DISPERSAL AND ANNUAL SURVIVAL OF THE MALLARD

By

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(*Anas platyrhynchos*)

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Saskatoon, Saskatchewan

June, 1965

The data represented herein are of a preliminary nature and are not for publication or quotation without permission of the author or Chief of the Canadian Wildlife Service.

ACKNOWLEDGEMENTS

More than 40 people assisted in the banding operations over a six-year period. Most of the personnel were supplied by the Canadian Wildlife Service. Special thanks are due Mr. Alex Dzubin who worked almost full time on the project for four seasons. The author is grateful to the U. S. Fish and Wildlife Service, the Saskatchewan Wildlife Branch, and Ducks Unlimited who made major contributions in one or more years. Mr. R. A. Lamont of Kindersley was particularly helpful during five field seasons.

The author wishes to thank Mr. A. J. Duvall, Director of the U. S. Fish and Wildlife Service's Bird Banding Office, for correlating the banding data and the reports from more than 1,600 hunters, as well as for IBM cards and listings used in this study. In the preparation of this thesis, the author wishes to acknowledge the assistance of his Committee and, particularly Dr. R. S. Miller and Dr. W. J. Maher. He also thanks his wife, Madeleine, for her patience through twelve years of field work, analysis and writing from initiation to completion of this project.

TABLE OF CONTENTS

Page

Page

LIST OF TABLES

LIST OF FIGURES

INTRODUCTION

Eighty per cent of North America's ducks breed in Canada and practically all of them winter in the United States. Their movements between breeding and wintering areas and their survival and mortality from year to year are important aspects of their life history. This study is concerned with Mallards (Anas platyrhynchos), the most abundant of some 30 species of ducks that breed in Canada. The objectives of the study were:

1) To determine the fall distribution of wild Mallards raised in the vicinity of Kindersley, Saskatchewan.

2) To determine the mortality and survival rates of these birds.

LITERATURE REVIEW

Studies of bird migration have been based on direct observations and on recoveries of banded birds. The first major publication based on field observations on this continent was by W.W. Cooke (1888) entitled "Report on Bird Migration in the Mississippi Valley in the Years 1884 and 1885". The emphasis in this 313-page bulletin was on spring migration. There have been three important publications in recent years on direct observations of waterfowl migration. Hochbaum (1955) summarized reports prior to 1954. Bellrose (1957) and Bellrose and Sieh (1960) described the major waterfowl migrations of 1955, 1956 and 1957 from Canada through the Mississippi Flyway.

Systematic bird banding as a technique for studying migration was first used by C.C. Mortensen in Denmark in 1899 (Jespersen and Taning, 1950). He published maps showing the points of banding and recovery of Teal (Anas crecca) and Pintail (Anas acuta) (Jespersen and Taning, ibid.). Maps of a similar type constituted the core of most analyses published during the next 45 years.

In North America, Wetmore (1923) banded seven species of ducks in Utah from 1914 through 1916 and discussed the results using maps and tables. In Canada, J.T. Miner (1923) banded more than 100 ducks in Ontario from 1914 through 1916; he banded his first geese in quantity (61) in 1922. The first large-scale banding of ducks in the Prairie Provinces using official bands was in 1923 by Bert Lloyd at Davidson, Saskatchewan, and P.E. Page at Lac Ste. Anne, Alberta (Lincoln, 1927). The results of these efforts were not published separately but Lincoln (1932, 1933a, 1933b, 1933c, 1933d) used them along with many other bandings to compile distribution data for ducks from four provinces and 22 states. He then defined four biological flyways for waterfowl explaining that migration routes were tributaries of flyways and that flyway boundaries were difficult to determine north of 45° latitude (Lincoln, 1935).

Pirnie (1932) working in Michigan was apparently the first to combine geographical and temporal distribution in the analysis of band recoveries as well as the first to separate banding data into first and subsequent migrations (Pirnie, 1941). A technique for determining age and sex finally became available when Gower (1939) and Hochbaum (1942) described a method for separating young ducks until they are about 10 months old from older birds; Hochbaum (ibid.) also presented the first method of reliably determining sex in waterfowl throughout the year. Mann, Thompson and Jedlicka (1947) were the first to analyse recoveries by age and sex, using ducks banded in Illinois.

Since 1939 Ducks Unlimited and the United States Fish and Wildlife Service have conducted most of the waterfowl banding in the Prairie Provinces. A brief summary of the migration routes for each of 16 species of ducks and geese was edited by Aldrich (1949). Cartwright and Law (1952) and Cartwright (1956) summarized migration data based on recoveries of 77,000 ducks of 19 species banded in Alberta, Saskatchewan and Manitoba. They included considerable data on homing to breeding and migration areas.

Until 1954, the objectives in waterfowl banding projects had been to band as many ducks as possible, regardless of age, sex, place or time of year. As a result large numbers of moulting and migrating ducks were banded in late summer and fall in Canada but no breeding ducks or broods were banded. Aerial surveys gave information on the numbers and species of ducks on the breeding and wintering grounds but there was no information on how many ducks from a particular section of the breeding grounds went to a specific wintering area and by what routes. It did not appear practical to trap and band breeding adults in large numbers and, therefore, a program was initiated in 1954 to band ducklings before they were old enough to fly. Only at this age could young ducks be definitely associated with a specific part of the breeding grounds. In the first three years of this project 38,000 ducklings were banded in the Prairie Provinces (Low, 1957). From 1954 through 1961, 63,000 flightless young Mallards were banded in Canada and the United States (Lensink, 1964), one-fifth of the total as part of this study.

Problems of interpreting the results of banding have still not been solved. Hickey (1951) questioned the effect of differential vulnerability between adults and young, of dates of banding in relation to the hunting season, and of differential hunting pressures in different areas on geographical distribution of band recoveries. Crissey (1955) outlined the problems of interpreting population movements because of differential reporting rates and crippling losses. Atwood and Geis (1960) discussed biases associated with attempts to increase the reporting rate of bands.

Solutions to some of the problems began to appear in the mid-fifties. Bellrose (1955) and Geis and Atwood (1961) developed correction factors for differential reporting rates. Bellrose compared the ratio of recoveries from reward and standard legbands on Mallards banded in Illinois and recovered primarily in the Mississippi Flyway from Canada to Louisiana. Geis and Atwood compared the number of bands that hunters in the United States reported that they had recovered in answer to a mail questionnaire with the number actually reported to the U. S. Fish and Wildlife Service Banding Office. Crissey (1956, 1958 and 1960), on the basis of mail questionnaires, estimated that 15 to 20 per cent of all species of ducks were crippled but not retrieved in the United States. Hansen (1964) compiled data obtained from biologists' observations of hunters' blinds and found that 32 per cent of the birds shot were lost to crippling.

J. A. Munro wrote a series of papers on individual species in British Columbia that included data on migration based on banding. He studied the Mallard, Pintail, Green-winged Teal (Anas carolinensis) and Widgeon (Mareca americana) (Munro, 1943, 1944, 1949a, 1949b). Addy (1953) published the first detailed analysis of the migration of a single species of duck based on all available bandings when he described migration routes for various subpopulations of Black Duck (Anas rubripes). A more comprehensive paper dealing with population distribution and hunting kill of Canvasbacks (Aythya valisineria) appeared in 1958 (Stewart, Geis, and Evans, 1958). The authors combined data from breeding and winter surveys with banding data, and gave quantitative estimates of populations and harvests in various parts of the species' range. A similar report on Redheads (Aythya americana) has since appeared (Weller, 1964).

Three books on bird migration have appeared in the last 10 years: Hochbaum (1955) is concerned primarily with tradition in waterfowl migration while Dorst (1962) and Griffin (1964) discuss a much broader range of species, the former concentrating on a descriptive approach and the latter emphasizing the biophysical aspects of migration.

Banding as a technique for studying survival and mortality in birds has been reviewed by Hickey (1952), by Farner (1955) and by Geis and Taber (1963). Important papers on wild waterfowl are those on British Mallards (Höhn, 1948), Mallards, Black Ducks and Blue-winged Teal (Anas discors) banded in Illinois (Bellrose and Chase, 1950) and Canada Geese (Branta canadensis) from the same state (Hanson and Smith, 1950), North American populations of Mallards and Redheads (Hickey, 1952), European populations of Pink-footed Geese (Anser brachyrhynchus), Teal and White-fronted Geese (Anser albifrons) (Boyd, 1956, 1957, 1958), and North American Canvasbacks (Geis, 1959).

An analysis of the geographical distribution of young Mallards from various breeding grounds in the United States and Canada has recently appeared (Lensink, 1964). Partial results of the present study have been discussed by Low (1957) and by Gollop (1958, 1963a and 1963b). Calculation of first-year mortality using Mallards from a known breeding area has not been attempted previously.

METHODS

Definitions

Cohort: A group of birds hatched in the same year.

Degree Block: A block of land bounded by consecutive degrees of latitude and longitude. It measures approximately 69 miles from north to south regardless of latitude and averages 43 miles from east to west at Kindersley, Saskatchewan (51° latitude) and 58 miles at Stuttgart, Arkansas (34° latitude). At these latitudes, the blocks vary in area from 2,970 to 4,000 square miles, respectively. Degree blocks are designated by the line of latitude forming the south boundary and the line of longitude forming the east boundary.

Direct Recovery: For purposes of this paper, a banded bird recovered between 1 September and 20 January, immediately following the summer of banding.

Flyway: A series of states grouped for purposes of administering hunting regulations; these regulations are usually similar within a flyway and different between flyways. In 1947 Lincoln put political boundaries to his biological flyways (Lincoln, 1947). They were as given below except that he included North and South Dakota and southeastern Texas in the Mississippi Flyway. When the flyway system was officially adopted for administrative purposes in 1948, those three areas were included in the Central Flyway (U. S. Department of the Interior, 1948). From that date through most of the period of this study, the states in each flyway were as follows (see also Fig. 3):

Pacific	Central	Mississippi	Atlantic
Arizona	Colorado	Alabama	Connecticut
California	Kansas	Arkansas	Delaware
Idaho	Montana	Illinois	Florida
Nevada	Nebraska	Indiana	Georgia
Oregon	New Mexico	Iowa	Maine
Utah	North Dakota	Kentucky	Maryland
Washington	Oklahoma	Louisiana	Massachusetts
	South Dakota	Michigan	New Hampshire
	Texas	Minnesota	New Jersey
	Wyoming	Mississippi	New York
		Missouri	North Carolina
		Ohio	Pennsylvania
		Tennessee	Rhode Island
		Wisconsin	South Carolina
			Vermont
			Virginia
			West Virginia

In 1962 the first changes were made in the flyway alignment. Those portions of Montana, Wyoming, Colorado and New Mexico west of the

Continental Divide became part of the Pacific Flyway (U. S. Department of the Interior, 1962).

Indirect Recovery: A banded bird recovered between 1 September and 20 January after the first migration.

Recovery Rate: The percentage or proportion of the number of birds banded that are recovered. Direct recovery rate is the percentage of banded birds recovered during the first fall migration. Relative recovery rate is the degree to which one component of the population, e.g., one age or sex, is more likely to be shot than another (Smith and Geis, 1961). This becomes the relative vulnerability rate of Bellrose et al. (1961) when both components are subjected to identical hunting pressure. Hunter selectivity of one component over the other, differential migration between components, etc., will cause relative vulnerability rate to become relative recovery rate.

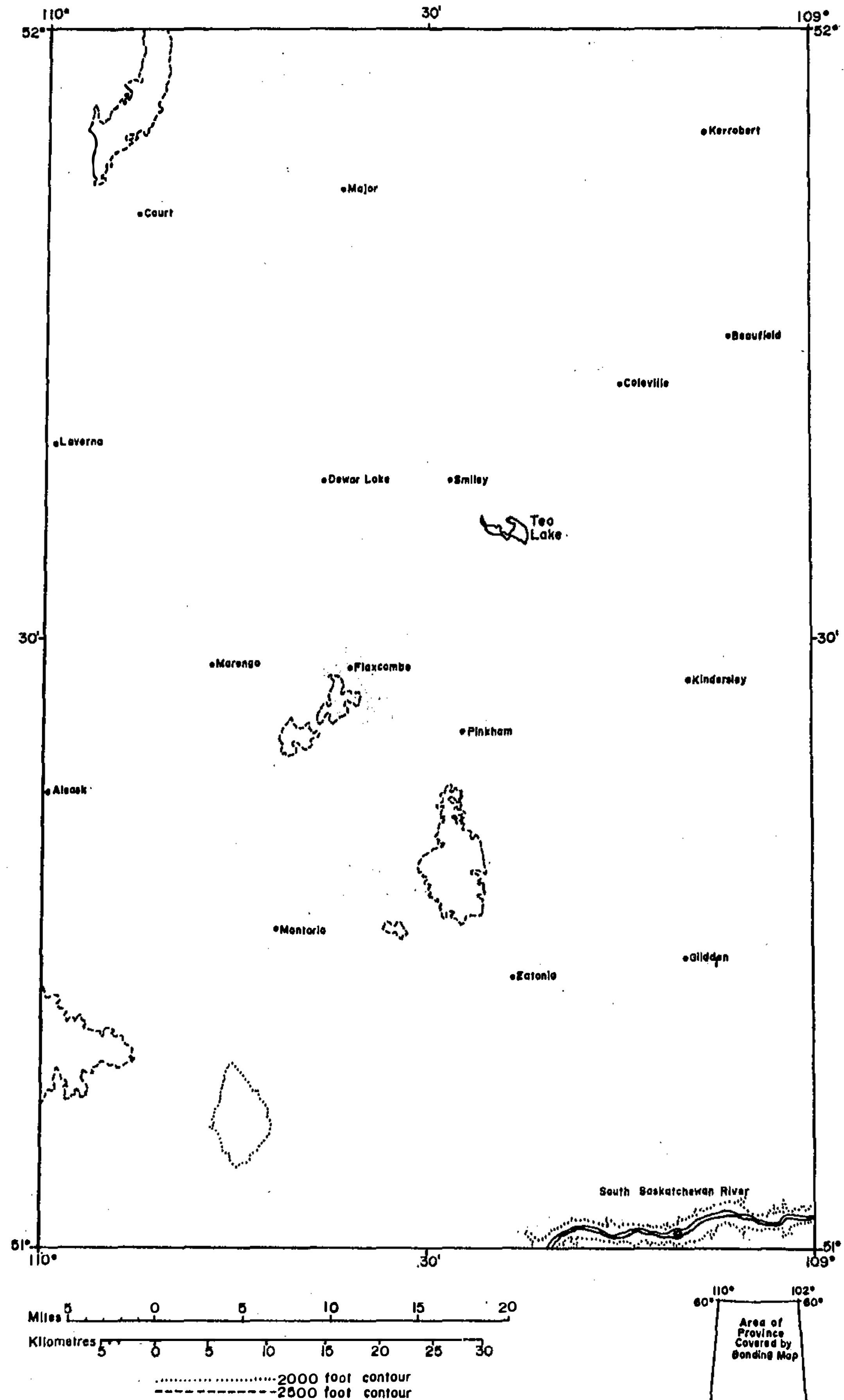
Description of Area

The area involved in this investigation includes a large section of North America. It covers the southern half of Saskatchewan and Alberta as well as the Mississippi, Central and Pacific Flyways. A detailed description of the area in which the Mallards were produced and brief descriptions of their areas of dispersal are presented below.

Production area

The production area or banding block is in the mixed prairie of west-central Saskatchewan. It is bounded by the lines of 51° and 52° north latitude and 109° and 110° west longitude and has an area of approximately 2,970 square miles (Fig. 1). Kindersley is located near the eastern border of the block and Kerrobert near the northeast corner. Part of the block touches the South Saskatchewan River, and the Alberta-Saskatchewan boundary is the western edge. The area extends from Townships 23 to 35 and from Ranges 22 to 29, west of the Third Meridian. A few Mallards banded within three miles of this block were also included in the study.

Kindersley lies in a middle latitude steppe characterized by a cold, semi-arid climate (Canada Department of Mines and Technical Surveys, 1957). It is in the Brown Soil zone. The topography is mainly undulating to gently rolling with small, scattered areas of flat to depressional alluvium and alkali (Mitchell, Moss and Clayton, 1944). The altitude varies from 1,950 to 2,550 feet. Sloughs more than 50 acres in size, and shallow lakes of more than a square mile, are typical of the district during periods of high water. Most of these larger areas were devoid of emergent vegetation; they yielded about half of the Mallards banded during the study. While much of the district had fewer than 10 water areas per square mile in May, a portion of the Neutral Hills Upland in



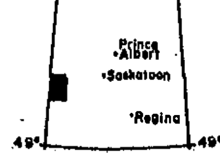


Figure I. Map of degree block of banding the northwest corner had a density of more than 50 ponds per square mile; practically all of these were less than one-half acre in size.

The climate is characterized by low and highly variable precipitation, cold winters, warm summers and almost constant winds of moderate velocity. Average annual precipitation at Alsask is 12 inches (Canada Department of Transport, 1947). At Kindersley, rainfall from April through July has varied from 3 to 17 inches (Champlin et al., 1950). The frost-free period averages 97 days from 31 May to 5 September (Boughner, Longley and Thomas, 1956). Average July temperatures are a minimum of 51° F, a mean of 66° F, and a maximum of 81° F. Average monthly winds from May through August at Swift Current, 100 miles southeast of Kindersley, are 13 to 15 mph with calm periods being recorded for less than one per cent of each month. The monthly average relative humidity for this same period is 50 to 60 per cent at 1330 hours (Boughner and Thomas, 1948).

The sloughs in the district depend primarily on runoff from the winter's accumulation of snow for their water supply. During the winter and spring of 1951-1952 snowfall and runoff were such that water levels in the spring of 1952 were reportedly higher than in any year since 1919. A coulee several miles long that was dry in 1950 held 17 feet of water in 1952. It was apparently the runoff from this winter that provided most of the water for the entire period of the study. The number of ponds decreased steadily through 1959. An area that had 10 feet of water in 1952 was dry in 1960.

The area is treeless except for windbreaks planted around farmsteads and for aspen (Populus tremuloides) growing naturally in some coulees and around some water areas. These trees are used for nesting by Magpies (Pica pica), Crows (Corvus brachrhynchos), Swainson's Hawks (Buteo swainsoni), Pigeon Hawks (Falco columbarius), Great Horned Owls (Bubo virginianus), Eastern Kingbirds (Tyrannus tyrannus), Brown Thrashers (Toxostoma rufum), Robins (Turdus migratorius) and Yellow Warblers (Dendroica petechia).

The dominant shrubs are buckbrush (Symphoricarpos spp.) and rose (Rosa spp.). These are used for food and cover by Porcupines (Erethizon dorsatum) and Skunks (Mephitis mephitis). They also serve as the main nesting cover for Mallards, Pintails, Widgeon, Gadwall (Anas strepera), Marsh Hawks (Circus cyaneus), Short-eared Owls (Asio flammeus), Brewer's Blackbirds (Euphagus cyanocephalus), Sharp-tailed Grouse (Pedioecetes phasianellus), Hungarian Partridge (Perdix perdix), and Clay-coloured Sparrows (Spizella pallida). Willows (Salix spp.) grow around some ponds; Red-winged Blackbirds (Agelaius phoeniceus) are the main nesting species in this habitat.

