*)

Mexican names: ansar, ansar blanco, ansar real (Friedmann et al. 1950), ganso blanco (Lopez and Lopez 1911).

Recent evidence indicates that the blue goose is a color phase of the lesser snow goose. The best known authority on this point is F. G. Cooch, biologist of the Canadian Wildlife Service. In the chapter which he wrote for *Waterfowl Tomorrow* (Linduska 1964:125-133) he said, "The white bird apparently was the original stock, and the blue followed along later. Therefore, I refer to them both as lesser snow geese—white and blue phases." On the basis of Cooch's conclusions (1961) and those of several taxonomists, both color phases are included in this report as the lesser snow goose.

The snow goose was formerly an abundant winter visitant to the central plateau of Mexico and to a lesser extent to the northern parts of the coastal plains. The largest concentrations wintered on the great *bolsones* of Chihuahua and Coahuila when those basins had extensive lakes and marshes, but unfortunately there were no estimates of numbers by observers during the 1800's. Large flocks occurred then as far south as the delta marshes of Lake Chapala and Lake Cuitzeo. Beebe (1905:119) described their former abundance at Lake Chapala and the importance of that locality as a wintering place for geese and ducks. By 1912, the diking and drainage of a large area of the Chapala marshes had greatly reduced the waterfowl habitat and the number of snow geese and other birds there.

Since early in the 1900's the diversion of water for agricultural, industrial, and municipal uses has resulted in the progressive shrinkage of the lakes and marshes in Chihuahua, Coahuila, Durango, and States farther south.

The first aerial survey made in the highlands on 16 February 1947 included a very limited coverage of Chihuahua. At Laguna Babicora, 50,000 of these geese were estimated to be in the concentration seen that day. Further aerial surveys were resumed in the highlands in 1951 and have continued to the present time. Babicora was scouted in only some of these years, but as recently as January 1963 its snow goose population was estimated at almost 34,000. Other localities in Chihuahua had fewer snow geese; their numbers ranged from a few hundred to as many as 12,000 at Laguna Bustillos in 1952, 1,900 at Laguna Santa Maria in 1963, 550 at Casas Grandes in 1961, and 360 at Lake Toronto in 1962. Numbers at Laguna Santiaguillo, Durango, ranged from 400 in 1953 to 5,600 in 1963. The annual average of the January aerial surveys from 1951 through 1963, from Durango northward, was about 16,000 snow geese.

To the southward, the lake that attracted the largest numbers of snow geese in most years was Atotonilco, and the population there ranged from about 600 in 1956 to 2,200 in 1961. Several hundred of them usually were also present near Chapala and Sayula. The highland totals, as determined by the annual aerial survey of localities south of Durango, ranged from about 7,000 to almost 50,000, and the average was slightly more than 17,000.

The percentage distribution in the highlands, as indicated by the findings of the January aerial surveys from 1951 to 1965, was Babicora 39.9, Mexicanos 17.7, Bustillos 13.7, Santiaguillo 10.3, Santa Maria 4.6, Atotonilco 2.8, Rio de Oro 2.3, Guzman 2.2, Toronto 1.8, Casas Grandes and Sayula each 1.3, and Patos, Chapala, Zapotlan, and Cuitzeo each with less than 1.0.

Habitat conditions and aerial coverage of lakes and lagoons in the northern highlands varied greatly in earlier years of the surveys; thus it is helpful to summarize the findings during 1961-65. In percentage, the distribution of lesser snow geese for those years was Babicora, 60.2; Santiaguillo, 13.8; Bustillos, 6.7; Santa Maria, 5.8; Mexicanos, 4.1; Sayula, 2.6; Atotonilco, 2.3; Casas Grandes, 2.0; Toronto, 1.3; and five localities each with less than 1.0.

Most of the lesser snow geese on the western coast of Mexico winter in the Colorado River Delta of Baja California, and on the Marismas Nacionales, south of Mazatlan, Sinaloa (Fig. 22). On sandbars of the delta about 5,000 were seen on the 1947 survey. It is probable that many escaped detection on our limited aerial reconnaissance because of the extent of this delta and the scattered distribution of goose flocks. They loafed and slept in the lower delta and flew many kilometers inland to feed on agricultural cropland and flooded fields, and to obtain grit.

Small flocks were also observed in the vicinity of Tobari Bay near Ciudad Obregon, Sonora, and south to the vicinity of Altata and Culiacan, Sinaloa. The

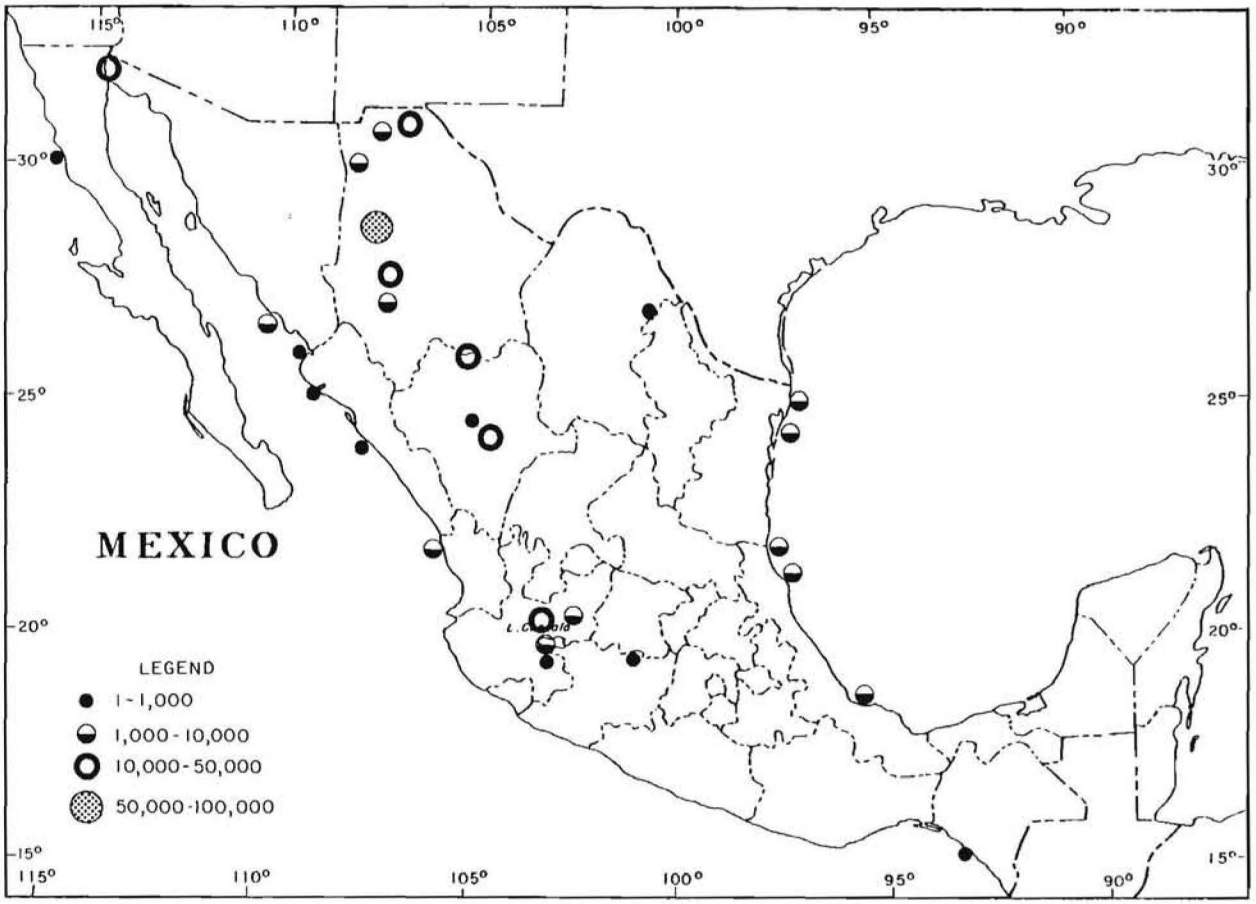

Fig. 22. Average numbers of lesser snow geese observed during January aerial surveys, 1948–62.

southernmost records on the Pacific were of four birds seen in a coastal marsh of the Sesecapa area, Chiapas, in January 1954. The percentage distribution of these geese on the Pacific Coast, as indicated by findings of the January aerial surveys, was Colorado River Delta, 73.8; Marismas Nacionales, 24.3; Ciudad Obregon, 1.8; and a trace in four other localities.

Regarding earlier records, Van Rossem (1945:43) wrote:

> Common, perhaps even abundant, winter visitant in the Colorado River delta. Observed by Dickey (notes) as common all along the river from San Luis to El Doctor between December 5 and 9, 1925, and similarly noted by Wright in February, 1929. In the U.S. National Museum catalogue is the record of two specimens taken by Mearns and Holzner on the Sonora side of the river opposite the mouth of the Hardy, March 27, 1894. There are a number of supplementary records from the Baja California bank (Grinnell and Storer 1928, p. 78). An extreme southern record, possibly that of a casual, is from Tobari Bay, November 25, 1944, where a single individual was seen by W. J. Sheffler (notes).

Lesser snow geese are common in the coastal areas of northern Tamaulipas, especially in the Rio Grande Delta and to a much lesser extent west of Laguna Madre. Small numbers winter in the Tampico area and in marshes on the southwest side of Laguna Tamiahua (Fig. 23). On January aerial surveys they have been recorded as far south as the Alvarado and Papaloapan areas of Veracruz and the marshes of Tabasco. E. A. and L. J. Goldman also recorded them in the Alvarado area near Tlacotalpan, 15 February 1936 (USBS files). There is also a record in the literature for two localities in Tabasco (Rovirosa 1887 as cited by Brodkorb 1943).

Small numbers of the blue phase of this species have been recorded in coastal areas of Tamaulipas more or less regularly each winter since the field surveys began in 1938. Among those seen, most were with other lesser snow geese on the deltas of the Rio Grande and the Rio San Fernando. A few were also observed on grassy flats west of Tampico and in the Papaloapan Delta of Veracruz.

On the January 1947 survey flight, David L. Spencer

Fig. 23. Lesser snow geese in flight over the marshes and meadows at the south end of Laguna Tamiahua, Veracruz, 1947. Their principal foods in this locality are spikerushes, grasses, the roots of saltwort, and the red berries of *Lycium*. Not many snow geese winter south of the Tampico Delta on the Gulf Coast.

and the senior author observed 50 blue geese in the Rio Grande Delta and 37 in the Papaloapan, Veracruz, area, among several thousands of the white phase. In 1948 and 1949, biologists Robert H. Smith and David L. Spencer recorded a total of 318 blue geese among the several thousand other lesser snow geese present on the salt marshes and lagoons of northeastern Tamaulipas. In January 1951 biologists Walter Crissey and John Ball found none in Tamaulipas, but saw 10 among other snow geese near Laguna Tamiahua, Veracruz. In January 1952 Walter Crissey and Ed Wellein saw 190 of them in the Rio Grande Delta, 100 in the Tampico area, and 250 in the Alvarado area among the much more numerous white phase.

The percentage distribution of lesser snow geese, as shown by findings of the January aerial surveys from 1948 to 1965, was Rio Grande, 34.6; Tampico–Tamiahua, 33.0; Laguna Madre, 21.1; and Alvarado, 11.2.

During January 1951 Mr. Wiebe of Cuauhtemoc, Chihuahua, an experienced goose hunter and long-time resident of that locality, reported to George Englehart of Chihuahua (City) the killing of a blue goose from a flock of other lesser snow geese (Saunders 1953).

All States were recorded except Colima, Aguascalientes, Morelos, Tlaxcala, Campeche, Yucatan, and Quintana Roo.

Among 60,947 lesser snow geese banded, 6,791 recoveries were reported by July 1962, of which only 63 (0.9%) were in Mexico. The overall recovery rate was 11.1%, but only 0.1% in Mexico. There were recoveries from 10 States in Mexico; the largest number

were from Chihuahua (32) and the next largest from Tamaulipas (17). Most (41) were reported from the interior States of Mexico, and 19 were from the Gulf States. Among these recoveries, two were of the blue phase. One was reported from Nuevo Leon and the other from Tamaulipas.

The largest number of these recoveries (27) was banded in the Keewatin District of Canada, and the next largest number (13) in the Mackenzie District of that country. Third, with 12 recoveries of 54 birds banded, was Colorado. The percentage of recovery in Mexico for the Mackenzie District was 14.1 and for the Franklin District, 12.5. Among the 28 recoveries of snows banded in the Keewatin District, mostly Southampton Island, 16 were recovered in Tamaulipas, and 2 in Veracruz, totaling 18 for the Gulf States; 4 were in Chihuahua, 3 in Durango, 1 in Coahuila, and 1 in Nuevo Leon, totaling 9 for the interior States, and 1 in Nayarit on the Pacific Coast.

Among the 13 recoveries of snows banded in the Mackenzie District, 11 were shot in Chihuahua and 2 in Baja California (Colorado River Delta). The largest number of recoveries (23) was in December with 10 each during November and January. Only 7 were reported during February, but there were 12 during March.

Although the lesser snow goose and the blue goose are now considered to be the same species by most taxonomists, the distribution of these color phases in Mexico is very different. The white birds range much more widely and winter from Tamaulipas across to Baja California and southward. The blue phase is seldom seen in Mexico, except on the Gulf Coast in the States of Tamaulipas and Veracruz. Although the rates of recovery of the two color phases throughout their principal range were similar, their rates in Mexico were very different, thus corroborating our observations that relatively few blues go as far south as Mexico.

Only 15 gullets of this species were available for a study of food habits. They were from the Rio Grande Delta, Tamaulipas, and the gullet contents were saltwort (chiefly roots) 59%, spikerush seeds and plants 10.3%, and smaller amounts of widgeongrass, *Lycium*, glasswort, and saltgrass, plus 15.8% unidentified vegetation.

More snow geese are shot near lakes in the agricultural districts of Chihuahua than elsewhere in Mexico. They are also commonly taken in Tamaulipas, especially in the vicinities of Matamoros, near Laguna Madre, and near Tampico. A few are shot in the Colorado River Delta, Baja California, south to Nayarit, and in the interior highlands from Durango to Lake Chapala and the Bajio.

Ross' Goose (*Anser rossii*)

Mexican names: None in popular usage to differentiate it from the lesser snow goose, ansar blanco.

This little snow goose is about the size of a mallard duck, so it is easily distinguished from lesser snow geese when it is associated with them. Friedmann et al. (1950) reported this form as "casual in Chihuahua (Bustilles) Lake." The correct name is Bustillos (Crane) Lake. In the manuscript notes of E. W. Nelson (USBS files) he states "A pair seen at Bustillos Lake, 75 miles west of Chihuahua City. One shot and now in Sanford's collection, New Haven, Connecticut."

Guy D. Noel, State Game Warden at El Centro, California, who is well acquainted with this species, inspected the bags of waterfowl killed by hunters in the Baja California part of the Colorado River Delta and entered at the port of Calexico during the season of 1950–51. He wrote us on 3 March 1951 that of 982 geese declared by hunters returning from Mexico, he "checked a few Ross Geese at the border which were declared as snows."

At Ciudad Obregon, Sonora, during December 1950–January 1951, experienced local hunters told us that on rare occasions they had seen several very small white geese associated with flocks of snow geese in that vicinity. During our stay there we saw several hundred lesser snow geese, but no Ross' geese. Two very experienced goose hunters in the Lower Rio Grande Delta reported seeing several Ross' geese among lesser snow geese on the coastal flats of northern Tamaulipas, but no specimens were obtained.

Baja California and Chihuahua were recorded.

Black-bellied Whistling Duck (*Dendrocygna autumnalis*)

Mexican names: pichichi, pijiji (Chiapas), pichichil (Tamaulipas), pichihuili, yaguasa (Veracruz), pato maizal (Tamaulipas), pato chiflador (Veracruz), pichichin (Lopez and Lopez 1911); pixixi (Nahuatl) (Santamaria 1942).

This tropical species, often called the whistler or squealer by American hunters, is very common locally in the coastal waters of Mexico, especially south of Sonora, in the Pacific lowlands. The largest numbers were observed on lagoons and marshes of Sinaloa and Nayarit, but they were locally numerous southward to the swamps of Chiapas (Rio Huehuetan, Rio Sesecapa, near Carretas, and Laguna Buenavista).

Black-bellied whistling ducks were formerly more numerous in the interior during the winter months than they are now. In recent years they have seldom occurred on the lakes and marshes of the highlands.

On the Gulf Coast, this species is a regular resident from Tamaulipas to the peninsula of Yucatan, but it is most common in north-central Tabasco and southern Veracruz.

At the time of the January waterfowl surveys, almost all these whistling ducks were south of Sonora and northern Tamaulipas. Because of their preference for swampy environments where they are well camouflaged, few are seen from the survey plane unless they take wing; thus their total population is much greater than the figures indicate. In 1947, 21,178 were seen, and the population of the areas scouted was estimated as 43,750 on the basis of the percentage of coverage. This estimate was undoubtedly a minimum figure. In 1949 only 1,660 were reported. No doubt many thousands in the marshes at that time escaped detection from the air. Because this duck is not a game species in the United States, it has not received the same careful appraisal on some of the surveys as have the game species.

For a general discussion of the biology of this species, see Bolen et al. (1964), Kortright (1967), Leopold (1959), and Phillips (1922-26, Vol 1). An item of interest regarding their nesting near Altamira, Tamaulipas, 2-23 April 1898, is found in the field notes of E. A. Goldman (USBS files).

> *Dendrocygna autumnalis*, black-bellied tree duck. The specimen sent in was killed just at dusk one evening from the top of a tall oak in the midst of the live oak forest. It contained an egg ready to be laid and it was evident that the nest was somewhere in the vicinity. The male was sitting close to her when I fired and at the report of the gun rose and circled about several times calling loudly for his mate before finally flying off. The nearest pond was about a mile and a half [2.4 km] away.

On the aerial surveys of 1948-65, the estimated numbers of whistling ducks seen on the Pacific Coast averaged more than 32,000. They were mostly the black-bellied species. The distribution, by percentage, averaged as follows: Marismas Nacionales, 50.0; Sesecapa, 15.4; Pabellon, 14.2; Mitla-Coyuca, 6.2; Topolobampo, 4.2; Nexpa, 3.4; Dimas, 3.1; Cuyutlan, 1.8; Caimanero, 1.3; and seven other localities each with less than 1.0.

The number of this species seen in the highlands was negligible.

On the Gulf Coast, observers on the aerial surveys of 1948-65 reported estimates that averaged more than 18,000; some years there were more than 30,000. Most of these birds were black-bellied whistling duck, and because of the incomplete coverage these figures were undoubtedly much below the actual population totals. Their distribution on this coast, by percentage, was Tabasco, 63.4; Alvarado, 19.5; Tampico and Tamiahua, 15.4; Rio Grande, 1.1; and Campeche-Yucatan and Laguna Madre each less than 1.0.

The gullets of three of these ducks from near Escuinapa, Sinaloa, contained the following plant food: bulrush seeds, 30%; waterlily and unidentified vegetation, each 15%; corn, floating heart, and widgeongrass, each 10%; and lesser amounts of two other species. The gullets of two black-bellied whistling ducks obtained a few kilometers south of Acapulco, Guerrero, contained 65% floating heart, sedges and grasses each 10%, and lesser amounts of three other items.

On the Gulf Coast, 13 black-bellied whistling ducks were examined, 8 from the Tampico Delta in Veracruz, 4 from the Papaloapan Delta in Veracruz, and 7 from Celestun in Yucatan. Their gizzard contents included plant food (18 items) 98.1% and animal food (25 items) 1.9%. The foods included unidentified vegetation, 27.2%; spikerush, 26.7%; sedge, 10.6%; lesser amounts of 12 other plant species; snails, 0.6%; insects, bivalves, and fish, each 0.3%; and diving beetles and hemipterans, each 0.2%.

Five specimens were examined from the brackish coastal lagoons near Sisal, Yucatan. Their gullet contents consisted of 98% plant food and 2% animal food including 50% widgeongrass, 25% corn grains, 10% sedge seeds, and aquatic insect larvae.

The mortality from hunting seems to be heaviest on the Pacific Coast, especially in the States of Sinaloa and Guerrero. The palatability and vulnerability of this duck make it a favorite with the market hunters who supply restaurants and tourist hotels. This increases the kill in the localities near such tourist centers as Mazatlan and Acapulco. It is also shot locally in Veracruz, Tabasco, Campeche, and Yucatan, chiefly by native hunters and sportsmen.

Fulvous Whistling Duck (*Dendrocygna bicolor*)

Mexican names: pichichi (Tamaulipas), chiquiote; tziquiotl (Nahuatl) (Friedmann et al. 1950); pitijio (Cuitzeo and Chapala), pato dorado, quapach, pijiji (Cuitzeo and Chapala) (Goldman and Goldman USBS); algarabi and algarabia (Tabasco) (Santamaria 1942); pato silvon (Leopold 1959); gallareto, gallarita, pijia, serrano (Arellano and Rojas 1956).

Friedmann et al. (1950) stated, "Breeds locally from central California east to southeastern Texas and south to Lago de Chapala, Jalisco, and the Valley of Mexico." This long-legged tropical species occurs throughout the year on both the eastern and western coasts of Mexico, principally in brackish and freshwater marshes or in the marshy edges of lagoons. It is also found on some of the interior lakes and streams that afford suitable habitats. During the January 1949 ground survey at Lake Chapala, 225 fulvous whistling ducks were seen among the hyacinth beds of the delta.

Because of their preference for a marshy envi-

ronment, and because of their concealing coloration, many are overlooked by the aerial observers, so that their total population is much greater than the survey figures indicate. In 1947 for example, 21,178 were seen, but the population of the areas covered was estimated at 43,750. In most subsequent years the figures for both species of whistling ducks were combined; consequently, it is not possible to give annual totals for each. Among the two, the fulvous is greatly outnumbered by the black-bellied whistling duck.

The fulvous whistling duck occurs in the United States only in the areas of Louisiana, Texas, and California. We do not know what percentage of these birds winter in Mexico. McCartney (1963) discussed the status, distribution, and biology of this duck, especially in Louisiana, and reviewed information on its migration in coastal areas of that State and Texas.

On the Pacific Coast, they were recorded in Mexico during the January survey from southern Sonora south to Chiapas. The largest numbers found there each winter usually were between Mazatlan and Acapulco. Grinnell and Storer (1928) reported several winter records for Baja California.

The fulvous whistling duck has been recorded as breeding in Tamaulipas and Veracruz, and from Lake Chapala and the Valley of Mexico northward (Cooke 1906). Local observers report it present during the breeding season from Baja California south to Oaxaca on the Pacific Coast.

On the Gulf Coast, fulvous whistling ducks are usually most common in the extensive marshes of the Papaloapan and Tampico deltas, but they are also present in smaller numbers on marshes of the lower Rio San Fernando and Rio Soto la Marina, Tamaulipas. They are seen frequently near the villages of Tamiahua and El Hatillo, Veracruz, and in some of the vast marshes from Tabasco to Yucatan.

Among 782 fulvous whistling ducks banded in the United States through 1962, 45 recoveries were reported, of which 21 (46.7%) were in Mexico. The total recovery rate was 5.8% and that in Mexico was 2.7%, the highest rate for any species of duck in Mexico. All of the latter were banded in California.

Fulvous whistling duck winter chiefly on the tropical coast of northwestern Mexico in localities where shooting is relatively heavy and where their habit of grainfield feeding makes them especially vulnerable. Almost half of the recoveries were reported from Mexico, but it is likely that at least two-thirds or more of those banded were shot in Mexico, and that fewer of the recoveries there were reported than of those shot in the United States. The recoveries were from six States of Mexico, as follows: Guerrero, seven; Nayarit, five; Baja California, four; Jalisco, three; and one each in Michoacan and Sinaloa. Sixteen of the 21 recoveries were from the Pacific Coast and 5 from the highlands. The largest number of recoveries was in February (five), with four in March and three each in November and January. Only one was reported during December.

Very few specimens were available for a study of food habits. One was obtained near Acapulco, Guerrero, on the Pacific Coast. Its gizzard was almost entirely filled with the seeds of floating heart, with only traces of sowbugs, beetles, and other insects. In the highlands one of these ducks from the delta of Lake Chapala, Michoacan, was also examined. Its gizzard contents included 84% sedge seeds and 16% smartweed.

On the Gulf Coast, six fulvous whistling ducks were examined from the Tampico Delta in Tamaulipas and Veracruz. The gizzards contained 90.3% plant food (16 items) and 9.7% animal food (7 items). Among the total foods, 41.6% was muskgrass, 19.3% sedge, with lesser amounts of nine other plant species, 5.9% snails, and 3.8% scuds (Amphipoda). Five more fulvous whistling ducks were obtained from the freshwater Tampico lagoons near Altamira, Tamaulipas. Their gullets contained 100% plant food, including 45% corn grain, 10% each of the seeds of sawgrass and wild millet, and lesser amounts of 10 other species.

The hunting of this duck in Mexico is localized because of its limited distribution and relatively small numbers. Shooting takes place principally near Matamoros and Tampico in Tamaulipas, the Alvarado district of Veracruz, near Acapulco in Guerrero, near Mazatlan, Sinaloa, and at Lake Chapala in Jalisco.

Muscovy Duck (*Cairina moschata*)

Mexican names: pato real; pato perulero, pato pinto, solareno (Tampico), pato almizclado, pato negro, cayetan (Tabasco).

Relatively few persons interested in waterfowl realize that the muscovy occurs as a wild duck in tropical America and that the domesticated forms were derived from it. The wild species ranges from Mexico south to western Peru, eastern Bolivia, and northern Argentina. Phillips (1922–26, 1:66) states that the Spaniards first saw domesticated muscovy ducks in Colombia. He gives a great deal of other general information on the history and biology of this bird, as does Leopold (1959:163–168).

The usual habitat of this big duck in Mexico is along heavily wooded tropical rivers where big trees such as cypress provide both roosting and nesting places above the water. Along the Rio Soto la Marina and its tributaries in Tamaulipas, and rivers of southeastern San Luis Potosi near Valles, where the great trees extend far over the clear water, muscovy ducks were common through 1952. Since the late 1950's, however, they are reported to have decreased greatly. We saw a hen and her brood of 3-week-old ducklings on the

cypress-bordered Rio Corona near Guemes, Tamaulipas, on 28 July 1941.

Because of their preference for wooded rivers and brushy lagoons, relatively few have been observed during the aerial surveys. In January 1947, 73 were seen near Tampico, and in January 1948, 240 were observed there, all of them in the western part of the delta on wooded lagoons or in mimosa-filled marshes. During the winter they are usually seen in small flocks of five or six birds, which may represent family groups.

On the western coast they are resident from Sinaloa south to southern Chiapas, and small numbers have been seen there on aerial surveys. The majority are not visible from the air because of the heavy forest cover they inhabit. On the eastern coast they have been observed as far south as the Minatitlan district, Veracruz, the swamp forests of Tabasco, and the lagoons of Yucatan and Quintana Roo. Our northernmost record in Tamaulipas was of one seen in flight on the Rio San Juan near China on 11 August 1943. On the Gulf Coast they were observed on several occasions near the mouth of the Rio San Fernando during both summer and winter, but they were much more common on the next large river to the south, the Soto la Marina.

Muscovy ducks are more apt to go farther inland along rivers to breed than are the black-bellied whistling ducks. They are especially fond of the big cypresses; on rivers of the Gulf drainage, from the Rio Purificacion south to the Isthmus of Tehuantepec, they have been observed along the wooded streams all of the way inland to the mountains.

We found no records that wild muscovy ducks have been banded.

On the Gulf Coast three of these ducks were examined from the Papaloapan Delta, Veracruz, and one from the Tampico Delta, Veracruz. Their gizzards contained the following foods: cormlike nutlets, 78%; spikerush seeds, 15% and floating heart seeds, 7%. There were only traces of such animal foods as crustaceans, beetles, and snails. Two muscovy ducks were examined from the freshwater Tampico lagoons near Cacalilao, Veracruz. Their gullets contained 95% plant food and 5% animal food including 60% corn, 15% grass seeds, 10% bulrush seeds, 10% entire dwarf spikerush plants, and aquatic insects.

The hunting of muscovy ducks was heaviest near Tampico, Tamaulipas, and from there westward to Valles and southward to Tuxpan, Veracruz, during the years of the greatest activity in oil production. Since the departure of many foreigners who were employed in the oil industry, however, hunting pressure in this area on this species, and on other waterfowl, has declined sharply. Muscovy ducks probably are now shot mostly in Tamaulipas, Veracruz, Tabasco, Chiapas, Oaxaca, and Guerrero by local residents.

Ernest L. Stevens of Mexico City, who hunted waterfowl in many parts of the Republic, was familiar with the muscovy duck on the Rio Naranjo and other rivers near Valles and Micos. In 1949 he told us that hundreds of these ducks had been there in earlier years, but that because of the intensive clearing of woodlands along the streams during the preceding decade and year-round shooting, few muscovy ducks were left.

The large size of this bird makes it more desirable than the smaller ducks. Also, the opening of more farmlands along the rivers has destroyed more woodland habitat and the birds were thus more vulnerable to shooting. They have decreased greatly in number and have disappeared from many localities where they were formerly common.

Muscovy ducks were recorded in Sinaloa, Nayarit, Jalisco, Colima, Michoacan, Guerrero, Oaxaca, Chiapas, Nuevo Leon, Tamaulipas, San Luis Potosi, Veracruz, Tabasco, Campeche, Yucatan, and Quintana Roo.

Mallard (*Anas platyrhynchos platyrhynchos*)

Mexican names: pato real; pato de collar, zolcanauhtli (Nahuatl) (Friedmann et al. 1950); el colvert, pato galan, concanauhtle (Nahuatl) (Lopez and Lopez 1911); pato comun (Santamaria 1942).

Many hunters in the United States assume that a large percentage of the mallard population winters in Mexico and that many are killed there, but this is not true. Formerly this species was reported to be a more frequent winter visitor as far south as Michoacan and the Valley of Mexico in the highlands, southern Sinaloa on the Pacific Coast, and central Veracruz on the Gulf Coast. In recent years, mallards have been rare south of about latitude 26°N (Fig. 24).

Early in this century, flocks were seen and specimens were collected in many localities where they do not occur now. Beebe (1905) saw mallards among the ducks of the Chapala marshes in Jalisco and Michoacan, others along the railroad between Guadalajara and Tuxpan, and in the Barranca Beltran near the Volcan de Colima. Several other writers mentioned their occurrence in the southern highlands.

Although the mallard apparently was a regular winter visitor southward to the Valley of Mexico until perhaps late in the past century, it is rare there now. Currently it is common only in a few localities on the northwestern coast and in the northern plateau States, but only in small numbers. It is doubtful that all of the grainfields, marshes, lakes, and rivers of northern Mexico, from Baja California and Sonora across to Tamaulipas, winter more than 10,000 mallards. This is only a tiny fraction of 1% of the total North American

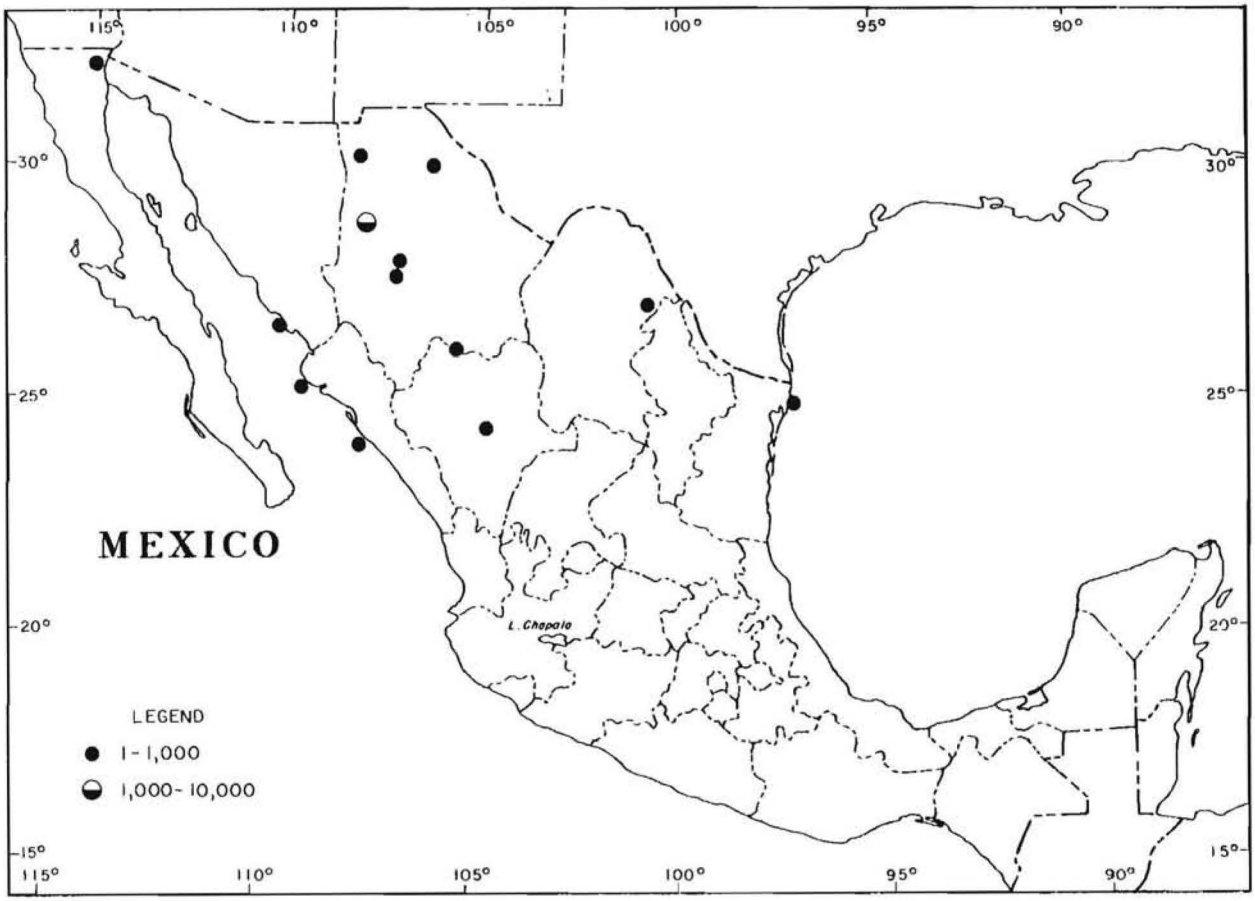

Fig. 24. Average numbers of mallard observed during January aerial surveys, 1948–62.

mallard population.

What has caused this reduction in the number and distribution of mallards wintering in Mexico? Probably the principal reason is that the mallard changed its feeding habits and became more dependent on cultivated grainfields than on native foods. It is probable also that the wider distribution of grainfields in the midwestern and western United States, and especially the great increase in the number of reservoirs and man-made lakes in those regions, accommodate almost all of the mallards on those migration routes which might otherwise migrate on to Mexico. Now they do not need to go farther south to find a suitable winter environment. Unlike many pintails that fly to Latin America for the winter, even though they have an adequate habitat in the southern United States, the hardy mallards seem to prefer to remain as far north as they can find winter quarters and food.

Another important change that has helped to cause the shortstopping of mallards north of the border is the decline of the *bolson* lakes in Chihuahua, Coahuila, and other States of the plateau. Lower water levels in general and the drying of some major lakes from drought, water diversion, and drainage for agriculture, have made these localities less attractive to waterfowl.

Not all parts of Mexico have experienced the general decline of mallards. In Sonora and Sinaloa, large areas that formerly were deserts or thorn forests now produce wheat, rice, and other grains by irrigation. With the decrease of wintering grounds in California, some mallards now go farther south to the agricultural areas in the Rio Colorado Delta, Rio Yaqui Delta near Ciudad Obregon, Sonora, and to other areas in Sinaloa. But the total population there is usually not more than a few thousand birds.

Observers on the annual aerial surveys see only a part of the mallards present, to judge from ground observations, hunters' reports, and band recoveries. At Ciudad Obregon in early January 1950, we checked 29 mallards in hunters' bags at one club; hunters saw flocks of hundreds of them at a small lake and in fields near Tobari Bay. Yet the aerial survey that month

noted fewer than 100 in that sector. The reason for this discrepancy is that grain-eating ducks, like the mallard, may be widely scattered over the fields. The aerial survey is chiefly of water areas; therefore, the coverage and time are too limited to allow an adequate appraisal of birds in the croplands. Also, the relatively few mallards tend to be lost among the much larger flocks of pintails and other species.

During most of the years from 1947 through 1965, fewer than 1,000 mallards were seen annually on the Pacific Coast of Mexico. During some years none were recorded, and the largest total was 3,000 in 1959. Each year, most of them were seen in the irrigated agricultural districts of Baja California, Sonora, and northern Sinaloa, and especially near Ciudad Obregon, Sonora. In the Colorado River Delta, including the Mexican part of the Imperial Valley, there may have been several thousands present, yet usually fewer than 100 were seen annually on the aerial survey made there by the California Department of Fish and Game.

In the highlands, some flocks winter in Chihuahua and Coahuila, chiefly in agricultural areas in the vicinity of lakes, reservoirs, and rivers. Most of the mallards seen on the January aerial surveys are in Chihuahua. Numbers seen have averaged about 1,000 and ranged from less than 1,000 to more than 11,000. The largest flocks were noted at and near Laguna Babicora, where 7,150 were recorded in 1961. Small groups wintered occasionally at Casas Grandes, Patos, Bustillos, Mexicanos, Toronto, and other lagunas in Chihuahua, at Don Martin, Coahuila, and in some years a few were at Santiaguillo, Durango. The most southerly record in recent years during aerial surveys was of 75 at Lake Cuitzeo, Guanajuato, in 1954. In the highlands, as on the coastal plains, some flocks are missed on these surveys.

In 1926 E. A. Goldman wrote in his field notes from Chihuahua (USBS files):

> Several hundred mallards were seen on small ponds surrounded by rather high, dry grass, along the borders of Bustillos Lake, west of Chihuahua City, March 22 (1926). As only a very small part of the general area about Bustillos Lake came under observation, it was evident that thousands of these ducks in the aggregate were present about the lake at the time of my visit.

More recently many of these lakes were very low or dry, marsh vegetation was gone, and habitat conditions were poorer than they were in the 1920's and earlier; however, the grainfields continued to provide food for the smaller numbers of mallards that came there.

This species is now rare in the Valley of Mexico and adjacent States. Sr. Julio Estrada of Mexico City, a veteran hunter, told us in 1949 that in 20 years of shooting at La Curva, near Lake Texcoco, he had seen only three mallards. He said that several had been observed at Lake Tultengo and Hacienda Zacatepec. When Starker Leopold was hunting ducks on Lake Tultengo near Apam, Hidalgo, he saw two drake mallards with a group of Mexican ducks (Leopold 1959:56). All the local hunters with whom we talked agreed with Estrada's statement regarding the rarity of this duck that far south in recent years.

On 16 January 1935 E. A. and L. J. Goldman wrote (USBS files): "A few mallards observed at Presa Los Angeles—only ones observed in the highlands." This locality is southeast of Guadalajara, near Penjamo, Guanajuato.

In northeastern Mexico this species was so rare until about 1959 that few if any were seen on the aerial surveys, and it is still very uncommon there. During 1937–47 we saw only two of them in the Rio Grande Delta.

Until the late 1940's the Tampico lagoons were one of the finest wintering grounds on the continent, and had very large numbers of ducks of many species. Yet E. S. Hudson, a resident of Tampico for more than 40 years and a very experienced duck hunter, told E. A. Goldman in 1926 that he had never seen a mallard in that locality (USBS files); in 1938 and 1952 he told us the same. During our field surveys in the Tampico district, we met only one man who had shot a mallard there. He was an old-time market hunter, and to prove his story he had the curly upper tail coverts of the mallard drake fastened to his hunting cap. In all of our field work there, including several aerial surveys, we saw only two mallards, both drakes, in February 1947 in a wet meadow south of Laguna Pueblo Viejo. Davis (1952) reported a flock of nine near Xilitla, south of Valles, San Luis Potosi.

Mallards have apparently increased very slightly in Tamaulipas during the past few years, probably because of the greater acreage of grain sorghum now grown between Matamoros and San Fernando. Most of these farms formerly produced cotton. There were some reports of mallards in several localities near Matamoros during the 1940's and early 1950's, but those we investigated proved to be mottled ducks. Some of the notes on mallards included in the recent January surveys also should have specified mottled ducks. Most or all of the 490 mallards reported for the 1949 survey, for example, were mottled ducks. Mallards are very partial to the extensive rice and other grain-raising areas of the Texas Coast north of Corpus Christi and, because there is abundant food available, very few journey any farther southward.

Those few mallards definitely identified on aerial surveys in Tamaulipas have been in the Rio Grande Delta, except for several on small lakes west of Laguna Madre and on lagoons near Tampico. The southernmost record on the Gulf Coast is of a banded mallard shot in Tabasco, which is the only known record of its occurrence south of Veracruz.

Until July 1962 there were 1,013,985 mallards

banded and 165,262 recoveries reported. An accurate summary of the recoveries in Mexico has not been prepared. We estimated that there have been fewer than 100 recoveries from 15 States of Mexico and of these we have 51 of the recovery records on hand for 1948–61, a sufficient sample to indicate the principal States of banding and recovery (A. S. Hawkins *in* Aldrich et al. 1949).

Among these 51 mallards, 8 were banded in New Mexico, 8 in Colorado, 8 in Saskatchewan, 5 in Wyoming, 4 in Arizona, 3 in Alberta, 3 in Nevada, and smaller numbers in 7 other States including Indiana (1) and New York (1). Most of the recoveries were from Chihuahua (21), but there were 7 in Sonora, 5 in Baja California, 3 in Durango, 3 in Jalisco, 2 in Michoacan, and 1 each in Nuevo Leon, San Luis Potosi, Tabasco, Coahuila, Zacatecas, Aguascalientes, Guanajuato, Mexico, and Guerrero, and one without the State designated. Among the 51, 22 were direct recoveries (recoveries occurring relatively soon after banding and before a change in direction of movement had occurred due to migration). The mallard banded in Indiana was shot near Mexico City 7 years later. The bird from New York was an adult female trapped at the Montezuma National Wildlife Refuge in Seneca County, New York, in September 1954 and shot in 1957 a few kilometers northeast of Lake Chapala. This is the only record of a recovery in Mexico of a mallard banded in the Atlantic Flyway.

A mallard shot in Guerrero was banded on Bowdoin National Wildlife Refuge in Malta, Montana, on 15 August 1950. A mallard banded in Maricopa County, Arizona, 28 December 1950, was shot at Falupa, Jalpa de Mendez, 19 January 1953. This locality is on a river in northwestern Tabasco and within a few kilometers of the Gulf of Mexico. It is a new species record for Tabasco.

On the Pacific Coast 19 mallards from near Ciudad Obregon, Sonora, were examined to determine the foods eaten. Their gizzard contents included 98.5% plant food (16 items), and 1.5% animal food (6 items). The food items included 51.3% rice, 9.9% pepperwort, 9.0% common spikerush, 0.9% beetles, 0.6% snails and bivalves, and many trace items.

Mallard shooting is localized, and occurs chiefly in the Colorado River Delta of Baja California and in the rice-growing districts of Sonora and Sinaloa. In the interior highlands, this duck is shot chiefly at lakes and fields of the agricultural localities west of Chihuahua. Elsewhere the bagging of a mallard is strictly an accident. In many of these other places the mallard is such a rarity that it is sometimes reported to the Bird Banding Laboratory as "brown brant," "black brant," "dove," or "sea gull," but in most instances it is reported as "duck." Among Mexican hunters who have shot and reported a mallard, only one identified the species correctly, which indicates how little it is known there.

Mallards were recorded in Baja California, Sonora, Sinaloa, Jalisco, Colima, Guerrero, Chihuahua, Coahuila, Durango, Aguascalientes, Zacatecas, Michoacan, Guanajuato, Mexico, Hidalgo, Tamaulipas, Nuevo Leon, Veracruz, and Tabasco. There are a few breeding records for mallards in northern Baja California in earlier years (Grinnell and Storer 1928), but no information is available regarding its present status as a nester.

Hawaiian Duck (*Anas wyvilliana*)

Mexican name: too rare to be known locally.

There is one record from Mazatlan, Sinaloa, of a straggler taken there before 1859. The duck (USNM 12789) is the type specimen of *Anas aberti* Ridgway (Ridgway 1878:250).

Mexican Duck (*Anas platyrhynchos diazi*)

Mexican names: criollo (Valley of Mexico); pato triguero (highlands of central Mexico); pato prieto; pato chaparro (Valley of Mexico); pato triguero de Diaz (Friedmann et al. 1950); el cenizo, pato silvestre (Guanajuato) (Lopez and Lopez 1911); pato real; pato garbancero (L. Cuitzeo) (Goldman and Goldman USBS); malago (L. Chapala) (Goldman and Goldman USBS).

The Mexican duck, which is a darker relative of the mallard, is a locally common, year-round resident in the highlands of Mexico, especially in the central lakes district, and is found as far south as the States of Mexico, Morelos, and Puebla. Its principal range is in the Bajio, an extensive, shallow basin now intensively farmed, which lies at the southern end of the Central Plateau chiefly in the States of Guanajuato, Jalisco, and Queretaro, and in the Transverse Volcanic Region which adjoins the plateau on the south (Fig. 25). Lake Chapala and the Rio Lerma drainage are mostly in this latter region. This duck was not numerous during any year in any locality scouted, except in the delta of Lake Chapala. It is also fairly common in marshes along the Rio Lerma, from above Lake Chapala to the river's headwaters near Toluca. Formerly the Mexican duck was reported to be common in the Valley of Mexico, but with the drainage of lakes and much shooting, relatively few of these birds remain. Some were observed as far north as Durango and northern Chihuahua.

The largest numbers observed in any one locality on the January survey in recent years were 6,000 at Laguna Oriental, Puebla, in 1958; 3,625 near Irapuato, Guanajuato, in 1960; and 3,620 in the Lake Chapala Delta marshes in 1964. Totals in recent years for all highland localities covered were from 780 in 1951 to 10,322 in 1958, and an average of 4,947 for the 14

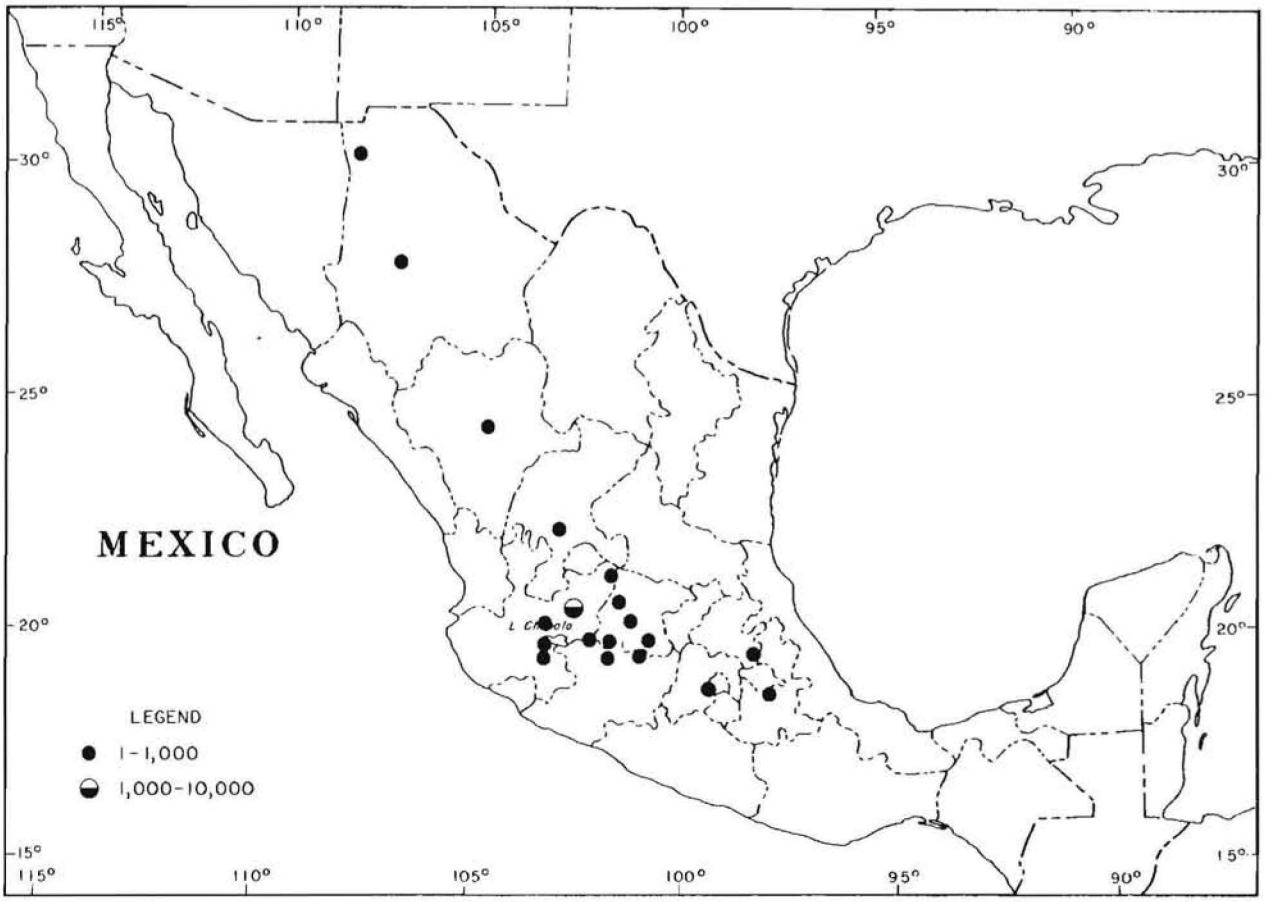

Fig. 25. Average numbers of Mexican duck observed during January aerial surveys, 1948-62.

surveys made from 1951 to 1965.

The percentage distribution of these ducks in the localities covered by the aerial surveys of the highlands from 1951 to 1965 was Chapala, 22.0; Irapuato, 16.2; Yuriria, 12.0; Zacapu, 10.7; Babicora, 6.6; Atotonilco, 5.4; Cuitzeo, 5.2; Oriental, 3.5; Apam, 2.6; Patzcuaro, 2.4; Acambaro, 2.3; Sayula, 2.2; Lagos de Moreno, 2.1; San Isidro, 1.5; Leon, 1.2; Santiaguillo, 1.1; Upper Lerma Valley, 1.0; and three other localities each with less than 1.0.

The small population in Chihuahua is considered to be a separate geographic race, the New Mexican Duck, *Anas diazi novimexicana* (American Ornithologists Union 1957:72), but other taxonomists do not believe these northern birds are distinct. Johnsgard (1961:37) wrote, "I am in firm agreement with Delacour (1956) that . . . *novimexicana* is inadmissible and should be synonymized with *diazi*."

One of the earliest field reports of this duck was that of E. A. Goldman in 1926 (USBS files):

> Mexican Duck . . . According to C. G. Ray, a well-informed local hunter, what he refers to as black mallards, presumably of this species, may be found in the valley of Mexico, but are very rare. None of these ducks were observed by me during my stay in the valley from January 16 to February 17, 1926. On February 18, flocks of 20 to 40, and a number of single pairs, of these ducks were seen in the great tule marsh near Lerma, at 8,200 feet [2,501 m] altitude on the bottom of the valley of Toluca, State of Mexico. These ducks appeared to favor very small, open water areas, some of which were only a few feet across, in the midst of the tules, while other ducks in the same locality preferred larger patches of open water. None of the birds were shot, but it seemed evident that many of them were already mated in preparation for breeding. The local name is "pato real." During a visit in 1904 these ducks were found nesting, and they are said by local hunters to remain throughout the year.
>
> These ducks were found in various places in the dyked-off area near the eastern end of Lake Chapala, Jalisco, February 23 to 26. They were commonly found sitting on the mud borders or in shallow water in pairs or small groups, probably including several mated pairs. While they might be near other kinds of ducks which were often found intermixed, the present species was not associated with them. They are said to be permanent residents in the marshy lands about Lake Chapala.

Fig. 26. Mexican duck, nest and eggs—The nest and eggs of a Mexican duck in a bulrush marsh of the upper valley of the Rio Lerma near Toluca, Mexico, 7 July 1904. In these earlier years, before extensive drainage and before anyone thought of diverting Lerma water through the mountains to Mexico City, this upper valley had many small lagoons, extensive deep marshes of bulrushes and cattails, many Mexican ducks, and other wintering waterfowl from the United States and Canada. Few lagoons, little marsh, and only small numbers of Mexican ducks and other waterfowl remain. This photograph was taken with an old-fashioned plate camera, and is typical of the valuable series of several thousand excellent photographs made in Mexico by E. W. Nelson and E. A. Goldman during their studies there (see Goldman 1951). (Photo by E. A. Goldman)

Hunters in Chihuahua told us in 1950 that most of the Mexican ducks there were in marshes and other cover along streams. They said that stretches of the Rio Conchos and its tributaries below Meoqui had more of this species than other parts of the State. The hunters also mentioned the lagoons of Babicora and Bustillos as a favorite habitat of this duck.

To our knowledge no Mexican ducks south of the border have been banded, and there have been no recoveries in Mexico of any banded in New Mexico.

The hunting of this species is chiefly in the highlands, localized mostly in the Rio Lerma Valley from near Toluca to Lake Chapala, and in the Bajio (Fig. 26). It is also hunted at small lakes northward to Durango and Chihuahua. During winter months duck hunting pressure in the highlands is mostly on migratory species, but after they have gone north the Mexican ducks in the localities accessible to hunters receive most of the hunting pressure for several additional months. It would be highly desirable to give further protection to these and other resident ducks during the breeding season.

The Mexican duck does not occur in the United States, except for a few birds in New Mexico, and consequently it is of little interest to most North American hunters. Leopold (1959:171-174) gives additional information on the biology, distribution, and hunting of this species. The most detailed information on its life history is in Lindsey (1946:483-492).

The Mexican duck has been recorded in the interior States of Nayarit, Jalisco, Michoacan, Chihuahua, Durango, Zacatecas, Aguascalientes, Guanajuato, Mexico, Distrito Federal, Morelos, San Luis Potosi, Queretaro, Hidalgo, Tlaxcala, and Puebla.

Mottled Duck (*Anas fulvigula maculosa*)

Mexican names: pato de verano (Tamaulipas), pato maizero, pato chaparro, pato negro, pato avado (Matamoros, Tamaulipas) (Goldman and Goldman USBS), pato tejano (Leopold 1959).

This relative of the mallard is found chiefly in the coastal marshes of Tamaulipas (Fig. 27). It is observed principally in the lagoons and marshes of the Rio Grande Delta and west of Tampico, but it occurs in winter at least as far south as the Papaloapan Delta of southern Veracruz and the marshes of Tabasco.

The mottled duck, like the muscovy and the two whistling ducks, did not receive adequate coverage on the January surveys. It is especially attracted to small marshy ponds and the marshes of winding estuaries and *resacas*. The surveys included principally the larger bodies of water where the majority of the waterfowl are within view of the plane, and although this provides information on most of the other species, very few mottled ducks use such habitats.

In the parts of Tamaulipas south of the Rio Grande Delta, more mottled ducks are seen on the old *resacas* and on the smallest ponds and marshes west of Laguna Madre than anywhere else north of Tampico. In the Tampico district, several hundred are observed each season during ground surveys. Most of them are in deep marshes that have small pools of open water.

Another favorite environment is in small lagoons and pools overgrown with brush, chiefly species of mimosa and acacia. These habitats are most numerous on the western edge of the Tampico Deltas.

Ground studies in Tamaulipas and northern Veracruz during the winter indicated that several thousand or more mottled ducks were present. On the 1948 survey 2,013 were seen on the Gulf coast: 1,243 were

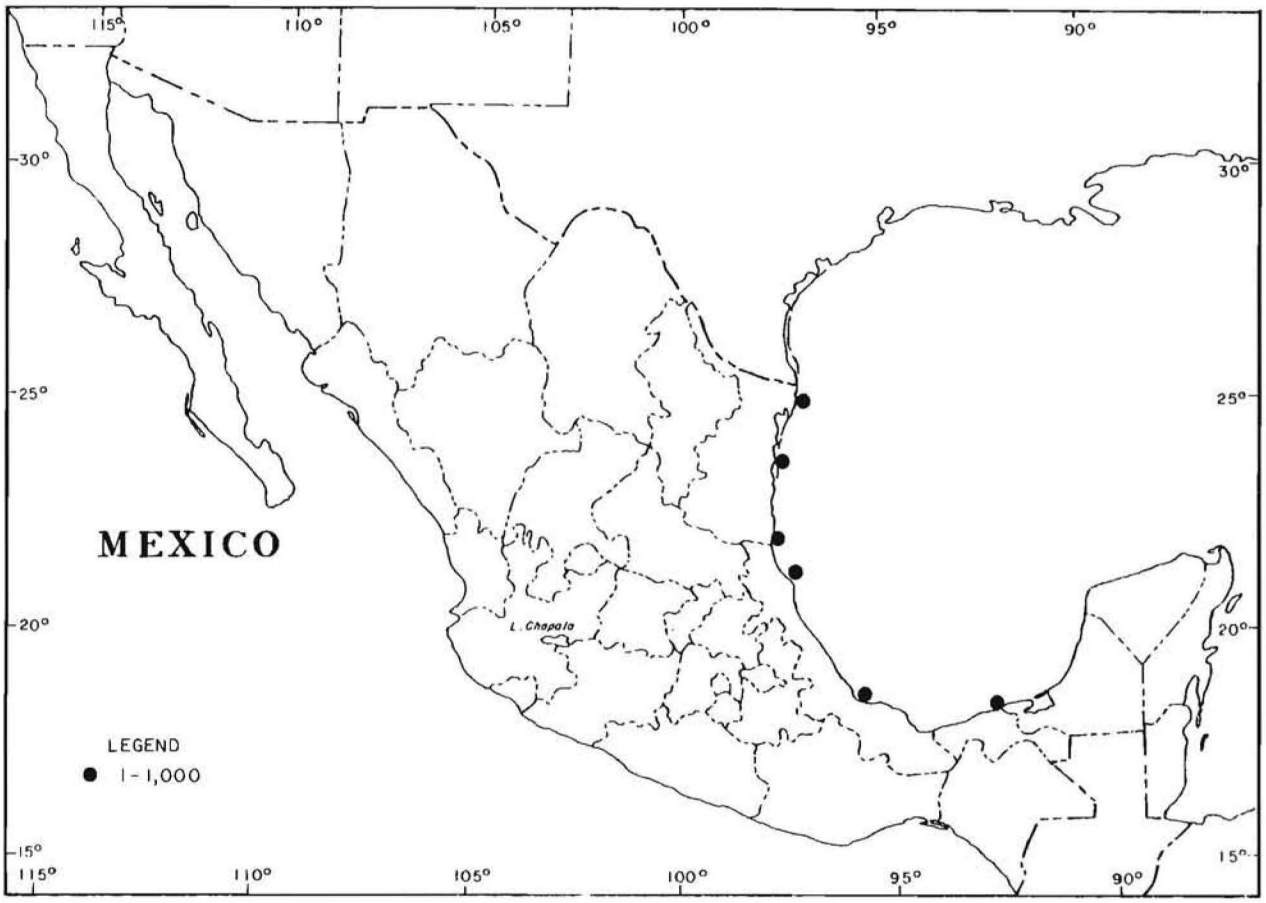

Fig. 27. Average numbers of mottled duck observed during January aerial surveys, 1948–62.

recorded in the Tampico sector, 387 near Laguna Madre, 210 in the Rio Grande Delta, and 173 in marshes of Laguna Tamiahua. They were also observed near Ebano in San Luis Potosi, which is in the upper Tampico marshes. The January 1951 survey recorded 58 in Tabasco and larger numbers in Tamaulipas and Veracruz.