About 60 per cent of the land was cultivated and almost one-half of the cultivated land was in summerfallow during this study. Three-fifths of the cultivated acreage was seeded to wheat (Triticum aestivum and T. durum), one-fifth to flax (Linum usitatissimum) and less than one-fifth to barley (Hordeum vulgare) and oats (Avena sativa) combined.

The ducks listed above, as well as Blue-winged Teal and Shovelers (Spatula clypeata) nest in the stubble left from the previous fall's harvest. Willets (Catoptrophorus semipalmatus), Godwits (Limosa fedoa), Wilson's Phalaropes (Steganopus tricolor), Vesper Sparrows (Pooecetes gramineus) and Savannah Sparrows (Passerculus sandwichensis) are also common nesters in this habitat.

Speargrasses (Stipa spp.), grama grasses (Bouteloua gracilis) and wheatgrasses (Agropyron spp.) are dominant in prairie and pasture. This is the habitat preferred by Richardson's Ground Squirrels (Citellus richardsoni) and Coyotes (Canis latrans) and used for nesting by Killdeer (Charadrius vociferus), Western Meadowlarks (Sturnella neglecta), and Horned Larks (Eremophila alpestris), as well as by the above-mentioned species of waterfowl.

Many of the water areas had no emergent aquatic vegetation but submergents, particularly sago pondweed (Potamogeton pectinatus) and water crowfoot (Ranunculus spp.) were abundant. Sedges (Carex spp.) were the most abundant emergent plant, followed by spikerush (Eleocharis spp.) and smartweed (Polygonum spp.). There was little cattail (Typha latifolia) or bulrush (Scirpus spp.). The few Canvasback, Redhead and Ruddy Ducks (Oxyura jamaicensis) that occurred nested in this vegetation, as did Red-winged Blackbirds, Black Terns (Clidonias niger), Horned Grebes (Podiceps auritus) and Soras (Porzana carolina).

Immediate vicinity of the production area

Grasslands similar to the production area extend for more than 150 miles to the west, south and east. The northern edge of the banding area is within a few miles of the Fescue Prairie (Festuca scabrella) Association of Coupland (1961). This association is also referred to as parklands because of the increasing occurrence of aspen. Parklands surround the mixed prairie in a narrow band on the east, north and west in Canada, extending northwest at least as far as Edmonton. Water areas in this region are more permanent than in the grasslands. As in the mixed prairie, wheat and barley remain important foods for Mallards in late summer and fall.

The three western flyways

The 14 states that comprise the Mississippi Flyway include 742,000 square miles. An average of eight million ducks, geese, swans and coots wintered in this flyway. Half of this total was usually Mallards and more than one million of these wintered in Arkansas. There were 18,000 square miles of wetlands of high or moderate value to waterfowl in the Mississippi Flyway in 1964. State and Federal agencies managed 5,500 square miles of waterfowl habitat in 1961. The major crops of the region also serve as important Mallard foods, particularly corn (Zea mays) in the central part of the Flyway and rice (Oryza sativa) in Arkansas and Louisiana. When mast crops are heavy, Mallards do most of their feeding in the flooded oak (Quercus spp.) bottomlands (Hawkins, 1964).

The 10 states in the Central Flyway have an area of 1,115,000 square miles of which 10,000 square miles were wetlands of high value to waterfowl in 1964. State and Federal Governments managed about 1,400 square miles of water and upland for waterfowl (Buller, 1964). Mallards are the most abundant wintering species. More than 2.5 million Mallards normally winter in this flyway, almost half of them in Texas and Colorado; in 1958 more than one million wintered as far north as South Dakota. The major Mallard foods from north to south are spring wheat, corn, winter wheat and rice. This flyway, more than any other, is susceptible to drought. During the first part of this study, migration and wintering habitat deteriorated so much that during the winter of 1954-55 in Nebraska, Kansas, Oklahoma and western Texas "Thousands of dry ponds and low, bare margined lakes produced the poorest waterfowl habitat and the lowest wintering populations since the mid-1930's" (Baumgartner, 1955). This situation continued through 1955 and 1956 but showed considerable improvement in 1957 (Baumgartner, 1957, 1958).

There are seven states with an area of 825,000 square miles in the Pacific Flyway. Some 6,200 square miles were classified as good waterfowl habitat. During the 1950's approximately 6 million ducks wintered here, two-thirds of them in California. Pintail is the most abundant species but Mallards have averaged almost 2 million wintering birds. Mallard populations in this flyway have been steadily increasing, and in 1961 almost 2 million wintered in the Columbia and Snake River drainages of Washington, Oregon and Idaho alone (Chattin, 1964). The Mallard's main food in this flyway is cereal crops, giving rise to complaints of damage to rice, wheat and barley in California (Biehn, 1951).

Banding Techniques

Banding was the basis for most of the data obtained in this study. Birds were caught, marked with individually numbered legbands, released, retaken by hunters and reported.

Mallards were caught by herding them into pens and by using trained dogs (Gollop, 1956a, 1956b, Jensen, 1956). On large water areas with more than 100 young Mallards, a pen of poultry netting from 20 to 50 feet in diameter was erected on shore. Two poultry netting leads from 50 to 300 feet in length formed a funnel from an opening in the pen; one lead was on shore and the other in the water. Three to seven men then went to the opposite end of the slough and slowly herded Mallards into the pen both by wading and by boat. On smaller areas or with fewer birds, the ducklings were first herded onto shore and then caught by retrievers. Approximately 60 per cent of the birds used in this study were caught by dogs. The birds were caught from 21 June to 11 September 1954, 21 June to 19 August 1955, 2 July to 31 August 1956, 17 June to 17 August 1957, 11 June to 22 August 1958, and 19 June to 27 August 1959. Banded birds were distributed on 100 to 150 water areas each year.

Two types of bands were used in this project. In all years standard, aluminum, 17 gauge butt-end bands of the approved size (No. 7A) for Mallards were used (Van Velzen, pers. comm.). In 1957 a lock-on band of similar size and material, but lighter in weight (similar to a No. 6 band) and with a locking mechanism, was used on 765 birds.

A basic assumption of the banding technique is that banded birds return to the population, become randomly distributed within it and, when recovered, are representative of it. It has been assumed in this project that this was true of young Mallards wearing one aluminum legband, either butt-end or lock-on, whether caught by man or dog, provided that the ducklings did not appear to be injured and that they had not been treated experimentally, e.g., neckbanded, transported from one slough to another, partly hand-reared, wing-tagged, etc.

The bander submitted banding details to the Banding Offices of the Canadian Wildlife Service and the U. S. Bureau of Sport Fisheries and Wildlife. Recoveries were usually reported to the U. S. Banding Office, as requested on the band, under an agreement between the two countries. The U. S. Banding Office then compiled banding and recovery data on a 3-624 form and supplied copies to hunter, bander, state or province of banding and recovery and Canadian Banding Office. (Since 1960 this form has been replaced by an IBM card.) The U. S. Banding Office supplied the author with IBM cards of all reports previously received on 3-624 forms and a machine-printed listing of the records.

Recovery records used in this paper were for birds believed to have been shot between 1 September and 20 January. Usually these were birds reported as "shot" or "killed", but 48 of 1,018 direct recoveries with such words as "taken" (30) and "bagged" (7) were included.

Birds "found dead" during the hunting season were among the records excluded from analysis, partly because there was no indication of why or when they died and partly because of biased geographical distribution. Fourteen of 18 direct recoveries in this category were within the banding area. There were six such indirect recoveries, two within the banding block. The Saskatchewan proportions of both types of recovery were high compared to their proportion among shot birds. This concentration in the vicinity of banding may largely be a reflection of intensity of work by the banding crews.

Nine other hunting season recoveries were rejected because of designations such as "taken on scientific permit", "picked-up disabled", "killed by a dog" or "found band". Fall recoveries that were "trapped and released" were not used; thirty-three of 38 such direct recoveries were in Saskatchewan, as were two of six indirect recoveries.

All recoveries received to 2 November 1964 were used in this report. This includes all recoveries from the 1963 hunting season.

Age and Sex Determination

Newly-hatched Mallards require about eight weeks to reach flying age. Most birds used in this study were caught when three to eight weeks old; 565 birds were less than three weeks of age. In 1954 ducklings were aged to the nearest week according to plumage descriptions given by Blankenship (1952). After 1954 the birds were divided into seven plumage classes according to Gollop and Marshall (1954). Classes Ia, Ib and Ic included birds that appeared to be completely downy at a distance; IIa, IIb and IIc included ducklings in various stages of down and feathers; the IIIa class was for young ducks that appeared to be fully feathered in the field. All Mallards designated as Ia, practically all Ib's and most Ic's were too small to hold a band. An eighth class, IIIb, was assigned to birds able to fly but not sufficiently well to escape capture.

Measurements of Distance and Direction

Except as noted below, distances were calculated from the point of banding to the point of recovery using a U. S. Department of the Interior Public Land Management map (1955), scale 1:5,000,000. The projection used for this map is not given but distances on it agreed closely with the National Geographic Society's map "The United States" (1961) which is based on an Albers Conical Equal-area Projection, Standard Parallels 29° 30' and 45° 30', scale 1:7,603,200.

Mileage arcs in Fig. 4 were measured from the centre of the block of banding - 51° x 109°. As a result, birds designated as having been recovered, e.g., 1,000 miles from their banding sloughs, were taken within 40 miles of either side of the 1,000-mile arc, since the banding block is 80 miles across on a diagonal.

The direction of a recovery from the banding area was measured from the centre of the degree block of banding to the centre of the block of recovery on a Mercator Projection of a map of North America from The Harmsworth Atlas and Gazeteer (1907).

Statistical Tests

Statistical significance is always at the 0.05 level. Unless otherwise stated, this was determined from Mainland, Herrera and Sutcliffe (1956).

Limitations of the Banding Technique

There are problems inherent in the banding technique and limitations in the use of recovery records resulting from hunting that must be considered in both distribution and mortality determinations.

Method of capture

Lensink (1964) found that the direct recovery rate of 23,000 dog-caught Mallards (8.4 per cent) was about 20 per cent lower than that for 29,000 man-caught birds (10.4 per cent) and that this difference was consistent in each of the Prairie Provinces. He assumed that the indicated mortality occurred shortly after banding and would not affect geographical distribution. In the present study, average direct recovery rates were the same for both groups, 7.8 per cent, and the difference on an annual basis was not statistically significant except in 1955 (Table 1). (All tables are in the Appendix.)

An analysis of direct recoveries of birds captured by these two methods by distance and time intervals is presented in Table 2. In each analysis, the number of discrepancies between the two methods is not enough to suggest serious bias.

Banding and recovery data

The chain of events between banding a bird, its death and receipt of a usable recovery has many weak links. The problems are discussed below.

Accuracy and adequacy of data: Errors and omissions may be made by the bander, both in field and office, by the hunter, and by the Banding Office, both when initially recording the data and when correlating bander's and hunter's reports. There is no check on most of these errors. In the present study, age and sex were not recorded in the field for several ducks. The two recoveries of such birds were assigned the sex reported by the hunter. Some errors have been found in banding schedules since their submission to the Banding Office. Hickey (1952) discussed the collating of banding and recovery data at some length. In the few cases where banding details in this study did not agree with data on 3-624 forms, corrections were made, in most cases after consultation with the Banding Office. Hickey (1952) noted that 12 per cent of hunters' reports failed to mention the place of recovery and 10 per cent the date of recovery. To help correct this situation the Banding Office made it a practice to send two follow-up letters containing stamped self-addressed postcards to people submitting incomplete reports. When a form with inadequate data was received by the author, he sent an additional follow-up letter to the hunter and occasionally received a useful reply.

Of 1,647 recoveries in the present study, only one could not be assigned to a specific degree block with some assurance. Of 1,018 direct recoveries, 7.1 per cent could not be assigned to a ten-day period (22 per cent in 1954) and 3.6 per cent could not be put into a specific month.

Band retention: Bands may be lost through removal by the bird or through corrosion of the band. Poulding (1954) tested butt-end and lock-on bands on juvenile Herring Gulls (Larus argentatus) in England and found that some, possibly 50 per cent, of the butt-end bands were lost within 18 months. He considered that the loss was due to removal by the bird rather than corrosion. In Russia, Isakov (1955) found that three of 10 tame young Sheldrakes (Tadorna tadorna) threw off their bands (butt-end?) within two weeks of banding. He also reported that 13 of 25 Greylag Geese (Anser anser), "reared in semi-open conditions", removed their lock-on bands in 15 months. Berger and Mueller (1960) reported that all three recoveries from Bald Eagles (Haliaeetus leucocephalus) and Great Horned Owls were based on lock-on bands; the birds had lost their butt-end bands within one year.

In the present study, it is possible that some downy (Ib and Ic) Mallards that appeared to hold adult bands satisfactorily at the time of banding, lost them. Direct recovery rates of samples that were too small for the differences to be statistically significant indicate either greater band loss or greater mortality among younger birds: 2.3 per cent of 86 Ib's banded were recovered, 4.8 per cent of 479 Ic's and 6.9 per cent of 2,204 IIa's.

Most lock-on bands were used alternately with butt-end bands in 1957. There was no statistically significant difference between the two types in either direct recovery rate or the subsequent annual distribution of recoveries (Table 3).

Coulson and White (1955) concluded that analysis of banding recoveries of British-banded Kittiwakes (Rissa tridactyla) did not give an accurate measure of mortality because the rings became lost before the life span of the species was reached. Hickey (1952) reported 33 bands from 7 to 10 years old and one 15 years old from a total of 1,230 recoveries of Mallards banded from 1922 to 1928. He also quoted Lincoln as stating that variation in the composition of bands had occurred at least until 1947. In discussing illegible bands, Hickey's data show a sharp drop in the number of Mallard bands requiring chemical treatment for deciphering after six years' wear, suggesting that band loss may have been a more important bias after that period. The bands used on Mallards at that time were lighter (No. 6) than those used during this study (No. 7). There have been reports of seven Mallards seven years after banding, three eight years later, and one nine years, four months after banding at Kindersley (these records include experimental, injured and other birds). There is no information on the condition of these bands. Since some Mallards were banded at Kindersley in 1952, maximum band age could have been 11 years at the close of this study.

Discovery and reporting of bands: Most natural mortality probably goes unnoticed. Little mortality occurs where man is as aware of and as interested in ducks as when he is hunting. A high proportion of bands may be returned from birds dying of disease on some managed waterfowl areas and from birds taken by some fur trappers but even these rates may not be consistent from one area or year to the next and in any case they are an insignificant portion of the total. Little has been published concerning finding and reporting rates for such losses although Boyd (1957) working with wintering Teal in England concluded that losses due to man were 5 to 10 times as likely to be reported as those from other causes.

In the present study 13 per cent of the banded birds were reported by hunters from 1954 through 1963. As will be shown below, the best data currently available indicate a reporting rate of 33 per cent for Mallards that are shot. This means that 39 per cent of the banded birds were shot. Less than one per cent of the remaining 61 per cent were reported as dying from other causes. This would indicate a reporting rate of less than 1.7 per cent for Mallards dying of natural mortality factors. In other words, Mallards that were shot were approximately 20 times as likely to be reported as Mallards dying from other causes.

Once found the band must be noticed, be legible and be reported. There is no information on the number of bands that go unnoticed on ducks that are retrieved by hunters. (The reporting rate referred to on the previous page accounted for bands noticed but not reported and for birds crippled but not retrieved.)

Unless the return address and the number on the band remain legible for the life of the bird, survival data may be seriously affected. Coulson and White (1955) concluded that illegibility of bands was an important bias in measuring mortality of English Kittiwakes. Hickey (1952) reported on 42 Mallard bands (size 6) that had to be treated chemically to decipher the numbers. The first was after only three years' wear and the maximum number (16) occurred during the sixth year. There were no data on the number of bands of similar ages which did not need treatment.

Approximately one-half the banded Mallards on which hunters notice bands are reported. This estimate applies only to hunters in the United States and central Canada (the Prairie Provinces and Ontario). It is based on data from Bellrose (1955) and Geis and Atwood (1961) which have already been described. It is likely that the estimate is low. The smaller the area of recovery involved the greater the probability that reporting rates will be highly variable (Crissey, 1955; Atwood and Geis, 1960).

Based on direct observations of hunters' blinds, Hansen (1964) combined data from several areas in the United States and estimated that 0.47 ducks were crippled and were not retrieved for every bird retrieved by hunters. Combining the estimate for crippling loss with that for nonreporting of retrieved birds, it is estimated that 33 per cent of shot Mallards are reported. As stated previously, this figure does not include bands that go unnoticed on retrieved birds.

Crissey (1964) suggested that large-scale banding in a small area may reduce reporting rates there because hunters lose their curiosity about the origin of the birds since most recoveries are likely to be from locally-banded ducks. There was no measure of reporting rate in the vicinity of the banding block during this study. The annual percentages of banded Mallards recovered in Saskatchewan during their first migrations were 2.9, 2.8, 2.5, 1.8, 2.0 and 2.4 from 1954 through 1959. The difference is statistically significant when the proportion for the first two years (2.8 per cent) is compared with that for the last four (2.0 per cent), but whether this is a reflection of reduced reporting rate or a lower proportion of the population being harvested in Saskatchewan is not known.

Population versus harvest

Some factors affecting quantitative, geographical and temporal distribution of band recoveries and the relationship of these recoveries to the population being harvested are discussed below.

Quantitative distribution: The numbers of Mallards and hunters present in an area are probably not the most important factors determining hunting mortality. The number of Mallards present varies in different areas and different years for several reasons: 1) different numbers of adults alive and young produced during the summer, 2) different proportions surviving until the hunting season, and 3) variations in migration routes as a result of, e.g., changes in wetland habitat in a given area and in adjacent areas. Other factors being equal, the number of Mallards available to hunters will determine kill. A million Mallards in one area may rest and feed under conditions where they are available to hunters while in another they may rest and feed on a refuge and not be available.

If populations of equal size are available to hunters and other conditions remain the same, the amount of time that the birds spend in an area will influence the number shot, within limits. Weather and possibly hunting pressure are the most important factors influencing the time Mallards spend in an area. The number of Mallard-days available to hunters may be the most important factor in determining kill.

Where equal numbers of Mallard-days are available to hunters, other factors being equal, the number of hunters will determine the size of harvest. The number of hunters is influenced by opportunity to hunt, regulations, leisure time, etc. People in different areas hunt different numbers of times (Crissey, 1958), making hunter-days a more important factor in Mallard kill than the number of hunters alone. Some hunters prefer to shoot geese, others Mallards, and others have no preferences. Therefore, the availability of other species may also influence Mallard kill.

Finally, hunting efficiency may vary because of weather, density of hunters, habitat, etc. Differential susceptibility of one age or sex to hunting is an important bias (Bellrose, 1944, Bellrose et al., 1961; Geis and Carney, 1961). This will cause the age or sex composition of the kill to be different from that of the population.