The status of this duck in Mexico was so little known that it was not included in Friedmann et al. (1950). Consequently the following quotation about its occurrence is included from the paper by Saunders (1953):

> The Mottled Duck has been shot by many hunters in coastal marshes and ponds on the Gulf coast near Brownsville, Texas. It is equally common across the Rio Grande in similar marshes and ponds of Tamaulipas. I first observed it in Tamaulipas in 1937, east and southeast of Matamoros on the Arroyo Pita and Arroyo Gomeño.
>
> On a reconnaissance trip from Matamoros southward along the coast to Tamiahua, Veracruz, on February 2 to 4, 1938, I recorded 245. Most were seen in the fresh-water marshes west of Tampico, Tamaulipas.
>
> Since then I have observed the Mottled Duck regularly in that part of Mexico, both during the winter and in the breeding season. No nests were found, but adults with broods of young were recorded occasionally at coastal ponds east of Matamoros from April through June. On a trip to the Rio San Fernando Delta, Tamaulipas, July 24 to 26, 1941, I observed two family groups of adults and month-old juveniles. Three other broods of young were seen at Altamira, near Tampico, on July 30, 1941. Localities in Tamaulipas where I have observed this duck during the breeding season are: Matamoros, San Juan (near Laguna San Juan), Tomates, Mogote Largo, Loma Chica, Arroyo de la Pita, Arroyo Gomeño, Anacahuites, a dozen others east and southeast of Matamoros, the vicinity of Barra Jesus Maria, the delta of the Rio San Fernando, Rio Tordo, Rio Tigre or Cachimbas, the Laguna de San Andres, and near Tampico.
>
> No large numbers have been observed together. To date, the largest flock recorded was one of 16 observed at a fresh-water pond near Anacahuites, a ranch near the north end of Laguna Madre. During the aerial reconnaissance made each January as a part of the Fish and Wildlife Service (Bureau of Sport Fisheries and Wildlife) water-fowl inventory, several hundred mottled ducks were seen in the localities listed.
>
> In the state of Veracruz I have recorded this duck in the winter at marshes near the village of Tamiahua, near Tuxpan, near the city of Veracruz, and in several

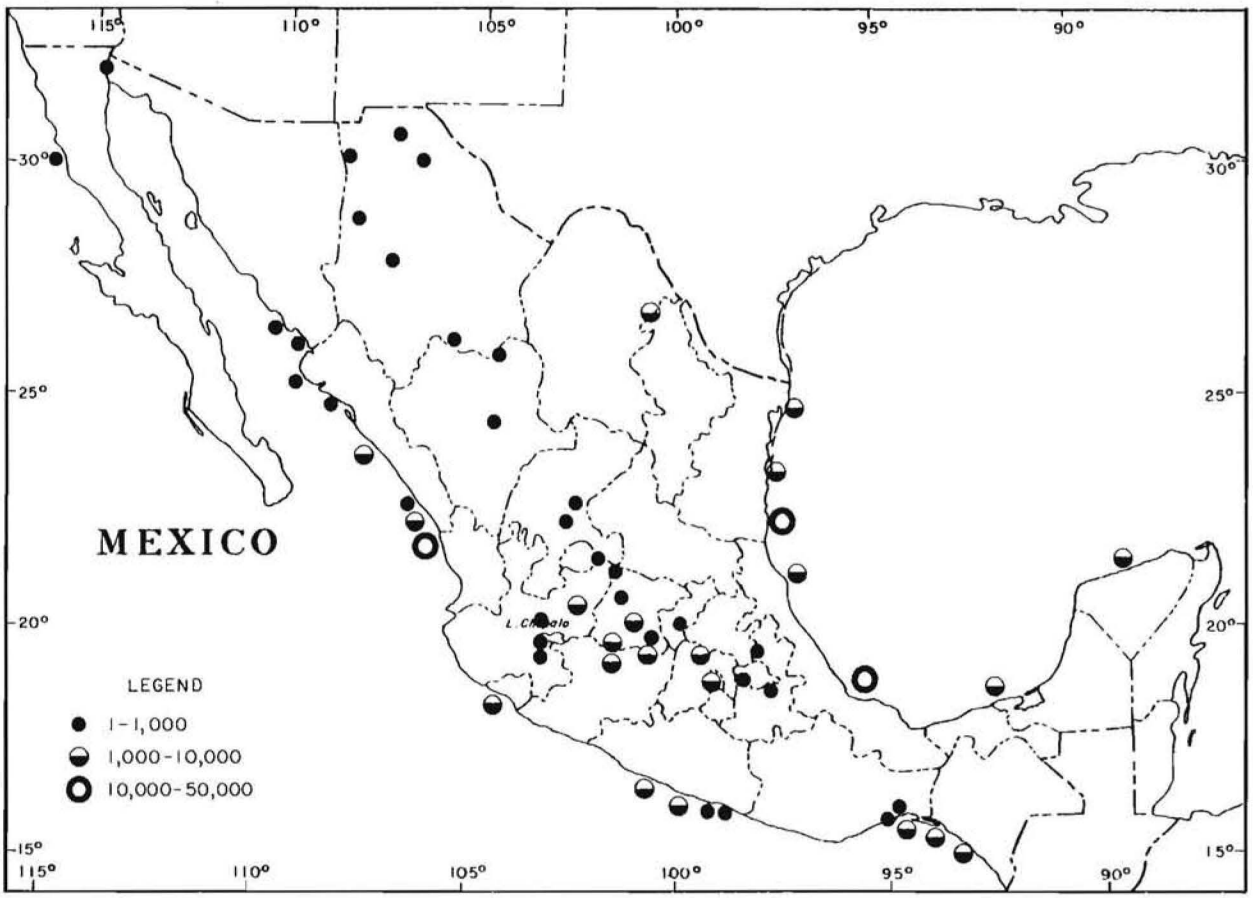

Fig. 28. Average numbers of gadwall observed during January aerial surveys, 1948–62.

places in the vast delta of the Rio Papaloapan, south of Alvarado.

There is a specimen (No. 419794) in the Fish and Wildlife Service collection taken by me on December 2, 1949, near Tampico, Tamaulipas.

The percentage distribution, as determined by aerial surveys through 1965, was Tampico, 31.1; Rio Grande, 25.6; Tamiahua, 25.4; Laguna Madre, 17.4; and Alvarado and Tabasco with less than 1.0.

Through June 1962, among the 370 mottled ducks banded in Texas there were 63 recoveries; however, only 1 (1.7%) was reported from Mexico, from northern Tamaulipas. Among 517 banded in Louisiana, none of the recoveries was from Mexico, although some of these birds probably wintered in Tamaulipas.

The gizzards of three mottled ducks shot in the Tampico Delta included 62% unidentified plant material, 8% pondweed seeds, 20% insect larvae, and less than 1% small snails. The gullets of eight of these ducks shot in the Rio Grande Delta, Tamaulipas, contained 12% of the seeds of wild millet, 10% of the entire plants of dwarf spikerush, 23% unidentified vegetation, 10% of smaller amounts of other plant items, and 45% of small fishes 2.5 to 5 cm long.

The hunting of this duck is chiefly localized in Tamaulipas near Matamoros, Laguna Madre, and Tampico. Few are killed because they are often in marshes relatively inaccessible to hunters.

Gadwall (*Anas strepera*)

Mexican names: pato pinto and pato real; pato cabezon (Tampico); pato silvestre (Guanajuato) (Lopez and Lopez 1911); colcanauautli (Nahuatl) (Santamaria 1942); pato pardo de grupo (Alvarado 1916).

The gadwall is widely distributed in Mexico and has been recorded in every State except Quintana Roo (Fig. 28). On the Pacific Coast its largest numbers are usually found in the area from San Blas north to Mazatlan, and between Mazatlan and Los Mochis. In the interior highlands this species is common and widely distributed as far south as the Valley of Mexico. It is especially common at Lake Patzcuaro, Lake Cuitzeo, and on some of the small, shallow reservoirs.

On the Gulf Coast it is usually most numerous in the Tampico lagoons. One of its principal wintering

grounds was the Laguna Tamiahua, but by 1948 fewer were to be seen there, and the larger flocks had moved to the nearby Tampico lagoons and marshes, or elsewhere, because of the decline of widgeongrass and naiad in the Tamiahua Lagoon. Other Gulf sectors in which this species is frequently found are the Tabasco marshes and the lagoons south of Alvarado, in the vast Papaloapan Delta, Veracruz.

On the January surveys from 1948 to 1962, this species had an average rank of sixth in each of the three zones of Mexico. The estimated numbers of gadwalls seen on these surveys averaged about 138,000; 58,000 were along the Pacific Coast, 56,000 on the Gulf coastal plain, and 24,000 in the interior. On the Pacific Coast the peak count was in 1948 when more than 160,000 were observed. Since then there were lesser peaks in 1950 and 1959. The lowest figures were in 1951 and 1961, when the numbers were less than 25,000.

Although this species is widely distributed on the Pacific Coast, the one area that is the most attractive is the Marismas Nacionales (Sinaloa-Nayarit) where the annual average is about 24,500. Other localities have fewer birds. Those of secondary importance include Laguna Caimanero and Ensenada de Pabellon, Sinaloa; Mar Muerto and Laguna de la Joya, Chiapas; and Laguna Cuyutlan, Colima. The annual average for 1948-63 was about 58,000. The actual fluctuations in wintering populations probably were less extreme than the annual counts indicate. Since the Marismas Nacionales is such a vast area, it is likely that in years when the gadwalls were widely dispersed many may have been missed by the surveys.

This species is widely distributed through the interior highlands, but its numbers are fewer here than in the coastal waters (G. H. Jensen *in* Aldrich et al. 1949). The largest concentrations recorded on the January aerial surveys were at Lakes Chapala and Patzcuaro. On Lake Chapala populations ranged from a few hundred to more than 13,000, and on Lake Patzcuaro from a few hundred to about 9,000. Ground surveys in 1950 and 1951 revealed much larger concentrations at both lakes. Other localities that are heavily utilized by gadwall are Zacapu, Cuitzeo, and the Upper Lerma Valley. Totals noted on the aerial surveys through the highlands ranged from more than 41,000 in 1952 to 3,000 in 1962. Total numbers seen have been less than 50,000; in some years they have been below 25,000.

Gadwall were far more numerous on the east coast in the 1940's than since then. At the times of the aerial surveys from 1938 through 1948 the greatest numbers seen were in the Tampico, Tamiahua, and Alvarado districts. As recently as January 1948, the estimate for the east coast totaled about 286,000 birds. Since then the number has ranged from 67,000 in 1950 down to 13,000 in 1958. The figures indicate a decided downward trend in this species on the eastern coast. Part of this probably is due to the decline, and in some places the disappearance, of naiad from favorite feeding grounds because of an increased brackishness or salinity of the water.

Two of the principal districts that continue to offer attractive feeding conditions to gadwall are the Alvarado and the Campeche-Yucatan lagoons. As recently as 1956 36,000 were seen at Alvarado, and in 1961, 35,000 were noted in Yucatan.

The percentages of the average population of gadwall along the Pacific Coast from 1951 to 1965 were as follows: Marismas Nacionales, 55.3; Pabellon and Caimanero each 8.7; Joya, 5.5; Cuyutlan, 5.3; Mitla-Coyuca, 3.9; Dimas, 3.2; Sesecapa, 3.1; Inferior, 1.9; Topolobampo, 1.3; Nexpa, 1.1; Obregon, 1.0; and nine localities with less than 1.0.

The average percentages in the interior highlands were Patzcuaro, 16.0; Chapala, 12.6; Upper Lerma, 11.8; Cuitzeo, 7.3; Texcoco, 7.1; Zacapu, 6.9; Huapango, 6.5; Oriental, 5.6; Yuriria, 4.4; Santiaguillo, 3.5; Sayula, 3.1; Babicora, 2.6; Palomas, 2.5; Acambaro, 2.4; Toronto, 1.9; Zapotlan, 1.4; Irapuato, 1.0; and 11 other localities each with less than 1.0. The average percentage distribution for the Gulf Coast was Tampico, 37.8; Tamiahua, 30.2; Tabasco, 14.8; Rio Grande, 9.3; Alvarado, 4.1; and Laguna Madre, 3.6.

A total of 19,546 gadwalls were banded through May 1962, and 3,154 recoveries were reported including 136 (4.3%) in Mexico. The overall recovery rate was 16.1%, but it was only 0.7% in Mexico. There were recoveries from 23 States in Mexico; 71 were from the interior zone, 34 from the Pacific zone, and 31 from the Gulf zone.

The largest number of these recoveries (28) was banded in Alberta, the second largest in Saskatchewan (26), third in Utah (15), and fourth in Oregon (13). The percentage recovery in Mexico of gadwalls banded in Alberta was 8.8 and of those banded in Saskatchewan, 7.2. The largest number of recoveries occurred in December and January; 32 were reported for each of these months. There were also 12 recovered in November, 19 in February, and 17 in March.

Nine gadwalls were examined on the Pacific Coast, eight of them from near Ciudad Obregon, Sonora, and one from Mazatlan, Sinaloa. Their gizzard contents included 100% plant food (nine items) and a trace of animal food (one item). Among the plant foods 99.1% was water hyssop, sedge, spikerush, ragweed, grass, lippia, and softstem bulrush (*Scirpus validus*), all too finely ground to permit further determination of ratios, 0.9% of *Carex*, and traces of beetles.

In the highlands six gadwalls were obtained in the Lerma Valley near Toluca, Mexico. Their gizzard contents were 100% plant food (five items), including 35.7% southern bulrush, 64.3% unidentified vege-

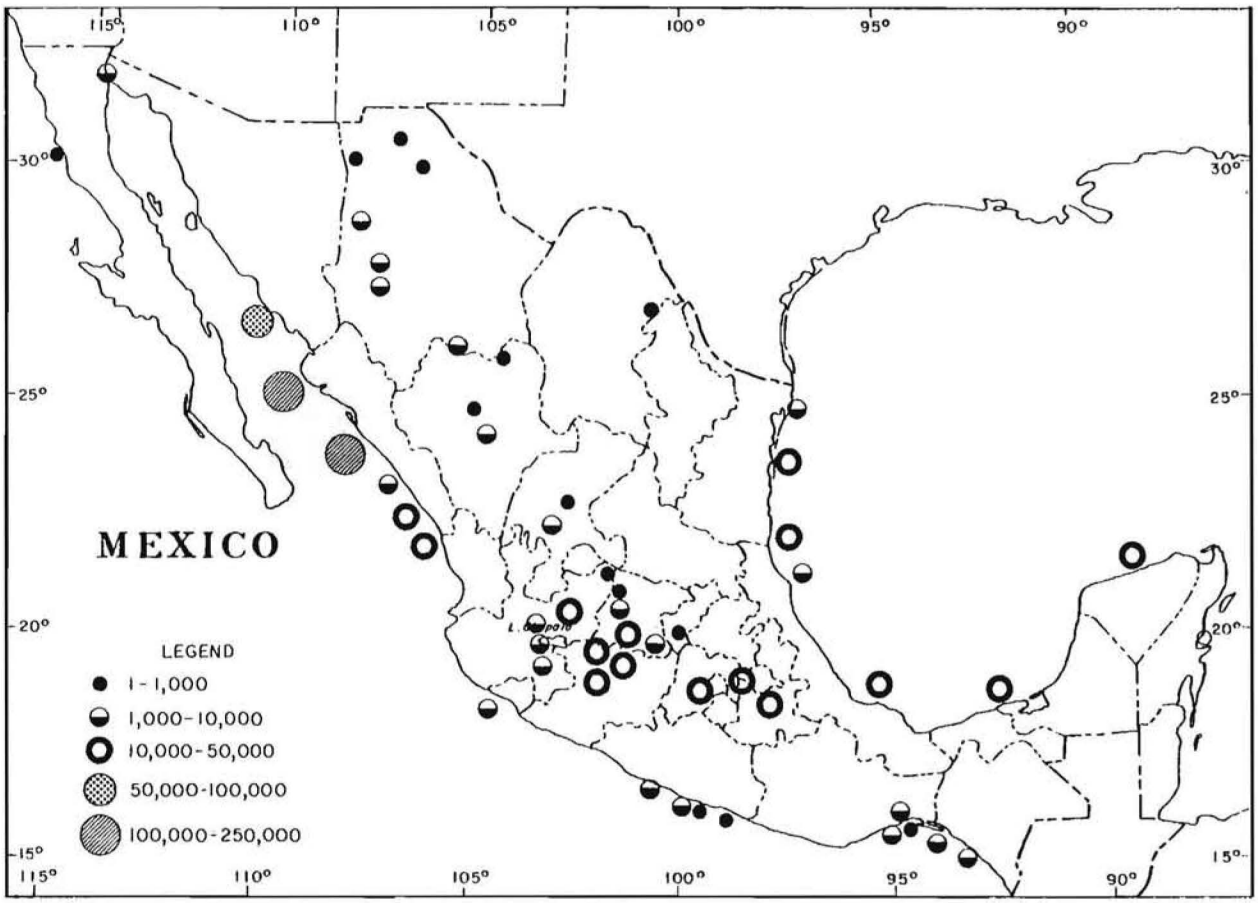

Fig. 29. Average numbers of pintail observed during January aerial surveys, 1948–62.

tation, and traces of insects.

On the Gulf Coast 29 gadwalls were examined from the Tampico Delta in Tamaulipas and Veracruz. Their gizzard contents included 84.1% plant food (28 items) and 15.9% animal food (6 items). Southern naiad made up 23% and spiny naiad 11.9% of the plant foods, along with small amounts of other plants, 15.7% snails, and 0.1% dragonflies and damselflies. The gullet contents of 13 gadwalls from brackish coastal waters, the lagunas Tamiahua and Alvarado in Veracruz, included 92.3% plant food and 7.6% animal food. Among the plant foods, widgeongrass seeds and leaves were 46.5%, naiad 15%, unidentified vegetation 13.4%, small snails 1.9%, aquatic insects 1.9%, and unidentified animal matter 3.8%.

Gadwall are hunted more in the interior highlands than elsewhere in Mexico. In the coastal localities pressure is believed to be greater in the northwest (Pacific) than on the Gulf Coast. In the latter zone more gadwall are shot near Tampico than farther south. Formerly, and up to 1948, many more of these ducks wintered in the Tampico district and on Laguna Tamiahua. There was much more hunting there during the years of activity by foreign oil companies, and gadwall were then one of the principal ducks bagged.

Pintail (*Anas acuta acuta*)

Mexican names: pato golondrino, pato cola espiga (Sonora), chichiqua, chichicuate, pato cuellilargo, blanquillo (San Fernando Delta, Tamaulipas), sak tsem (Maya); tsitzihoa (Nahuatl) (Friedmann et al. 1950), source of former subspecific name; pato de guias (Lopez and Lopez 1911); pato floridano (Tabasco), sacal and sacsen (Maya) (Goldman and Goldman USBS); zacal (Leopold 1959).

This very popular duck, the most abundant in Mexico, is widely distributed and it occurs in every State (Fig. 29). It is numerous in coastal waters, especially in Sonora and Sinaloa on the Pacific, and Tamaulipas and Yucatan on the Gulf of Mexico. In the interior it is common south to the Valley of Mexico, especially on the larger lakes of Chapala, Cuitzeo, and Patz-

cuaro. Many of these ducks journey farther south than Mexico; they are observed passing beyond Yucatan in the Caribbean and Chiapas on the Pacific, en route to wintering grounds in Central America. Small flocks also continue south to sojourn briefly in northern South America (S. H. Low *in* Aldrich et al. 1949).

Migration

The earliest autumn flights reach northern Mexico in August; conspicuous migration continues from September through November, and the latest flights come in December. The heaviest autumn flights are usually in the Pacific Flyway, but they are also noticeable in the highlands via the Central Flyway. Great flocks from the Central and Mississippi Flyways merge in Texas along the Gulf Coast and move southward to favorite wintering places in coastal waters.

During spring migration, many birds that come southward via the Pacific and highland routes ride westerly winds to reach the Gulf Coast, and then migrate northward via the Mississippi and Central Flyways to return to their preferred breeding grounds. Northward flights begin in January, when they are usually heavy on the coast of Tamaulipas. They continue as late as April, and some stragglers come along even later.

Winter Distribution

In the January surveys from 1948 to 1962 pintail were the most abundant duck in the interior highlands and the Pacific coastal waters; on the Gulf coastal plain it was second only to the lesser scaup. Estimated numbers of pintails on these surveys averaged about 855,000; 427,000 were along the Pacific Coast, 239,000 in the interior, and 187,000 on the Gulf Coast.

The pintail is as widely distributed on the Pacific Coast as any species of duck, but it is most abundant in the grain-producing localities. From 1948 to 1956 the vicinity of Ciudad Obregon, Sonora, had more pintail than any other wintering ground, but after 1956 an increasing number moved to the Topolobampo and Culiacan districts, Sinaloa. In 1954 their population near the Ensenada de Pabellon had greatly increased, and in subsequent years more pintail were found there and in Topolobampo. From 1951 through 1965 the annual average at Ciudad Obregon was about 74,000, at Topolobampo almost 171,000, and at Pabellon about 145,000. The total pintails seen annually from 1948 through 1962 on the entire coast ranged from about 167,000 in 1956 to 875,000 in 1962. The annual 1951–65 average was 427,000.

During the aerial surveys through 1965 the average percentage distribution of the population on the Pacific Coast was Topolobampo, 33.5; Pabellon, 28.3; Obregon, 14.4; Marismas Nacionales, 11.0; Caimanero, 5.2; and 17 other localities each had less than 1.0.

The pintail is also widely distributed on lakes, lagoons, and reservoirs of the interior. On the basis of the January aerial surveys, the highest counts and averages (in parentheses) in the northern localities were as follows: Laguna Santiaguillo, 32,000 (7,000); Laguna Bustillos, 24,000 (4,000); and Laguna Babicora, 13,000 (4,000). Farther south the estimates were Lake Patzcuaro, 63,000 (13,000); the Upper Lerma Valley, 58,000 (24,000); Lake Chapala, 49,000 (19,000); Lake Cuitzeo, 47,000 (21,000); and Lake Zacapu, 52,000 (27,000).

The annual totals in the highlands recorded on the January aerial surveys ranged from a low of 56,000 in 1962 to a high of 473,000 in 1956; the annual average was 239,000.

Population distribution in the highlands during the aerial surveys through 1965 averaged the following percentages: Oriental, 13.2; Zacapu, 11.7; Upper Lerma, 10.0; Cuitzeo, 9.1; Apam, 8.6; Texcoco, 8.4; Chapala, 8.1; Patzcuaro, 5.5; Yuriria, 5.2; Santiaguillo, 3.0; Irapuato, 2.3; Sayula, 2.0; Huapango, 1.9; Babicora and Bustillos each 1.8; San Isidro, 1.7; Atotonilco, 1.0; and 15 other localities each with less than 1.0.

The population of this species noted on the Gulf Coast during the aerial surveys varied considerably from year to year: 408,000 in 1948, 389,000 in 1952, and 235,000 in 1961. During the intervening years the populations were smaller, declining to about 32,000 in 1963. During 1948–62 the average population was 187,000. Whether the annual changes were due to actual declines in numbers in Mexico, or to shifts in distribution, is not known. With the vastness of the Gulf Coast wintering grounds, it is easy for large numbers of ducks to escape detection at the time of the surveys. Also some of the pintail that are seen on the Gulf Coast during migration winter in the coastal waters of Nicaragua, Honduras, and farther south. In years when large numbers of these migrants were on Yucatan lagoons at the time of the aerial survey, the tally there increased greatly. For example, in January 1961 the number seen on Yucatan lagoons was estimated at almost 203,000, yet in the previous year it was less than 17,000, and in 1963 less than 4,000. In other years large flights of northbound pintails were counted on the coast of Tamaulipas, especially on Laguna Madre, due to the earlier progress of migration. In 1955 more than 97,000 were seen on Laguna Madre; in 1952 the largest numbers were in the Tampico Deltas.

It is especially easy to miss big flights of pintails at the time of their northward migration because many of them pass over the Gulf some distance offshore. When they rest they may concentrate in almost solid rafts of

birds on the sandbars, sandy beaches, or on small isolated lakes.

During the aerial surveys of 1948-65 the pintail population was distributed as follows: Tampico-Tamiahua, 22.2%; Alvarado, 21.3%; Campeche-Yucatan, 21.0%; Laguna Madre, 15.8%; Tabasco, 10.5%; and Rio Grande, 9.2%.

The percentage of recovery in Mexico was highest for those from Utah (19.3), followed by New Mexico (12.1), Oklahoma (10.4), Montana (8.8), and Colorado (7.9), probably because of the proximity of most of these States to Mexico. Among the recovered pintails banded in Alberta (177) the recovery percentage in Mexico was 5.9, of those banded in California (906) it was 3.5%, and of those in Saskatchewan (298) it was 7.5%.

The largest number of recoveries occurred in January, especially in the Pacific States, which is evidence that the heaviest kill in Mexico occurs then. In the Gulf States and interior, November and December had almost as many recoveries as January.

Thirty-three recoveries that were tabulated "D.F." were of birds probably shot in the State of Mexico, but sent from a Distrito Federal address. This adjustment makes a total of 77 pintail recoveries from the State of Mexico and only 7 from the Distrito Federal. As the Federal District is very small, has a negligible amount of waterfowl habitat, and is surrounded by the States of Mexico and Morelos, there is some doubt that any of the banded ducks were actually taken in the District. To simplify the tabulations and reduce the extent of error, the Distrito Federal has been omitted from the list.

The largest numbers of reported recoveries in Mexico were from the following States: Sonora, 339; Sinaloa, 261; Michoacan, 251; Jalisco, 234; Baja California, 188; and Mexico, 126.

The following should explain some of the reasons for the large number of pintail recoveries: (1) the pintail is the most common duck in the Republic; (2) its size and fine flavor make it the top choice of most shooters; and (3) its preference for grainfield feeding makes it more available to many hunters, which is especially true in the agricultural districts of Sonora and Sinaloa, where many of the North American hunters go, and in agricultural fields in the highlands; (4) the hunters in these localities are more familiar with the procedure in reporting bands than are hunters in some of the other parts of Mexico, so a higher percentage may be sent in from these States; (5) the banding of large numbers of pintails in California and other western States and the provinces of Canada has increased the odds of recoveries in western and central Mexico; and (6) heavy hunting pressure in the United States, and the loss of much wintering habitat, are believed to have caused more pintails to move to Mexican wintering grounds.

Foods and Habitats

The pintail uses as great a variety of habitats and foods as any duck in Mexico. Although the largest concentrations are seen on saltwater bays and lagoons along the coasts, they are numerous on many brackish lagoons, and on freshwater lakes and marshes. They also use reservoirs in agricultural districts where they feed in nearby grainfields, especially in rice stubble. Many migrants are observed on the small ponds that dot the farms and ranchlands. Widgeongrass is the staple natural food in their diet in much of Mexico, but other preferred foods include the seeds of bulrushes, spikerushes, sawgrass, wild millet, and other grasses.

Considering the wide distribution of pintails, it is not surprising that its diet contains a great variety of items. Foods vary from tiny "wild tomatoes" of tomatillo in the Rio Grande Delta, waterhemp and sea blite seeds on the Tampico flats, waterlily seeds in the Papaloapan Delta, plankton "soup" at Laguna de la Joya, to midge larvae and small snails near Mazatlan.

On Laguna Madre, Tamaulipas, some of the migrant and winter concentrations observed before 1947 contained more than a million pintails gathered near the great rafts of redheads. Most of these ducks were feeding chiefly on the submerged succulent roots of shoalgrass. In the coastal lagoons of Yucatan, the principal pintail foods were widgeongrass and muskgrass. In the highlands the most common items eaten were widgeongrass and pondweeds.