Evidence that size of harvest is unrelated to size of population, at least beyond certain limits, is available. Bellrose (1944) working in the Illinois River Valley found that the weeks of highest total duck kill in 1941 and 1942 occurred before peak duck populations arrived and, in 1940, weekly duck kill and duck populations fluctuated independently. Most of the birds present and harvested were Mallards. During the fall migration of 1961 in Nebraska it appears that Mallards made up 79 per cent of the entire duck harvest and more than 90 per cent of the fall duck flight. Kill data for all species combined were divided into four 10-day periods. The highest kill (34 per cent) occurred during the first 10-day period when the total duck population was about half as large as it was during the third 10-day period when 24 per cent of the season's harvest occurred (Sweet, 1962).

The foregoing indicates that it cannot be assumed that characteristics of the Mallard kill apply to the population being harvested. Biases are produced by: (1) number of Mallards present, (2) their availability, (3) the number of days they are available, and (4) differential vulnerability of population components; (5) the number of hunters, (6) the number of days they hunt, (7) hunter preferences and (8) hunter efficiency are also important factors. To this must be added hunting regulations which vary from area to area and year to year.

Some of these biases may be more consistent and, therefore, less important for determining trends, or tend to cancel each other out, as the number of birds, the size of area and the period of time increase. In other words, such biases may be more significant in the harvest of a small population that remains on one slough for 10 days than of a large population in a flyway for 100 days.

The validity of measuring harvest based on hunters' reports of banded birds has been questioned and discussed by Hickey (1951), Bellrose (1955), Crissey (1955), Atwood and Geis (1960) and Geis and Atwood (1961). The problems discussed by earlier writers have been partly solved by later investigators. However, important assumptions must still be made about band recoveries in considering harvests for areas smaller than administrative flyways.

<u>Geographical distribution</u>: An indication of the geographical limits imposed because of reliance on hunters' reports was obtained by plotting the distribution of direct and indirect recoveries of Mallards banded as flightless young throughout North America (Fig. 8). The data were from a listing of recoveries, dated 31 January 1963, provided by the U.S. Fish and Wildlife Service Banding Office. It included reports of birds shot or found dead between 1 September and 1 March. The 10,284 records were distributed through 733 degree blocks. The main area in which Kindersley Mallards were likely to occur but not be harvested or reported was in Canada north of 55° latitude. Lack of a reported harvest would probably be due to sparse human populations and language problems. In the present study, there was one record of a Kindersley Mallard trapped in West Virginia during the hunting season (3 December 1956) but there were no hunting recoveries from this state.

<u>Temporal distribution</u>: This study was concerned primarily with the movements of Mallards between 1 September and 20 January each year from

1954 through 1963 because the results were based on hunting recoveries. Within any province or state there was only a 40- to 95-day period within the above dates in which Mallard movements could be detected. The hunting seasons, daily bag limits and numbers of hunters by provinces and states are presented in Tables 4 and 5.

Surveys conducted during portions of the period of this study showed that Mallards, which the observers presumed to be migrants, arrived in many states of the Mississippi Flyway before hunting seasons opened (Yancey et al., 1958); there are similar data for parts of the Central and Pacific Flyways (Wetmore, 1923). Surveys conducted between 1 and 15 January also revealed that Mallards occurred every year in every state of the three western Flyways, long after many hunting seasons had closed.

While recoveries from sources other than hunting and from periods other than the hunting season are few, four records are available to show that Kindersley Mallards may have been among the birds referred to in the previous paragraph. Kindersley-banded birds were trapped in banding operations near Swift Current (8 August 1955) and in North Dakota (14 September 1962) before legal seasons opened, and in Montana and South Dakota after seasons closed (15 January 1963 and 18 January 1961, respectively).

Discussion

What reliability can be placed on analysis of banding data after considering the limitations detailed above? The method of capture probably biases neither distribution nor mortality data in the present study. It has been assumed that the records are reasonably accurate. Band loss may not have been a serious factor for Mallards and, in any event, it should not bias distribution data. Correction factors are available for the unreported segment of hunting recoveries on a country and flyway level. This bias is probably more important in the analysis of annual data on a province and state basis but less important when data for six years are combined whether on the province-state or degree block level. Where distribution of the population is discussed in this report, it has been assumed that the proportions of birds recovered as well as reporting and crippling rates were similar in the areas or periods concerned.

The limitations imposed on geographical distribution may not be too important in view of the known distribution of the Mallard (American Ornithologists' Union, 1957). Lensink (1964) has summarized present possibilities in this connection as follows: "The distribution of recoveries suggests locations of migration routes, but such data must be treated with caution because variations in timing of migration, hunting pressure, and other factors may influence the proportion of birds killed to those present in a given location." The limitations on temporal distribution probably did not affect a large portion of the Kindersley population during the 1950's. More recently they may have been important in individual years with more Mallards wintering further north.

RESULTS

Bandings and Recoveries

The number of normal flightless young Mallards banded in this study was 12,962 (Table 6). Until 1961 this was the largest sample for a degree block in North America (Lensink, 1964). There were 1,018 direct recoveries and 629 indirect recoveries (Table 6).

Distribution of Kindersley Mallards

Preflight dispersal

Practically all Mallards nest on land and, therefore, the young make an overland trip by the time they are 24 hours old (Raitasuo, 1964). They are guided by the hen on this journey which varies from a few feet to more than a mile in length.

There is evidence that many Mallard broods use more than one slough during the flightless period. Some are forced to move because water areas dry up; many observed cases of movement from apparently suitable sloughs may have been due to human disturbance. Evans, Hawkins and Marshall (1952) found that broods of all species were less mobile in an area of low pond density than in one of high density in Manitoba. They found that Mallard broods spent an average of seven days on a pothole. They recorded two Mallard broods that moved 0.16 miles in 18 days and 0.32 miles in 20 days. Evans and Black (1956) reported a brood of Blue-winged Teal that moved 2.25 miles from its nest before the brood was two weeks old. Stoudt (1961), on the other hand, observed Mallard broods remaining on sloughs as the areas dried up and the young disappeared day after day; areas with water were one-half mile away and were visited by the hens.

In the present study, young were often recaptured on sloughs other than those on which they had been banded. In 1958 R. T. Sterling, Ducks Unlimited, and the author marked 123 young Mallards on 6, 13 and 19 June on a slough that was expected to dry up before the birds reached flying age. The area went dry during the week of 29 June and on 10 July a banding drive was held on a brood area 1.6 miles southwest. Few Mallards were thought to have escaped this operation. Thirteen per cent of 93 birds banded when downy (Class I) on the dry slough and 17 per cent of 30 banded when partly feathered (Class IIa) were recaptured during this drive. There were no other water areas within two miles. On 14 July none of the marked Mallards were caught on a slough 2.5 miles northeast of the dry area. The drying of brood sloughs and distances such as the above between sloughs were not uncommon features of the banding block during the late 1950's.

First migration

Mallards remaining on brood sloughs: Recoveries within 10 miles of the banding sites may be interpreted as birds that were using their brood sloughs as resting areas. Hochbaum (1955) indicated that flights of 10 to 15 miles to grain fields were usual near Delta, Manitoba. Bossenmaier and Marshall (1958) found that the maximum distance of a field-feeding flight was 12 miles for Mallards near Whitewater Lake, Manitoba.

Twelve per cent of all recoveries in the present study were made within a 10-mile radius of the banding sites. They occurred through September, October and into November (Table 10). The difference in the proportions of males and females was statistically significant (10.6 and 14.5 per cent, respectively) and there was a significantly higher proportion of late-hatched than early-hatched recoveries[a] (27 and 5 per cent, respectively) within 10 miles, and this difference persisted through September and October. All November recoveries within this radius were late-hatched birds.

Approximately six weeks separated the mean flight dates of these two groups and about half the late-hatched birds were flying before hunting seasons opened. The preponderance of late-hatched birds occurred through an eight- or nine-week period after 1 September indicating that this group was behaving differently from early-hatched birds for reasons other than the date of hatching. It is possible that a higher proportion of sloughs used by May-June broods than by July-August broods dried up during this study, and it may be that loss of a brood slough is sufficient cause for immediate wandering.

Dispersal within the vicinity of the production area: This discussion of the timing and direction of initial dispersal in all directions has been based on recoveries within a 300-mile radius of the brood sloughs because the most distant direct recovery north of a banding site was 295 miles. (There was only one Canadian recovery beyond 300 miles.) Recoveries within 10 miles of the point of banding have been omitted because hunters' reports were seldom precise enough to allow determinations of exact locations within this radius.

Twice as many birds were reported from north of the banding sites as south, and there were more northerly recoveries each year (Table 7). Equal numbers were taken east and west. There were more recoveries from the northwest quadrant than from the two southern quadrants combined. Recoveries to the north peaked between 1 and 20 October and those to the south between 21 and 30 October, although during this latter period there were still more recoveries north than south. It would appear that an important segment of Kindersley Mallards moved northwest during late September and early October and began moving southward in late October.

[a]Early-hatched: hatched prior to 9 June; late-hatched: after 29 June.

There was an indication that populations moved steadily away from their brood sloughs as the season progressed. Recoveries peaked in the 11-100-mile zone between 1-20 October, in the 101-200-mile zone between 11-30 October and in the 201-300-mile zone between 21-30 October. There was another indication that distance within 300 miles of the brood slough is a function of time: more early-hatched Mallards occurred at greater distances earlier in the fall than late-hatched birds. In September, twice as many early-hatched as late-hatched Mallards (4.2 vs. 1.8 per cent) occurred in the 11-100-mile zone and, while 1.6 per cent of the continental harvest of early-hatched birds was in the 101-300-mile zone in this month, there were no late-hatched ducks.

There were no differences in distribution of the sexes between 10 and 100 miles from the brood sloughs but males occurred in higher proportions than females between 101 and 300 miles every year (except in 1954 when there were no recoveries of either sex in this zone). The differences were statistically significant for 1957, 1958 and the six-year average; the latter was 10.9 per cent for males and 4.9 for females.

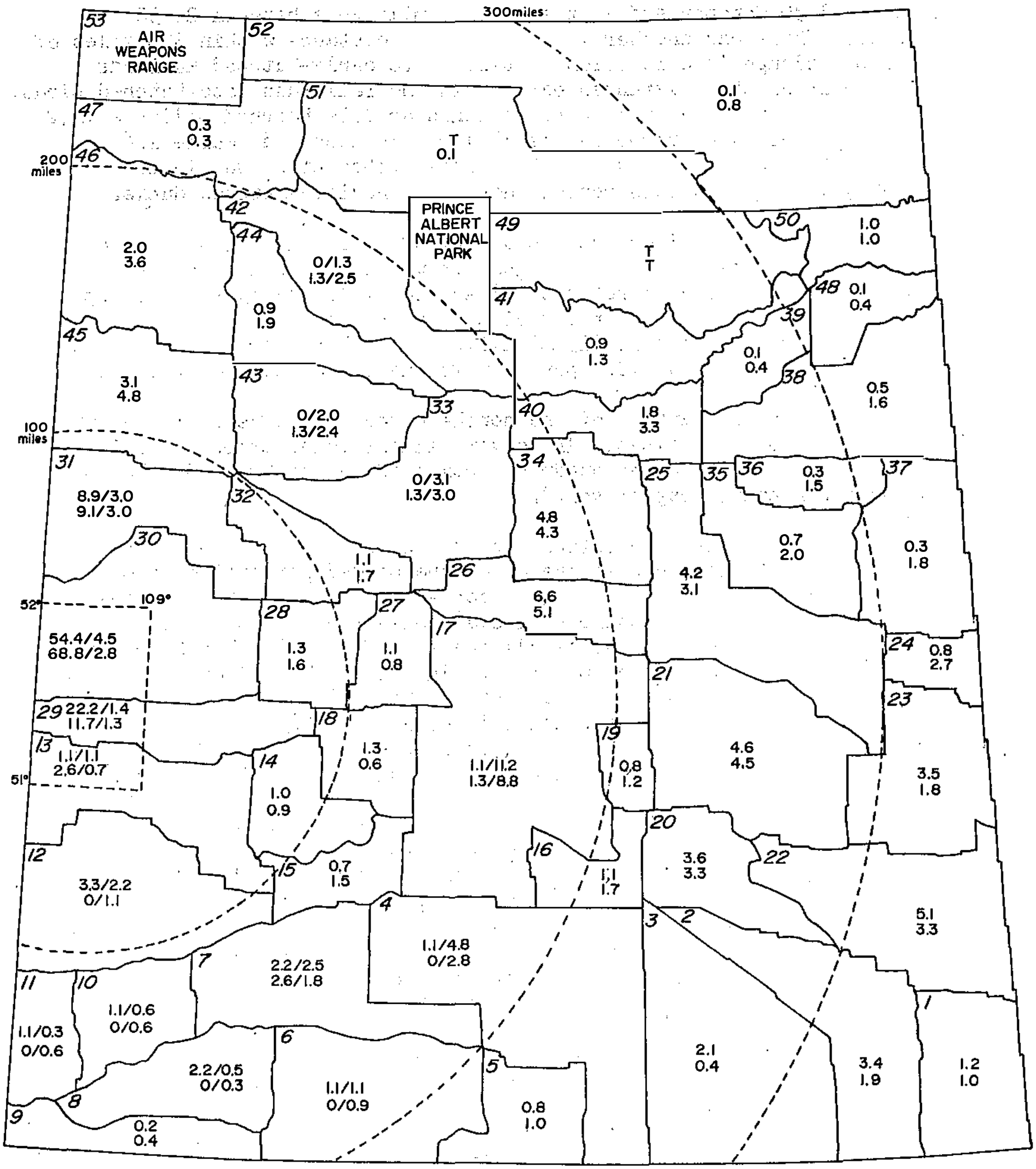
Almost three-quarters of the northern recoveries were within 100 miles of the banding sites. There were almost equal proportions in the northwest and in all other quadrants combined in the 201-300-mile zone (3 and 4 per cent, respectively).

For a preliminary investigation of whether band recoveries reflect distribution of hunting pressure or of the banded population, some Saskatchewan data appear to be the best available. The Saskatchewan Department of Natural Resources (1960a) collected data by mail questionnaire on the harvest of all species of ducks combined for each game management zone in the province. In Fig. 2 the percentage of the Saskatchewan harvest of Kindersley-banded Mallards is compared with the percentage of the provincial duck kill by game management zones for 1957 and 1958. In the absence of data on the proportion of the population harvested, duck kill is assumed to be a measure of hunting pressure.

Percentages within 100 miles of the centre of the banding block include an average of 91 per cent of Kindersley Mallard recoveries and 13 per cent of Saskatchewan ducks. Between 100 and 200 miles the percentages average 9 and 44, respectively, and beyond 200 miles, they are 0 and 43. The rate at which the proportion of recoveries decreases as the distance from Kindersley increases may be interpreted as an indication of dilution to the extent that too few Kindersley Mallards, if any, occurred beyond 200 miles of the banding sites in Saskatchewan to show up in the harvest. On the other hand, 10 per cent of recoveries within 300 miles to the west of the banding sites were reported between 200 and 300 miles away (Table 7); there was no indication of hunting pressure in Alberta.

The ratio of Kindersley recoveries to Saskatchewan duck harvest in the zones adjacent to zones 13, 29 and 30 indicate that there was movement of Kindersley Mallards north and south but not east.

Another factor complicating the relationship between distribution of harvests and populations is differential hunting pressure through



T= less than 0.1%	Sample	Banded Mallards	Total Ducks
	1957	90	1,256,027
	1958	77	741,541

Figure 2. Comparison of percentage distribution of direct Saskatchewan recoveries of Kindersley-banded Mallards and of the Saskatchewan duck kill for 1957 (upper line) and 1958 (lower line) by game management zones.

a season. A comparison is available of the temporal distribution of recoveries of Kindersley-banded Mallards and the Saskatchewan harvest of all Mallards, the latter based on hunter surveys by the Saskatchewan Department of Natural Resources (1960b, 1961, 1962, 1963, 1964; Table 8). There is close agreement in the two distributions, although the years involved are different. Practically all the Saskatchewan Mallard harvest occurs south of 54° N latitude and includes adults and young; it is conceivable that most of southern Saskatchewan's breeding adults moved north by early September and were returning with other adults and young to produce peak harvests during the first half of October. On the other hand, there is no reason to believe that there were fewer Kindersley-raised Mallards in Saskatchewan in September than in October. Also they were probably more vulnerable to hunting in September. Conceivably the pattern of the Saskatchewan harvest reflected the size of Mallard populations, whereas the distribution of Kindersley Mallard recoveries probably reflected increasing hunting pressure until mid-October, after which time there is evidence that more of these birds had left Saskatchewan than remained (Table 16).

Northward movement: The phenomenon of northward movement in late summer and fall has been noted in many species of birds. Northward movement of young Mallards after they begin flying apparently occurs in all parts of the breeding grounds. Lensink (1964) presents band recovery data so that movements beyond the state of banding can be determined but not movements within a state or province. Mallards banded as flightless young were recorded moving north to Canada from Washington, Montana, North and South Dakota, Nebraska, Minnesota, Pennsylvania and possibly from Michigan and New York. Northward movement within the United States was noted from California, Nevada, Utah, Colorado, and New Mexico. The largest proportions northward of out-of-state recoveries were from Nebraska (12 per cent of 81 direct recoveries), California (9 per cent of 150), Montana (8 per cent of 37), and South Dakota (5 per cent of 383). The longest movement was one of at least 500 miles north-northwest from Nebraska to Saskatchewan. In the present study 16.3 per cent of direct recoveries were reported more than 10 miles north of the banding sites and 4.6 per cent more than 100 miles north (Table 10). The farthest was 295 miles.

Northward movement in the year of banding has also been demonstrated for adults (Cartwright, 1945, Cartwright and Law, 1952, Lee and Bue, 1954, Table 4). In the present study, 18 per cent of 88 direct recoveries of male Mallards banded as adults at Kindersley in 1958 were reported north of the banding sites; from 1954 through 1958, 11.5 per cent of 53 direct recoveries of adult females were reported to the north.

The timing of this movement is difficult to determine because few northerly recoveries are made within a short period of banding. The results of banding studies have shown that Mallards move north as early as 13 September from Saskatchewan (Cartwright and Law, 1952) and as late as 19 November from Illinois (Mann, Thompson and Jedlicka, 1947). For Mallards banded at Kindersley in the fall, the period has been 18 September to 17 October (Dzubin, in press; Table 9).

In the present study, Mallards hatched prior to 9 June made up two-thirds of the recoveries more than 100 miles north of the banding sites. They were the only group represented there in September and they were twice as abundant in October as birds hatched after 29 June; early-hatched birds were slightly more common in November (Table 22). There were no late-hatched birds beyond 200 miles north. The first late-hatched birds were not flying until the last week of August and although northward movement from Kindersley occurred through September and into October, there was apparently not enough time for these birds to wander more than 100 miles. Males of both groups dominated the northward movement beyond 100 miles.

Direct observations of northward movement are few. Hochbaum (1955) described northward migrations to Delta, Manitoba, in 1949 and 1954; he found that both adults and young were involved. Mann (1950) observed 50,000 to 100,000 waterfowl, mainly Mallards, flying north from Lower Souris National Wildlife Refuge, North Dakota, between 4:30 and 6:00 p.m. on 10 October 1948. There were 14 direct recoveries from Manitoba up to 175 miles north of the banding sites, which were within 20 miles of the Canadian border. While the samples were small, each age-sex group was recovered in Manitoba in approximately the same proportions that they were banded. It was suggested that these Mallards were migrants from Canada, driven south by the opening of the hunting season in Manitoba on 1 October and sent north again by the opening of the North Dakota season on 8 October.