Before the development of extensive grainfields on the Pacific Coast, this species fed chiefly on the native vegetation of the coastal lagoons and in the adjacent marshes. Principal foods were widgeongrass, muskgrass, and the seeds of many grasses, sedges, and bulrushes. With the advent of rice culture, that became their principal food; in one large series of specimens, rice was more than 95% of the diet. The tender young leaves of winter wheat and some widgeongrass also were commonly taken.

A series of 60 pintails were examined from the agricultural fields near Ciudad Obregon, Sonora. Their gullet contents included 95.8% plant food and 4.2% animal food. The contents included 82.8% rice grains, 5.5% wheat leaves, lesser amounts of six wild plant species, 3.5% unidentified animal matter, and 0.7% insects.

In the highlands 12 pintails were obtained (7 from the Lerma Valley near Toluca, Mexico, and 5 from Lake Chapala, Michoacan). Their gizzard contents were 98.6% plant food (18 items), including 19.8% softstem bulrush, 19.1% floating heart, 13.1% sago pondweed, 12.4% sedge, 11.3% southern bulrush, and lesser amounts of six other species and 2.8% unidentified vegetation. The animal food (5 items) was 1.4%, made up of 1.1% bivalves, 0.2% snails, and 0.1% beetles.

On the Gulf Coast pintails still rely almost entirely on native foods. The kinds eaten differ from one locality to another. A series of 81 pintails was examined; 77 were from Tamaulipas and Veracruz and 4 from Celestun, Yucatan. Their gizzard contents included 98.9% plant food (58 items) and 1.1% animal food (10 items). The foods were 58.4% waterhemp, 11.7% sawgrass, 5.7% coontail, 4.7% sedge, lesser amounts of 17 other plant species, 0.8% snails, and 0.3% dragonflies.

The gullet contents of 75 pintails from the saline Laguna Madre, Tamaulipas, included 90% plant food and 10% animal food. Shoalgrass made up 60%, widgeongrass 15%, aquatic insects 3%, and mollusks 2%. The gullet contents of 16 pintails from the freshwater lagoons and marshes of the Tampico Delta in Tamaulipas and Veracruz were composed of 97.9% plant food and 2.1% animal food. The total included 30.6% spikerush seeds, 17.8% waterhemp seeds, 14.6% widgeongrass, 13.9% unidentified vegetation, 1.5% aquatic insects and 0.6% unidentified animal matter.

Among 18 pintails from the brackish coastal waters of the Laguna Tamiahua, Veracruz, gullet contents were composed of 95% plant food and 5% animal food. Seventy percent was widgeongrass; 10% naiad seeds; 5% each of bulrush, spikerush, and unidentified vegetation; 3% mollusks (mostly small snails); and 2% aquatic insects.

Twenty-four of these ducks were examined from the brackish coastal lagoons near Sisal, Yucatan. Their gullet contents were 90% plant food and 10% animal food. The contents included 45% widgeongrass, 10% each of muskgrass and shoalgrass, 3% mollusks (chiefly snails), 5% unidentifed animal matter, and 1% each of crustaceans and aquatic insects.

Band Recoveries and Hunting Mortality

Among the 583,081 pintails banded before May 1961, there were 60,638 recoveries reported through May 1962, including 2,294 (3.8%) in Mexico. The continental recovery rate was 10.4%, but it was only 0.4% in Mexico. Every State in Mexico was represented among these recoveries, but most (1,028) were from the interior highlands; 957 were from the Pacific coastal plain, and only 305 from the Gulf Coast. The largest number of recoveries were banded in California (906), Saskatchewan (298), Alberta (177), and Utah (118).

Although more pintail winter on coastal waters than in the highlands, the greater hunting pressure in the highlands is evident in the relative number of recoveries, especially in localities where these birds come to agricultural fields to feed.

These recoveries indicate that the heaviest hunting mortality in the highlands is in Jalisco and Michoacan, States with relatively high densities of human population. Although the hunting pressure has not been observed to be heavy in any single locality, the size of the kill seems to be correlated with the large number of places where ducks are vulnerable to shooting. These include the hundreds of small ponds, lakes, and reservoirs where the birds can be ambushed more easily.

The next heaviest hunting toll is on the Pacific Coast from Baja California south to Nayarit, and especially in the rice-growing districts of Sinaloa and Sonora. Most of this hunting is done at grainfields or at nearby lagoons where the ducks return after feeding. Many North Americans hunt in these States, probably more than in any other parts of Mexico.

The pintail harvest is much lighter on the Gulf Coast, the majority of which is in Tamaulipas and Veracruz; the harvest has increased in recent years at the coastal lagoons of Yucatan. Formerly the favorite localities were Tampico, the Alvarado lagoons, Laguna Madre, and the Yucatan lagoons, in that order. Now most of the North American hunters who seek pintail soon learn that the Pacific Coast offers the best shooting, but those who have hunted on the Gulf Coast the past several years have shot more in Yucatan than in any other State.

On 10 January 1951 a series of 217 pintails examined in hunters' bags, chiefly near Ciudad Obregon, Sonora, included 121 males (55.7%) and 96 females (44.3%). The weights of the males ranged from 862 to 1,270 g (average, 998 g) and females ranged from 680 to 907 g (average, 862 g).

American Green-winged Teal (*Anas crecca carolinensis*)

Mexican names: zarceta de invierno; cerceta de lista verde; salseno (Tampico); cerceta comun (Martin del Campo 1948), quetzaltecocolton (Nahuatl) (Friedmann et al. 1950); pepatzca (Lopez and Lopez 1911); golondrinito (Toluca Valley) (Goldman and Goldman USBS); metzcanauhtli, cuicuitzcatl (Villada 1891-92).

The green-winged teal is a common winter resident on both coasts and in the interior highland lakes. It has been recorded from every State. On the Gulf Coast the largest numbers usually are recorded in the Tampico area, but far more are present on the Pacific Coast, especially in Sinaloa, Nayarit, and Sonora (Fig. 30). They are regularly observed during the winter in all of the coastal States, although they are ordinarily more numerous in those farther to the north. At the time of the 1947 inventory, however, most of them were farther south, and the largest concentrations were from Sinaloa south to Guerrero. In the interior they commonly occur as far south as the Valley of Mexico, and small numbers winter on the waters of Puebla and Oaxaca.

The January aerial surveys (1948 to 1962) indicate

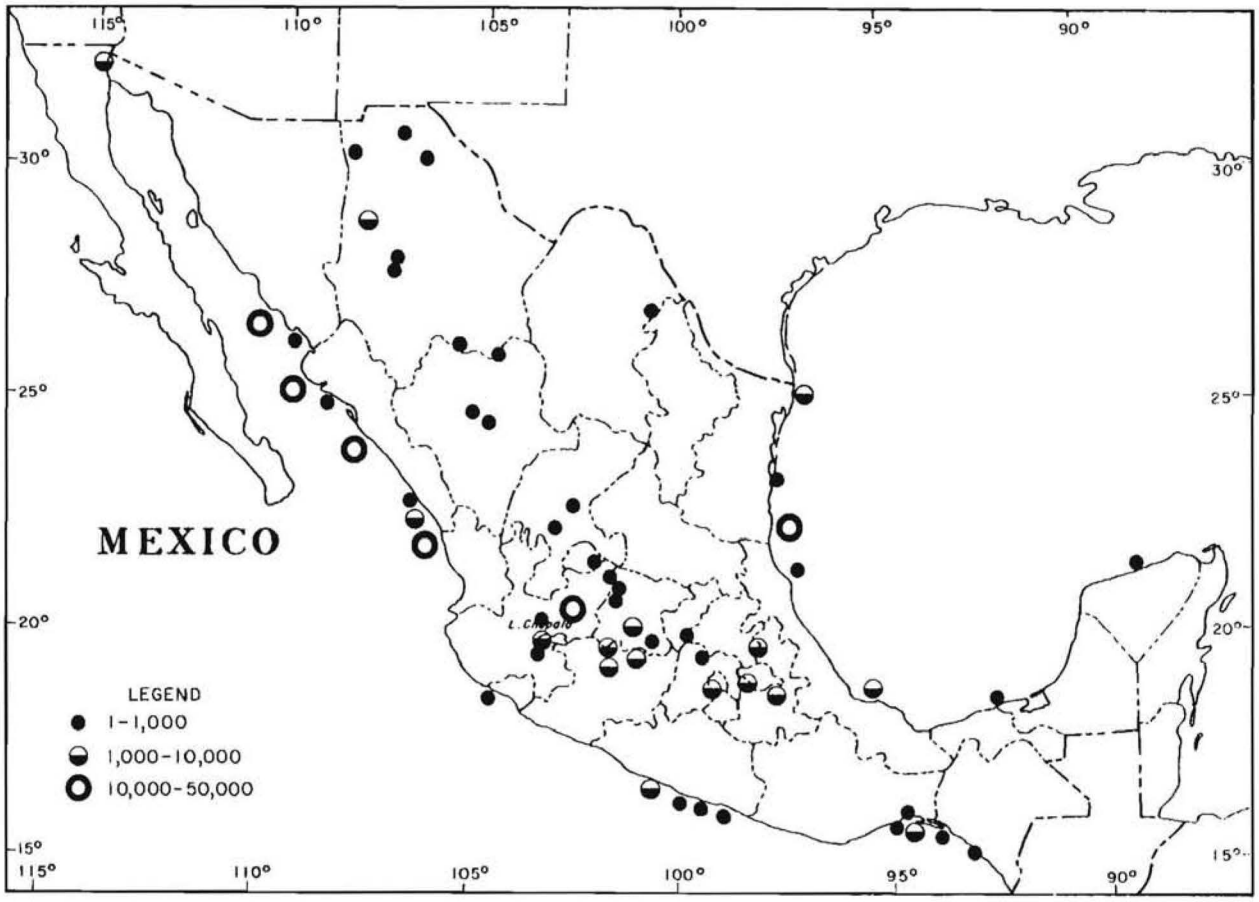

Fig. 30. Average numbers of green-winged teal observed during January aerial surveys, 1948–62.

that this species had an average rank of third in abundance in the interior highlands, fourth in Pacific coastal waters, and seventh on the Gulf coastal plain. Estimated numbers of green-winged teal seen on these surveys averaged about 205,000: 124,000 along the Pacific Coast, 63,000 in the interior, and 18,000 on the Gulf Coast.

The green-winged teal is more widely distributed along the Pacific Coast than is the blue-winged teal. Most of them winter there, whereas many of the blue-winged teal are seen in migration. As the January aerial surveys indicate, the green-winged teal were especially numerous in the large areas of brackish and saline coastal lagoons. From 1948 through 1963, the largest numbers recorded were at and near the Ensenada de Pabellon, where the average numbers seen were about 51,000. The second highest populations were at the Marismas Nacionales (average, about 43,000). The localities that were next most important were the Topolobampo-Los Mochis and the Obregon districts, each with about 25,000. Small numbers wintered in other localities, extending from the Colorado River Delta southward to southern Chiapas.

During the aerial surveys the largest number recorded on the Pacific Coast was 409,000 in 1959, the smallest number was 13,000 in 1950, and the annual average was about 124,000. It is likely that the aerial surveys detect a much smaller percentage of wintering green-winged teal in wet years when the greater extent of coastal lagoons and marshes causes these ducks to spread over larger areas. During dry years, these teal are much more concentrated and therefore more conspicuous.

The average percentage distribution of the population through 1965 was Pabellon, 32.2; Marismas-Nacionales, 27.2; Topolobampo, 15.5; Obregon, 15.4; Caimanero, 6.2; Mitla-Coyuca, 1.7; and 12 other localities each with less than 1.0.

The green-winged teal is also more widely distributed over the highlands than is the blue-winged teal. The green-winged teal is a hardier species and migrates south of Mexico less frequently than the blue-

winged teal (S. H. Low *in* Aldrich et al. 1949). Most of the lakes and lagoons of the northern highlands provide winter habitats for a few hundred to a few thousand of these teal, but Laguna Babicora in 1963 had almost 25,000. The most important of the waters in the central and southern parts of the plateau, as shown by the aerial surveys, were Lake Chapala (as many as 25,000), Lake Texcoco (20,000), and the Upper Lerma Valley (18,000). The annual totals of the aerial surveys in the highlands ranged from about 10,000 in 1962 to about 144,000 in 1959 (average, about 63,000). In years when there is plenty of surface water in much of the highlands, green-winged teal are more widely scattered and more of them are probably missed on the surveys.

The average percentage distribution of the population, as shown by the aerial surveys through 1965, was as follows: Chapala, 14.7; Texcoco, 11.7; Cuitzeo, 11.4; Apam, 10.4; Oriental, 9.3; Yuriria, 6.6; Zacapu, 6.2; Santiaguillo, 5.1; Sayula, 3.9; Babicora, 3.7; Upper Lerma, 3.6; Huapango, 2.6; Irapuato, 2.3; Patzcuaro, 1.8; San Isidro, 1.2; and 17 others each with less than 1.0.

Other average distribution in percentages, as shown by the aerial surveys from 1948 to 1965, were as follows: Tampico–Tamiahua, 55.8; Rio Grande, 22.2; Alvarado, 12.9; Laguna Madre, 6.2; Tabasco, 2.2; and Campeche-Yucatan less than 1.0.

Until July 1962, 7,404 band recoveries were reported of 107,112 green-winged teal banded, including 120 (1.6%) in Mexico. The recovery rate was 6.9%, but was only 0.1% in Mexico. There were recoveries from 18 States in Mexico; by far the largest number (47) was from Baja California. Most (61) were from the Pacific Coast, 49 were from the interior zone, and 10 from the Gulf States.

The largest number of these recoveries (41) were banded in California; 15 were banded in Saskatchewan, 8 were banded in New Mexico, and 6 in Nevada. Most of the recoveries in Mexico were banded in New Mexico (34.6%), followed by Colorado (11.4%) and Nevada (6.7%). Among those banded in California, 2.7% were recovered in Mexico. There were 16 recoveries in November, 25 in December, 29 in January, 28 in February, and 11 in March.

On the Pacific Coast 42 green-winged teal from near Ciudad Obregon, Sonora, were examined for the foods studies. Their gizzard contents included 98.4% plant food (39 items) and 1.6% animal food (9 items). The contents were 26.6% jungle-rice, 20.8% cultivated rice, 11.5% aneilema, 8.1% grass, 7.6% unidentified vegetation, and 1.6% beetles.

Twenty-two green-winged teal were examined from brackish and saline coastal lagoons near Mazatlan and Escuinapa, Sinaloa. Their gullets contained 82.1% plant food and 17.6% animal food. The contents included 60% widgeongrass, 5% alkali bulrush, 7.2% unidentified vegetation, 7.2% bloodworms, 5.4% small snails, and 5% unidentified animal matter. The soft, quickly digested bloodworms probably would not have been detected by examination of their gizzard contents. Only the gullet contents were available from these teal.

In the interior highlands of Mexico the gizzard contents of three teal from the Upper Lerma Valley near Toluca were as follows: softstem bulrush, 25%; Illinois pondweed, 24%; bramble, 12%; unidentified vegetation, 10%; and traces of small snails and beetles.

On the Gulf Coast 36 green-winged teal were examined from the Tampico Delta in Tamaulipas and Veracruz. Their gizzard contents included 80.7% plant food (24 items), and 19.3% animal food (10 items). Softstem bulrush made up 31.2%; spikerush, 19.2%; sawgrass, 9.1%; sedge, 6.3%; snails, 14.8%; crustaceans, 2%; and dragonflies and damselflies, 1% of the total foods.

More green-winged teal are shot on the Pacific Coast than elsewhere in Mexico. Hunting pressure is especially heavy in Baja California, where most of the banded birds were recovered. In the interior highlands the majority killed are in Jalisco and Michoacan. On the Gulf Coast more are shot in Tamaulipas than farther south, but the number is small.

Blue-winged Teal (*Anas discors*)

Mexican names: cerceta, zarceta, zarceta comun, zarceta de ala azul (Yucatan), cutz ha (Maya), zarceta de otono; metzcanauhtli (Nahuatl, moon bird), cerceta de alas azules (Friedmann et al. 1950); zarceta de verano (Valley of Mexico), zarceta tulera (Valley of Toluca), chichi pato (Maya) (Goldman and Goldman USBS); toltecoloctli (Nahuatl), patillo (Tabasco) (Santamaria 1942); atalpacetl.

The blue-winged teal is the earliest autumn migrant to reach Mexico in large numbers. By August large flights are moving through Mexico, and most of them continue on to Central America and northern South America.

The schedule of spring migration varies from year to year. During some seasons a much larger percentage of the population has reached Mexico by the time of the January survey, and this results in a spectacular increase in numbers found then.

Those that winter in Mexico are widely distributed, but most are in the tropical lowlands; the largest number are usually scattered over the marshes and lagoons of Tabasco (Fig. 31). During migration blue-winged teal are especially conspicuous in the larger lagoons between Celestun and Progreso, Yucatan, but usually no large concentrations are there throughout the winter. There is reason to believe that in years when food is abundant in Tabasco and Yucatan, more of the blue-winged teal than usual remain there rather

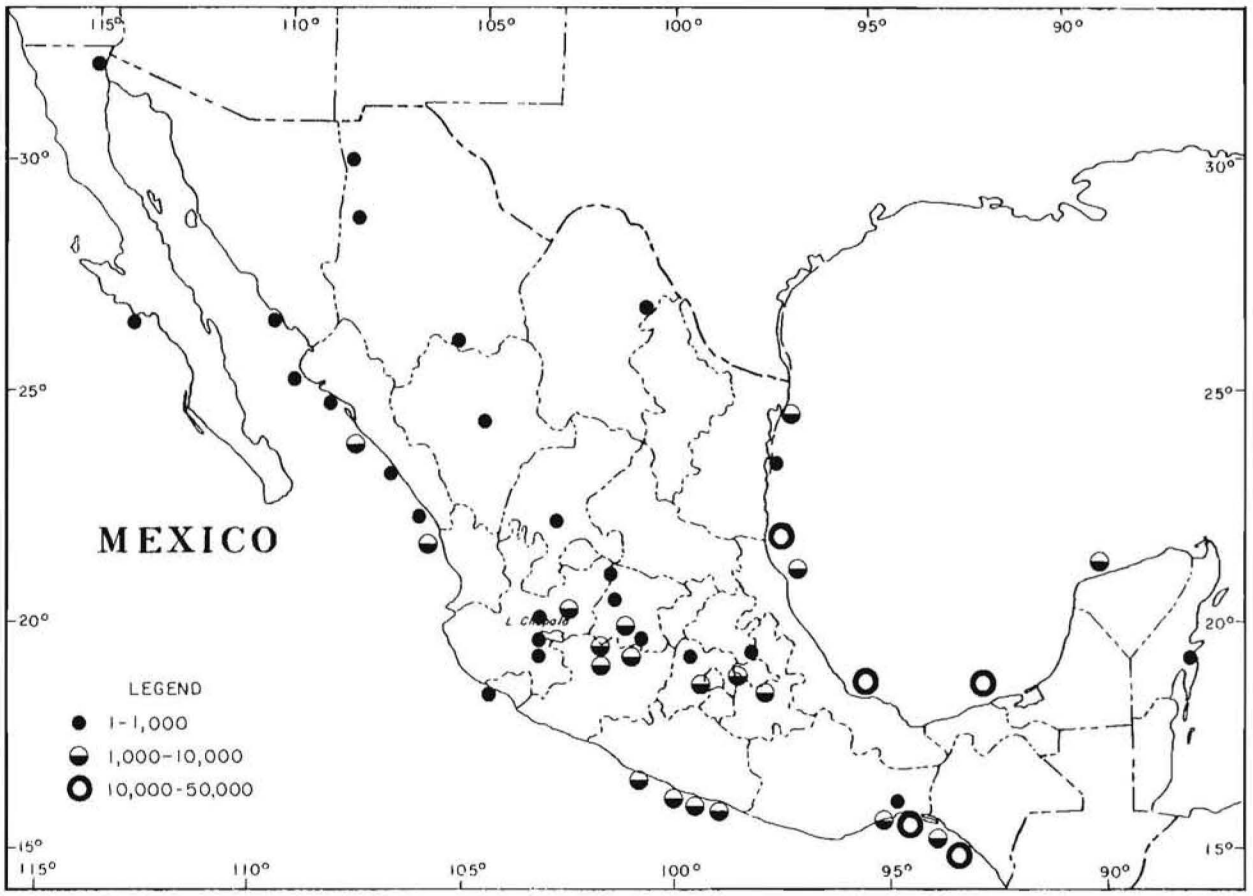

Fig. 31. Average numbers of blue-winged and cinnamon teals observed during January aerial surveys, 1948–62.

than migrate farther south. Some flights apparently cross the Gulf directly between Louisiana and Yucatan, but others follow the coastline for much of that distance.

Bennett (1938), in his studies of the blue-winged teal, did some field work in Mexico, chiefly in the Valley of Mexico and south of that latitude. Speaking of that Valley and of the Lerma Valley near Toluca he wrote (1938:29):

> Local sportsmen informed the author that the Blue-winged Teal became common in the interior valleys during the latter half of January. They were of the opinion that the birds worked slowly down from the north and did not arrive that far south until the latter part of January. However, our own observations of thousands of teal to the south of Mexico City on Pacific Coast lagoons indicated that the birds are on their way north when they visit the Valley of Mexico and the Toluca Valley in January. It may be that the greater part of the fall flight follows the Gulf Coast to southern Mexico and Central America, where some of the birds cross over to the Pacific Ocean and then work north and later cross over to the Gulf on the spring flight, traversing the Valleys of Mexico and Toluca in January. Such a movement would explain the influx of teal into those interior water areas.

During the January aerial surveys of 1948–62 it was impracticable in most localities to separate the blue-winged and cinnamon teals in the population estimates, because the females of both species are indistinguishable from the air. Also, the males are sufficiently mixed in some feeding localities to make a separate enumeration impossible, because of the speed of the plane.

On the Gulf Coast almost all were blue-winged teal. In the highlands and on the west coast there was a much larger percentage of cinnamon teal present, but in both of these zones blue-winged teal were the more numerous by a substantial margin.

The average estimated population of both species on the Gulf Coast was 135,000, on the Pacific Coast 54,000, and in the interior highlands 47,000.

Among the wintering grounds on the Pacific coastal plain, the largest number of blue-winged teal were at Marismas Nacionales, Sinaloa (range, 830 to 17,850; average, about 13,000). The second largest winter

population was at Sesecapa, Chiapas (range, 1,100 to 23,500; average, 11,300). The average numbers wintering at other places were 11,250 at Mitla-Coyuca, Guerrero; 8,600 at Laguna de la Joya, Chiapas; and 7,000 at Mar Muerto, Chiapas. The other wintering grounds had fewer blue-winged teal.

On the Pacific Coast 1950 was a peak year, when more than 175,000 were seen; since then fewer than 75,000 have been noted in any one season. As mentioned earlier, the wide variation in numbers from year to year also is probably due, to a considerable extent, to differences in the relative advance of the spring migration at the time of the aerial survey.

The percentage distribution of the Pacific Coast population, as shown by averages of the aerial survey findings through 1965, was Marismas Nacionales, 17.2; Sesecapa, 15.0; Mitla-Coyuca, 14.9; La Joya, 11.5; Pabellon, 11.2; Mar Muerto, 10.5; Caimanero, 4.3; Topolobampo, 3.2; Inferior and Papagayo each with 2.8; San Marcos, 2.0; Nexpa, 1.2; Cuyutlan, 1.0; and seven other localities each with less than 1.0.

This teal also varies greatly in numbers from year to year in the interior highlands for the same reason as on the Pacific Coast. In some years many more blue-winged teal have reached the central lakes of Mexico from more southerly wintering grounds by the time of the annual survey.

These teal concentrate principally on lakes Oriental, Cuitzeo, Zacapu, Patzcuaro, and the Upper Lerma Valley. The largest number recorded on any survey in the highlands was at Oriental in 1959 when 57,100 were seen. Top numbers recorded on the 1962 survey were about 30,000 at Cuitzeo and 29,000 at Zacapu. Annual totals of the surveys ranged from about 11,000 in 1951 to 209,000 in 1959, and averaged 47,000.

The percentage distribution of the population in the highlands, as shown by averages of the aerial survey findings through 1965, was Oriental, 15.2; Cuitzeo, 11.9; Upper Lerma, 11.6; Yuriria, 9.4; Zacapu, 9.0; Chapala, 8.0; Patzcuaro, 7.8; Texcoco, 5.4; Apam, 5.2; Sayula, 4.0; Acambaro, 2.8; Huapango, 2.3; San Isidro, 1.6; Zapotlan, 1.0; and 11 other localities each with less than 1.0.

The population of this species that wintered on the Gulf Coast was similar in 1949 and 1961. The January 1949 aerial survey tallied about 152,000, and that of 1961 recorded 161,000. The largest population observed (211,000) was in 1956. Lows occurred in 1948, 1960, and 1962, when fewer than 75,000 were observed. We believe that most of the fluctuations in numbers are caused by shifts in distribution rather than in declines of populations. With the great expanses of available wintering grounds it is easy for these ducks to be missed during the aerial coverage. In 1948 the largest numbers were seen in the Tampico lagoons, but by 1950 the majority were observed in the Alvarado-Papaloapan Delta. In 1952, 1953, 1958, and 1961, most of them were on the Yucatan lagoons; but in 1951, 1955, 1956, and 1963, more were seen on the Tabasco lagoons and marshes than elsewhere.

The wide variation in numbers seen on coastal lagoons of Yucatan is also due chiefly to differences in the migration schedule of the birds from year to year. By late January and early February, many blue-winged teal are in Yucatan en route northward, but during some years the advance of migration is delayed, and relatively few teal have arrived there by the time of the survey.

Before the winter of 1957-58, the January surveys in the United States showed only a few thousand blue-winged teal in Louisiana. Subsequently there was a spectacular increase, and we do not know whether this subtracted appreciably from the January population which otherwise would have gone to Yucatan and other parts of Mexico. In 1956 the blue-winged teal population on the eastern coast of Mexico was 211,000, the highest on record since 1947. There was no survey in 1957, but in 1958 the second highest population (200,000) of blue-winged teal was recorded in eastern Mexico. This was the first winter of their great increase in Louisiana (from about 4,000 in 1957 to 157,000 in 1958).

Since 1958 the Louisiana population of wintering blue-winged teal estimated on the January surveys increased to 267,000 in 1960, 284,000 in 1961, and 299,000 in 1962. In eastern Mexico the January blue-winged teal count was down in 1959 and 1960, up in 1961 and down in 1962. However this is one of the least satisfactory species to appraise in Mexico because of the vast areas of marsh where teal are hidden by the cover of shrubs and other vegetation. When there are high water levels in Veracruz and Tabasco even more teal are missed, because of the great expanses of newly flooded lowlands.

The percentage distribution of blue-winged teal populations on the Gulf Coast through 1965 was Campeche-Yucatan, 36.7; Tabasco, 30.2; Alvarado, 20.3; Tampico-Tamiahua, 11.2; and Rio Grande and Laguna Madre each with less than 1.0.

Among 251,355 blue-winged teal banded by July 1962, 10,514 recoveries were reported including 582 in Mexico. The overall recovery rate was 4.2%, but only 0.2% in Mexico. Band recoveries from Mexico included 96 from Veracruz, 89 from Yucatan, 53 from Tabasco, 29 from Tamaulipas, and 12 from Campeche, a total of 279 for the Gulf States. In comparison, there were 211 from the interior, and 92 from the Pacific Coast.

There were recoveries from every state in Mexico except Baja California, Queretaro, and Quintana Roo. The largest number of these recoveries (144) were banded in Alberta, followed by Manitoba (78), Nebraska (71), North Dakota (59), and Missouri (53).

Minnesota also banded 33, Kansas 22, Montana, 20, British Columbia 19, and New Mexico 18.

Examination of recovery records of the blue-winged teal in Mexico reveals that the heaviest kill of those banded occurred during October (84), November (94), and December (87). There were about 40% as many in September (34) as in October. Recoveries along the Gulf Coast were 76 in January, 71 in February, 29 in April, and 18 in May. The peak of recoveries may indicate the incidence of the principal flights northward along that coast.

As Stoudt (see Aldrich et al. 1949:19) pointed out: "The general migration pattern of the blue-winged teal from the breeding grounds is from the northwest to the southeast with a very small percentage moving straight southward or in a southwesterly direction." The tabulations by States of banding and by Mexican zones of recovery confirm this generalization.

We believe that most of the blue-winged teal that go to Mexico migrate southward through the United States down the Mississippi and the Central flyways, reaching the Gulf Coast of Louisiana or Texas. Most of those that winter in Latin America go beyond Mexico, as is attested to by the recovery totals given in 1949 (Aldrich et al. 1949): 50% in South America, 25% in Cuba and the West Indies, 14% in Central America, and 11% in Mexico.

Geis et al. (1963) reported that, of adults banded, direct recoveries of males south of the United States totaled 40.4% and of females 20.4%. Of the Mexican recoveries for which detailed information is available, the analysis by zones of recovery is as follows: Pacific, 34 males (89.5%) and 4 females; Interior, 19 males (65.5%) and 10 females; Gulf, 64 males (80%) and 16 females; the average percentages are 79.6% males and 20.4% females. The greatest preponderance of males is in the Pacific States of Mexico (8:1), followed by the Gulf States (4:1) and the interior States (2:1).

Most of the Mexican recoveries of banded locals are direct and there is no great difference in the ratio of males to females. It appears that the adult females are subjected to a much higher proportional kill north of Mexico. A later migration schedule than those of adult males and young of the year subjects the adult hens to more hunting pressure in the United States.

Only two blue-winged teal specimens were examined from the Pacific Coast for a study of food habits. One was from near Mazatlan, Sinaloa, and the other from Ciudad Obregon, Sonora. Their gizzards contained 33% seeds of pepperwort, 33% spikerush, 13% sedge, 20% unidentified vegetation, and a trace of small mollusks.

Five blue-winged teal from the Upper Lerma Valley, near Toluca, Mexico, had the following gizzard contents: 96.2% plant food (15 items) and 3.8% animal food (4 items). There were seeds of softstem bulrush (13.9%), whitestem pondweed (*Potamogeton praelongus*) (13.5%), southern bulrush (13.2%), Illinois pondweed (12.7%), smaller amounts of six other plant items, unidentified vegetation (24.5%), tiny snails, and traces of other mollusks and insects.

Among 36 blue-winged teal from the Gulf Coast, chiefly the Tampico Delta (25), the gizzard contents included 87.1% plant food (29 items) and 12.9% animal food (8 items). Muskgrass was 45.5%, softstem bulrush 7.7%, 27 other plant items occurred in smaller amounts, small snails made up 1.1%, plus smaller amounts of tiny fishes, insects, and small mollusks.

Other blue-winged teal (11) from the Tampico Delta contained almost 100% plant food and included the seeds of jointed spikerush (30%), dwarf spikerush (seeds and entire plants) (15%), widgeongrass (10%), bermuda grass (10%), plus smaller amounts of nine other items, 10% unidentified vegetation, and traces of small snails and crustaceans.

The gullet contents of six blue-winged teal from freshwater lagoons near Villa Union, Tabasco, included 85% plant food and 15% animal food. The contents included widgeongrass 25%, naiad 25%, seeds of grasses 10%, miscellaneous seeds and plant fragments 25%, and aquatic insects. The gullets of nine blue-winged teal shot at brackish lagoons near Celestun, Yucatan, contained 75% plant food and 25% animal matter. Muskgrass was 45% and widgeongrass 25% of the diet. The animal food consisted chiefly of small snails and insect larvae.

The heaviest shooting pressure is in the interior highlands although there are more blue-winged teal present on the Gulf Coast than in other parts of the Republic. The vulnerability of these teal on small ponds and lagoons results in a much heavier kill there than elsewhere. The second highest hunting mortality occurs in the Gulf States because of the shooting near Tampico in Tamaulipas and Veracruz, in several localities of southern Veracruz and Tabasco, and at the coastal lagoons of Yucatan. This species is a favorite of market hunters, and this preference adds to the kill in some localities, especially in the Valley of Mexico, Veracruz, Yucatan, and along the United States-Mexican border.

Cinnamon Teal (*Anas cyanoptera septentrionalium*)

Mexican names: chiflador; cerceta, cuaras (Lake Patzcuaro), pato colorado; cerceta cafe, chilcanauhtli (Nahuatl) (Friedmann et al. 1950); zarceta colorado, zarceta coyota (Interior and Valley of Mexico) (Goldman and Goldman USBS).

This beautiful little teal is common locally on both coasts as well as in the interior. The areas of Mexico in which it is most numerous in midwinter are Sinaloa and Nayarit on the west, the southern lakes and espe-

cially Lake Cuitzeo of the central plateau, and Tampico and Laguna Tamiahua on the east.

During the January aerial surveys the estimates of cinnamon teal were lumped with those of blue-winged teal, because the speed of the plane made an accurate separation of the two species impossible in localities where flocks were intermingled. We know from ground counts that blue-winged teal are in the majority and may make up 90% of the totals, but cinnamon teal often are the much more common on strongly alkaline lagoons, such as the Marismas Nacionales. In midwinter a large percentage of the blue-winged teal have gone farther south, but most of the cinnamon teal winter no farther than Mexico.

This species breeds in northern Baja California, Jalisco, Chihuahua, and Tamaulipas (Friedmann et al. 1950). Maps in the U.S. Fish and Wildlife Service files also show breeding records for Mexico City (probably Lake Texcoco). Like the blue-winged teal, the cinnamon teal is an early migrant, but it is less widely distributed in Mexico. It is more western in distribution and most numerous in the highlands and on the Pacific coastal plain.

The following information on this teal is quoted from field notes of E. A. Goldman (USBS files).

> The cinnamon teal, locally known as "zarceta coyota" and "zarceta colorado," is one of the most abundant species of ducks found in the valley of Mexico at the time of my visit. On January 30, 1926, I visited one of the principal resting places for ducks in the valley, an area including considerable open water, with sedge and other aquatic vegetation growing in shallow water, near El Penon Viejo. Here I estimated there were 75,000 ducks densely massed on the water, of which about sixty percent were cinnamon teal. The other species occurring with these teal in the greatest abundance were the pintail and blue-winged teal.—On February 8, in the same place my estimate of the numbers of cinnamon teal was only five percent of the total number of ducks, which did not appear to have diminished, although many of the green-winged teal were probably gone. At the same time the numbers of pintail were so predominant that I placed the percentage of this species present at seventy.—On February 18, while on a trip to the great marsh at 8,200 feet altitude along the Lerma River in the bottom of the valley of Toluca, I observed flocks aggregating about 2,000 of this species in limited areas of open water, where it was associated with a still larger number of pintails, and smaller numbers of other ducks. As in the Valley of Mexico, it is here locally known as "zarceta coyota."
>
> This species was next noted on February 20 in a tule marsh along the southern shore of Lake Cuitzeo, Michoacan. Here about 40 were observed from the car window as the train passed, associated with small numbers of blue-winged teal and coots. Later in the day, while on a trip by motor boat on Lake Patzcuaro, Michoacan, a number of small flocks, rarely exceeding 20 together, but aggregating thousands, were seen well out from shore on the open water, where they were associated with, or swimming near, larger numbers of wigeons and small groups of canvas-backs.
>
> Mexico, City of Mexico and vicinity, Jan. 17-19 and June 22-30; Lerma, July 1-11, 1904. A few were seen in the markets in the City of Mexico on January 19, and on July 6 one was brought in by a native hunter at Lerma which on being dissected showed signs of breeding. Apparently not a common breeder.

Until July 1962, 656 recoveries were reported from 12,680 banded cinnamon teal including 166 in Mexico. The overall recovery rate was 5.2% and 1.3% in Mexico. There were recoveries from 22 States in Mexico: 98 from the Interior States, 49 from the Pacific ones, and 19 from the Gulf States. The largest number of these recoveries were banded in California (105), followed by Utah (21), Oregon (20), and Nevada (12). Recoveries in Mexico were highest (85.7%) for those banded in Idaho, followed by Utah (53.9%), Nevada and New Mexico (50.0% each), Oregon (40.0%), Arizona (37.5%), and California (22.3%). There were 26 recoveries in November, 28 in December, 30 in January, 25 in February, and 20 in March.

A series of 24 cinnamon teal, shot near Ciudad Obregon, Sonora, had the following gizzard contents: 75.4% plant food (33 items), with 26.6% cultivated rice, 9.8% common spikerush, and 31 other items in smaller quantities; 24.6% animal food (10 items) including 17.4% small snails, 4.7% beetles, 2.1% mollusks, and the remainder insects and crustaceans.

In the highlands four cinnamon teal were shot in the Upper Lerma Valley near Toluca, Mexico. Their gizzards contained 65% plant food and 35% animal matter. Most of the former were seeds of pondweeds (35%) and smaller amounts of 12 other items, and unidentified vegetation (24%). Several kinds of small mollusks, especially snails, totaled 22%. The most common items of animal food were tiny crustaceans (13%). In the interior highlands at Lake Patzcuaro, Michoacan, the gullets of eight cinnamon teal contained 85% plant food and 15% animal matter. Pondweed made up 35%; the seeds of bulrushes, sedges, smartweed, spikerush, and grasses almost 50%, aquatic insects 10%, and small snails 5%.

The gizzards of 14 cinnamon teal shot in the Tampico marshes contained 70.1% plant food (18 items) and 29.9% animal food (9 items). Spikerush seeds constituted 35% and softstem bulrush seeds 21.0%; there were other lesser items. Small snails were the most common animal food; much smaller amounts of insects, crustaceans, mollusks and tiny fishes also were present.

The heaviest harvest of cinnamon teal, as is true of the blue-winged teal, is in the interior States. This is especially true on small bodies of water near Lake Chapala and elsewhere in Jalisco and Michoacan. The kill at Lakes Patzcuaro and Cuitzeo also is considerable.

On the Pacific Coast the greatest mortality is in

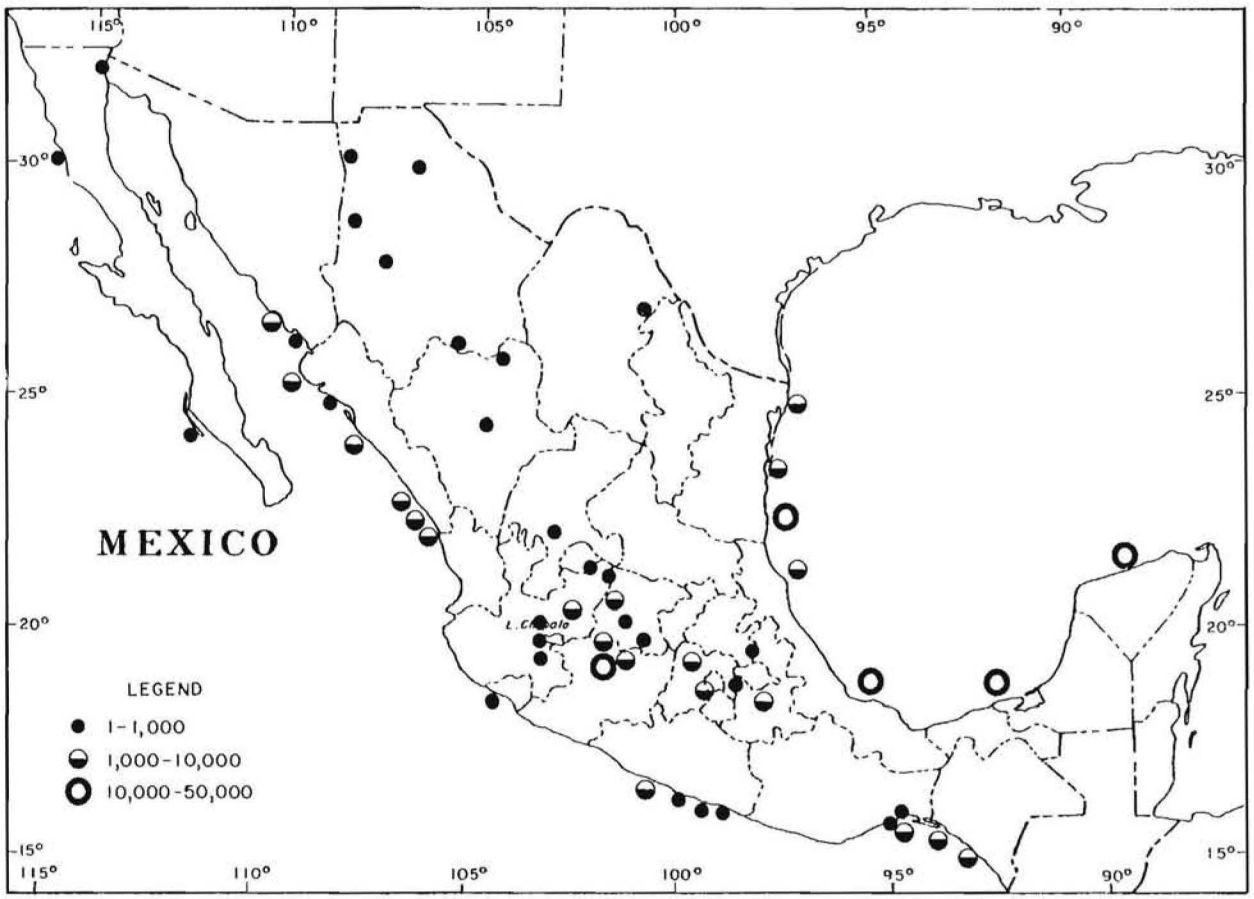

Fig. 32. Average numbers of American wigeon observed during January aerial surveys, 1948–62.

Baja California; lesser numbers are shot in Sonora and Sinaloa. Relatively few of these teal are killed on the Gulf Coast, and those are mostly in the State of Veracruz.

The cinnamon teal is recorded in every State except Quintana Roo, and it undoubtedly occurs there also.

European Wigeon (*Anas penelope*)

Mexican name: none in general use.

Friedmann et al. (1950) report, "One record from northern Baja California (Descanso)." This specimen was reported on in detail by Abbot (1933). At the Culebron reservoir near Matamoros, Tamaulipas, the senior author observed an adult drake at close range in a small flock of American wigeon and gadwall, 2 January 1943. No other records are on file.

The European wigeon was recorded in Baja California and Tamaulipas.

American Wigeon (*Anas americana*)

Mexican names: solareno (Tampico); chiflador; pato chalcuan, corruption of xalcuani (Nahuatl) (Friedmann et al. 1950), "one who eats sand"; xalcanauhtli (Nahuatl) (Martin del Campo 1948); pato panadero (Valley of Toluca) (Goldman and Goldman USBS); zaradillo (Lake Chapala) (Goldman and Goldman USBS); cotorrito (Friedmann et al. 1950).

The wigeon is one of the most common and widely distributed ducks wintering in Mexico. It frequents both saltwater and freshwater bays and lagoons on both coasts, and the lakes of the interior highlands. It has been recorded from every State (Fig. 32).

On the January surveys from 1948 through 1962, this species had an average rank of fourth on the Gulf coastal plain, fifth in the interior highlands, and eighth in the Pacific coastal waters. Estimated numbers of wigeon seen in Mexico on these surveys averaged about 200,000: 105,000 on the Gulf Coast, 51,000 along the Pacific Coast, and 43,000 in the interior.

The wigeon is common on most of the wintering grounds of the Pacific Coast, but it is not abundant. It is much less numerous on the Pacific Coast than on the Gulf Coast. A peak population of about 100,000 birds was seen in 1950. Fewer than 50,000 have been observed during most of the years since then. The largest numbers were recorded in the Ciudad Obregon area, near Topolobampo, and at Laguna Caimanero. A total of about 26,000 seen at Laguna Caimanero in January 1954 was the largest number observed on the annual aerial surveys of the Pacific coast. The annual totals tallied on the 1948-63 surveys ranged from 17,525 in 1953 to 102,313 in 1950. The annual average was 52,422.

The wigeon is widely distributed on waters of the interior highlands. The northern localities seldom have more than a few hundred birds, but some of the lakes of the central region winter much larger numbers. Lake Patzcuaro is especially important to this species. During some years it has had almost 40,000 birds at the time of the January aerial survey.

The second most important wintering place usually is Lake Chapala, where numbers of these birds on the aerial surveys have ranged from a few hundred to more than 16,000. The lagoons near Zacapu, Michoacan, are also important wigeon habitat. In 1954 the aerial survey revealed more than 18,000 there. Another popular place is Laguna Oriental, Puebla, where up to 10,000 wigeon were counted in 1953.

Most of the other principal lagoons provide wintering habitat for a few hundred to several thousands of these ducks. The total number recorded in the highlands on the 1951-62 aerial surveys ranged from about 10,000 in 1962 to about 93,000 in 1954, and the average was about 43,000.

The population of this species that wintered on the Gulf Coast held up relatively well during 1948-62. There was, however, wide variation in numbers seen from year to year. The population noted in 1948 was about 245,000; as recently as 1961 it was 230,000. During 1948-62, wigeon had three peaks of abundance on the Gulf Coast: 1948, 1956, and 1961. The highest was in 1956 when the population was about 325,000. The lows have reached slightly less than 25,000 birds seen in 1952.

The distribution changed greatly during 1948-62. In 1948 the largest numbers were noted in the Alvarado and Tampico districts. In 1953 most were seen in both the Tabasco and Yucatan districts but, in 1956, the majority were found scattered widely over the vast Tabasco lagoons. In 1961 almost 90% of all the wigeon seen were in the Yucatan lagoons. It seems likely that these shifts were caused by changes in the relative abundance of preferred foods, but each of the major wintering grounds continued to have plenty of food attractive to wigeon during all of these years.

To summarize the population distribution on the Pacific Coast, percentages from 1948 through 1965 were Obregon, 21.2; Topolobampo, 15.6; Caimanero, 12.4; Sesecapa, 8.4; Laguna Inferior, 8.2; Pabellon, 6.7; Mar Muerto, 4.2; Mitla-Coyuca, 2.8; Marismas Nacionales, 2.7; Dimas, Nexpa, and Laguna de la Joya each 2.6; Santa Maria, 2.4; Agiabampo, 2.3; San Marcos, 1.4; Cuyutlan, 1.3; and four other localities each with less than 1.0%.

The percentage distribution of wigeon in the interior highlands was as follows: Oriental, 16.7; Zacapu, 13.3; Chapala, 12.1; Upper Lerma, 9.3; Cuitzeo, 7.3; Acambaro, 5.4; Sayula, 4.2; Apam, 4.0; Patzcuaro, 3.9; Irapuato and Texcoco each 3.2; Casas Grandes, 3.0; Huapango, 2.7; Santiaguillo, 2.4; Yuriria, 1.8; Babicora, 1.5; Zapotlan, 1.2; and other localities each with less than 1.0. Their percentage distribution on the Gulf Coast was Campeche-Yucatan, 43.2; Tabasco, 22.9; Alvarado, 16.7; Tampico-Tamiahua, 11.2; Laguna Madre, 3.4; and Rio Grande Delta, 2.6.

Among 94,402 wigeon banded by 31 May 1962 there were 10,227 recoveries reported, including 159 (1.5%) in Mexico. The overall recovery rate was 10.8% but only 0.17% in Mexico. There were recoveries from 23 States in Mexico, 62 from the Pacific States, 60 from interior ones, and 37 from the Gulf States. The largest number of these recoveries (47) were from those banded in Saskatchewan, followed by Alberta (34), California (23), and Colorado (12). The percentage of recovery in Mexico was highest for those from Utah (26.9), followed by Colorado (7.5), Saskatchewan (4.9), and Alberta (3.9). There were 27 recoveries in November, 25 in December, 37 in January, 30 in February, and 21 in March, indicating that the kill continues throughout the winter and into the spring (A. G. Smith *in* Aldrich et al. 1949).

On the Pacific Coast 42 wigeon were examined from near Ciudad Obregon, Sonora, and 1 from Mazatlan, Sinaloa. Their gizzard contents included 99.7% plant food (24 items) and 0.3% animal food (4 items). Food items were widgeongrass, 22.1%; spiny naiad, 17.6%; rice, 18.3%; spikerushes, 18.5%; smaller amounts of 19 other plant items; 13.2% unidentified vegetation; and minute quantities of insects and small mollusks.

In the highlands, five wigeon were obtained in the Upper Lerma Valley near Toluca, Mexico, and two at Lake Chapala, Michoacan. Their gizzard contents were almost 100% plant food (nine items), including pondweed, 73%; small quantities of seven other items, 22.3% unidentified vegetation, and a trace of tiny snails.

On the Gulf Coast 18 wigeon were sampled from the Tampico Delta with 1 each from Laguna Madre, Tamaulipas, and Celestun, Yucatan. Their gizzard contents included 96.1% plant food (26 items) and 3.9% animal food (5 items). Foods included widgeongrass

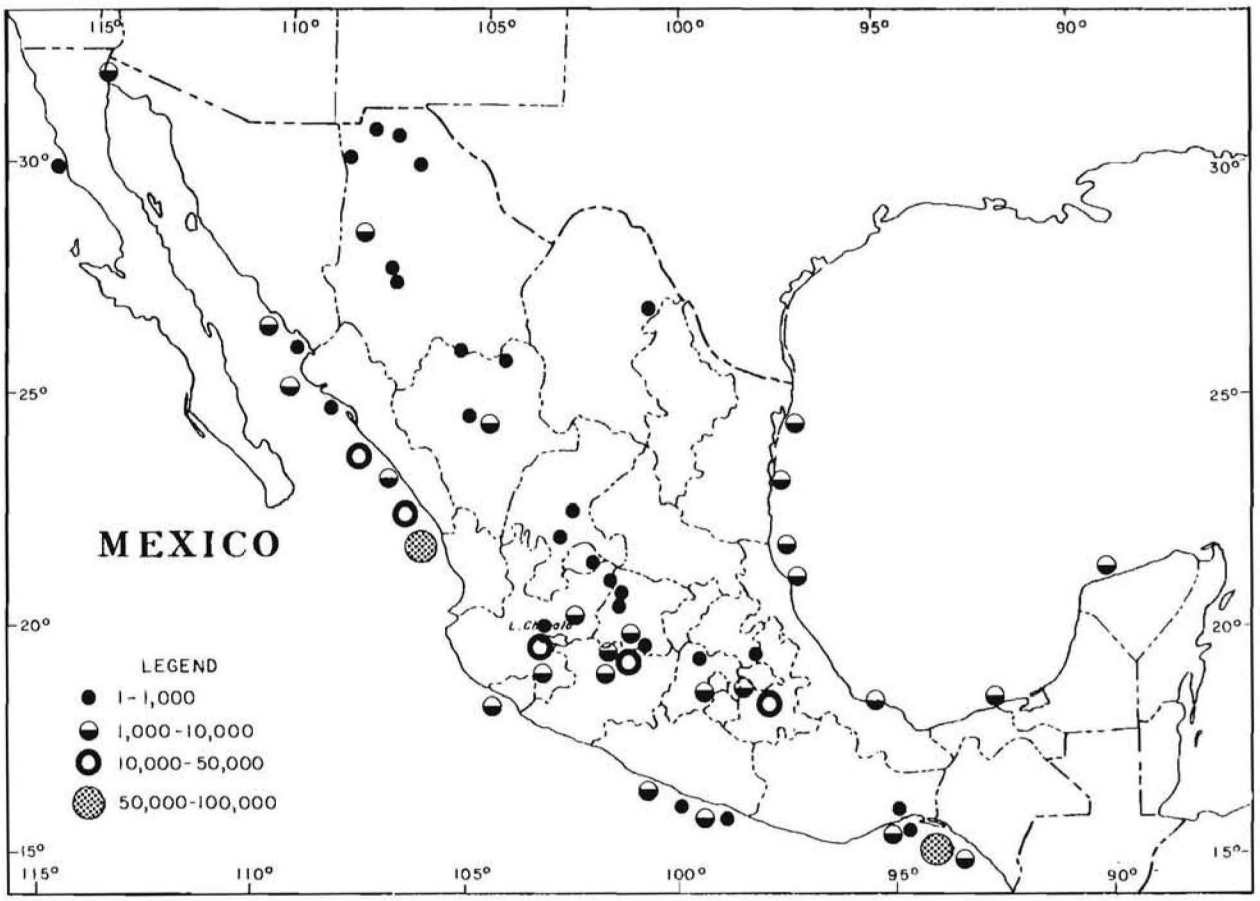

Fig. 33. Average numbers of northern shoveler observed during January aerial surveys, 1948–62.

(49%) and muskgrass (23%). The animal food was mostly tiny snails, but there were also small clams and aquatic insects, including the larvae of midges.

Thirteen wigeon from the Papaloapan Delta, Veracruz, had the following food in their gullets: wigeongrass, 38%; muskgrass, 20%; seeds of wild millet, sedges, and waterlilies, each 5%; seeds of smartweed, bulrush, and sawgrass, each 3%; and the remaining plant material unidentified. Animal food eaten totaled 15% of the contents and included aquatic insects, 5%; mollusks (mostly small snails), 2%; and unidentified material, 8%. A specimen obtained near Colonia Diaz, Chihuahua, in the winter of 1904, which was examined by S. D. Judd (USBS files), contained 64,000 spikerush seeds and a few seeds of *Panicum*.

The hunting pressure on wigeon seems to be equally heavy on the northwest coastal plain, especially in Sinaloa, Sonora, and Baja California, in the interior highlands near the principal lakes in the Bajio, and in the Valley of Mexico. This species is shot much less on the Gulf Coast, except in Yucatan where locally the pressure is estimated to be especially heavy.

Northern Shoveler (*Anas clypeata*)

Mexican names: pato cucharon, pato de cuchara, cuchareta; cucharada (Tampico), pato cuaresmeno; yacapatlahoac and tempatlahoac (Nahuatl) (Friedmann et al. 1950); pato pinto (Lopez and Lopez 1911); pato bocon, bocon pinto (Goldman and Goldman USBS); paxastli (Villada 1891–92).

The shoveler or spoonbill finds its wintering grounds in Mexico much to its liking; most of the continental population of this species goes there for the season. It is common in most of the Republic, and has been recorded in every State (Fig. 33). Known locally in the Valley of Mexico as *bocon*, it is one of the most numerous species there and is said to be one of the first to arrive in the fall and among the last to leave in the spring. The shoveler is also called *pato cuaresmeno* in the Valley of Mexico because it remains as late in the season as *Cuaresma* or Lent.

On the January surveys from 1948 through 1962 this species had an average rank of second in numbers in both the interior highlands and Pacific coastal waters, and eighth on the Gulf coastal plain. Esti-

mated numbers of shovelers seen on these surveys averaged about 335,000; 240,000 were along the Pacific Coast, 78,000 in the interior, and 16,000 on the Gulf Coast.

This species is widely distributed along the Pacific Coast, as the figures from the January aerial surveys show. From 1948 through 1963 the total number seen each year ranged from about 148,000 in 1953 to 391,558 in 1949, and the average is about 240,000. The four most important localities, from the standpoint of wintering populations, are the Marismas Nacionales (average, about 89,000), Laguna de la Joya, Chiapas, (about 49,000), Laguna Caimanero, Sinaloa, (about 30,000), and Ensenada de Pabellon (about 19,000). The other coastal wintering grounds have had much smaller populations of shovelers.

During some years more of these spoonbills have wintered in Chiapas than in Sinaloa, but in other years the opposite is true. Their principal food is phytoplankton, and the variations in their choice of a wintering ground may be the result of highly variable conditions on the Marismas Nacionales that affect the abundance of this food.

A summary of their distribution on the Pacific Coast, by percentages, through 1965 was Marismas Nacionales, 40.3; La Joya, 21.9; Caimanero, 13.7; Pabellon, 8.4; Colorado Delta, 2.9; Mitla-Coyuca, 2.6; Obregon and Sesecapa each 1.8; Topolobampo, 1.7; San Marcos, 1.3; Cuyutlan, 1.1; and nine other sites less than 1.0 each.

The shoveler is a common duck on the waters of the interior highlands. Among the many localities where it has been recorded on the January aerial surveys, the largest numbers have been at Oriental, Cuitzeo, Sayula, and Chapala. Tallies at those places have ranged from a few hundred in some years to more than 40,000 at Cuitzeo in 1962, 36,000 at Sayula in 1953, and about 28,000 at Chapala in 1952. At Laguna Oriental numbers have ranged from 15,000 to more than 39,000. During several winters Lake Texcoco had about 11,000 and Lake Yuriria had as many as 8,500. Other wintering places had enough birds to raise the annual total from 51,000 in 1951 to 139,000 in 1955; the average was about 83,000.

Their average percentage distribution on the 1951-65 aerial surveys of the highlands was Oriental, 19.6; Cuitzeo, 14.7; Sayula, 12.8; Chapala, 8.0; Yuriria, 6.3; Babicora, 5.8; Texcoco, 5.3; Upper Lerma, 4.6; Santiaguillo, 4.2; Zacapu, 2.7; Patzcuaro, 2.4; Zapotlan, 2.1; Huapango, 1.9; Patos, 1.6; Atotonilco, 1.7; Apam, 1.2; and 15 other localities each with less than 1.0%.

This species winters on the Gulf Coast in relatively small numbers. Its population there has fluctuated considerably over the years of the aerial surveys. In 1948 the number seen was about 44,000; in 1954 it dropped to 23,000, and by 1962 it was slightly less than 2,000. We do not know whether there was a decline in the population or whether many of the birds shifted to other localities during some years.

Their percentage distribution on the Gulf Coast, based on the averages of the 1948-65 aerial surveys, was Tampico-Tamiahua, 37.9; Rio Grande, 20.3; Madre, 16.4; Alvarado, 15.3; Campeche-Yucatan, 7.4; and Tabasco, 2.7.

Among 22,923 shovelers banded by July 1962, 1,964 recoveries were reported, including 168 in Mexico. The overall recovery rate was 8.6% but only 0.7% in Mexico.

There were recoveries from 22 States in Mexico; 91 were from the interior States, 59 from the Pacific ones, and 18 from the Gulf States. J. H. Stoudt (*in* Aldrich et al. 1949) reported the recovery of a banded shoveler in Quintana Roo, but that State is not among those listed in the tabulation provided us.

Among the 168 recoveries 66 were banded in Saskatchewan, 64 in Alberta, and 12 in Utah. The percentage of recovery in Mexico was highest for those from Montana (35.7%), Utah (16.2%), Saskatchewan (12.9%), North Dakota (11.0%), and Alberta (10.2%). There were 20 recoveries in November, 32 in December, 37 in January, 25 in February, and 21 in March, showing that the kill continues throughout the winter.