Apparently 1948 was an exceptional year for northward movement from North Dakota. With incomplete returns, there were 11 birds recovered in Manitoba per 1,000 banded in 1948 compared to 5 birds per 1,000 for all other years (Mann, 1950). In the present study, the proportion of banded birds recovered north of the banding sites was fairly constant each year. In terms of direct northward recoveries per 1,000 Mallards banded, the annual figures for 1954 through 1959 were 15, 14, 10, 14, 12 and 13 for an average of 13 birds. In terms of their percentage of the continental harvest, there was considerable fluctuation: 18, 13, 9, 21, 15 and 26 for an average of 16 per cent.

<u>Dispersal by distance, month and direction</u>: Overall dispersal will now be considered in terms of distance, time and direction, without reference to political boundaries.

During September most of these birds were within 10 miles of their brood sloughs and very few had moved beyond 100 miles (Table 10). In October about one-quarter of them were still less than 10 miles from where they had been banded but almost half of the remainder were north of the banding sites; a few had moved southward beyond 1,100 miles. In November two-thirds of the birds were from 600 to 1,600 miles south of Kindersley. Through December and January most of them concentrated in a zone 1,100 to 1,600 miles south, where they probably wintered.

When these data were examined on an annual basis there was a positive correlation between the proportion reported by 1 November and that within 600 miles of the banding sites, the range being from 24.6 and 31.4 per cent, respectively, in 1956 to 58.8 and 64.1 per cent respectively, in 1959.

The two 100-mile zones with the highest numbers of recoveries were 0-100 (29 per cent) and 1401-1500 (11 per cent). These include the production area and the main wintering area. The zones with fewest recoveries were 501-600 (1.3 per cent), 1801-1900 (1.6 per cent) and 201-300 (1.9 per cent); the first and third zones are migration areas and the second is the most distant zone with recoveries every year, apparently a fringe wintering area.

The distribution of recoveries indicates that these birds spent more time between 1 September and 15 January within 100 miles of their brood sloughs than in any 500-mile zone beyond them. However, it should be remembered that they were probably more vulnerable to hunting early in the season, and they formed a higher proportion of the duck population near Kindersley than further away.

The direction of movement was recorded by five-degree sectors from block of banding to block of recovery for recoveries more than 200 miles[a] south of the banding sites, excluding all Canadian recoveries. The distance limitation was necessary partly because of the lack of precision in hunters' reports and partly because of the method of determining direction. In Table 11, all recoveries to the southwest were put under one heading (183°-237°) and the remaining five-degree sectors were grouped into three 20-degree arcs beginning with the most easterly; this left a 10-degree sector almost due south of the production area.

The range in direction of recoveries from the banding sites was 120 degrees (117°-237°). One sector (133°-152°) was dominant when all years were combined, regardless of distance, zone or month. The same was true on an annual basis for each of the last three mileage zones (601-2100) and for each month in every one of the four years for which there were more than 30 recoveries (1955 through 1958). Within the 201-600-mile zone recoveries to the southwest were more frequent in three of four years. This 20° sector included more than 60 per cent of recoveries in the United States each year.

A relationship between movement to the northwest and subsequent southward migration is demonstrated for years with more than 100 direct recoveries, 1956, 1957 and 1958 (Table 12). The increased proportion of banded birds recovered beyond 100 miles to the northwest in 1957 was not reflected by an increase anywhere to the west of the major sector (152°-137°). It would appear that variations in northwest movement do not affect the direction of subsequent southward migration.

When recoveries beyond 200 miles to the south are examined by five-degree sectors (Fig. 3), it would appear that 138°-142° is the most important southward direction for Kindersley-raised Mallards. It contains the greatest proportion of recoveries each month from November through January and for the two zones from 601 to 1600 miles. In October and within 600 miles of the banding sites, this sector is on a par with

[a]Included are U.S. recoveries beyond 190 miles.

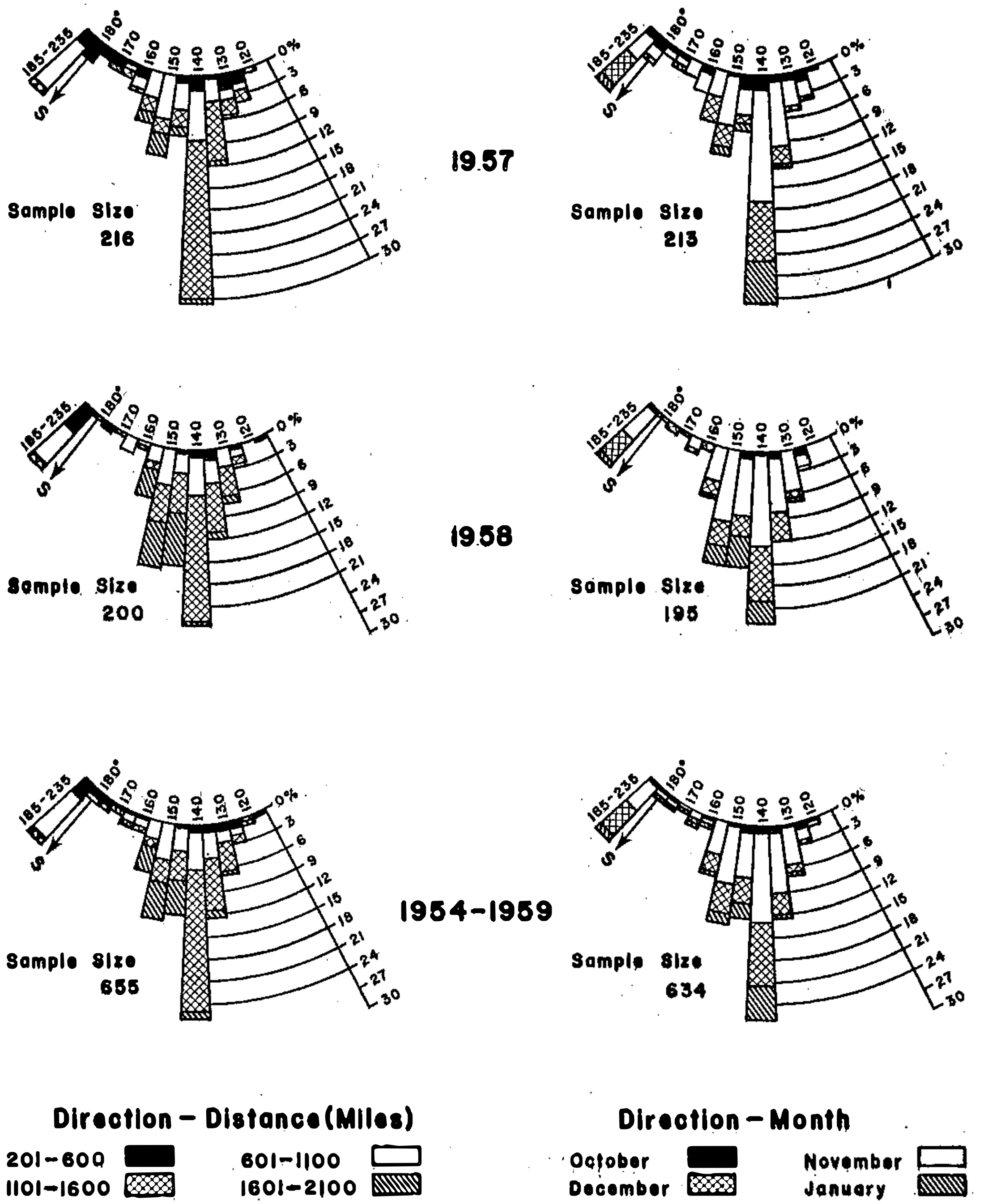


Figure 3. Percentage distribution of direct recoveries of Kindersley Mallards within the United States by direction (5° sectors), distance and month for 1957, 1958 and 1954-1959 combined.

several others. Between 1601 and 2100 miles there is a definite shift to adjacent, more southerly or westerly sectors from 145° through 155°.

If the major direction arc (140° or 138°-142°) is projected northward through the center of the banding block and beyond, it passes slightly northeast of the main concentration of northern recoveries but it does pass through four ~~of the four~~ of the five degree blocks where two-thirds of the northern recoveries occurred.

It would appear that a bearing of 138°-142° and a distance of 1401-1500 miles from the banding sites represent a goal for a major segment of Kindersley Mallards in their first southward migration. The increasing proportion each month that the 140°-sector includes of birds reported southeast of the banding sites (16 per cent in October, 25 in November, 33 in December and 46 in January) indicates that many Mallards harvested elsewhere early in the season were headed for this area. (Important segments of young Mallards from all three prairie provinces were reported from this target area - Arkansas, Table 14.) However, hunting seasons were closing from north to south beginning in November, thus reducing the opportunity to detect birds remaining in the north as the season progressed.

Distribution by political units: Having discussed distribution by distance, time and direction from the production area, consideration will now be given to the first migration in relation to countries, flyways, provinces and states, and then on a monthly, weekly and daily basis.

a) Distribution by country and flyway. On the average, approximately one-third of the harvest was reported from Canada, two-thirds from the United States and a trace (0.2 per cent) from Mexico. The Canadian portion varied from one-quarter in 1956 to almost two-thirds in 1959 (Table 13).

The distribution by administrative flyways within the United States is also shown in Table 13. However, the unadjusted figures in Table 13A are subject to the biases pointed out by Crissey (1955). To determine the magnitude of differential reporting rates for Mallards, Bellrose (1955) used reward and control bands in 1950 and 1951 while Geis and Atwood (1961) used mail questionnaires and Banding Office data from 1954 through 1956. Bellrose found that Canadians (probably from Saskatchewan and Manitoba based on Cary, 1954) reported 52 per cent of the bands they found while Mississippi Flyway hunters reported 43 per cent. Geis and Atwood found the lowest reporting rate in the Mississippi Flyway (42 per cent) and the highest in the Pacific Flyway (61 per cent); their study did not include Canada or Mexico.

The raw data in Table 13A can be adjusted for differential reporting rates by using the Mississippi Flyway as a common denominator and by applying an average correction factor to each year's data. The distribution between flyways can also be adjusted for unretrieved crippled birds. This second adjustment was calculated from mail questionnaires distributed to hunters in the United States from 1955 through 1959. Crippling losses of all duck species combined varied from a mean of approximately 20 per cent of the birds actually killed in the

Atlantic and Mississippi Flyways to 14 per cent in the Central and Pacific Flyways (Crissey, 1957, 1958, 1960). More reliable data on crippling losses based on direct observation have recently become available but they were based on small samples from 1961 through 1963 (Hansen, 1964). The proportions between flyways did not differ importantly from the mail survey data. Comparable data were not available for Canada.

Adjusted figures (Table 13B and 13C) showed little change in the proportions taken in Canada and the United States. Important differences did occur, however, among the three western flyways. The Mississippi Flyway percentage increased at the expense of both the Central and Pacific Flyways. It now appears from the adjusted values that 56 per cent of the kill in the United States occurred in the Mississippi Flyway, 36 per cent in the Central, 7 per cent in the Pacific and less than 1 per cent in the Atlantic Flyway.

The raw data indicated that the birds remained longer in the Central than the Mississippi Flyway in 1954 and 1957. The application of both correction factors reversed this relationship for 1957 and an adjustment for reporting rate alone did the same for 1954. The adjusted data show that differences between the Mississippi and Central Flyways were statistically significant in 1955, 1956 and 1958. These two flyways reported 92 per cent of the harvest in the United States. The consistency of migration through these two flyways is indicated by the small range in annual adjusted figures (90.8 and 93.1 per cent) for the period 1955 through 1959. A trend toward an annual decrease in the Pacific Flyway's harvest of Kindersley-raised Mallards from 9.8 per cent of direct recoveries in 1954 to 3.9 per cent in 1959 is suggested; the differences are not statistically significant.

The comparative distribution of Mallards from Kindersley and from other areas in southern Canada during their first migration is shown in Table 14. There is a general shift in migration and wintering areas of young Mallards from west to east corresponding to the origin of the birds (Lensink, 1964). From British Columbia to Manitoba the proportions of continental recoveries of birds banded in each of the four provinces decreases in the Pacific Flyway from 36 to 0 per cent and increases in the Mississippi Flyway from 1 to 31 per cent. The distribution from Kindersley is intermediate between that from Alberta and Saskatchewan based on recoveries in Alberta, Saskatchewan, the Pacific and Mississippi Flyways. The high proportion of Kindersley Mallards reported from the Central Flyway corroborates what Pacific Flyway percentages indicated, namely, that Kindersley is east of the zone that separates predominately southeast and southwest movements.

The distribution of direct recoveries of Mallards banded as flightless young at Redvers, Saskatchewan, is also shown in Table 14. Redvers is near the Manitoba border, about 350 miles east and 130 miles south of Kindersley. Data from the two areas show a shift in distribution from west to east within Saskatchewan.

A significantly lower reporting rate might be expected from Mexico, with the result that many more than two of 1,018 recoveries should have been reported from there. Lensink (1964) had an even lower proportion taken in Mexico, six of 9,272 direct recoveries of Mallards banded as flightless young throughout North America. Saunders (1964) indicates that Mallards winter only in the highlands of Mexico and that in recent years "flights of a few thousand" have occurred. The Mallard is not listed among the 10 species which accounted for all but 3 per cent of the 566,000 ducks noted during winter surveys in that part of Mexico (Saunders, 1964).

b) Distribution by province and state. Average distribution by percentage categories for each province and state is shown in Figure 4. For provinces and states forming the boundary of the distribution pattern, shading has been restricted to the areas in which recoveries have been made. States in the three western flyways with only one or two recoveries are not included in the main pattern but are shown individually as are recoveries from the Atlantic Flyway and Mexico.

It is apparent from Fig. 4 that young Mallards dispersed in all directions from their brood sloughs, and that most of them eventually moved southeast. Kindersley Mallards were reported from all seven states in the Pacific and all 10 states in the Central Flyway, in 13 of 14 Mississippi Flyway states (Wisconsin excluded) and in four of 17 Atlantic Flyway states (Georgia, Florida, North and South Carolina).

The provinces and states included in the major migration route of these birds were, by average frequency of occurrence of direct recoveries: Saskatchewan, 27 per cent; Arkansas, 12; Alberta, 9; Nebraska and Louisiana, 6 each; Missouri, 5; Texas, Montana and Kansas, 4 each; and South Dakota, 3 for a total of 78.6 per cent. The remaining one-fifth of the reports came from 26 other states and Mexico. Sixteen of these states and Mexico each averaged less than one per cent of the reported harvest. (Up to the time of writing, adjustments for differential reporting rates and crippling losses were not available for individual states. No attempt has been made in this paper to apply flyway correction factors to data for each state.)

Saskatchewan and Alberta, the only provinces in the Canadian distribution, were represented every year. If recoveries from the degree block of banding were excluded, the ratio of recoveries between the two provinces would drop from 3:1 to 0.9:1, in favour of Alberta. In spite of the fact that there were only 20 recoveries in the United States in 1959, five states were included in the distribution in all six years: Arkansas, Nebraska, Missouri, Kansas and Illinois. Seven states were represented in only one year: Arizona, Nevada, Michigan, Ohio, Georgia, Florida and North Carolina.

c) Annual variation in geographical distribution. Some areas were fairly consistent in the proportions of the harvest reported each year while others showed considerable variation. The more consistent areas based on years with more than 100 recoveries each (1956, 1957 and 1958) were: Saskatchewan, 23.9 to 25.6 per cent; Arkansas, 10.2 to 14.4; Nebraska, 5.3 to 7.4; Missouri, 4.3 to 5.9; Kansas, 2.7 to 4.5; Oklahoma, 1.4 to 2.3; Idaho, 1.3 to 2.1; and Washington, 0.5 to 0.7. Areas with wide variations in annual percentages were: Louisiana, 2.8 to 9.6 per cent; Alberta, 2.7 to 13.1; Montana, 1.1 to 6.5; South Dakota, 1.1 to 4.5; and North Dakota, 0.7 to 2.6. These latter differences are

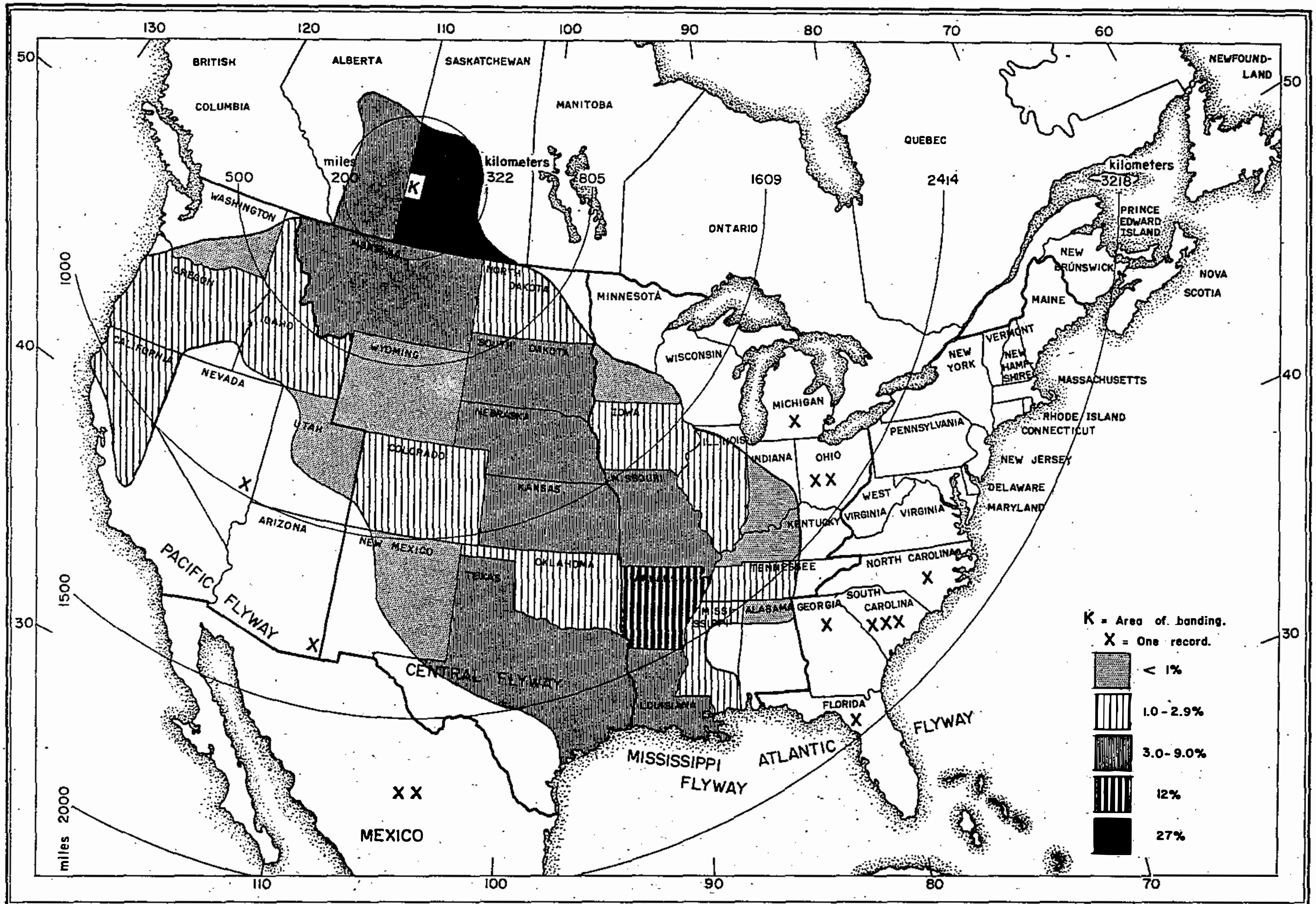


Figure 4. Percentage distribution by province and state of direct recoveries of young Mallards banded at Kindersley, Saskatchewan, 1954-1959 combined.

statistically significant.

In Alberta, Montana, North and South Dakota, the highest proportion was reported in 1957; for Alberta there were more recoveries in 1957 than in the other five years combined (42 vs. 40). There was a positive correlation each year from 1955 through 1958 between the proportion of the harvest that occurred in Alberta and the subsequent proportion reported in Montana, North and South Dakota (Table 15). Each year the Alberta harvest approximately equalled the three-state harvest. Apparently, most of the Mallards that moved into Alberta went southeast eventually but the more that moved into Alberta the more there were to move through the northern part of the Central Flyway. Also the proportion in the Pacific Flyway did not fluctuate with the proportion reported from Alberta.

There was no consistency in the pattern of states affected by a high kill at the north end of the migration route, but in 1957 Iowa, Missouri, Louisiana and Texas reported their lowest proportions for the four years.

d) Monthly distribution. The monthly percentage distribution of direct recoveries by province and state for each of the four years with 60 or more recoveries (1955 through 1958) is shown in Figure 5. Provinces and states are shaded if there was no legal hunting during the month. Hunting seasons in Atlantic Flyway states and in provinces other than Saskatchewan and Alberta are not designated.

The monthly pattern of first migrations based primarily on these four years was as follows:

September. With hunting seasons closed throughout the United States, Kindersley Mallards were reported only from Saskatchewan and Alberta, although there were none reported from Alberta in September 1955. The percentage of annual harvest occurring in this month varied from 6.4 to 10.3. The small samples of 1954 (42) and 1959 (52) had September proportions that were below (2.4 per cent) and above (15.1 per cent) the extremes for the other four years.

October. The hunting season remained open in Canada through the entire month and it opened in all states of the three western flyways except for eight south of 39° latitude (New Mexico, Texas, Arkansas, Louisiana, Mississippi, Alabama, Tennessee and Kentucky).

The October harvest varied from 15.1 to 31.6 per cent, second only to November in proportion of reports. The birds appeared to be largely in Canada and the reported Saskatchewan and Alberta harvests were heavier in October than in September or November each year with one exception (September 1956 in Alberta). The harvest in the United States was usually 3 per cent or less, but in 1957 both the United States and Alberta harvests were particularly high (8 per cent each). In that year also, Kindersley Mallards were reported further to the southwest and southeast in October than in any other year (California, Missouri and Michigan).

November. Hunting seasons were open every year in Canada and in every state in the three western flyways for at least part of November.

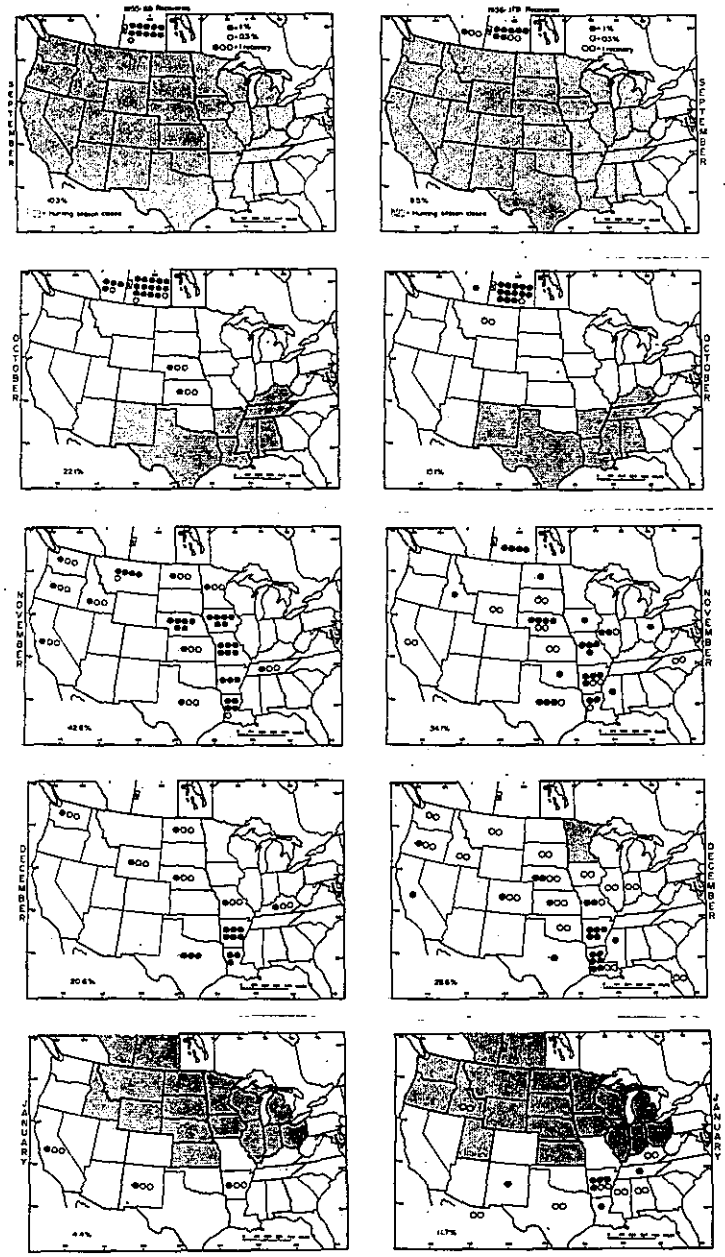


Figure 5. Monthly percentage distribution by province and state of direct recoveries of Mallards banded as flightless young near Kindersley, Saskatchewan, for each year from 1955 through 1958.

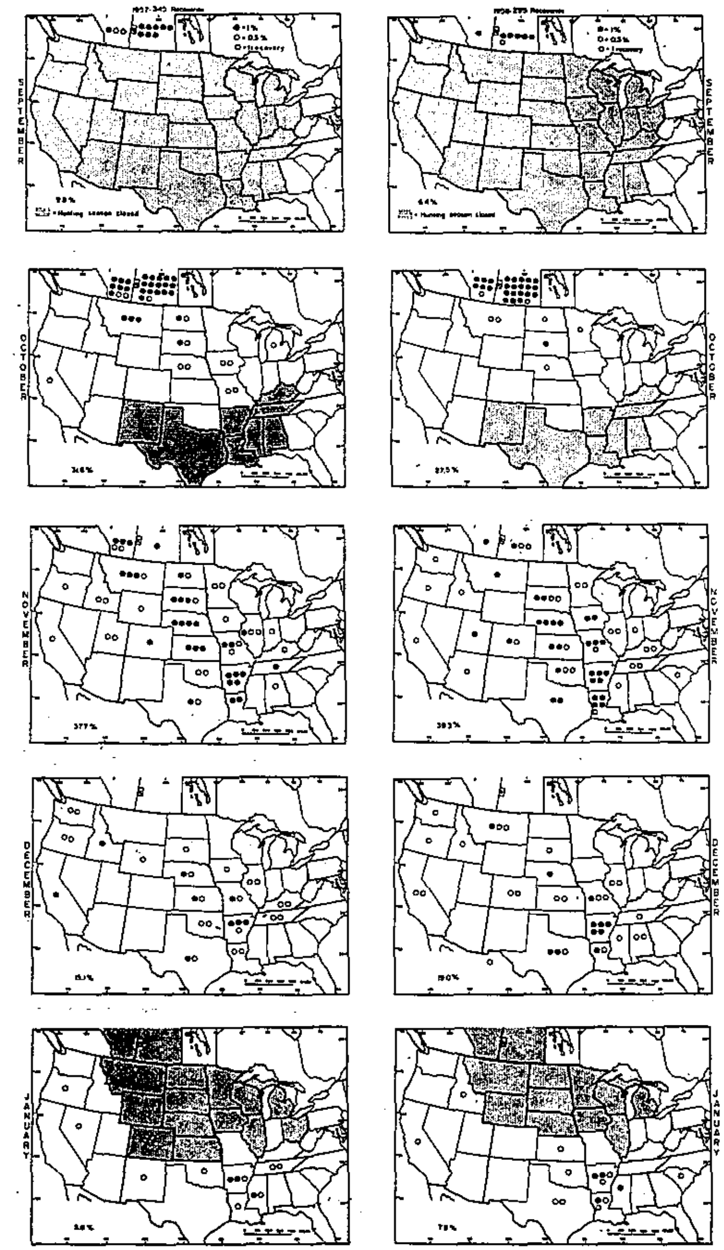


Figure 5. continued.

Freezing weather in Canada usually drove the last Mallards south by the middle of the month. November distribution was more widespread than that for any other month. Recoveries were usually reported from Canada to the Gulf of Mexico and from Pacific to Atlantic coasts. In 1955 there were no November recoveries in Canada although they averaged about 4 per cent of the annual harvest in the other three years. Harvests were fairly consistent, varying from 34.1 to 42.6 per cent of the annual total.

December. Hunting was legal in all states and both provinces for part of the month (except in Minnesota in 1956). Field observations showed that there were practically no Mallards left in the Prairie Provinces. There were no recoveries in Canada and there were few from the north-central states (north of 43° latitude) in December. Annual harvests varied from 15.1 to 29.6 per cent of the total. The birds appeared to be concentrated in Arkansas, Louisiana and Texas.

January. From 14 to 21 southern and western states had open seasons in different years during at least part of the first half of January. The reported kill varied from 4.4 to 11.7 per cent. Arkansas appeared to be the major concentration area every year; Texas and Louisiana reported Kindersley Mallards in January in only two of the four years.

e) Weekly distribution. In order to determine movements and harvests at intervals of less than a month, the average weekly distribution of direct recoveries is presented for the seven most important provinces and states: Saskatchewan, Arkansas, Alberta, Nebraska, Louisiana, Missouri and Texas (Table 16).

Waterfowl harvest on the opening day of the hunting season in the United States is usually higher than on any other. An indication of this may be seen in the seasonal distribution of Mallard kill based on wings submitted by hunters to conservation agencies for species, age and sex determination. Six per cent of 781 wings in Illinois were reported on the first day of a 40-day season in 1959, 14 per cent of 532 wings in Missouri, and 10 per cent of 889 in Arkansas. With 50-day seasons in Minnesota and Wisconsin, birds reported on opening day made up 19 per cent and 9 per cent, respectively, of the season totals of 1,095 and 1,341 wings (Geis and Atwood, 1961). This did not occur in any state any year with Kindersley-banded Mallards, indicating that these birds were not present in large numbers on opening day.

In Canada more than one-third of the harvest occurred between 29 September and 12 October in Saskatchewan and between 6 and 19 October in Alberta. One-third of the harvest in Louisiana occurred at the beginning of the season before or by approximately the same dates as similar proportions north and west in Nebraska, Missouri, Arkansas and Texas. The problem of the most southerly harvest occurring earlier than that to the north will be discussed later.

During each of the three weeks between 3 and 23 November, Kindersley-raised Mallards occurred from Canada to the Gulf of Mexico. Two periods of peak harvest are suggested in Arkansas, Louisiana and Texas. Split hunting seasons do not account for these peaks.

An examination of the continental harvest by weekly periods shows a gradual rise from 1-7 September (0.5 per cent) to a peak between 10-16 November (10.9 per cent) and a steady decline to 12-20 January (1.2 per cent). The week of 6-12 October produced a minor peak (8.0 per cent) because of similar peaks in 1955, 1956, 1958 and 1959 that were higher than any of the preceding weeks and at least two of the subsequent weeks each year. This could probably be attributed to harvest in Canada and may have been associated with an influx of American hunters who timed their waterfowl hunting trips to coincide with the opening of upland game bird seasons about this period, and with a change in emphasis by local hunters from geese to ducks.

The two-week period of largest harvest occurred between 3 and 30 November each year except 1959 when it was 29 September-12 October. The one exception resulted from an unusually high harvest in Canada (twice the average) which, in turn, may have been associated with a large proportion of late-hatched birds (twice the average).

f) Daily distribution. Monthly and weekly analyses do not give a proper appreciation of the extent of waterfowl distribution because of the long distances that ducks and geese can travel in short periods. Bellrose (1957) stated that in a mass migration from 31 October to 3 November 1955, many ducks flew 1,300 to 2,000 miles in two days, some birds flying nonstop from the Canadian Prairies to Louisiana.

To show how far apart these birds were on individual days, the distribution of direct recoveries for 14 consecutive days, 6 through 19 November 1958, is presented in Table 17. On 15 November birds that had been raised within 80 miles of each other in July were at least 1,800 miles apart, and were reported in Canada and the four flyways.

The effects of weather: The migration of 31 October-3 November 1955, referred to above, was a spectular flight involving millions of ducks (Bellrose, 1957). Bellrose and Sieh (1960) described similar flights in 1956 and 1957. Such a migration may be expected in late October and early November every year, but either it did not materialize in 1958 or it went unobserved. The distribution of Kindersley-raised Mallards in relation to these major migrations may be seen in Table 18.

In 1955, no Kindersley Mallards were reported in Canada after the mass flight. In 1956, three of the four birds recovered after the mass migrations were more than 70 miles south of their brood areas. In 1957, 16 of the 24 subsequent recoveries were in Alberta and southern Saskatchewan, more than 100 miles from the banding sites.

The effect on reports from the United States was even more marked. Less than 5 per cent of the recoveries occurred before the major migrations in each of the three years. However, it appears that some Kindersley Mallards moved only 200 to 400 miles in these flights, more if they started northwest of the banding sites, since a similar recovery pattern occurred in Montana and North Dakota, the first two states over which these birds must have flown. Although hunting seasons opened between 1 and 8 October in these states, an average of only 10 per cent of the two states' harvest of Kindersley Mallards occurred in the three to five weeks before the major migrations.

These data indicate that Kindersley Mallards moved with other Mallard populations on these flights. However, these young birds may actually have left before or remained after the major migrations, and the subsequent kill may reflect a reduction of hunter activity in Canada because of the departure of so many ducks and an increase in hunting pressure in the Central and Mississippi Flyways because of their arrival. Certainly some Kindersley Mallards were at least 900 miles from their brood sloughs before the mass flights (Table 18).

Low (1957) examined the distribution of direct recoveries of Kindersley Mallards (mainly experimental birds) for 1954 and 1955 and concluded that weather was the controlling factor in the timing of migration. "Freezing weather arrived unusually early in the prairie portions of Canada and the United States during the fall of 1954, while the fall of 1955 was extremely mild...Large numbers (of waterfowl) were still present during mid-December of 1955 and a fair number actually wintered there."

These statements are contradicted by other evidence, notably by weather data for November 1954 and 1955 (Canada Department of Transport 1954, 1955), by Bellrose (1957) and by Hawkins (1954a, b, c). Hawkins' summaries of migration in the Mississippi Flyway were based on reports from waterfowl biologists in Canada and the United States. In the issue of 29 October 1954, Hawkins (1954a) stated, "Generally throughout the region hunting has been poor because of a shortage of birds in many areas and 'bluebird weather'." In the 12 November 1954 issue he said: "In short a substantial flight out of Canada still can be anticipated." (Hawkins, 1954b). The 26 November 1954 summary read: "ducks have been slow in leaving Canada this year but are now progressing down the flyway in substantial numbers." (Hawkins, 1954c).

On 3 November 1954, an aerial survey of waterfowl showed that there were 19,000 ducks, practically all Mallards, in the Kindersley district. Large sloughs were 90 per cent ice-free and even small ponds were partly open. On 4 November 1955 a similar survey yielded 9,200 ducks; some large sloughs were completely frozen while others had only small areas of open water in them.

Lensink (1964) discusses the effects of weather on relative size of the harvest in the Central and Mississippi Flyways in 1954, 1955 and 1957. His analysis of 1954 and 1955 weather agrees with the author's interpretation above. He suggests that in 1957 "extremely mild weather throughout the hunting season caused Mallards to remain much farther north than normal, allowing them to be shot in the northern states of the Central Flyway." The high proportion of Kindersley Mallards reported in the Central Flyway in 1957 has already been noted (Table 13). However, it would appear that this was due to Kindersley Mallards moving into Montana, North and South Dakota in greater numbers than usual in October, and being taken in greater proportions than normal in November. In these three states 1957 was the only year that there were no recoveries in December (Fig. 5), indicating that Kindersley Mallards did not remain in the northern part of the Central Flyway as late as in other years.

<u>Route and timing of the first migration</u>: In order to gain a more detailed picture of the route taken by most Mallards on their first migration from Kindersley, direct recoveries to the northwest and southeast of the production area, between 85° and 114° longitude, were analysed by degree blocks. Ninety-four per cent of all direct recoveries were included, i.e., all those from Canada and almost all from the Central and Mississippi Flyways. The degree blocks were then examined by successive lines of latitude and the latitudinal distribution examined by 10-day periods.

In Fig. 6B the groups of degree blocks with the narrowest possible distribution of two-thirds of the recoveries along each line of latitude are differentiated from degree blocks in which the remaining third of the recoveries occurred. Fig. 6A shows the shortest period in which two-thirds of the direct recoveries occurred along each line of latitude as well as the time period for all recoveries. Fig. 6C shows the shortest north-south distance in which two-thirds of the recoveries occurred for each 10-day period as well as the latitudes over which all recoveries for each period occurred. This method is a modification of one proposed by F. C. Bellrose (unpublished).