Among 117 shovelers examined from the Pacific Coast 110 were from near Ciudad Obregon, Sonora, 6 from Mazatlan, Sinaloa, and 1 from the Laguna de la Joya, Chiapas. Their gizzard contents included 74.8% plant food (46 items) and 25.2% animal food (17 items). Of the total, 41.5% was cultivated rice, 5.3% ragweed, 5.2% unidentified vegetation, 4.7% dodder (*Cuscuta* sp.), lesser amounts of 19 other plant species, 17.2% snails, 3.8% water boatmen, and lesser amounts of 7 other species. The gullets of four ducks from Laguna de la Joya, Chiapas, contained 97% plankton and 3% insect larvae.

In the highlands three shovelers were obtained in the Upper Lerma Valley near Toluca, Mexico. Their gizzard contents consisted of 66% animal food and 34% plant food. Foods included 26% small snails, 26% bivalves, 13% bivalves and small crabs, 1% beetles, 16% pepperwort sporocarps, 8% Illinois pondweed, 3% each of softstem bulrush and spikerush, and lesser amounts of three other species.

Twenty-six shovelers were examined from the Gulf Coast; 21 were from the Tampico Delta in Tamaulipas and Veracruz, and 5 from near Matamoros, Tamaulipas. Their gizzard contents included 52.3% plant food (43 items) and 47.7% animal food (14 items); 40.3% was southern naiad, 2.3% pondweed, with lesser amounts of 22 other plant species, 37.3% snails, 5.2% water boatmen, 3.2% dragonflies, and small amounts

of 4 other species. The gullet contents of six of these ducks from brackish coastal lagoons near Laguna Madre, Tamaulipas, included 80% plant food and 20% animal food. Plankton was 70%, algae 10%, small snails 10%, and unidentified animal matter 10%.

Three specimens were examined from the freshwater lagoons and marshes near Villa Union, Tabasco, and their gullet contents were 75% plant food and 25% animal food. The contents included 60% plankton; 5% each of smartweed seeds, waterlily seeds, and duckweed; 15% insect larvae; and 5% each of small snails and unidentified animal material.

The January survey figures show very conclusively that the large concentrations of shovelers are in Pacific coastal waters, especially in Chiapas, Guerrero, and Sinaloa. There is almost no hunting pressure in Chiapas (only one recovery) and in Guerrero it is localized almost entirely near Acapulco (five recoveries). In Sinaloa much heavier shooting near Mazatlan has resulted in 22 recoveries reported.

The numbers of shovelers that winter in the highlands are very small compared with those of Pacific waters, but the vulnerability of these ducks on the many small lakes, ponds, and reservoirs, and the larger number of hunters there, have resulted in 25 recoveries from Michoacan, Mexico and Guanajuato 14 each, Chihuahua 13, and smaller numbers from several other plateau States. Thus, although most of the shovelers winter on the Pacific Coast, the more widespread hunting in the highlands has resulted in 93 recoveries there compared with 58 in the Pacific States.

Wood Duck (*Aix sponsa*)

Mexican names: "book names" are pato de arbol; pato de charreteras; pato real cimarron (Friedmann et al. 1950); pato de la Carolina (Alvarado 1916).

The wood duck winters "occasionally to northern Mexico," and it has been recorded in "Sinaloa and Distrito Federal" (Friedmann et al. 1950). Baird et al. (1884) stated that "according to Mr. Lawrence, Colonel Abert met with this species near Mazatlan, in western Mexico." Phillips (1925, 3:51,52) wrote:

> Villada (1891-92), who states that it is found in the Valle from October to March, says that specimens are sometimes taken on the Laguna de Texcoco in August. Dr. E. W. Nelson, however, who travelled and collected much in various parts of Mexico, never saw it there and the well-known collector, Mr. W. W. Brown, did not find it in the Valle when making a collection for the Museum of Comparative Zoology a few years ago.

During field surveys in Mexico (1937-1960) the senior author saw no wood ducks south of the border although he saw a male and a female, on separate occasions, at woodland ponds in Texas adjacent to the Rio Grande and within sight of Mexico. He also saw a specimen which was shot on the Rio Grande near Brownsville, Texas, in the winter of 1936-37, and heard of others shot along that river near McAllen, Texas. The wood duck should, therefore, occur rarely at wooded lagoons of the Rio Grande Delta in northern Tamaulipas.

None of the field reports by other Bureau biologists in Mexico, including those by Nelson and Goldman (USBS files, 1892-1906), had listed it until 11 January 1963, when pilot-biologist Arthur Brazda recorded a flock of 25 in the Rio Grande Delta during the aerial survey. Brazda was based at Lafayette, Louisiana, and was familiar with the field characteristics of this species. Evenden (1952:112-113) observed a female on a roadside pond 117 km southwest of Matamoros, Tamaulipas, along the highway to Victoria on 23 February 1951. Davis (1952:345-355) noted one near Xilitla, on the Rio Axtla, San Luis Potosi.

No recoveries of banded wood duck had been reported by July 1962 in Mexico, and we have no information about their food habits there.

Redhead (*Aythya americana*)

Mexican names: guayareja (Tamaulipas); cabeza colorada; pato cabeza roja.

On the January surveys from 1948 through 1962 this species had an average rank of 5th on the Gulf coastal plain, 10th in Pacific coastal waters, and below 10th in the interior highlands. The estimated numbers of redheads seen on these surveys averaged about 110,000; 85,000 on the Gulf Coast, 23,000 along the Pacific Coast, and 1,000 in the interior (Fig. 34).

Redhead ducks formerly had their principal wintering grounds in Mexico on Laguna Madre, Laguna Morales, and Laguna San Andres, Tamaulipas. They are especially fond of the starchy rhizomes of Gulf shoalgrass (*Diplanthera wrightii*), and their concentrations on the Gulf Coast of Texas and Mexico are in bays where that plant is most abundant. Observations indicate that *Diplanthera* is not present between the Laguna de San Andres and the Laguna Alvarado in Veracruz. Redhead did not go beyond Tamaulipas as long as the food supply there was abundant, but during the recent years, when Laguna Madre was almost as saline as brine and devoid of shoalgrass, small flocks journeyed much farther south, and in 1961 some appeared in the coastal waters of Yucatan.

The redhead has shown a great decline in the numbers that have wintered on the Gulf Coast of Mexico during the past 20 years. As recently as January 1947 the number seen on the aerial survey was estimated at 469,000, most of them in Laguna Madre; in January 1948 the count was only 219,000. From a low in 1950 (21,000) until 1959 (240,000) there was a more or less

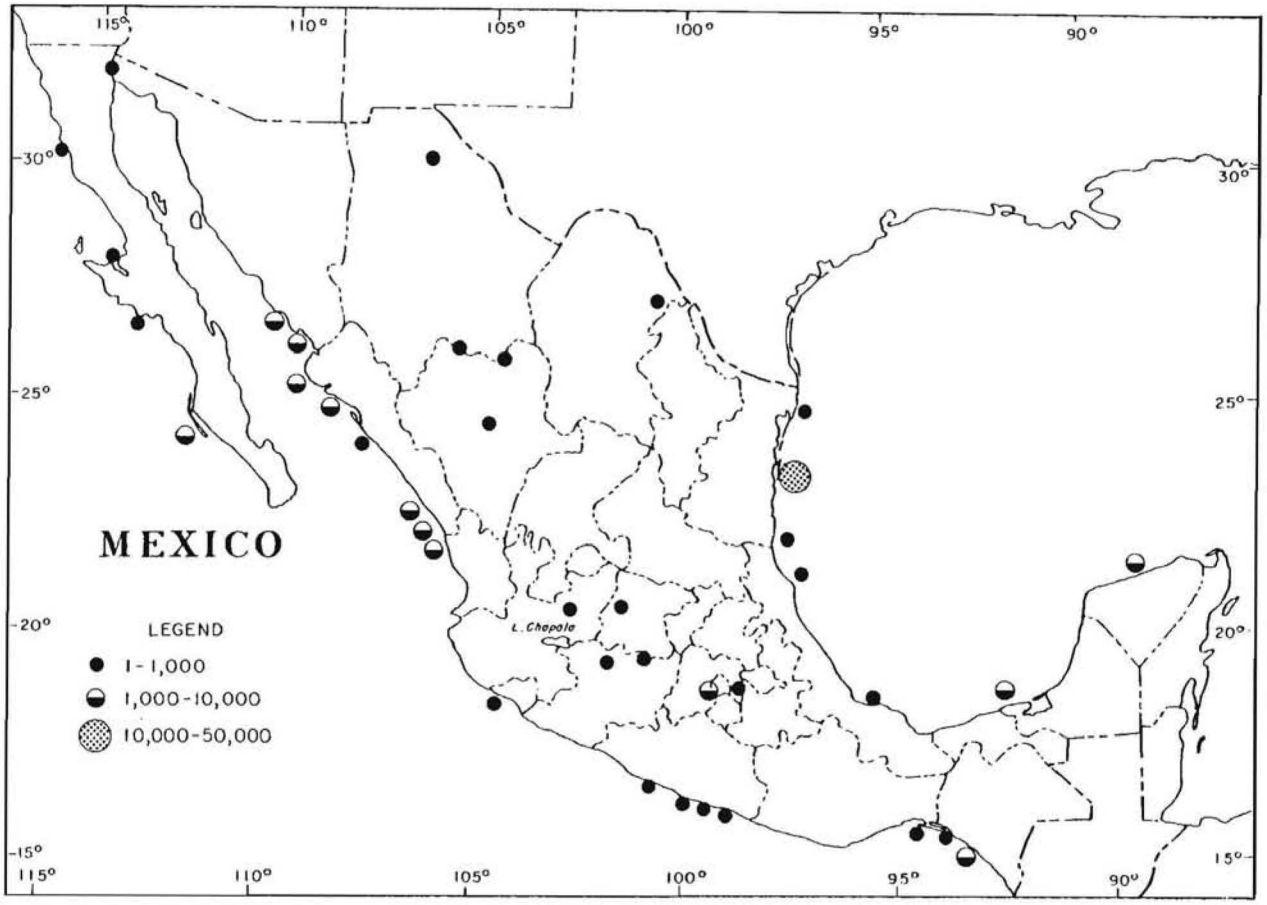

Fig. 34. Average numbers of redhead observed during January aerial surveys, 1948-62.

steady increase, but from 1959 until 1962 (2,262) there was a great decline in redhead there.

From 1963 to 1964 there was an increase from 44,000 to 49,000, but the redheads were on the lakes of the mainland to the west of Laguna Madre, because the latter was almost devoid of shoalgrass. In 1965 the number seen was 23,000.

The average total in Gulf Coast waters from 1948 through 1965 was about 79,000. The overall decrease may have been due partly to a continental decline in the redhead population, but it was caused chiefly by the almost complete disappearance of shoalgrass, their preferred food, in Laguna Madre, Tamaulipas. With the decline of this plant, most of the redheads which would have wintered in that lagoon evidently returned to the coastal waters of southern Texas or went elsewhere in Mexico. A summary of the changes in habitat and food conditions at Laguna Madre is given in the chapter describing the wintering grounds.

Redhead ducks were not observed on the coastal bays of Yucatan from 1938 until 1961, but in 1961 25 birds were noted on the January survey. In January 1962 more than 1,400 were seen, and in January 1963 there were more than 5,000. These protected waters are the nearest ones to southern Tamaulipas that have fine beds of shoalgrass. Although the plant occurs offshore in the Gulf shallows for much of the distance from Tamaulipas to Yucatan, little if any of it seems to be utilized by redhead, because they prefer more sheltered bays and coastal lagoons. In 1962 small numbers of redhead ducks were seen near Alvarado, Veracruz, which is the nearest bay south of Laguna de San Andres that has any shoalgrass. In January 1963 for the first time there were almost 3,000 of them in the Tabasco lagoons. This population figure suggests that with the decline of the formerly used Tamaulipas wintering grounds some of these ducks moved southward to new localities.

When habitat conditions are normal in the Laguna Madre area, the redheads usually feed almost entirely on shoalgrass beds, especially those inside the passes to the Gulf. But at times they leave the salt water and fly en masse to favorite bodies of fresh water on the mainland to rest and drink. Some of these lagoons and

ponds may be 24 km or more inland and surrounded by woodland. This is similar to the flights that hundreds of thousands of redheads formerly made from the coastal waters near Port Isabel, Texas, to Laguna de San Juan, below the Rio Grande in Tamaulipas, and to Laguna San Martin and Laguna Atascosa just across the border in Texas.

One season when we were scouting the Rio San Fernando Delta, we observed that the redheads left Laguna Madre at 0800 to 0830 and flew inland to freshwater ponds and lakes on and near the delta, and that they stayed there until 1700 to 1730, at which time they returned to Laguna Madre for the night. Much of their feeding on shoalgrass was done during the night, as we determined by scouting downwind from them by canoe. There was a steady drift of leaves as the feeding redheads clipped off the starchy rhizomes and discarded the leaves. So to inventory redheads successfully, it is necessary to scout their usual haunts in salt and brackish bays, and also to visit all suitable bodies of fresh water on the mainland.

Percentage distribution on the Gulf Coast, as shown by the January surveys through 1965, was Laguna Madre, 93.7; Campeche–Yucatan, 2.1; Tabasco, 1.9; Tampico–Tamiahua, 1.5; and the Rio Grande and Alvarado each with less than 1.0.

On the Pacific Coast redheads are most common on the lagoons and bays of Sinaloa. They are uncommon south of Manzanillo, but a few have been observed as far south as Chiapas. The totals seen in Pacific waters through 1964 were below 50,000, and in some years, especially in 1950, 1951, 1956, 1958, and since 1960, totals were less than 25,000. In 1965 the total was almost 51,000.

Percentage distribution of these ducks, as shown by findings of the aerial surveys, was Agiabampo, 29.4; Santa Maria, 28.2; Topolobampo, 18.6; Obregon, 8.3; Marismas Nacionales, 6.3; Sesecapa, 2.3; Magdalena, 1.4; Cuyutlan, 1.2; and 11 other localities each with less than 1.0.

This species is scarce in the highlands. Most of its former favorite haunts have been greatly lessened in attractiveness by drainage. The largest numbers seen there were in 1951 when 6,460 were noted from Lake Chapala to the Valley of Mexico. In 1953 there were 4,150 seen, of which 4,000 were on the small lakes of the Upper Lerma Valley. The northernmost records were of a few on Lago Toronto and at Laguna de los Patos.

Percentage distribution of redheads in the highlands, as indicated by the January surveys through 1965, was Upper Lerma, 61.5; Texcoco, 7.1; Cuitzeo, 6.3; Patzcuaro, 5.2; Irapuato, 4.0; San Isidro, 3.9; Huapango, 2.7; Toronto and Rio de Oro each 1.8; Santiaguillo 1.7; Chapala 1.5; and six other localities each with less than 1.0.

Until July 1962, among the 77,823 redheads banded, 10,851 recoveries were reported, including 244 in Mexico. The overall recovery rate was 13.9% but only 0.3% in Mexico. There were recoveries from 21 States in Mexico, but most of them (168) were from the Pacific States; 57 were from the interior States and only 19 from the Gulf States.

The largest numbers of reported recoveries were from the following States: Sinaloa 64, Sonora 58, Baja California 36, Chihuahua 19, and Tamaulipas 16. The redhead duck is so largely restricted to coastal waters that only 10 recoveries were reported from Jalisco and Michoacan.

The largest number of these recoveries (73) was banded in Utah, followed by California (72), Nevada (33), Oregon (15), and Idaho (12). The percentage recovery in Mexico was highest for those banded in Idaho (22.6), followed by those banded in Oregon (7.0), Nevada (6.7), Utah (5.6), and California (5.5). There were 36 recoveries in November, 65 in December, 55 in January, 33 in February, and 22 in March.

By far the greatest numbers of redheads, especially before 1960, wintered in Tamaulipas, but their relative inaccessibility and almost insignificant hunting pressure were responsible for the few (16) recoveries reported from that State. In Sinaloa and Sonora the redheads were much fewer, but the flocks were much more vulnerable to shooting and they included many banded in nearby California and Utah. Some, including groups from Utah and Colorado, came southward to the plateau States where 19 were reported from Chihuahua and 5 from Durango.

There is a likelihood that many more redheads from Utah winter on the Gulf Coast in Tamaulipas than in the nearer Pacific coastal waters of Sinaloa and Sonora. Band recoveries, aerial surveys, and other field observations substantiate the occurrence of a strong migration of redhead from western United States and Canada to the coastal waters of the western Gulf of Mexico, but almost all of the recoveries have been in Texas where there is much heavier hunting pressure (C. S. Robbins *in* Aldrich et al. 1949).

The records of the January 1961 survey showed the redhead continental population, by flyways, including Mexico, as follows: Pacific 43,499, Central 614,412, Mississippi 11,146, and Atlantic 89,205. Most of the Central Flyway redheads usually winter on the Coast of Texas and Tamaulipas.

In Baja California the 36 recoveries were distributed from near Mexicali to La Paz and San Jose del Cabo; no one locality received a majority, although there were more from the Colorado River Delta than elsewhere. The majority of recoveries in Sonora were from the vicinity of Navojoa and the Rio Mayo, but several were from the Ciudad Obregon district. In Sinaloa recoveries were reported from Los Mochis and Ahome

in the north to Rosario in the south, but most were taken near Mazatlan, Culiacan, and Los Mochis.

There were 13 redheads examined on the Pacific Coast, 6 of them from near Ciudad Obregon, Sonora, and 7 from Mazatlan, Sinaloa. Their gizzard contents contained 84.9% plant food (13 items) and 15.1% animal food (5 items). The diet included 59.8% widgeongrass, 8.3% shoalgrass, 7.8% cultivated rice, 7.5% unidentified vegetation, 10.4% snails, and 4.6% midges.

The gullets of nine other redheads from the brackish coastal lagoons of Mazatlan, Sinaloa, contained 20% widgeongrass, 75% bloodworms, and 5% small snails which were on the leaves of the widgeongrass.

On the Gulf Coast the gizzard contents of two redheads from near Matamoros and the Laguna Madre, Tamaulipas, had plant food consisting of 54% water shield (*Brasenia schreberi*), 33% shoalgrass, 5% heliotrope (*Heliotropium* sp.), and 8% bivalves.

Ninety-four redheads were examined from the saline coastal Laguna Madre, Tamaulipas. Their gullet contents were made up of 91.4% plant food and 8.6% animal food. The principal items were shoalgrass, 79.7%; widgeongrass, 4.8%; 4.8% unidentified animal matter; and 3.8% mollusks, mainly snails. Shoalgrass is not common in the Pacific bays of Mexico and is not found at all north of Sinaloa, according to available information. Widgeongrass is the predominant submerged aquatic plant in parts of Mexico's brackish bays and lagoons.

More redheads are shot in Pacific localities than in other parts of Mexico, because of the hunting pressure in Baja California, Sonora, and Sinaloa, and the accessibility of good shooting places there. Much smaller numbers are shot in the interior highlands where redheads are relatively scarce. Hunting is chiefly in Durango, Jalisco, Mexico, and Hidalgo. The largest numbers of this duck usually are present in Tamaulipas, but the concentrations are accessible to few hunters and so the kill is very light.

Ring-necked Duck (*Aythya collaris*)

Mexican names: pato chaparro; texoloctli (Nahuatl) (Friedmann et al. 1950); pato tlololacte, chaparro grande (Santamaria 1942); tzoyayacqui (Villada 1891–92); pato boludo prieto (Ferrari-Perez 1886).

On the January surveys from 1948 through 1965 this species had an average rank of 9th on the Gulf coastal plain, and below 10th in the interior highlands and Pacific coastal waters. It has been recorded in every State of Mexico. Estimated numbers of ring-necked ducks seen on these surveys averaged slightly more than 10,000; 10,000 were on the Gulf coastal plain and only a few birds were in the interior and along the Pacific Coast (Fig. 35).

This species has not received its deserved attention on the aerial surveys, and the records have varied with changes in observers and their experience in identifying this duck. In some localities, such as the Yucatan lagoons, ring-necked ducks are mixed with rafts of lesser scaups and coots, and from the air are easily confused with the scaup. At other times they are widely scattered over the Alvarado and Tabasco lagoons and marshes and are easily overlooked there. Their fondness for small lagoons covered with waterlilies makes them especially difficult to see. For these and other reasons the population estimates of ring-necked duck are undoubtedly far below their actual wintering population in Mexico.

Ring-necked ducks are observed chiefly on the Gulf Coast from the Tampico area around to the lagoons of northern Yucatan. Those frequenting the Tampico district are mostly found on fresh water, but those in Yucatan are on brackish and saltwater bays and lagoons because very little fresh water is available on that coast. Many of those in Yucatan waters evidently migrate across the Gulf of Mexico from Louisiana and they have been observed a few kilometers offshore to the north of Yucatan, apparently en route to that coast.

Percentage distribution on the Gulf Coast, as indicated by the aerial surveys through 1965, was Tampico-Tamiahua, 38.0; Campeche-Yucatan, 27.1; Tabasco, 15.4; Alvarado, 13.4; Rio Grande, 5.0; and Laguna Madre, 1.1.

The largest number recorded on the Gulf Coast was almost 37,000 on the Yucatan lagoons in 1948. The following year the majority of those seen was in the Tampico district and totaled only 14,000. In other years, as in 1959, no more than 130 individuals of this species were reported on the entire Gulf Coast. In 1961 the total was 135 birds, but in 1963 more than 26,000 were recorded. It seems likely that during these years some changes in distribution occurred and that many of the ring-necked ducks may have been on waters not covered by the surveys.

Duvall reported that, "Texas is the wintering ground for ringnecks which reach that State via two routes; one following the Mississippi River to the Louisiana Gulf Coast and Texas, and another one through the eastern part of the great Plains" (in Aldrich et al. 1949:31). Although they reach Texas by these routes, many pass through Texas or along its shore to wintering grounds on the eastern coast and in the interior of Mexico. Inventories of them taken by the Texas Game and Fish Commission showed a peak population early in December and much smaller numbers in January and February. Obviously, many of those birds shot on the Texas Coast during November and December are en route to Mexico. On the Pacific Coast they winter from Sinaloa south to Chiapas, but they

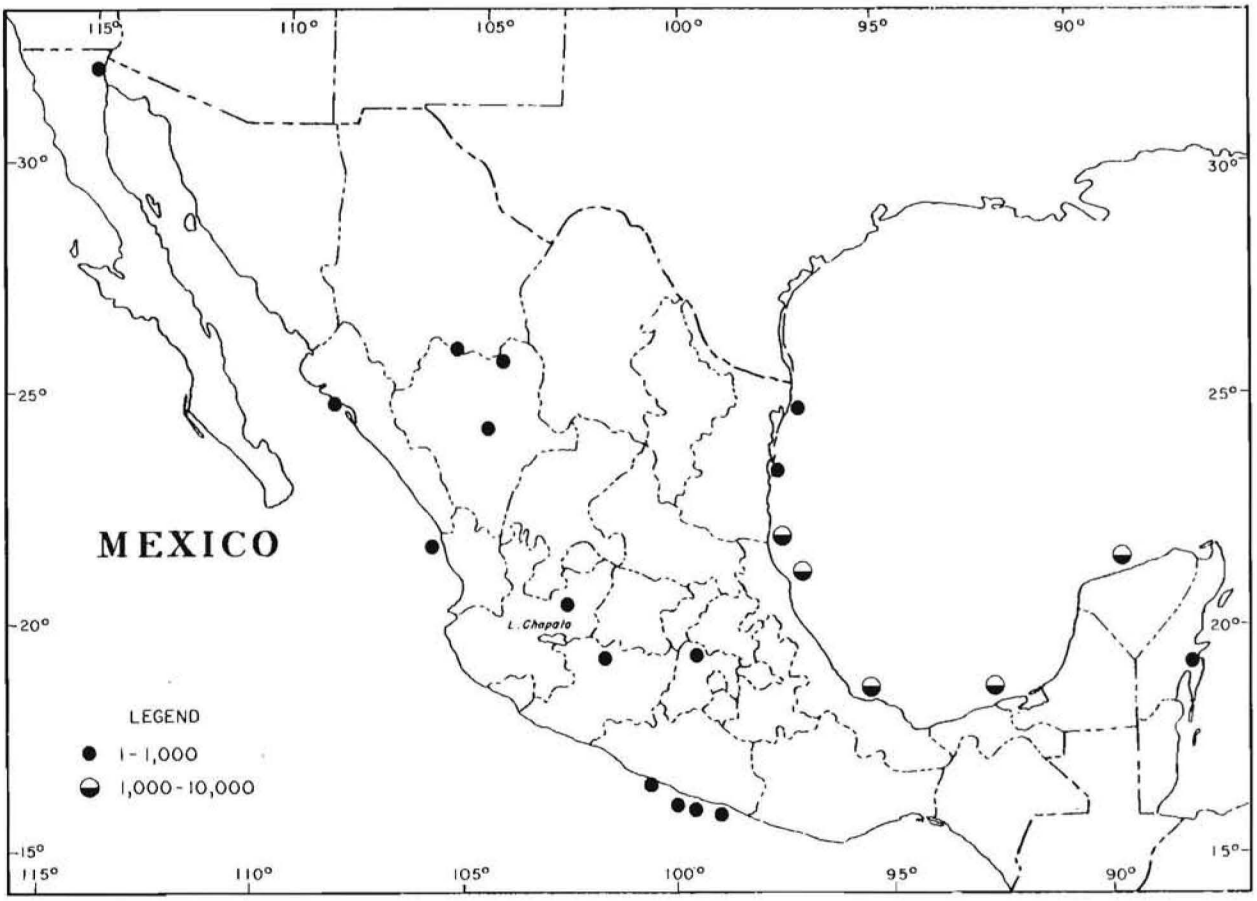

Fig. 35. Average numbers of ring-necked duck observed during January aerial surveys, 1948–62.

are most common from southern Sinaloa to northern Oaxaca. The northward migration occurs chiefly during March.

The ring-necked duck is undoubtedly at times confused with scaup during the aerial surveys because an observer passing over rafts of scattered birds at 160 km or more an hour usually has insufficient time to differentiate between these two species. During the aerial inventory of January-February 1949 none was recorded in the Acapulco area but groundwork done there at the same time showed 195 ring-necked ducks among a raft of 2,660 scaup on Laguna Coyuca. Nelson and Goldman (USBS files) found this species to be abundant in the sector from Manzanillo to the Rio Armeria, Colima, especially on Laguna Cuyutlan, during January-March 1892. On the 1948 aerial survey 4,915 were seen at Mitla-Coyuca and 2,070 on Papagayo, both in Guerrero. At Marismas Nacionales 2,505 were recorded in 1950 and 1,300 in 1963. Very few ring-necked ducks were listed elsewhere.

This species has seldom been recorded in the interior highlands on the January aerial surveys. A few hundred birds were noted some years in the northern part of the interior plateau, mostly at Laguna Santiaguillo, and smaller numbers were seen at Lake Toronto and Laguna de las Palomas. At the more southern lakes about 2,000 were recorded at Cuitzeo and 1,400 at Chapala in 1965, but in many years none was listed. Ground surveys have shown that small flocks of ring-necked ducks were widely distributed in the highlands, so obviously they were often overlooked from the air.

Until July 1962, 4,517 recoveries were reported among 37,154 ring-necked ducks banded; only 12 (0.3%) were in Mexico. Six recoveries were from interior States and three each from Gulf and Pacific States. The overall recovery rate was 12.2%, but only 0.3% in Mexico. There were recoveries from nine States in Mexico: three in Veracruz, two in Hidalgo, and one each in Baja California, Chihuahua, Guanajuato, Jalisco, Michoacan, Nayarit, and Sinaloa. Six of these 12 recoveries were banded in Minnesota, 3 in Louisiana, and 1 each in Colorado, Maine, Nevada,

New Mexico, and Oklahoma. There were four recoveries during January, three in December, and two each in November and February.

On the Pacific Coast one of these ducks was obtained near Ciudad Obregon, Sonora. Its gizzard contained mostly unidentified vegetation and a trace of ragweed seed. Two of these ducks, one from the Tampico Delta and the other from Celestun, Yucatan, had in their gizzards sawgrass seed, 58%; unidentified vegetation, 32%; and 4% each of bivalves and small snails.

Eight ring-necked ducks were examined from the brackish coastal lagoons of the Rio Grande Delta in Tamaulipas, and Laguna Alvarado in Veracruz. Their gullets contained 88.5% plant food and 11.1% animal food (41.2% widgeongrass, 13.7% naiad, 10% bulrush seeds, 10% unidentified vegetation, and lesser amounts of three other plant species, 5% unidentified animal matter, 3.1% snails, 1.8% insect larvae, and 1.2% crustaceans).

Although many more of these ducks are present in Gulf coastal waters than elsewhere in the Republic, they receive very little shooting pressure, chiefly because of their occurrence in isolated places. More are killed in the interior highlands at the many small lakes and reservoirs so accessible to hunters. Small numbers are also shot locally on the Pacific Coast, especially in Sinaloa and Guerrero.