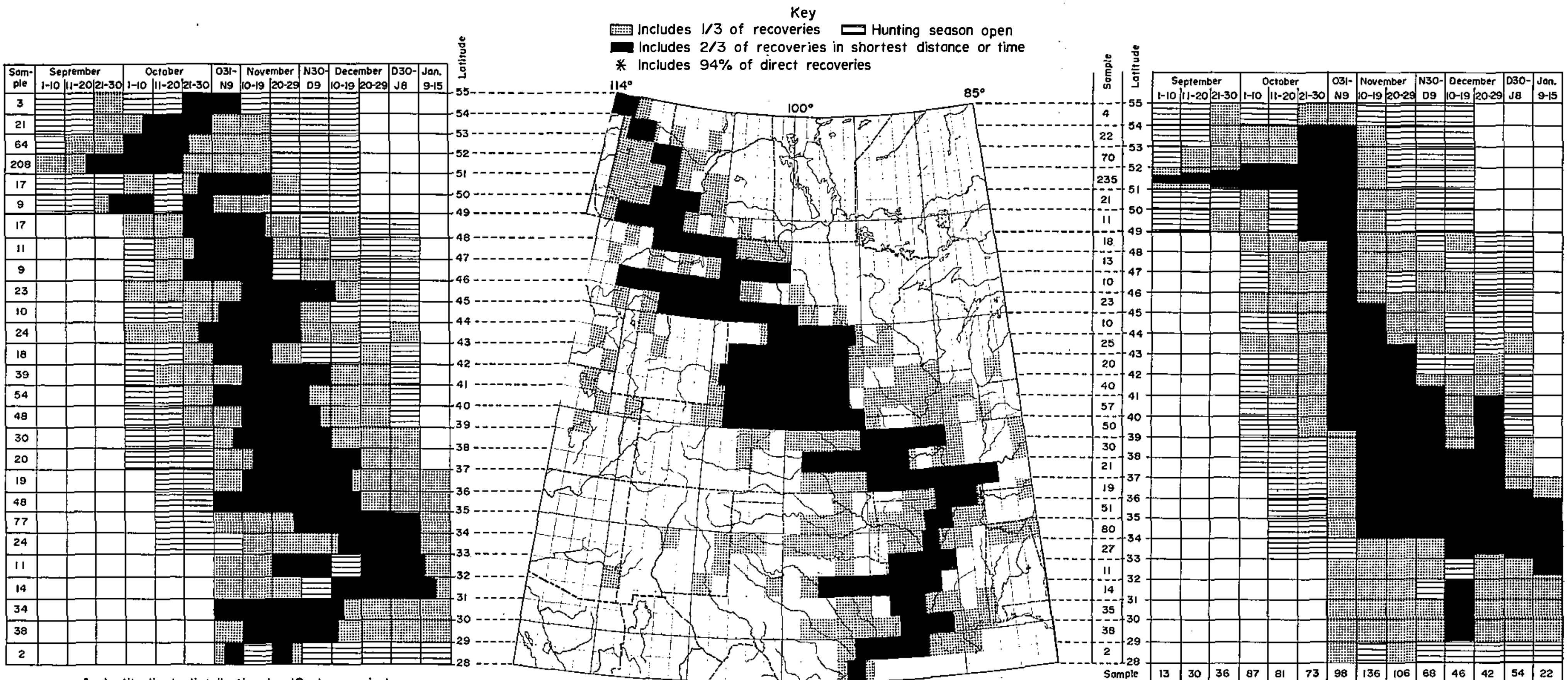
Two-thirds of the reports were concentrated in a band less than 65 miles wide at two latitudes - 51° and 34°. Northwest of the banding block, the major distribution averaged 78 miles across. At its widest points (40° and 45° latitude) the route was 475 miles across. Although irregular in shape due to small samples, two-thirds of the recoveries were included along a path that averaged 255 miles in width (Fig. 6B). Hickey (1951) found that a band 250 miles wide included 90 per cent of approximately 180 indirect recoveries of Mallards banded on migration at one station in Illinois; none of these birds went to the Pacific Flyway.

That part of the route including two-thirds of the recoveries went northwest from the banding block, with a concentration in the Beaverhill-Cooking Lake district of Alberta. To the southeast, the major route was loosely associated with the Yellowstone River in Montana and spread over both sides of the Missouri River through South Dakota. Almost the entire state of Nebraska was covered. Most birds entered Missouri from the northwest near the Missouri River and then moved across the state to the Mississippi River. They turned southwest near the point where Missouri, Arkansas and Tennessee meet and then flew to the Gulf of Mexico; the main line of flight was west of the Mississippi River.

The route indicated by Hickey (1951) for Mallards banded on migration in northeastern Illinois is farther north and east of the above flight-path for most of its length. It is similar from southern Illinois to the Gulf of Mexico.

The northwest section of the Kindersley Mallard route is approximately 300 miles in length, the southeast leg approximately 1,300 miles and the final, southwest, segment is about 600 miles. From the brood sloughs into Alberta and then to the Gulf coast of Texas is 2,500 miles.

There was considerable variation in the numbers of recoveries at different latitudes as shown in the "Sample" column of Fig. 6B. The



A. Latitudinal distribution by 10-day periods (892 records)

B. Distribution by latitude and longitude (957 records)

C. Temporal distribution by latitude (892 records)

Figure 6. Distribution by latitude and 10-day periods of direct recoveries of Mallards banded as flightless young near Kindersley, Saskatchewan, 1954-1959. (Only recoveries between 85° and 114° longitude).

major peak is between 51° and 53° (305 records) with minor peaks at 41° to 39° (107), 36° to 34° (131) and 31° to 29° (73). If hunting pressure, vulnerability, reporting rates, etc., are assumed to be minor causes of these variations, these peaks may indicate areas where Kindersley-raised Mallards spent most of their time, i.e., largest numbers of duck-days. The concentration areas were: (1) Kindersley-Wilkie, Saskatchewan, (2) southern Nebraska-northern Missouri, (3) east-central Arkansas, and (4) southern Louisiana-Gulf coast of Texas. Distances from centre to centre of these areas are approximately 1,100, 325 and 400 miles, respectively. Cary (1954), on the basis of Bellrose's banding in Illinois, suggested that ducks migrate by 200- to 500-mile flights, except for the mass flights described earlier.

The temporal distribution of two-thirds of the kill by successive groups of latitudes is summarized in Table 19 (based on Fig. 6A). The earliest period for two-thirds of the reports was at the latitude of banding. There were few reports south of the banding sites before 21 October, by which time most of the harvest north of 52° latitude was finished. Major concentrations southward began one 10-day period later for each five- or six-degree interval (350-420 miles) to 35°. Between 35° and 31° peak harvest did not begin until two 10-day periods later than the zone to the north. This area also reported the latest harvest, since peak harvest in each of the three latitudes to the south was practically completed before it started farther north. South of 31° latitude the period of two-thirds harvest concluded about the same date as it did 1,100 miles north at 45°.

For 16 of the 27 lines of latitude, two-thirds of the harvest occurred within 30 days of the 40- to 90-day seasons. It was spread over a longer period south of 39° latitude, possibly because Kindersley Mallards were arriving on wintering areas and remaining through the hunting season.

In examining the distribution of reports by 10-day periods, it appears that two-thirds of the September recoveries were restricted to the latitude of banding (Fig. 6C). For the first two weeks of October most reports were still confined to 51° and 52° latitude. In the 10-day period 31 October-9November most birds were spread over 15° of latitude (54° to 39°) and after that the majority was south of 46°. Only between 10-19 December did two-thirds of the harvest reach as far south as 29° latitude; from 20 December to 15 January it was concluded north of 32°.

The distribution of Kindersley Mallards at the southern end of their migration route suggests that they reached the Gulf of Mexico in Louisiana and then moved west into Texas, east to Florida and north into Arkansas. While the eastward movement was probably the least important of the three, it is apparently the only one discussed in the literature. McAtee et al. (1944) list 58 species based on field observations that are believed to follow at least part of the route from Louisiana through Mississippi, Alabama, Georgia, Florida and the West Indies. Only one duck is listed (Cinnamon Teal, Anas cyanoptera) but several species of birds that breed in the Kindersley district are included, e.g., Swainson's Hawk, Curlew (Numenius americanus) and Willet.

Lensink (1964) concluded that three routes are used from central North America to the Atlantic Flyway, on the basis of data from Mallards banded through most of their breeding range. The major route, including possibly 80 per cent of the birds, is through Kentucky, Tennessee and northern Alabama to South Carolina. To the north there is a minor route through the Great Lakes to Chesapeake Bay, and to the south "a small fraction of birds from the Canadian prairies, the Dakotas, and Minnesota moved along the Gulf Coast and were recovered in western Florida, but none appeared to reach the Atlantic Coast."

Kindersley Mallards apparently used the Tennessee and Gulf coast routes on their first migration in proportions similar to other populations, but they did not follow the northern route beyond the Great Lakes. In subsequent migrations, more Kindersley birds used the Gulf coast route to Florida than the Tennessee route and in the north a smaller proportion of adults than young reached the Great Lakes. It should be remembered that for both age groups approximately one per cent of the population was reported east of 85° longitude.

Distribution of male and female Mallards: While it is a common observation that flocks of Mallards composed almost entirely of drakes are a regular occurrence in fall and winter, there appears to be little documentation of this in the literature. Based on hunting and other observations in New Mexico in 1917 and 1918, Leopold (1919) proposed the following: "1. When the season opened in October, there was a notable preponderance of hen Mallards in the Rio Grande Valley near Albuquerque. 2. By the first week in November this preponderance of hens disappeared, and until the main flight was over, about December 1, there was a preponderance of drakes. 3. Among the Mallards wintering here after the main flight was over, the proportion of drakes to hens was normal." Further north, Hollister (1920) reported seeing flocks of 50 and more male Mallards in winter in southeastern Wisconsin. Wetmore (1930) suggested that "Where there is segregation of the sexes, the young often accompany the female. In fact, we may explain the flockings of such ducks as Mallards if we consider that the autumn flocks of males are mainly the old drakes that have remained banded together since the breeding season, while the mixed flocks of early fall are females accompanied by young of both sexes."

A further indication that this segregation does occur is found in the age and sex composition of Mallards banded at Kindersley in the fall of 1961 and 1962 (Dzubin, in press; Table 20). Adult drakes comprised 80 per cent of the banded sample. The use of cannon net traps to capture the birds probably eliminated age and sex biases associated with bait-trapping as demonstrated for sexes by Freeman (1949) and as suggested by Bellrose et al. (1961).

As stated earlier, there appeared to be no difference in the proportions of young males and females harvested between 10 and 100 miles of the production areas but more females than males were harvested within 10 miles and more males were reported from 101 to 300 miles away. This last difference was significant north but not south of the banding sites. In this section further differences and similarities in distribution of the sexes on first migration will be discussed.

While significant differences occurred in some distance zones some years, no zone showed a persistent preponderance every year, and the six-year average showed that 0-100-mile and 1601-2100-mile zones had almost identical proportions of each sex (Table 21). However, significantly more females were reported from the 1101-1600-mile zone. There were more females than males in each of the five 100-mile intervals and in each month in this zone. This indicates that females travelled farther than males. The mean straight-line distance between banding and recovery points for females was 80 miles greater than that for males (814 vs. 734). Also, when the recoveries were arranged in sequence by mileage and divided into 20 segments of equal size, female mileages at the end of each segment equalled or exceeded male mileages in 78 per cent of the 80 segments in the four years with largest samples (1955 through 1958); in 1955 the female mileage was greater in every case. On the other hand, if more males than females moved beyond 100 miles north of the banding sites, the actual distance covered through a full migration may be similar for both sexes.

There were no significant differences between male and female distributions each month within years and there were no consistent differences from year to year; the six-year averages showed almost identical proportions of each sex within each month. The week of 1-7 December showed a higher proportion of females than males harvested every year from 1955 through 1958, and 15-21 December showed males predominating in each of these four years. In only one case was the difference statistically significant (15-21 December 1956). The six-year averages for each of the 20 weeks showed no significant differences, either individually or cumulatively. If the above differences were real, they may have been due to differences in behaviour on migration or wintering areas or to selection of drakes by hunters. This last factor is difficult to evaluate. If it could be assumed that males and females were potentially exposed to identical hunting pressures, then differences in the proportions of each sex that were actually shot might be attributed to hunter selectivity, differential vulnerability, or to different methods of feeding. Bellrose et al. (1961) made this assumption for Illinois-banded Mallards and concluded that "hunter preference" was the factor responsible for drakes being "1.05 times as likely to be taken by hunters as were hens." However, they were working with unaged birds and a higher proportion of young drakes than young hens in the banded sample could have given similar results, as young Mallards are recovered in greater proportions than adults (Bellrose et al., 1961). In the present study, 8.42 per cent of 6,523 males and 7.32 per cent of 6,408 females were reported shot in their first migration. These percentages are significantly different and give a relative recovery rate of 1.15 in favour of males. This difference does not affect the relative distribution of harvest as indicated in Table 21 but would cause sex ratios of the population to be different from sex ratios of the harvest.

In considering the direction of recoveries from banding sloughs in more detail, Canadian recoveries were eliminated because of their proximity to the banding sites and the lack of precise data on the locations of recoveries. There was no significant or consistent difference between the sexes in mean direction of recovery from the banding point (152° for males, 149° for females), in the range of direction of recoveries

(236°-117° for males, 237°-119° for females), in the location of or proportion in the most frequented 5° segment (138°-142°, containing 27 per cent of the males and 26 per cent of the females), or in the proportions going southeast and southwest, the latter accounting for 12 per cent of the males and 9 per cent of the females.

In summary, the rate and direction of first migration in the United States was essentially the same for both sexes of Kindersley-raised Mallards. Almost identical proportions of each were taken within 100 miles and beyond 1600 miles of the banding sites, although there were significant differences in 3 of 22 distance-month categories (Table 21), and females may have travelled farther than males.

Distribution of early- and late-hatched Mallards: For this analysis, banded birds were divided into three groups according to hatching dates: (1) 12 May to 8 June, (2) 9-29 June, and (3) 30 June-11 August. The three groups occurred in almost identical proportions in banded and recovered samples in each period (23.8 and 24.7 per cent, 53.1 and 52.0 per cent, and 23.1 and 23.3 per cent, respectively). Mallards hatched before 9 June were referred to as early-hatched, those after 29 June as late-hatched.

As stated earlier, late-hatched Mallards remained on their brood sloughs later and in greater proportions than early-hatched young. In November the only birds on the brood sloughs were late-hatched and only early-hatched birds were reported more than 200 miles north of Kindersley. These two groups will be compared in more detail in this section.

Significantly greater proportions of early-hatched birds were taken in each of the three 500-mile zones from 101 to 1600 miles and almost equal proportions were taken beyond 1600 miles (Table 22).

More late- than early-hatched young were taken within 100 miles of the banding sites every year; the differences were statistically significant in 1955, 1957 and 1958. For the three years with more than 30 recoveries in each group (1956-1958) the proportions of early-hatched within 100 miles varied from 12.9 per cent in 1958 to 22.5 per cent in 1957; the range for late-hatched birds was 34.9 per cent in 1956 to 45.9 per cent in 1957.

Greater proportions of late-hatched than early-hatched Mallards were taken in September and in October in 11 of the 12 month-year comparisons, but the difference was statistically significant only for October 1957 and for the six-year October average. Early-hatched birds were harvested at a greater rate each November, December and January from 1956 through 1958 (except November 1956); the difference was significant only for the December average. The data in Table 22 indicate that late-hatched birds remained within 100 miles of the banding sites through September and possibly all of October but then moved through the next 1,500 miles at a more rapid rate than early-hatched birds. Late-hatched Mallards were subsequently harvested at a higher rate than early-hatched birds in the most distant zone (1601-2100 miles) in November and December.

There were proportionately more late-hatched young reported on an average each week before 20 October and proportionately more early-hatched each week after 16 November (except 15-21 December when the two were equal). Significant differences occurred in only two of 20 weeks: 6-12 October (4.3 per cent early and 15.0 late) and 1-7 December (7.4 per cent early and 1.8 late).

Detailed analysis of the direction of movement was restricted to direct recoveries in the United States and Mexico. However, with a three-week period separating early- and late-hatched birds, the late-hatched sample was reduced to 125 records because of the high proportion taken in Canada. To remedy this, records for 23-29 June were added to the late-hatched group, providing 220 recoveries for comparison with 180 early-hatched records. The two categories were separated by two weeks (9-22 June) for this analysis only.

There was only one significant difference between early- and late-hatched birds in direction of recoveries from the banding sites. There was an indication based on the six-year average that more early- than late-hatched birds were recovered southwest of the banding block. The percentages were 13.3 and 7.7, respectively; the figures are significantly different. Mean directions were 153.4° and 148.5°, respectively; the range from southwest to southeast was from 236° to 117° for the older birds and 237° to 123° for the younger group; the peak 5° sector was 138°-142° in each case and it contained 29.1 per cent of early-hatched and 27.7 per cent of late-hatched records.

What the foregoing means in terms of country and flyway distribution may be seen in Table 23. The differences between early- and late-hatched birds are statistically significant for Canada, the Pacific and Mississippi Flyways. A preponderance of late-hatched Mallards in the Kindersley district resulted in an important increase only in the Canadian harvest. This increase was further restricted to the production area in Saskatchewan as there were more early- than late-hatched Mallards harvested in Alberta. An early hatch meant more Kindersley Mallards in the Pacific and Mississippi Flyways. There were no other significant differences within the United States except in Arkansas where 16.7 per cent of the older birds and 8.4 per cent of the younger birds were reported.

The above analysis was based on the distribution of recoveries throughout North America. The proportion taken in Saskatchewan, therefore, was dependent on hunting regulations and conditions both there and elsewhere. To eliminate the effect of hunting outside of Saskatchewan on the proportions of early- and late-hatched birds taken in Saskatchewan, the number of Saskatchewan recoveries from each group may be related to the number banded. This is a valid procedure if significant proportions have not been harvested elsewhere before the Saskatchewan harvest. Alberta had the only other September and October harvest of importance and this was not large enough to seriously influence the results. Equal proportions of early- and late-hatched young were harvested throughout North America (8.1 and 7.9 per cent, respectively) but in Saskatchewan twice the proportion of late Mallards were taken (3.2 vs. 1.6 per cent). The difference was statistically significant, confirming the results based on total harvest.

In summary, fewer early-hatched Mallards remained on their brood sloughs; they moved away earlier and went farther in Canada than late-hatched birds. Older birds were harvested in greater proportions than younger birds in Alberta and the three western flyways but both groups were taken in equal proportions more than 1,600 miles from the banding sites. Late-hatched Mallards were harvested in greater proportions in September and October than early birds. The direction of migration was similar south of 49° latitude except that more early-hatched young went to the southwest (Pacific Flyway).

Migratory associations: Munro (1943) suggested "that Mallard populations in general are definite associations, nesting in the same locality, migrating together and wintering together in the same areas from year to year." His hypothesis was based on 32 samples of two birds each banded between November and April and trapped or shot at or near the banding sites in British Columbia on or about the same dates in subsequent winters. Hickey (1951) attempted a preliminary test of this hypothesis using Mallards banded on migration in Illinois and concluded that it remained unproven. It is obvious that Kindersley-raised Mallards did not winter in one area. To determine whether dispersal was less widespread from various parts of the block, the banding area was divided into four quadrants and the temporal and geographical distribution from each was examined. No significant differences were found; in each case the birds were distributed in similar proportions in Canada and the United States and in the three western flyways.

A further analysis was made of the distribution of young Mallards from a single brood area. Mallards were banded on a slough on the south side of the town of Marengo in July and August 1954, 1956, 1957 and 1958. The combined unadjusted distribution for these four years shows no significant differences between countries and flyways when compared with distribution from the entire block (Table 24). The birds from this one area were distributed from Atlantic to Pacific coasts of the United States.

The lack of association exhibited by young birds was also demonstrated by adult female Mallards banded on a single moulting area within the degree block (Table 25). On the other hand, two adult male Mallards banded while moulting on this same slough on 21 July 1958 were trapped at Lake Andes, South Dakota, on 11 and 12 February 1965.