Canvasback (*Aythya valisineria*)

Mexican names: espalda de canamo, pato marino, pato grande, pato coacostle, coacoztli (Nahuatl) (Friedmann et al. 1950), cuaco (Toluca) (Goldman and Goldman, USBS Files, 1926–40), pato borrado (Leopold 1959).

The inventory figures and other observations reflect a population decline in the number of canvasback wintering in Mexico. Although in some areas there have been changes in the relative abundance of its preferred foods, especially of small mollusks, there continue to be ample amounts for many times the numbers of canvasback coming there in recent years.

On the January surveys from 1948 through 1962 this species had an average rank of 7th in abundance in the interior highlands, 9th on the Gulf coastal plain, and below 10th in Pacific coastal waters. The estimated numbers of canvasbacks seen on these surveys averaged about 25,000; 15,000 were in the interior, 8,000 on the Gulf Coast, and 1,000 along the Pacific Coast (Fig. 36). Some of the totals were 50,000 or more on the Gulf Coast alone before 1948.

Before 1949 it was most numerous in the Tampico, Laguna Tamiahua, and Alvarado areas. At Laguna Tamiahua the preferred foods were several species of small mollusks and widgeongrass. In the Tampico area small mollusks were eaten on Laguna Pueblo Viejo and Laguna Chairrel, but most of the canvasback congregated on Laguna Corcovado where they had an abundance of banana waterlily tubers. The first of those major wintering grounds to decline was Laguna Tamiahua, which had been the favorite canvasback wintering ground in Mexico. On a local aerial survey in February 1938 the number estimated on the northern part of Laguna Tamiahua was more than 50,000; in February 1939 an aerial survey revealed 32,400 canvasbacks there. Since 1948 the wintering population on the Gulf Coast has continued to drop; in 1963, it was only 800 in the Tampico district and 4,400 on Laguna Tamiahua. There may have been some correlation between the population decline in these areas and the subsequent increases in canvasbacks wintering in the highlands.

On the January 1947 inventory it was estimated that there were 51,971 in the Tampico area and 10,720 on Laguna Tamiahua. Only 185 were seen on the Pacific Coast. In January 1948 the estimates were Tampico area, 22,014; Tamiahua, 9,546; and Alvarado, 4,330. At that time the Pacific Coast population was 6,486. The first relatively complete coverage of the interior highlands was in 1951, and during that year the inventory estimates were Gulf Coast, 5,110; Pacific Coast, 2,278; and central highlands, 15,040.

In the interior the canvasback is commonly observed on the large lakes of the highlands and some reservoirs, but usually in small numbers. In the years before the level of Lake Tultengo near Apam, Hidalgo, was lowered by partial drainage, it was a favorite wintering place for small numbers of this species. Lake Chapala and Lake Patzcuaro also have had from a few hundred to several thousand of these birds at the time of the January survey.

The canvasback has decreased greatly in the highlands of Mexico during the years since the January aerial surveys began there in 1948. Although small numbers have been recorded at some localities in the northern highlands, most of these birds winter in the central lakes district. The most important place for them used to be Lake Chapala, which had nearly 42,000 in 1956, but only 25 birds in 1963. Lake Patzcuaro had nearly 19,000 in 1954, but since 1961 it has had fewer than 2,000. Other lakes and lagoons of the central and southern highlands have had much smaller numbers of canvasback. The annual totals for the January aerial surveys have been from about 2,000 in 1959 and 1962 to about 44,000 in 1956; the annual average was about 15,000. The decline in the population of these ducks cannot be correlated with losses of habitat at these highland lakes because food conditions continue to be good for this species.

Percentage distribution, as indicated by January surveys through 1965, was Chapala, 32.6; Patzcuaro, 26.7; Oriental, 8.7; Texcoco, 7.8; Cuitzeo, 4.5; Upper

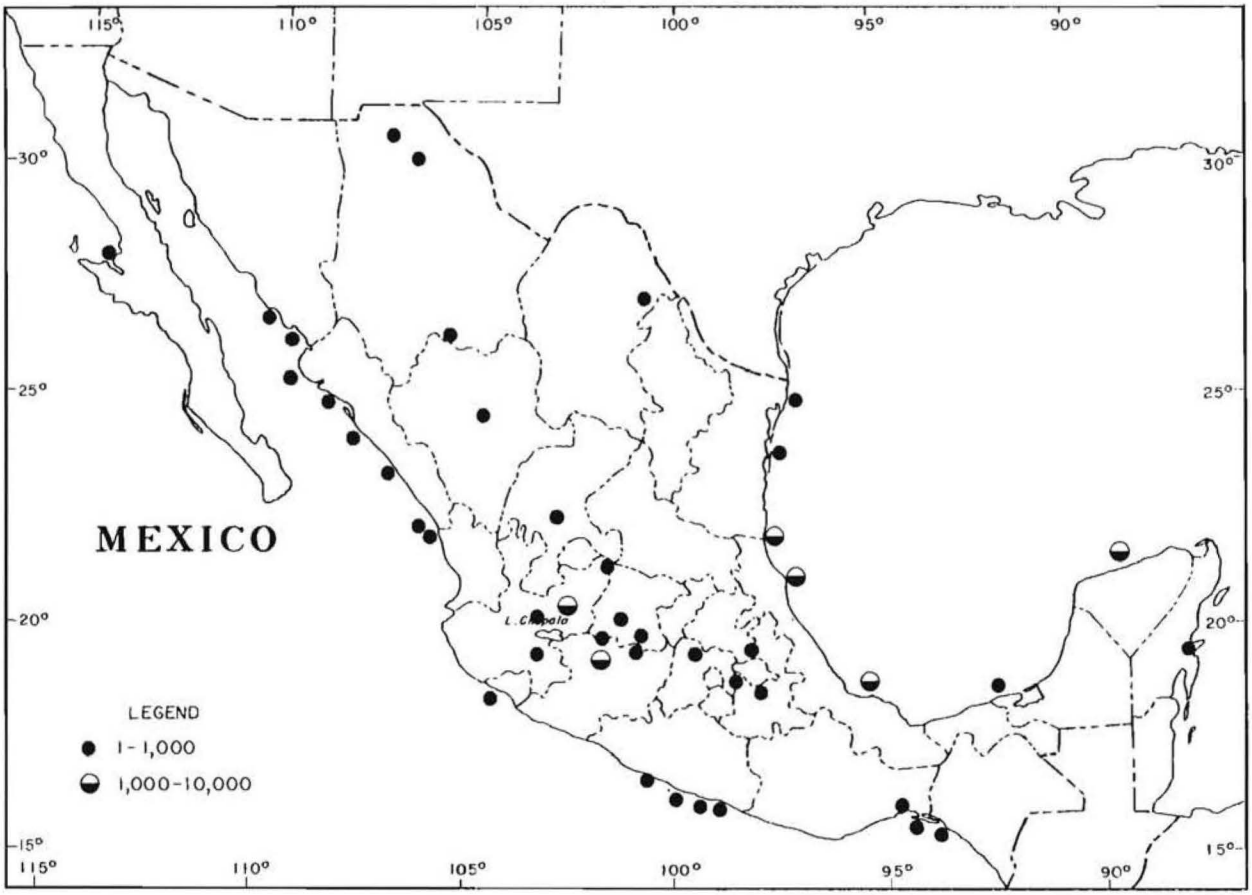

Fig. 36. Average numbers of canvasback observed during January aerial surveys, 1948–62.

Lerma, 2.9; Zacapu, 2.8; Santiaguillo, 2.6; San Isidro, 2.2; Yuriria, 2.0; Huapango, 1.7; and Lagos de Moreno, 1.2. Thirteen other localities had less than 1.0% each.

The percentage distribution on the Pacific Coast, as shown by the aerial surveys through 1965, was Marismas Nacionales, 48.7; Ciudad Obregon, 19.8; Dimas, 7.2; Topolobampo, 5.8; Pabellon, 5.5; Mar Muerto, 4.0; Cuyutlan, 3.1; Agiabampo, 1.4; Caimanero, 1.4; Papagayo, 1.0; and eight other localities each with less than 1.0. On the Gulf Coast, the percentage distribution, as shown by the aerial surveys, was Tampico-Tamiahua, 41.7; Campeche-Yucatan, 20.6; Alvarado, 19.9; Laguna Madre, 12.1; Tabasco, 3.4; and Rio Grande, 2.3.

In his field notes in 1926, E. A. Goldman wrote the following summary of his observations of this species.

> C. G. Ray, an American resident of the City of Mexico for many years, and perhaps the best informed of local hunters, told me (in 1926) that he had never seen the canvasback in the Valley of Mexico until about six years ago, but that the species is now becoming rather common. According to Mr. Ray, they begin to arrive about the middle of January, and increase in numbers for some time thereafter. None were observed by me until February 3, when I visited Lake Zumpango, and saw at least 2,000 in one flock on the open water. About the same number were observed on the same date, also well out on the open water in a lake known as the Charco de San Mateo, on the northern side of the Valley of Mexico. According to Professor Carlos Lopez, the Aztec name of this species, still used in the Valley of Mexico, is "coacoxtli." At Lake Patzcuaro, February 20, thousands of canvasbacks in the aggregate were seen during a trip by motor boat well out on the open water. These were in scattered flocks, numbering from 50 to 75 to 100, sometimes associated with flocks of widgeons, cinnamon teal, and blue-winged teal, but usually they were seen by themselves. March 5, thousands of canvasbacks in the aggregate were observed while on a motor boat trip through Tamiahua lagoon (Veracruz, south of Tampico). Flocks of 50 to several hundred were seen well out on the open water of the lagoon, a habitat favored also by the lesser scaups and the redheads. Aside from the lesser scaups and redheads, no other ducks were seen on the lagoon.

These observations probably were made in the northern part of Laguna Tamiahua because the

mollusks preferred by the canvasbacks were found there. The middle and southern parts of the lagoon were not scouted by him.

Of 39,030 canvasbacks banded through the years ending 31 May 1962, 4,741 recoveries were reported, including 29 (0.61%) in Mexico. The overall recovery rate was 12.14% but only 0.07% in Mexico. There were recoveries from 11 States in Mexico; the largest number (17) were from the interior States of Michoacan, Jalisco, and Mexico. Two recoveries each were recorded from Chihuahua, Durango, Sinaloa, and Veracruz.

Seven of these recoveries were banded in Saskatchewan, four in Manitoba, and three in Louisiana. Two recoveries each were banded in Alaska, Alberta, California, Idaho, and North Dakota. The percentage recovery in Mexico of birds banded in Manitoba was 1.3%; among ducks from Saskatchewan it was 2.7%. The largest number of recoveries was in December (nine), followed by January (seven). Four each were killed in November, February, and April.

On the Pacific Coast 15 canvasbacks were examined from near Ciudad Obregon, Sonora. Their gizzards contained 94.9% plant food (13 items) and 5.1% animal food (86% of the total was "water-chestnut-like" plants, 6.5% mesquite beans, 4.5% crabs, and lesser amounts of snails and bivalves). In the highlands one small group was obtained consisting of two birds from the Lerma Valley near Toluca, Mexico, and two from Lake Chapala, Michoacan. Their gizzards contained 44% pondweed seeds, 21% whitestem pondweed, 10% sago pondweed (*Potamogeton pectinatus*), and 25% unidentified vegetation.

Another group of five of these birds was examined from Lakes Patzcuaro and Chapala in Michoacan. Their gullets contained 49% plant food and 51% animal food (36% pondweed seeds, 9% unidentified vegetation, 4% miscellaneous seeds, 43% mollusks of several species, 5% crustaceans and aquatic insects, and 3% unidentified material). On the Gulf Coast the gizzards of three of these ducks obtained at the Laguna Tamiahua, Veracruz, contained 92% animal matter (91% bivalves, 1% snails, 5% sea lettuce, less than 1% each of muskgrass and naiad, and lesser amounts of three other species).

Another group of 30 birds was obtained from brackish Laguna Tamiahua. Their gullet contents consisted of 41.4% plant food and 58.3% animal food (13.8% naiad, 12.5% widgeongrass, 5% muskgrass, 4.1% each of bulrush seeds and miscellaneous seeds, 37.5% clams [chiefly *Macoma*], 15.8% other mollusks [chiefly snails], and 5% crustaceans and aquatic insects). Seven canvasbacks were examined from the freshwater lagoons of the Tampico Delta in Veracruz. Their gullets contained 98.8% plant food and 0.7% animal food (small snails). Sixty-two percent was waterlily seeds and rootstocks (chiefly banana waterlily), 14.2% wild celery buds and seeds, 7.1% widgeongrass seeds and leaves, and lesser amounts of six other species.

Before about 1947 the heaviest shooting pressure on this species was on Laguna Tamiahua, Veracruz, and in several other localities near Tampico, Tamaulipas; at Laguna Tultengo in the highlands near Mexico City; and near Guadalajara, chiefly at Lake Chapala. With the changing distribution of this species due to losses of habitat, hunting during the past 15 years has occurred mostly at small lakes in the highlands, especially in the States of Jalisco, Michoacan, Mexico, and Chihuahua. There seems to be little pressure on the canvasbacks that winter on the Pacific Coast, probably because they are less accessible and because of the greater availability of pintails and other field-feeders there.

Canvasback were recorded in every State except Quintana Roo.

Greater Scaup (*Aythya marila*)

Mexican names: pato boludo; pato boludo americano (Friedmann et al. 1950); pato bocon (Lopez and Lopez 1911).

Reported by the Check-list from "Baja California (once), Sinaloa (twice)." The first record is based on the "Specimen in Museum of Vertebrate Zoology (female, No. 52068) taken by C. C. Lamb in the Colorado Delta one mile northeast of Cerro Prieto, February 7, 1928" (Grinnell and Storer 1928).

We have seen and collected this species as far south on the Gulf of Mexico as Corpus Christi, Texas, within 208 km of the United States-Mexico boundary. Banded greater scaup also have been shot in the Corpus Christi area. Since there are large numbers of lesser scaup that winter on both coasts of Mexico, it is very likely that an occasional individual of the greater scaup journeys south of the border with them, but during the aerial and ground surveys of 1948-65 no scaup of this species was identified.

By July 1962, there were no recoveries in Mexico of banded individuals of this species.

Greater scaup were recorded in Baja California and Sinaloa.

Lesser Scaup (*Aythya affinis*)

Mexican names: pato negro and pato moreno (Tamaulipas); pato boludo chico (Friedmann et al. 1950); pato bocon (Lopez and Lopez 1911); pato voludo (Yucatan) (Goldman and Goldman USFWS files, 1926-42); hualpol and box pato (Maya) (Goldman and Goldman USFWS files, 1926-42); pico azul (Goldman and Goldman USFWS files, 1926-42); chaparro grande (Laguna Tultengo) (Goldman and Goldman USFWS files, 1926-42).

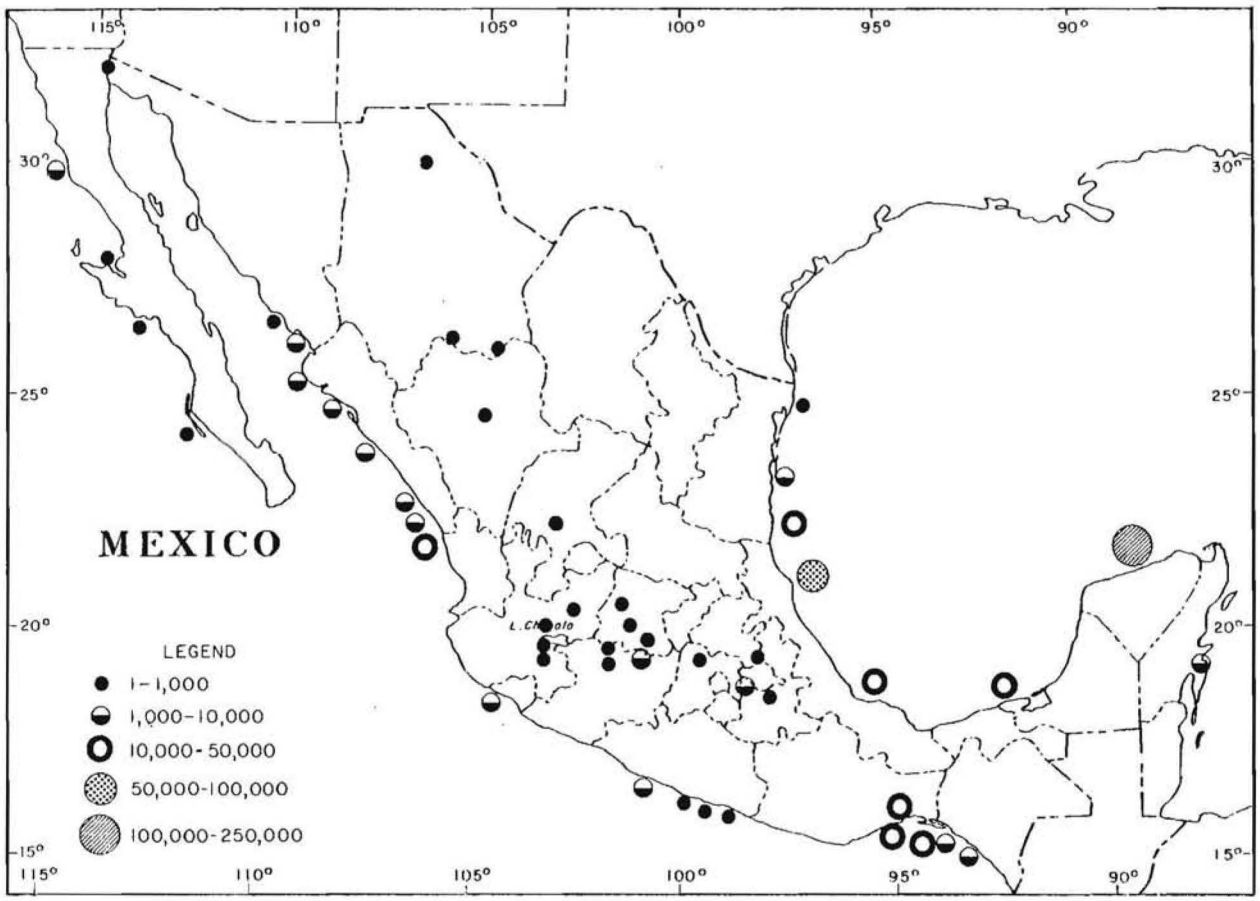

Fig. 37. Average numbers of lesser scaup observed during January aerial surveys, 1948–62.

The lesser scaup can be found in every State in the Republic (Fig. 37). Most of those wintering in Mexico have been observed on coastal lagoons and bays, in most instances where extensive beds of small mollusks were found (Aldrich et al. 1949). In the January surveys from 1948 through 1962 this species, compared with others, ranked first in numbers on the Gulf coastal plain, third in Pacific coastal waters, and eighth in the interior highlands.

Estimated numbers of lesser scaup seen on these surveys averaged about 410,000; 227,000 were on the Gulf Coast, 176,000 along the Pacific Coast, and 7,000 in the interior. On the Pacific Coast the peak was in 1948, when almost 350,000 birds were seen. Lesser peaks were in 1949, 1952, 1954, 1958, and 1959. Lows were in 1951, 1955, 1956, and 1960.

Percentage distribution of lesser scaup in the Pacific coastal waters through 1965 was Marismas Nacionales, 20.5; Caimanero, 12.4; Superior, 12.0; Mar Muerto, 11.6; Inferior, 7.6; Cuyutlan, 4.9; San Marcos, 4.2; La Joya, 4.2; Mitla-Coyuca, 3.0; Sesecapa, 2.6; San Quintin and Topolobampo each 2.1; Agiabampo and Pabellon each 2.0; Nexpa, 1.8; Dimas, 1.5; Ciudad Obregon, 1.4; San Marcos, 1.3; Santa Maria, 1.1; and four others each with less than 1.0.

It is surprising that the January aerial surveys revealed so few scaup on the waters of the northern highlands. Totals there have seldom been more than 1,000 birds and usually much less. The largest numbers elsewhere in the highlands were noted on Lake Cuitzeo in 1956, when more than 6,000 were found, and on Lake Chapala where more than 4,000 were seen that same year. The totals recorded in the interior on the January aerial surveys were from about 1,000 in 1952 to about 16,000 in 1959; the annual average was about 7,000. It is apparent that relatively few scaup leave the coastal waters during the winter.

Percentage distribution in the highlands, as shown by the aerial surveys through 1965, was as follows: Cuitzeo, 24.1; Acambaro, 10.8; Apam, 10.0; Texcoco, 7.3; Huapango, 6.8; Oriental, 6.7; Irapuato and Chapala each 4.8; Yuriria, 3.9; Toronto, 3.5; Zacapu, 2.6;

Patos, 2.5; San Isidro, 2.0; Lagos de Moreno, 1.0; and four other localities each with less than 1.0.

This is the most abundant duck on the Gulf Coast of Mexico. During some years it has been outnumbered by the pintail, but its average is considerably higher than the latter. Numbers of scaup during 1948–63 ranged from 445,000 in 1948 to 69,000 in 1951; the average was 217,000.

This species has shifted its distribution considerably from year to year. At the times of many of the aerial surveys there were more scaup on Laguna Tamiahua than elsewhere on the Gulf Coast, but during some years the largest flocks were on the Yucatan lagoons. To what extent these shifts were caused by changes in food supplies is not known. Feeding conditions have remained very good for this species throughout the survey period on Laguna Tamiahua, but they were even better in the Yucatan lagoons for part of the time. Other factors are the numbers of scaup that winter in Central America but stop to rest in the Yucatan lagoons, and the many rafts of scaup that spend at least part of their days during the winter offshore in the Gulf.

Although Laguna Tamiahua was usually a most important wintering ground for scaup, the numbers seen there in 1950 were less than 4,000. The average total for this lagoon was slightly more than 55,000. The only locality that wintered more scaup was the Yucatan lagoons, which had an average total of almost 103,000 birds. The numbers noted in Yucatan during the aerial surveys ranged from 11,000 in 1963 and 17,000 in 1951, to 210,000 in 1949 and 261,000 in 1958.

The Alvarado district is another area in which scaup numbers varied widely. In 1948 more than 64,000 were seen there, chiefly on Laguna Alvarado; however, in 1953 only 1,200 were counted. Large numbers of waterfowl in this locality are easy overlooked during the aerial surveys. It is also possible that much of the fluctuation in numbers that has been observed from year to year may have been due to differences in the advance of migration.

Percentage distribution as shown by aerial surveys through 1965 was as follows: Campeche-Yucatan, 57.7; Tampico-Tamiahua, 21.1; Tabasco, 9.1; Alvarado, 7.6; Laguna Madre, 3.7; and the Rio Grande with less than 1.0.

During migration flocks of scaup are often observed flying offshore in the Gulf or feeding in the shallows, especially near the passes and mouths of rivers.

Information from long-time residents of Tampico indicates that the waterfowl must have suffered heavy mortality from pollution in the early years of oil production in that sector. In 1909 and later, they reported, blowouts of wells in the oil fields west of Laguna Tamiahua resulted in that great body of water being completely covered with a heavy film of oil. This pollution was again very bad from 1921 to 1923. Some of the Tampico lagoons were also covered with oil from nearby wells of the Panuco field.

Until July 1962 of 134,949 lesser scaup banded, 10,531 recoveries were reported, including 169 (1.6%) in Mexico. The overall recovery rate was 7.8%, but only 0.1% in Mexico.

There were recoveries from every State in Mexico except Campeche, Chiapas, Colima, and Quintana Roo. Most (73) were from the Pacific States, 57 from the interior States, and 39 from the Gulf States. The largest number of these recoveries was banded in Alberta (81), followed by Alaska (20), British Columbia (17), and Louisiana (10). There were 21 recoveries in November, 43 in December, 45 in January, 26 in February, and 17 in March.

On the Pacific Coast gizzard contents of 51 lesser scaup were examined: 26 came from near Mazatlan, Sinaloa; 24 from Ciudad Obregon, Sonora; and 1 from San Blas, Nayarit. The total plant food consumed was 49.7% (39 items), and the animal food was 50.3% (14 items). The foods included 15.7% ragweed, 8.4% widgeongrass, 5.5% heliotrope, 3.8% unidentified vegetation, 26.6% snails, 10.9% midges, and 8.6% bivalves.

One lesser scaup was obtained in the highlands from the Upper Lerma Valley near Toluca, Mexico. Its gizzard contained 74% plant food and 26% animal matter. The foods included 53% whitestem pondweed seeds, 10% southern bulrush, 10% unidentified plant material, 25% snails, and a trace of bivalves.

Seventeen lesser scaup were examined from the Gulf Coast, 5 were obtained from near Sisal and Celestun, Yucatan; 4 from the Tampico Delta and Laguna Madre, Tamaulipas; and 4 from the Laguna Tamiahua, Veracruz. Their gizzards contained 43.5% plant food and 56.5% animal food (31.8% muskgrass, 5.9% widgeongrass, 28.7% snails, 21.5% bivalves, and 6.4% insect galls).

Twenty-two lesser scaup were also examined from the saline coastal Laguna Madre, Tamaulipas. Their gullet contents included 45% plant food and 55% animal food (20% widgeongrass, 15% shoalgrass, 5% muskgrass, 5% unidentified vegetation, and 55% small mollusks).

The heaviest shooting of scaup occurs along the Pacific Coast from Baja California south to Guerrero. The next heaviest mortality is in the interior highlands at lakes and small reservoirs, from Chihuahua south to Michoacan and Hidalgo. On the Gulf Coast hunting occurs chiefly at Laguna Madre and near Tampico, Tamaulipas, in Veracruz, and Yucatan.

Common Goldeneye (*Bucephala clangula*)

Mexican name: No name in common use. pato chillon ojos dorados (Friedmann et al. 1950).

The few individuals of this hardy species that winter as far south as northern Mexico are chiefly found in the saltwater bays of Baja California, Sonora, Sinaloa, and Tamaulipas.

On the Pacific Coast the goldeneye was seen on the January aerial surveys only in northern coastal waters, and its numbers were small. In most years fewer than 1,000 were seen; the largest inventory was in 1950 when 2,318 were noted from the border south to Sinaloa (over 1,200 were between Mazatlan and Topolobampo and about 1,100 from the latter locality to Guaymas). A few were present in the coastal lagoons of Baja California, chiefly at San Quintin and Scammon, and from the Colorado River Delta along the margins of the Gulf of California.

Seventy goldeneyes were recorded on the waters of the Rio Colorado Delta during the aerial survey of 1948. On the Pacific Coast they were also observed on saltwater bays in Baja California, near Ciudad Obregon in Sonora, and the coastal waters of Sinaloa.

In the highlands three goldeneyes were seen on 16 February 1947 on Lake Toronto, Chihuahua. Leopold (1959) wrote that during a week's stay at a camp on the Rio Nazas west of Ciudad Lerdo, Durango, he saw a few goldeneyes nearly every day.

On the Gulf Coast goldeneyes were noted in the Rio Grande Delta, and on the aerial survey of 1949, 50 were seen on Laguna Madre, Tamaulipas. This species had been recorded from Laguna Madre in small numbers totaling up to 60 birds during several previous surveys beginning in 1938, and also in several subsequent years. Friedmann et al. (1950) reported goldeneyes from Baja California (rare), Sinaloa (once), and Durango (once). Until July 1962 there were no recoveries in Mexico of the more than 2,000 banded ducks of this species.

No information is available on the foods of goldeneye in Mexico. Studies of winter specimens taken in the United States, however, show that crustaceans and mollusks were the most common foods eaten that season. Crabs were an especially important item in their fare. These foods are abundant on the Mexican wintering grounds of this species. Because of the small numbers and their relative inaccessibility to hunters, the mortality of these ducks from shooting in Mexico is negligible.

Common goldeneye were recorded in Baja California, Sonora, Sinaloa, Chihuahua, Durango, and Tamaulipas.

Barrow's Goldeneye (*Bucephala islandica*)

Mexican names: none in use, but the book name would be pato chillon ojos dorados de Barrow.

The listing of Barrow's goldeneye for Mexico is based chiefly on the recovery of a banded individual shot at Rosarito Beach, Baja California, on 31 May 1954, which was banded in British Columbia on 28 August 1950. It was not only the first band recovery, but also the first specimen of this duck ever to be taken in Mexico. By July 1962 12,273 Barrow's goldeneye were banded and 1,149 recovered, but only one was reported from Mexico.

The only other record is by L. J. Goldman, who observed two Barrow's goldeneyes at close range on waters above Santa Rosalia, Chihuahua, on 3 March 1939 (USBS files). He was very familiar with this species in British Columbia and elsewhere during his work as Pacific Flyway biologist. This species is judged to be a rare migrant and winter resident.

There is no information on the food utilized in Mexico by this goldeneye.

Barrow's goldeneye was recorded in Baja California and Chihuahua.

Bufflehead (*Bucephala albeola*)

Mexican names: pato chillon jorobado (Friedmann et al. 1950); amanacochi (Nahuatl) (Friedmann et al. 1950); pato monja and ixtactzonyayouqui (Lopez and Lopez 1911). These names are not in common use.

Buffleheads have been observed regularly on aerial surveys of the Pacific Coast waters in all recent years. In the interior highlands some bufflehead were recorded almost every year, but their numbers were always less than 1,000. On the aerial surveys of Gulf Coast waters this species has been noted there only 1 year out of 3.

On the Pacific Coast this handsome little duck was regularly present from the border southward to Sinaloa. Several records for Baja California were listed by Grinnell and Storer (1928). There have also been aerial records during recent years. In most years not more than 1,000 were observed during the January aerial surveys, but in 1949 almost 9,000 were seen. Most of the latter were in the bays and lagoons of Baja California. In 1952 about 5,000 were recorded as follows: about 2,500 at and near Tobari Bay near Ciudad Obregon, Sonora; 400 near Agiabampo, 200 near Topolobampo, and 30 at Laguna Santa Maria, Sinaloa; and 1,050 at San Quintin, 350 at Scammon Lagoon, and 200 at San Ignacio Bay, Baja California. Localities in Sonora have included the Laguna Yavaros, offshore from the Galvan Ranch, Guaymas, Bahia Agua Dulce, Rio de la Concepcion, Punta Penasca, and the Rio Colorado Delta.

Undoubtedly many buffleheads are overlooked because the surveys follow a route near or inside the shoreline, whereas many birds of this species are farther offshore.

On the Gulf Coast of Mexico this little duck is very scarce. During the January aerial surveys made

through 1965, those observed were on or near Laguna Madre, Tamaulipas, except for a flock of five birds seen in January 1948 on the coastal lagoon near Progreso, Yucatan, and a small flock near Sabancuy, Campeche, on 8 January 1949. Buffleheads at Laguna Madre numbered from 12 to 132.

Some of the isolated observations of buffleheads were not recorded on the January surveys because of their scarcity in Mexico. Large numbers of more important game species were seen, which took all of the available recording time.

During the January 1949 ground survey several were seen at Lake Patzcuaro, Michoacan. E. A. and L. J. Goldman (USBS files, 1935) also recorded it at Patzcuaro in 1935. Nelson (USBS files, 1903) saw four on a small lagoon at La Barca near Lake Chapala, Jalisco, on 8 January 1903. Mearns obtained a specimen at Laguna Palomas, Chihuahua, on 8 April 1892 (Catalogue of Mearns Specimens, Mexican Boundary Survey). J. L. Goldman (USBS files) reported that it had been taken at Lago Tultengo, Hidalgo.

The one bufflehead obtained for an examination of food eaten was from Ciudad Obregon, Sonora, on the Pacific Coast. Its gizzard contained 56% pepperwort, 38% ragweed, and 6% convolvulus seeds, plus a trace of small snails and bivalves.

Because most of the small numbers of this species in Mexico winter on the coasts of Baja California and Sonora, hunting pressure and mortality from shooting are negligible. About 10,000 of these little ducks have been banded, but none has been recovered in Mexico. According to Friedmann et al. (1950), there are specimens from Coahuila, Chihuahua, Durango, Guanajuato, Jalisco, Mexico, and the Federal District.

Bufflehead were recorded in Baja California, Sonora, Sinaloa, Jalisco, Michoacan, Chihuahua, Durango, Zacatecas, Aguascalientes, Guanajuato, Queretaro, Mexico, Distrito Federal, Hidalgo, Coahuila, Tamaulipas, Campeche, and Yucatan.

White-winged Scoter (*Melanitta deglandi*)

Mexican names: negreta; negreta de alas blancas (Friedmann et al. 1950).

During the January survey flights this maritime scoter was recorded regularly offshore, in the bays of western Baja California, and off the coast of Sonora from Bahia Agua Dulce northward to the Colorado River Delta.

In estimating the numbers of game ducks in this sector it is necessary to follow the shoreline. It is not possible, therefore, to include an adequate appraisal of the numbers of white-winged scoter, the more numerous surf scoter, and other nongame divers that are present farther out in deeper water. They are seen each year, but they are omitted from some reports and in other reports the species are lumped together.

Typical notes from the 1947 aerial survey are as follows: "Bahia Agua Dulce, several thousand scoters widely scattered over bay, mostly surf but a few whitewings; Puerto Libertad, 15 whitewings; and Punta Penasca, 62 whitewings." In January 1951 small numbers were recorded on the western coast of Baja California and in the Gulf of California off the coast of Sonora.

Phillips (1926, 4:33) wrote that it occurred "as far south as San Quintin Bay, Lower California (Howell 1911)." Grinnell and Storer (1928) cited several records for Lower California.

Fewer than 2,000 white-winged scoters have been banded, and before July 1962 there were no recoveries in Mexico.

There is no specific information on the food habits of these ducks in Mexico. In coastal waters of the United States they feed in winter chiefly on mollusks. Since mollusks are abundant on their wintering grounds in Mexico, it is likely that it is their principal fare there.

To our knowledge this species is not hunted in Mexico.

The white-winged scoter was recorded in Baja California and Sonora.

Surf Scoter (*Melanitta perspicillata*)

Mexican names: pato negro, negreta de marejada (Friedmann et al. 1950)

The surf scoter is the most common sea duck of northwestern Mexico and especially of the Gulf of California. Since it is a nongame species no attempt is made to record accurately the numbers of these birds seen during the January aerial surveys. They are widely scattered and many far offshore. Perhaps the best coverage of this species was in 1952 when almost 25,000 were recorded; the largest number were in San Ignacio Bay, Baja California. However, even that survey did not list many of the scattered flocks, which totaled thousands, seen in the Gulf of California.

They have been recorded on the coast of Sonora and off the Rio Colorado Delta, as well as in bays of Baja California. Many thousands must winter in this general region, far more than the survey figures indicate. On the 1947 survey in Sonora, surf scoters were recorded from Bahia Agua Dulce northward to the Bahia de Adair. The largest numbers were seen on 15 February near Punta Penasca, where several thousand were observed between Isla Blanca and the shore. Many others were visible farther out.

On the 1950 survey 5,900 scoters, most of them surf scoters, were recorded on the eastern coast of Baja California near the Rio Colorado Delta. Grinnell and

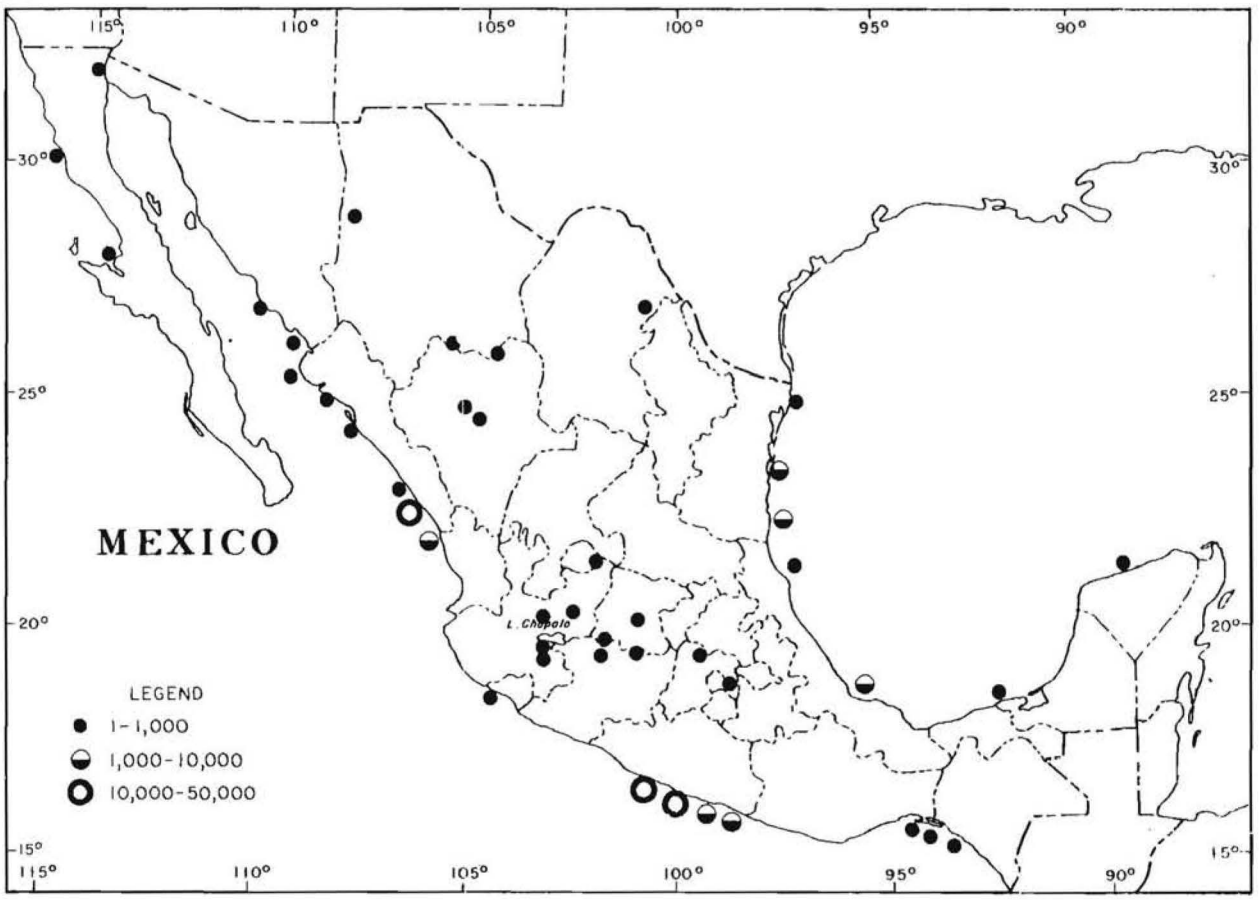

Fig. 38. Average numbers of ruddy duck observed during January aerial surveys, 1948–62.

Storer (1928) cite many localities in Lower California where the species has been observed.

Very few surf scoters have been banded and by July 1962 there were no recoveries in Mexico.

There is no specific information on the food habits of these ducks in Mexico. Reports of their diet in United States waters during winter months show that they feed chiefly on mollusks (Cottam 1939). Their wintering grounds in Mexico have an abundant supply of this food.

To our knowledge this species is not hunted in Mexico.

Surf scoters were recorded in Baja California and Sonora.

Black Scoter (*Oidemia nigra*)

Mexican name: too rare to be known locally, but would probably be called negreta.

This scoter, recorded by Hubbs (1955) as a rare summer visitor off the northern coast of Baja California, is an accidental straggler in winter. To date it has escaped observation but it seems likely that a few are probably present in the offshore waters of Baja California. It is also the least common of the three scoters that winter off the Pacific Coast of California. Some nonbreeders remain there through the summer.

Ruddy Duck (*Oxyura jamaicensis*)

Mexican names: patito; pato tepalcate (Friedmann et al. 1950); yacatextli (Nahuatl) (Friedmann et al. 1950); pato sonso (Lopez and Lopez 1911); atapalcatl (Nahuatl) (Lopez and Lopez 1911); pato chiquito and chaparro chiquito (Tultengo) (Goldman and Goldman USFWS files, 1926–42).

On the January surveys from 1948 through 1962 this species had an average rank of 9th in Pacific coastal waters, 10th on the Gulf coastal plain, and below 10th in the interior highlands. Estimated numbers of ruddy ducks seen on these surveys aver-

aged about 45,000; 38,000 were along the Pacific Coast, 4,000 on the Gulf Coast, and 2,000 in the interior (Fig. 38).

There were some large concentrations of these little ducks on the Pacific Coast. In 1948 more than 80,000 were seen, in 1952 more than 125,000, and in 1959 more than 70,000. In years when the major concentrations were missed, the totals were less than 20,000. In the highlands these birds were most common on some of the larger lakes, but the totals seen in any year were less than 10,000 and were usually considerably below 5,000. In 1953 only 50 were noted.

On the Gulf Coast ruddy ducks tended to be widely scattered, except for occasional concentrations on the lagoons of Yucatan. The largest numbers seen were more than 13,000 in 1948, and more than 10,000 in 1955. In years when many flocks were missed on the surveys fewer than 3,000 were seen.

One of the unexpected finds on the Pacific Coast during the first aerial survey in 1947 was the large number of ruddy ducks wintering on the coastal lagoons from central Sinaloa (north of Mazatlan) to southern Guerrero (near Acapulco). In several localities, and especially on the Marismas Nacionales south of Mazatlan, ruddy ducks were abundant. In 1948 82,350 ruddy ducks were on that coast of Mexico.

In 1953 there was a great concentration of them on Laguna Coyuca near Acapulco. It was estimated that there were 107,700 ruddy ducks, together with a few other ducks, on this one lagoon. This was by far the largest number of this species ever seen in one locality in Mexico. In 1947 a total of 99,502 were seen. They were widely distributed from Oaxaca to Baja California, but 52,232 of them were found in waters between Mazatlan and Manzanillo, and chiefly in one part of the Marismas Nacionales.

Nelson and Goldman (USBS files, 1892) wrote that at Laguna Cuyutlan, Colima, this little duck was common from January to March of 1892. During some of the years between 1947 and 1965, ruddy ducks were also common at the time of the aerial surveys, but our studies have shown a great decrease in the use of Laguna Cuyutlan since 1950. This has probably been caused by fluctuations in salinity and the resultant drastic effects on the animal food available. During some years very few ruddy duck were seen, as in 1954 when the Pacific tally was 300. It is obvious that the concentrations were missed that year, which is very probable, especially on a wintering ground as vast as the Marismas.

Usually these ducks are scattered widely over a lagoon, spaced from 0.6 to 2 m apart. In some instances they covered many hectares of water, as uniformly separated as though their positions had been measured. At the approach of our low-flying plane they dived, so that if the observer did not look ahead for them, all he saw were numerous concentric circles upon the surface of the water.

The percentage distribution of ruddy duck on the Pacific Coast, based on aerial survey findings, was Mitla-Coyuca, 34.9; Caimanero, 16.7; Papagayo, 15.1; Nexpa, 10.6; Marismas Nacionales, 6.5; Cuyutlan, 5.8; Inferior, 3.3; La Joya, 2.0; San Marcos, 1.3; Superior, 1.0; and 10 other localities each with less than 1.0.

Although this little duck was observed in many localities in the highlands during the January aerial surveys, they were more numerous on some of the central lakes than elsewhere. At Lake Chapala the numbers observed ranged from 10 in 1962 to more than 4,000 in 1956. Sayula, which was dry some years, had favorable conditions in 1956, and there were 3,000 ruddy duck present at that time. It seemed to be a favorite locality for them in those winters when it contained water, and the abundance of aquatic insect larvae present probably was the reason for its attraction for ruddy duck and shorebirds. From a few up to several hundred birds usually were recorded at Yuriria, Cuitzeo, and Patzcuaro.

Nelson and Goldman wrote (USBS files, 1904), that on 7 July 1904 the ruddy duck was rather common in parts of the Lerma marshes. It was seen in pairs, "but the sexual organs were only slightly swollen." They gave the local name as *atapalcatl*, which is from the Nahuatl (Aztec). They said it was also rather common at the eastern end of Lake Chapala, Jalisco, from 23 December 1902 to 9 January 1903.

In Chihuahua the majority was seen on Lago Toronto, where estimates ranged from 150 in 1961 to almost 3,000 in 1963. At Laguna Palomas there were from 100 to 900 ruddy ducks seen at the times of the surveys.

Their percentage distribution in the highlands as shown by the aerial surveys, was Chapala, 25.6; Toronto, 17.5; Palomas, 14.7; Sayula, 12.5; Patzcuaro, 9.1; Santiaguillo, 4.6; Yuriria, 4.4; Oriental, 3.7; Cuitzeo, 2.1; Zapotlan, 1.8; Texcoco, 1.0; and several other localities with less than 1.0.

On the Gulf Coast this little duck is most commonly seen on the Tampico Lagoons, at freshwater lakes on the mainland west of Laguna Madre, and on the lagoons of the Alvarado district. The numbers seen ranged from 600 to 1955 to almost 14,000 in 1948; the average over the years of the aerial surveys was 4,100.

The ruddy duck is attracted to small open ponds and lagoons on the Tamaulipas mainland, as well as to little marshy lagoons bordered with tall vegetation such as southern bulrush and sawgrass. They are easily missed in these places because the majority of the other ducks are in larger and more open waters.

Sheldon (USBS files, 1904) wrote that this duck was abundant on Laguna Tamiahua, Veracruz, during 12–26 April 1904. We found very few there on the

aerial surveys of 1947–65.

The percentage distribution of ruddy ducks on the Gulf Coast, as shown by the aerial surveys, was Tampico-Tamiahua, 56.8; Laguna Madre, 25.9; Alvarado, 13.2; Campeche-Yucatan, 2.5; Rio Grande, 1.2; and Tabasco with less than 1.0.

By July 1962, of the 2,764 ruddy ducks banded, 155 recoveries were reported including 5 (3.23%) from Mexico. The overall recovery rate was 5.60%, but only 0.19% in Mexico. There were recoveries from four States in the Republic: two in Sinaloa, and one each in Sonora, Chihuahua, and Campeche. Two of these ruddy ducks were banded in Utah, and one each was banded in California, Montana, and Saskatchewan. One recovery was in December, two in January, and one each in March and April (A. G. Smith *in* Aldrich et al. 1949).

On the Pacific Coast 40 ruddy ducks were studied for gizzard contents. Thirty-six of them came from near Mazatlan, Sinaloa; 3 from Ciudad Obregon, Sonora; and 1 from near Acapulco, Guerrero. They contained 80.9% plant food (21 items) and 19.1% animal food (11 items). The total foods included 71.4% widgeongrass, 3% heliotrope, 18.2% midge larvae, and small amounts of two other animal species.

Ten ruddy ducks were also obtained from a brackish coastal lagoon near Mazatlan, Sinaloa. Their gullet contents included 7% plant food (widgeongrass), 83% aquatic insect larvae, and 10% small snails.

The favorite food of the ruddy duck in Pacific waters, and probably elsewhere in Mexico, is the bloodworm or larva of the chironomid midges and related insects. These insects breed in countless numbers in the alkaline and saline lagoons. In some of the shallow margins one can find the tiny red larvae filling every depression. In some places they are abundant also at depths up to 0.6 m. There the diving ducks, especially ruddy ducks, feed on them during the day. Some ducks have been observed feeding in the shallows at night. Specimens of ruddy duck and other divers taken near shore had full gullets of bloodworms, with a small percentage of widgeongrass seeds and leaves.

In the highlands, the gullets of 16 ruddy ducks were obtained from hunters at the freshwater lakes of Chapala in Jalisco-Michoacan and Patzcuaro in Michoacan. Their gullet contents contained 79% plant food and 21% animal food (50.3% pondweed seeds, 9.6% bulrush seeds, 7.4% unidentified vegetation, 6.8% naiad, 9.6% aquatic insects and larvae, and 6.5% unidentified animal matter).

Two other ruddy ducks were obtained from the delta of Lake Chapala in Michoacan. Their gizzards contained 41% sago pondweed seeds, 39% of another pondweed species, 21% smartweed, and a few insect fragments. One ruddy duck from near Tampico on the Gulf Coast had eaten only vegetable food, and its gizzard contained 44% unidentified material, 41% sawgrass seeds, 10% spiny naiad, and 5% softstem bulrush. Two ruddy ducks from the freshwater Tampico lagoons near Altamira, Tamaulipas, had the following gullet contents: 20% muskgrass, 15% spikerush seeds, 10% unidentified vegetation, 25% aquatic insect larvae, 20% unidentified animal material, and 10% small mollusks, which were chiefly snails.

The shooting of this little diver is local, occurring chiefly at small lagoons on the Pacific Coast. At accessible places near Mazatlan, Sinaloa, and Acapulco, Guerrero, there is heavy hunting from power boats. They are also taken in small numbers at lakes in the highlands, especially at Lake Patzcuaro. There the local hunters, including some Tarascan Indians, often seek them out because of their relative tameness. In earlier years (1940–52) we saw a few ruddy ducks killed there by Tarascan Indians using spears of the *atlatl* type, which was the throwing stick of the Aztecs.

Masked Duck (*Oxyura dominica*)

Mexican name: pato enmascarado (Friedmann et al. 1950).

This duck, a tropical relative of the ruddy duck, is rare in Mexico. It is recorded by Friedmann et al. (1950) from Nayarit, Jalisco, Colima, Tamaulipas, and Veracruz. Although it undoubtedly breeds locally in Mexico, we found no records. Its status in Mexico is only of scientific concern and of no interest to hunters. The principal range is in South America, but it is also in the West Indies, Central America, and Mexico.

Grayson, as reported by Lawrence (1874), saw about 50 masked ducks on a lagoon near Tepic, Nayarit. Several females that he shot there in June 1867 had enlarged ovaries, but there was no specific reference to their nesting. Grayson said it was not a common species. Two were seen on the Laguna de San Pedrito, just north of Manzanillo, Colima, on 15 July 1959 by Schaldach (1963:20). At that late date they probably were on or near their breeding territory. J. H. Batty collected a specimen at Escuinapa, Sinaloa, on 28 December 1903 (Miller 1905). Specimens were also collected at Jalapa, Veracruz, by Salle (Sclater 1857*a*, 1860), and one at La Tuxpena, Campeche, which is about 160 km south-southeast of the city of Campeche (Storer 1961).

The species was seen at Lake Chapala, Jalisco, by Nordhoff (1922), but there were no notes given regarding its nesting. It may be a rare breeder in the marshes near Tampico (Tamaulipas and Veracruz), of the Papaloapan Delta, Veracruz, and of Tabasco.

We have not seen this species in Mexico, probably because no surveys were made there during the breeding season. The senior author saw a pair within 91 m of

the border at Brownsville and another pair near Harlingen, Texas, in June 1941. A third pair was observed on the Laguna Atascosa National Wildlife Refuge, Texas, in 1942. Several were observed in the vicinity of Harlingen and San Benito, Texas, by L. Irby Davis and others. It rarely occurs in the United States and there chiefly in the Lower Rio Grande Valley. The masked duck often prefers the densest of marshes. In such localities it seldom takes flight and is easily overlooked, even by experienced field observers.

Wetmore (1965), writing of this species in Panama said:

> The masked duck is an inhabitant of fresh-water ponds and the quiet waters of the larger streams, where there are extensive growths of aquatic plants that make suitable shelter. Usually two to a dozen or more are found together in small pools or in open stands of floating vegetation where they remain quiet or seek cover. If they have not been disturbed by shooting often they are tame and allow fairly close approach. At such times they remain quiet, with neck drawn in, even when boats pass close at hand, as they are camouflaged against their background, if indeed they are not actually hidden. Their flight is swift and strong, with the white patch in the wing showing prominently. As they rise from open water they may splatter along for 4 or 5 meters to gain momentum, but they also go straight up as readily as teal. In alighting they come in a few feet above the surface, bank, back stroke into the wind, and then drop with a plump into the water, where they bob up and down for a few seconds, often without moving forward appreciably. Both methods—that of arising and that of alighting—are practical adaptations to a water surface covered with floating or submerged vegetation. On the wing masked ducks suggest their relative, the ruddy duck (*Oxyura jamaicensis*), as they have the same bulky head, thickened neck, and short, rounded form. Flight in the two is equally strong, but masked ducks rise more easily from the surface of the water. While they are active on the wing they hide regularly among standing water plants. Sometimes when approached they submerge quietly, and then usually disappear completely, even where the plant cover appears too sparse to give them protection.

No information is available on the food habits of this rare species. If its preferences are similar to those of its close relative, the ruddy duck, insect larvae would make up much of its diet in Mexico (Cottam 1939).

The masked duck was recorded in Nayarit, Jalisco, Colima, Tamaulipas, Veracruz, and Campeche.

Hooded Merganser (*Mergus cucullatus*)

Mexican names: pato de copito (Chihuahua), mergo de caperuza (Friedmann et al. 1950); ehecatototl (Nahuatl) (Friedmann et al. 1950); pato rampla (Leopold 1959).

The records of this little merganser are reported by Friedmann et al. (1950) as follows: "Baja California (once), Distrito Federal (three specimens in the Mus. of Nac. Hist. Nat., Mexico City), and Veracruz (once)." The one specimen from Baja California was taken at San Jose del Cabo (Brewster 1902; Grinnell and Storer 1928) and Belding recorded it at La Paz (Bryant 1889). The specimen from Jalapa, Veracruz, is in the British Museum (Salvadori 1895). It was seen in the Valley of Mexico (Sanchez 1877-78; Herrera 1888; Villada 1891-92). It was also recorded by Berlandier at Matamoros, Tamaulipas (Baird et al. 1884), and by Gaut (USBS files, 1904) near Colonia Garcia, Chihuahua, 11-24 February 1904. E. A. Goldman reported (USBS files, 1926) that R. D. Camp, game warden at Brownsville, Texas, said that several hooded mergansers had been noted near Matamoros, Tamaulipas. We observed two males on the wooded Laguna Culebron near Matamoros, Tamaulipas, on 2 January 1943, and two males and one female in the interior highlands at Lake Patzcuaro, Michoacan, on 28 January 1949.

Only a few hundred hooded mergansers have been banded, and as of July 1962 there were no recoveries in Mexico.

The only information on the food habits of this merganser in Mexico is given in the following note from Colonia Garcia, Chihuahua, by J. H. Gaut (USBS files, 1904). "Few seen at various times along the mountain streams a short distance west of Colonia Garcia. Shady deep holes were usually preferred where they fed on a small mollusk (February 11-24, 1904)."

This handsome little merganser, so rare in Mexico, should not be shot.

The hooded merganser was recorded in Baja California, Michoacan, Chihuahua, Mexico, Distrito Federal, Tamaulipas, and Veracruz.

Common Merganser (*Mergus m. americanus*)

Mexican names: pato pescador (Tamaulipas); mergo americano (Friedmann et al. 1950).

Friedmann et al. (1950) wrote, "Recorded from Baja California (two of the three records unsatisfactory), Sonora (uncommon), Chihuahua, Mexico and Tamaulipas (once)." This large merganser is a rare-to-uncommon winter visitor in some northernmost localities in Mexico, chiefly on inland reservoirs of Chihuahua and Coahuila. Baird et al. 1884 wrote, "Kennerly saw large flocks on the Boca Grande and Conalitos Rivers, Chihuahua." Consular reports in 1935 (USBS files) listed several other rivers, including the Rio Conchos, Chihuahua, where hundreds had been observed.

Several observers from El Paso, Texas, reported in 1935 that since the 1920's there had been a continued increase in the numbers of common mergansers on the upper Rio Grande and on reservoirs and creeks in that vicinity, including some of the waters of northern Chi-

huahua. A few of this species, seen on the aerial surveys of 1948-65, were on reservoirs of the northern highlands. Specific records include six on Lake Toronto, Chihuahua, 16 February 1947, and others at several reservoirs in the same State on 9-11 February 1951.

In Coahuila small flocks were seen at Don Martin reservoir, north of Monterrey, in 1949 and later. Van Rossem (1945) cited several records for Sonora. In Tamaulipas, several were noted on inland reservoirs near Reynosa, and they were observed twice at Laguna Madre: six on 6 February 1940, and two on 2 January 1941.

With the records in the 1920's and early 1930's of hundreds and even thousands of these mergansers on reservoirs and streams of the northern plateau, it is difficult to understand why so few were there in recent years. Perhaps the explanation for their decrease in Mexico is provided by the number of new reservoirs built in the southwestern United States since the 1920's. All of this additional deep water, with its supply of fish, may have solved most of the wintering problems for the common (American) merganser in the western and southwestern States.

As of July 1962 there were no recoveries in Mexico of banded ducks of this species, and we know of none since, but fewer than 2,500 have been banded. Since this merganser is not considered to be a game species, few are shot by hunters.

No specific information is available regarding the diet of this merganser in Mexico. In the United States its food at reservoirs is chiefly rough fish.

The common merganser was recorded in Baja California, Sonora, Chihuahua, Mexico, Coahuila, Nuevo Leon and Tamaulipas.

Red-breasted Merganser (*Mergus serrator*)

Mexican names: pato pescador (Tamaulipas); mergo copeton (Friedmann et al. 1950).

This species is a common winter resident on the Pacific Coast, where it has been recorded regularly in Baja California, Sonora, and Sinaloa during the January waterfowl surveys. Occasionally flocks have been noted with cormorants, fishing at the mouths of rivers in Sonora and Sinaloa. In 1949 the estimated number observed between Los Mochis, Sinaloa, and Guaymas, Sonora, was 1,430 and 1,300 in 1950, 147 in 1951, and 700 in 1965. Undoubtedly the total population in these Pacific waters, including the Gulf of California and the mouths of tributary streams, is many thousands. Aerial surveys are chiefly for information on game ducks and time does not permit a comprehensive survey of mergansers.

The red-breasted merganser is also a regular winter visitor along the coast of Tamaulipas and northern Veracruz, but its numbers are relatively few there. Small flocks, totaling a few hundred birds, were observed each season during field work on Laguna Madre and in the waters of the Gulf off Tamaulipas, especially near the mouths of passes. Friedmann et al. (1950) said, "Baja California and Sonora (Apparently fairly common)."

Only about 200 red-breasted mergansers have been banded, and as of July 1962 there were no recoveries in Mexico. No hunting of mergansers was noted; chiefly because of their preference for marine waters, they are relatively inaccessible to hunters. Because of their diet of fish they are unpalatable unless cleaned very promptly and cooked in a special way to improve their flavor.

No specimens of this species were obtained for the study of food habits, but commercial fishermen who have caught some in their nets report that their gullets were filled with a variety of small fishes. The species are chiefly those without commercial value.

The red-breasted merganser was recorded in Baja California, Sonora, Sinaloa, Tamaulipas, and Veracruz.

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