Wetmore (1930) suggested that young birds may accompany adult females in migration. However, Raitasuo (1964) stated that shortly after young Finnish Mallards were 7 to 8 weeks old "the brood joins the flock of other ducks of the area while the female seeks shelter in the reeds to accomplish her moult. The family bonds finally break up and the young ducks thereafter have no closer contact with their mother nor with other members of the brood than with other flock companions." One method of investigating this suggestion is to compare the proximity of direct recoveries of the two age groups in time and place. An adult hen and a young bird shot at the same time and place and originating on the same water area may not have migrated together, but a series of such occurrences would be evidence that the two age groups did travel together. Only two such examples were found in this study and these involved recoveries in September and early October in the vicinity of the banding sites. There were several other cases of recoveries within one day of each other spread through the three western flyways, but in these cases the adult hens and the young did not originate from the same sloughs.

Another method of examining part of this hypothesis is to determine whether individuals of a brood remained together or separated in migration. Because an average of one in 13 banded Mallards was shot and reported during its first migration, and because most groups of birds recorded as broods in field books varied from four to seven individuals, there were only five broods with more than one recovery each. To increase the sample, a group of ducklings was assumed to be a brood, even though not designated as such at the time of banding, if all birds caught on a slough were of the same age and if they numbered no more than eight. These are probably conservative criteria. As a result 10 broods were found for which there was more than one direct recovery each. Five of these were not suitable for the present analysis because dates and places of recovery neither proved nor disproved the hypothesis; the other five are listed in Table 26.

Individuals of broods A and B dispersed east and west of the Rocky Mountains and a Florida recovery was reported 17 days before a Louisiana recovery in brood C. Broods D and E apparently stayed together and two members of each were shot in the same place on the same day. However, in both cases the young had been flying for less than two weeks.

The distribution of direct recoveries month by month (Fig. 5), on individual days in November (Table 17), from an individual slough (Table 24), and of brood mates (Table 26) indicates that Kindersley-raised Mallards neither migrated nor wintered as definite associations. As will be indicated below, a high proportion of females returned to Kindersley to breed.

<u>Subsequent migrations</u>

Data on fall movements subsequent to the first southward migration are based on indirect recoveries. It was apparent from direct recoveries that many young Mallards remained in the vicinity of their brood sloughs from hatching through August, September and October. Homing by females has been frequently demonstrated. Sowls (1955) found that probably all of the surviving Pintail hens that he banded on nests near Delta, Manitoba, one year, returned to nest the next year. At Kindersley 40 per cent of 73 Mallard hens trapped on nests in 1957 and 46 per cent of 28 hens trapped with broods on one slough in 1958 had been previously banded either as young or adults in the same vicinity (Gollop, 1959). Proper interpretation of these proportions is not possible because unknown fractions of the adults and young occurring in the area prior to 1957 and 1958 were banded. However, it would appear that a significant proportion of hens hatched in an area may be found there in subsequent years, at least through July.

Homing has not been clearly established for males, partly because they are difficult to trap in numbers during the breeding season. It is generally felt that Mallard drakes are less likely to home than females because pairing takes place in the late fall and winter, when segments of the population from many parts of the continent are together. The hen presumably leads her mate north to her previous breeding grounds and, therefore, the occurrence of a drake twice in the same breeding area is probably due to chance. Dzubin (in press) retrapped three Mallard drakes during the breeding season at Kindersley where they had been banded in previous years. One Kindersley-banded drake was reported from Russia on 2 July 1959, approximately 2,500 miles northwest of where it had been banded 26 September 1958 (Dzubin, 1962).

The fact that a hen returns to the Kindersley district to breed does not mean that she remains there during the late summer and fall. A Mallard hen that was trapped, neck- and leg-banded on a nest on 28 May 1957, successfully hatched her clutch. She was shot 500 miles north near Lake Claire, Alberta, on 2 October of the same year (Gollop, 1960). As shown earlier, adult Mallards have been recorded moving north in September, October and November. Such movements may occur in July and August but they are not so likely to be detected because there is no legal hunting season at that time.

Geographical distribution: During their first migration Kindersley Mallards were reported from two provinces, 34 states and Mexico; in seven subsequent hunting seasons they occurred in five provinces and 28 states (Fig. 7).

The most noticeable differences in geographical distribution between the first and subsequent fall migrations were the lower proportion of adults reported in Canada and the higher proportion of this age group in the two western flyways (Table 27). Nine of the 10 most important harvest areas were the same for both age groups (Table 28). One-fifth of the adults as compared with one-third of the young were reported in Canada. This was due primarily to a harvest of 27 per cent of the young and only 10 per cent of the adults in Saskatchewan. Within Saskatchewan the major drop occurred in the banding block where the ratio of direct to indirect recoveries was 12.5:1 compared to a continental average of 1.7:1.

The reduction in relative proportion of adults in Canada was accompanied by a westward shift of the harvest of this age group in the United States. The Pacific-Central Flyway proportion increased from 32 per cent of direct to 45 per cent of indirect recoveries while the Mississippi-Atlantic proportion remained stable (32 vs. 35 per cent). Idaho, Oregon, Washington, Colorado, Nebraska and South Dakota accounted for 11.7 of the 12.7 per cent increase in the two western flyways. At the same time, a block of four states in the northeast (Minnesota, Iowa, Illinois and Wisconsin) increased their proportion of the continental harvest from 4.8 to 9.7 per cent.

This indication that adults occur farther north than young birds is more carefully examined in Table 29 where the percentages of direct (young) and indirect (adult) recoveries are compared by 5° segments of latitude. These differences are statistically significant from 54° to 29° latitude, inclusive. Except for the segment that includes the latitude of banding, a higher proportion of adults than young was taken in each

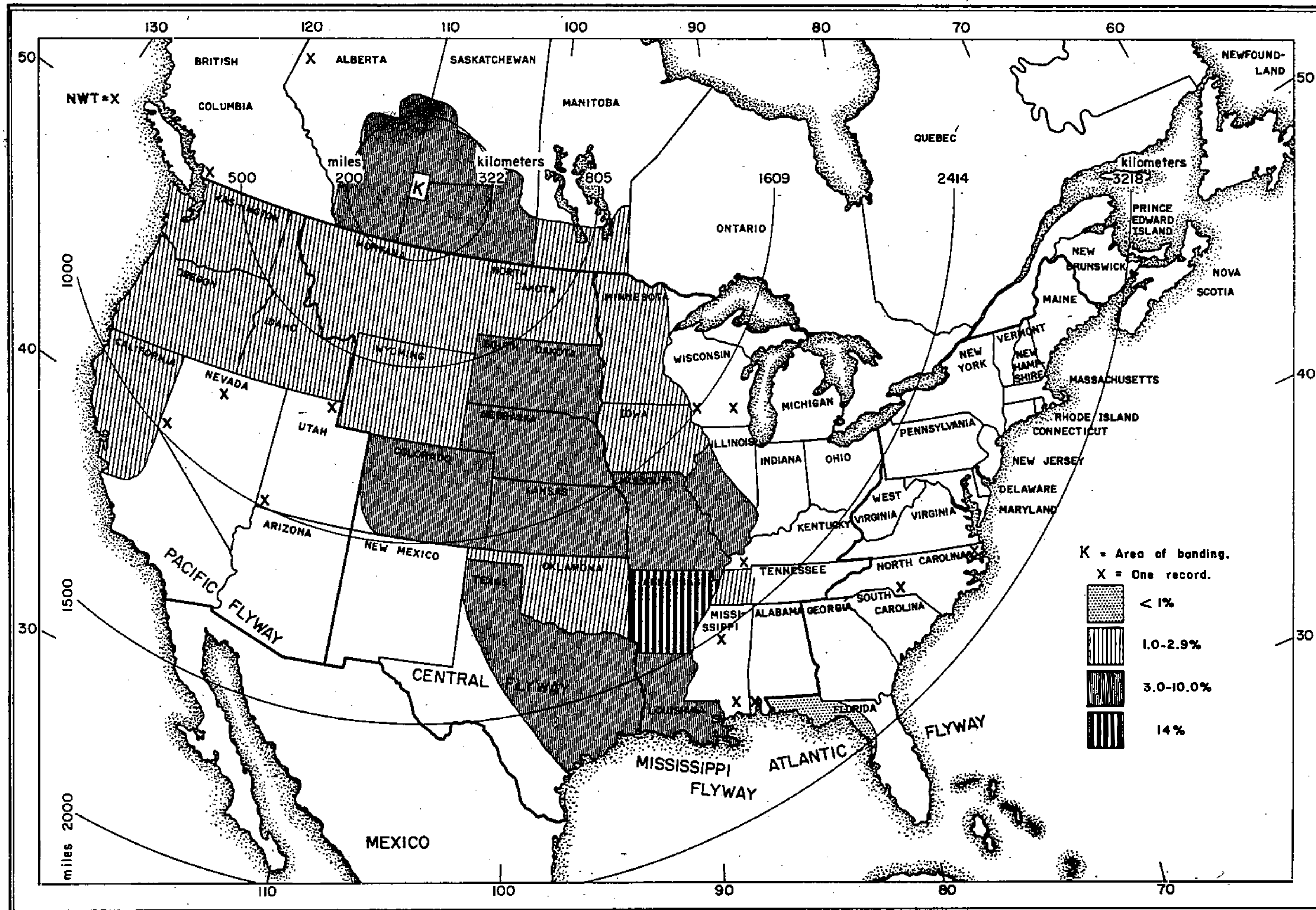


Figure 7. Percentage distribution by province and state of 629 indirect recoveries of Mallards banded at Kindersley, Saskatchewan. Recoveries from 1955 through 1963.

zone north of 34° (central Arkansas and northern Texas). If recoveries from the block of banding are excluded for both groups, the proportions between 49° and 54° are equal - 20.6 and 20.0 per cent.

The shift in distribution of young and adult recoveries may be further defined as being from southeast in the first migration to northwest in subsequent migrations. The continental ratio of direct to indirect recoveries was 1.7:1; however, east of 88° longitude and south of 32° latitude it was 3.2:1 (147 recoveries), while west of 117° longitude and north of 53° latitude, it was 0.7:1 (146 recoveries).

The more southerly distribution of young Kindersley Mallards, primarily in the Mississippi Flyway, may have a parallel in California. Age ratios from Mallards shot at three areas in 1959 varied from north to south as follows: Tule Lake (latitude 41°): 0.35 immatures per adult (313 birds); Willows (latitude 39°): 1.61 immatures per adult (1,303); and Merced (latitude 37°): 2.57 immatures per adult (573; Geis and Carney, 1961). J. E. Chattin (in Geis and Carney, ibid.) reported that age ratios in banding operations conducted prior to hunting seasons had for many years shown a substantially lower ratio of young to adults at Tule Lake than at the two areas further south. Also in 1959 the Louisiana-Mississippi age ratio (0.61 immatures per adult; 182 birds) from the wing survey was higher than the Missouri-Arkansas ratio (0.51 immatures per adult; 1,440 birds), but the difference was not statistically significant.

The foregoing deals with the results of all seven subsequent migrations combined. There is, however, an indication that the proportion of the harvest taken in the Pacific Flyway increased with each successive migration when all cohorts were combined (Table 27). It should be noted, however, that age may not have been the only factor involved in successive migrations; the years involved were also different. Second migration recoveries were reported from 1955 through 1960 while seventh and eighth migrations occurred from 1960 through 1963. There is the possibility that a change in Mallard distribution in recent years, regardless of the birds' ages, may be the cause rather than the increasing age of the birds. Hickey (1951) noted that indirect recoveries of Montana-banded Mallards occurred in greater proportions than direct recoveries in California but in lower proportions in Washington. Geis (1963) suggested that a wintering Mallard population in Washington was maintained in spite of high mortality by annual influx of young birds whose parents wintered elsewhere. The present study suggests that such a population may be maintained by adults whose young winter elsewhere.

Further comparisons of the geographic distribution of direct and indirect recoveries are presented in Table 30. In this table the distribution of direct recoveries of young Mallards is compared with that of all indirect (adult) recoveries of birds banded in the same year as the young and then with that of all indirect (adult) recoveries made in specific years regardless of the year of banding. The percentage distribution of direct and indirect recoveries of birds banded in the same year (Table 30, columns A and B) showed similar trends for most areas, indicating that the initial migration route influences subsequent migration routes. This is supported also by the fact that when direct and indirect recoveries made in the same year are compared (Table 25, columns A and C), such a trend is not evident and there appears to be no relationship between the two groups of indirect recoveries. For all three categories of recovery, there is a decrease in the proportion of the harvest reported from the Pacific Flyway each year. This is not in conflict with an earlier suggestion that an increased proportion went to the Pacific Flyway in successive migrations; in the former case all cohorts were combined for each year of recovery.

There were important differences in the distribution of males and females during first and subsequent migrations and between the direct recoveries of adults and the indirect recoveries of young (Table 31). Twice the proportion of Kindersley-raised male Mallards were harvested in Canada on their first migration as on subsequent migrations. There were significantly higher proportions of adults of both sexes in the Pacific and Central Flyways. The comparison of indirect recoveries of males banded as flightless young with direct recoveries of adult males trapped on moulting areas in 1958 shows few similarities. However, only the proportions taken in the Pacific Flyway were significantly different and the significance did not hold when the direct recoveries of adult males banded in 1958 were compared with all indirect recoveries of males. It appears that adult males (indirect recoveries) rather than females were the main reason for a wider distribution of adults in Canada (British Columbia, Northwest Territories and Manitoba). Significantly more indirect young than direct adult male recoveries were reported from Arkansas (15.3 vs. 11.5 per cent) and from Minnesota-Illinois (6.0 vs. 2.9 per cent).

A higher proportion of adult (indirect) females than males was harvested in Canada from 1955 through 1963, but the difference was not statistically significant. The adult female (indirect) proportion was significantly lower than that of young females in Canada and higher in the Pacific Flyway. Identical proportions of indirect and direct adult female recoveries were reported from Canada. (The latter group was trapped on nests, with broods and on moulting areas within the Kindersley degree block.) Differences between the direct recoveries of adult males and females were not significant on a flyway basis. Adult females (indirect recoveries) were harvested at significantly higher rates than young females in Alberta (11.8 vs. 5.5 per cent) and, like adult males, in Minnesota-Illinois (7.4 vs. 3.0 per cent). Adult females (indirect) were reported at a significantly lower rate than young hens only in Montana (1.2 vs. 4.1 per cent).

It would appear that significantly lower proportions of both sexes were harvested in Canada as adults than as young and that higher proportions of adults than young of each sex were taken in the Pacific Flyway. Adult males contributed more to increases in the Central and Mississippi Flyways than did females.

Monthly distribution: A comparison of the monthly distribution of young and adults indicates: (a) that the overall monthly distribution of recoveries for each age group had a similar pattern, (b) that the reduction in adult harvest that occurred in Canada in October coincided with increases that month in each of the three western flyways, and (c) that more adults than young were taken in the Pacific and Central Flyways each month from October through January (Table 32).

The overall monthly distributions of indirect recoveries of males and females were similar; however, significantly more females than males were reported from Alberta in September (14.0 vs. 1.7 per cent) and from the Pacific Flyway in November (5.0 vs. 2.0 per cent).

Repeated use of migration and wintering areas

Recoveries were examined by degree blocks in order to determine the frequency with which specific areas were visited each fall. The size of these blocks does not appear to be incompatable with this analysis. While most refuges, lakes and reservoirs used as resting areas may be less than 100 square miles in area, a feeding radius of 30 miles in all directions (Bellrose, 1954) includes 2,800 square miles around any one point. Feeding ranges may be smaller in Canada than in the United States; the 30-mile range in Illinois compares with normal flights of 10 to 15 miles in Manitoba although one flight of 50 to 60 miles has been recorded from Lake Manitoba (Bossenmaier and Marshall, 1958; Hochbaum, 1955). Degree blocks were used for this determination in spite of the fact that they increase in area by approximately 61 square miles for each degree of latitude from north to south. The alternative appeared to be the drawing of arbitrary blocks which would make comparisons with other studies difficult, if not impractical. Degree blocks have served as a basis for banding analyses since 1957 (Low, 1957).

Biases due to differential reporting rates and crippling losses may vary inversely with the size of the area. Crissey (1955) reported that bands marked "Reward" and standard bands on Canadian-banded Mallards were reported from two stations in Oklahoma and one in Colorado at ratios of 1.1:1, 3.0:1 and 4.0:1, respectively. He also indicated that major biases may occur in individual years. It has been assumed in the following analysis that such biases were not the major causes of differences in the numbers of recoveries among degree blocks when several years' data were combined.

The distribution of direct and indirect recoveries of Kindersley Mallards by degree blocks is presented in Figure 8. This map also indicates the limitations imposed on geographical distribution because of reliance on hunters' reports: it shows degree blocks with direct and indirect recoveries of Mallards banded as flightless young throughout North America. Kindersley Mallards were distributed almost as widely as Mallards banded from most of the breeding range. While recoveries of Kindersley-raised birds occurred in only 54 per cent (393) of the potential blocks, the general pattern of distribution in Fig. 4 covers 70 per cent (512) of the total. Major gaps in the distribution of Kindersley birds were on the northern and eastern borders of the continental distribution: Alaska, parts of British Columbia and Manitoba, eastern Canada and the northeastern United States. While recoveries of Kindersley-raised birds might not be expected outside of these limits, 23 of the 733 blocks reported only Kindersley Mallards.

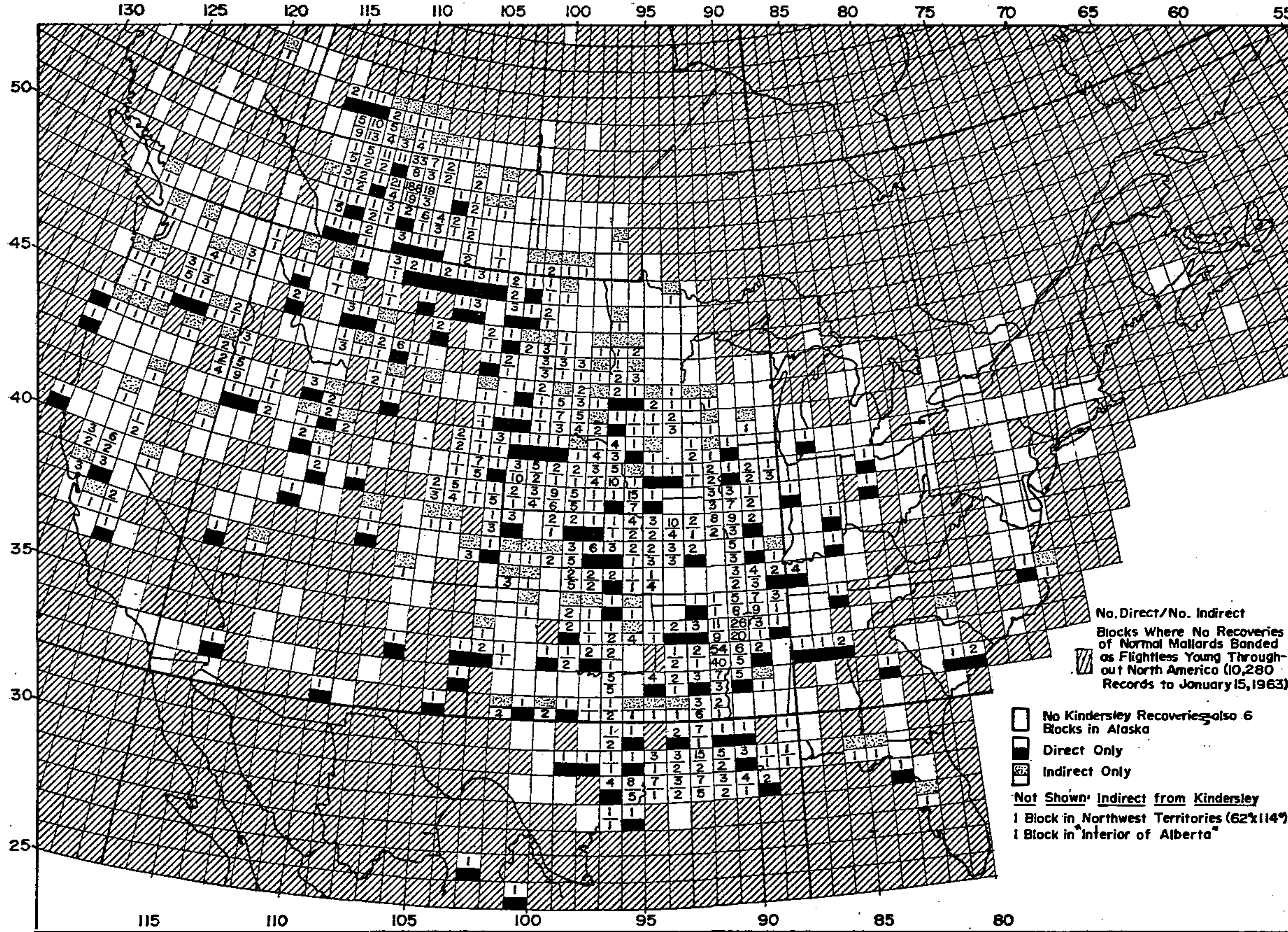


Figure 8. Distribution by degree blocks of 1,018 direct and 629 indirect recoveries of Mallards banded as flightless young at Kindersley, Saskatchewan, all years combined.

The frequency of first migrations and total migrations by degree blocks will now be examined. Figure 9 shows the number of first migrations reported for each degree block. Table 33 shows the relationships between first and subsequent migrations and between direct and indirect recoveries by degree blocks.

Kindersley Mallards visited five degree blocks on their first migration in each of the six years. These were the production area, three blocks adjacent to it and one in Arkansas (34° x 91°). Five other degree blocks were visited in five of six first migrations. All of these were in the Mississippi Flyway between 1,000 and 1,700 miles from the banding sites. (All frequencies would probably have been higher had banded samples been larger, particularly in 1954 and 1959 when only 32 and 28 degree blocks, respectively, were represented.)

The fact that there were only four of 10 five- and six-year blocks in Canada indicates a consistently restricted movement in Canada. Three of the degree blocks were adjacent on 51° latitude; the block immediately to the east of these three never had a direct recovery and that immediately to the west had only one; two blocks on the south side of this group had totals of two and three recoveries and were reported in only two years. At the other extreme, blocks with recoveries in only one of six years may be considered as occupied by stragglers; there was about the same percentage of these blocks in Canada (55 per cent) as in the U.S.A. (59 per cent). With 98 per cent of Canadian recoveries within 200 miles of the banding sites, a higher percentage of frequently used blocks and a lower proportion of accidentally used blocks might be expected if dispersal were random.

Relatively few areas accounted for major portions of the harvest although direct recoveries were reported from 291 degree blocks spread over 2,000 miles from north to south and from the Pacific to Atlantic coasts. Seven degree blocks reported 35.0 per cent of the direct recoveries; these were two 12,000-square-mile areas centered on Kindersley, Saskatchewan, and Stuttgart, Arkansas. The 26 degree blocks (8.9 per cent of the total) from which Kindersley-raised Mallards were regularly reported, i.e., on four to six first migrations, accounted for 48.7 per cent of the harvest. Twenty-nine degree blocks each of which had six or more direct recoveries reported 51.6 per cent of the total.

The concentration of a high proportion of juvenile birds in a relatively few degree blocks year after year on their first migration suggests either a strong inherited orientation if they determined their own routes southward, or that adults were leading the young to restricted resting areas.

To obtain some idea of the consistency with which degree blocks were visited as these birds became older, Table 34 has been compiled. Because these data were from shot birds, homing as normally determined by repeat visits of individual ducks was not possible. It is also likely that shooting as a method of detection failed to record birds that actually did return to an area. Because of these problems, all banding year-classes have been combined to increase the sample.

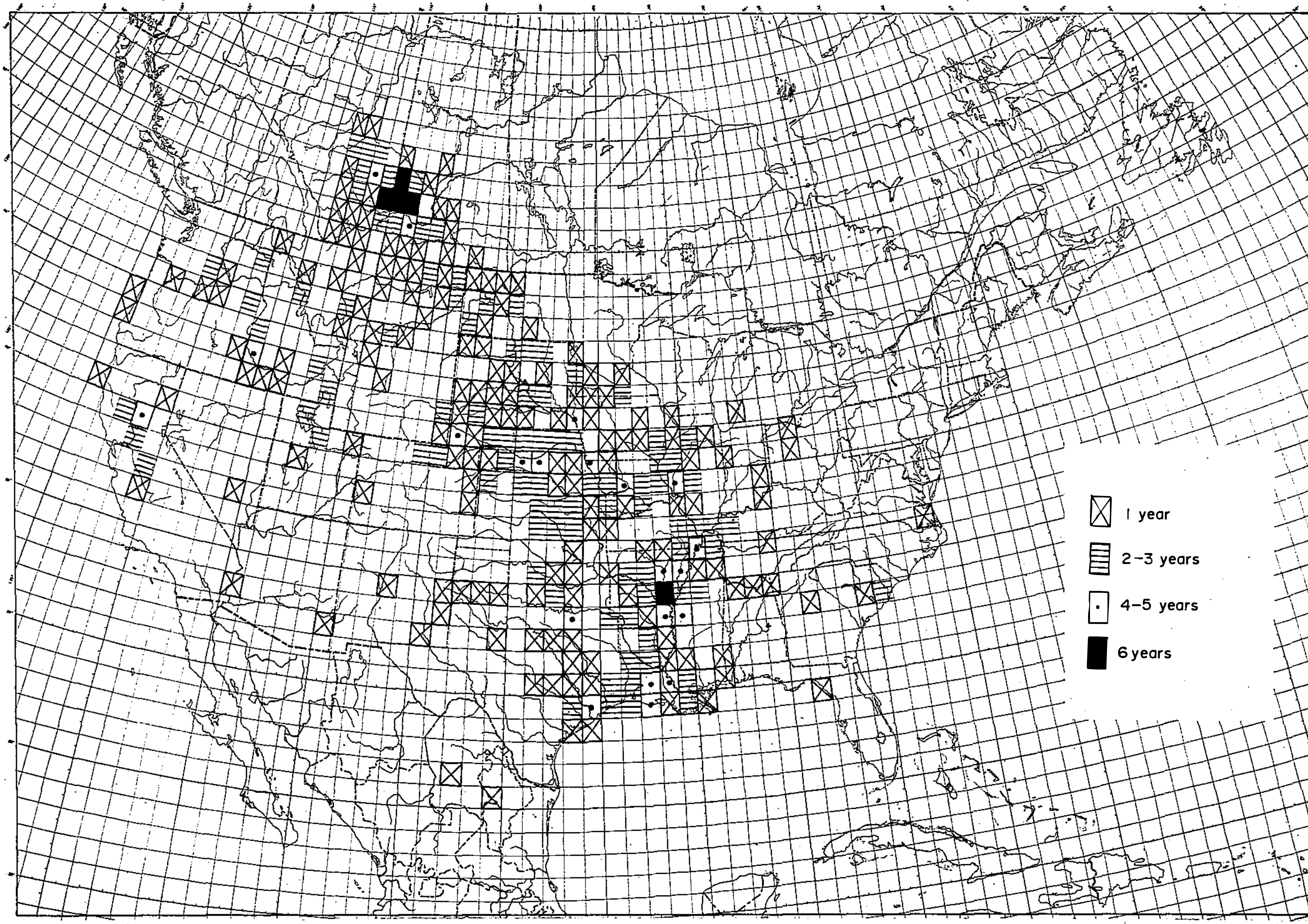


Figure 9. Yearly frequency of direct recoveries by degree blocks. 1954—1958.

Homing by Mallards of both sexes to migration and wintering areas has been demonstrated by Mann, Thompson and Jedlicka (1947) in Illinois; by Cartwright and Law (1952) in the Prairie Provinces, and by others. Bellrose and Chase (1950) stated in relation to Mallards banded in Illinois: "Our band returns show that, although in each year there is some degree of return by Mallards to the same flyway rest stops, the degree of return varies from year to year."

In the present study, recoveries were reported through eight of a possible 10 fall migrations. Recoveries during the eighth migration were possible for birds banded from 1954 through 1956 and there were four eight-year-old birds reported. None of the 291 degree blocks visited on first migration reported Kindersley Mallards on all eight migrations. Only the production area recorded birds in seven successive migrations. Three degree blocks reported recoveries in six migrations: two blocks approximately 200 miles northwest of the production area in Alberta (53° x 112° and 53° x 113°) and one in Arkansas (34 ° x 91°). Of the 291 first-migration blocks, 1.7 per cent reported a total of five migrations each, 7.6 per cent reported four, 16.5 per cent reported three, 27.8 per cent reported two and 45.0 per cent were visited only on the first migration. Blocks which had no direct recoveries reported no more than three migrations; two such blocks reported three migrations each, 13 reported two migrations each and 87 reported a single migration; this last group included two of the four blocks reported during the eighth migration. The 31 degree blocks with four or more total migrations accounted for approximately equal proportions of direct and indirect recoveries, 42.1 and 39.6 per cent, respectively. The 218 degree blocks with only one first or subsequent migration included 12.1 per cent of all recoveries. The 122 degree blocks visited by Kindersley Mallards on more than the first migration accounted for 78.2 per cent of 628 recoveries on subsequent migrations. These blocks included 82 per cent of reports in the second migration, 79 per cent of those in the third, 72 per cent of the fourth migration recoveries and an average of 73 per cent of the 71 recoveries from the fifth through eighth migrations. While there is an indication that older Mallards showed a lower rate of homing, the differences between migrations are not statistically significant.

Degree blocks which reported more first migrations reported subsequent migrations more frequently (Table 33). Degree blocks with a greater number of total migrations also had more first migrations (Table 34); this would be expected although there were only two blocks common to the 9 and 10 blocks of highest frequency in each case.

There are indications that some degree blocks were favoured by young and others by adult Mallards. Six of the 11 degree blocks with 11 or more direct recoveries were in Canada and five of these were the banding and adjacent blocks (Fig. 8). Only three of the 10 blocks with nine or more indirect recoveries were in Canada: the production area and two blocks more than 200 miles northwest in Alberta; these are the same two areas that reported recoveries in six of eight migrations. Four degree blocks were common to both lists: the production area, 51° x 109°, and three blocks in northeastern Arkansas, 34° x 91°, 35° x 91°, 35° x 90°. Different blocks within Alberta, Louisiana, Nebraska and Illinois were visited consistently by each age group; the more westerly blocks of importance, e.g., in Oregon, Idaho and Colorado, were characterized by adult (indirect) recoveries.

There is an indication that females more than males were responsible for maintaining continuity in Canada after the fourth migration. In the three blocks reporting recoveries through five or more migrations (51° x 109°, 53° x 112° and 53° x 113°) the ratio of males to females was 1:8 (9 birds), while the continental ratio for the last four migrations where there had been a first migration was 1.25:1 (54 birds). For all indirect recoveries the ratio was 1.46:1 (628 birds). The preponderance of drakes in later migrations may partly explain the tendency for a lower incidence of homing among older birds.

It would appear that there was a strong tendency for succeeding generations of young birds to visit the same areas on their first migration. Approximately 80 per cent of these birds homed to the same areas in subsequent fall migrations. Females more than males were responsible for homing in Canada but there was an overall preponderance of males after the first migration which tended to lower the incidence of homing in later migrations.

Survival and Mortality

In this section mortality and survival rates of the Kindersley Mallard population will be investigated for the preflight period, the early flying period, for adults and for each sex.

The usual method for such calculations in waterfowl work is the use of one of several formulas based on recoveries of previously marked birds over a period of years. The two most frequently used methods are the dynamic or horizontal and the time-specific or vertical (Deevey, 1947). Hickey (1952), Farner (1955), and Geis and Taber (1963) discuss these methods in some detail with special emphasis on the use of band recovery data.

A. D. Geis (unpublished) proposed the "relative recovery rate" method at a meeting of the Central Flyway Technical Committee in Denver, March 1965. The mortality rate of the first age interval is calculated from the relationship between the recovery rate for all age intervals and the recovery rate for all age intervals minus the first. Similarily, the mortality rate for the second year is the proportion that recovery rate from third to last year is of recovery rate from second to last year. All banded cohorts are combined.

In nature the rate of mortality during the first age interval should not affect mortality rates in subsequent age intervals. In the dynamic method first year recoveries do influence calculations for all age intervals. The relative recovery rate method eliminates this bias; the calculation of mortality for each year is independent of recoveries in earlier years. On the other hand, it is not valid for determining first-year mortality of young birds and, like the dynamic method, mortality rates escalate near the end of the recovery period. However, it may produce more reliable data than the dynamic method for intervening years. The composite dynamic method and the relative recovery method have been used in this study. All data could not be analysed by the time-specific method and the method described by Ricker (1958) could not be used because direct recovery rates were not available for adequate samples of adult Mallards each year.

Mortality from three to eight weeks of age

Mallards were banded from the age of three to eight weeks. To determine losses among flightless young, a comparison of recovery rates of birds banded when three and seven weeks old, both early and late in the season, is presented in Table 35. The criteria for better survival to 1 September is a higher direct recovery rate between that date and 15 January, assuming that both groups were exposed to identical hunting pressure[a]. Samples were too small for differences within age groups and within banding periods to be significant, although birds banded when seven weeks old had a higher recovery rate than three-week birds in each banding period. Birds that were banded at three weeks of age on 10 July were obviously seven weeks old a month later. The comparison which approximates this situation shows a hunting recovery rate of 6.0 per cent for three-week-old birds banded prior to 14 July and 8.8 per cent for seven-week-old birds banded after 3 August. This difference is statistically significant and indicates a 32 per cent loss in the month preceding first flight, if we assume that these were the same birds banded at different ages and, therefore, subject to the same losses after 1 September. The main factor contributing to this loss was probably normal natural mortality. Raitasuo (1964) found that attacks by the female of a Mallard brood on downy young of other broods that approached too closely was the main decimating factor in one part of Finland. Band loss and mortality due to disturbance from banding these birds when only three weeks old may not have been important factors since this loss is less than the 46 per cent mortality experienced by Mallards between 10 and 56 days of age, as determined from census data at Kindersley during part of the period of this study (Dzubin, in press).

A preliminary experiment to determine the success of brood movement from a drying slough was described in the section on distribution. Class I birds were marked with fingerling tags in the wing while Class II birds were marked with standard legbands. There was probably little chance of fingerling tags becoming lost but they may have been an added source of mortality as a result of infection or catching on vegetation. A mortality rate of 83 per cent in approximately one month for birds banded as Class IIa (30 in sample) was much higher than indicated above in the present study. The birds in this experiment had to cross prairie, weed fields and cultivated areas, a railroad, a highway and a secondary road with no surface water en route, provided that they were headed for the slough in question. The rails may have been an important barrier. No birds, judged to have died within the previous two months, were found on the 120-acre dry slough when three men searched it for 2.5 hours on 14 July.

Evans, Hawkins and Marshall (1952) suggested that broods that travelled overland may suffer lower mortality than nonmobile broods in southwestern Manitoba. The above data suggest that the opposite may have

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[a]Since the groups compared began flying at least a month apart, a condition basic to the criteria - equal hunting pressure - may not be met.

been true at Kindersley.

Losses among flying young during the summer is indicated from a comparison with other bandings in the Kindersley degree block. Dzubin (in press) banded 382 flying young Mallards in August and September 1956 through 1959 before hunting seasons opened. The direct recovery rate of 8.6 per cent for these birds[a] is almost identical to the rate of 8.8 per cent for seven-week-old birds noted above. It may be that there is little loss of Mallards between the time that they are seven or eight weeks old (15 July at the earliest) and early September. It should be noted, however, that the requirement of exposure to equal hunting pressure may not have been met by these two samples, since it cannot be assumed that they were composed of birds from the same population.

Losses after 1 September of early- and late-hatched Mallards

Direct hunting recovery rates per se cannot be used to investigate the survival of early- and late-hatched young because it is not likely that each group was exposed to equal hunting pressure. Therefore, composite life tables based on the dynamic or horizontal method have been compiled (Table 36). Early-hatched Mallards are those hatched before 9 June; late-hatched, after 29 June; their average ages on 1 September were approximately 90 and 50 days, respectively. Calculations of total mortality based on hunting recoveries show a significantly higher rate in the first year, after 1 September, for late-hatched birds (64 vs. 55 per cent). Perrins (1965) found that "many more" early-hatched than late-hatched Manx Shearwaters (*Procellaria puffinus*) survived in Great Britain.

Direct recovery rates indicate that a higher proportion of early- than late-hatched birds were taken by hunting (8.2 vs. 7.3 per cent). These figures suggest that early-hatched birds were 1.12 times as vulnerable as late-hatched birds. If this correction factor were applied to the number of recoveries in the 0-1 age interval ~~to~~ compensate for increased vulnerability to hunting, the discrepancy between first-year mortality rates due to causes other than hunting would be greater still.

Using the best data currently available for reporting rates and crippling losses (Geis and Atwood, 1961; Hansen, 1964), it appears that one-third of the banded Mallards lost to hunting are reported. When the above direct recovery rates are adjusted by this factor, indications are that hunting contributed less than half of the total mortality of each group (Table 37). One explanation for an unexpectedly low proportion of hunting mortality among late-hatched birds may be that they suffered much higher natural mortality than early-hatched ducks prior to 1 September. If the number of late-hatched birds eligible to be harvested in Table 36B

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[a]Dzubin's starting date for eligible recoveries was opening day of the hunting season (6-14 September) as opposed to 1 September for birds banded when flightless. This difference is not important in this comparison.

were reduced by 50 per cent, total mortality rates would not be affected but the proportion taken by hunting would be doubled. Also late-hatched birds may have been more vulnerable to hunting but they remained near the banding sites where hunting pressure was relatively light.

The dynamic method shows average adult mortality rates of 48 per cent for early-hatched Mallards and 43 per cent for late-hatched birds. These differences are not statistically significant and there are no field observations to support a higher subsequent mortality among adults banded as early-hatched young. It may be suggested that these birds become regular early or late nesters depending on whether they were early- or late-hatched. There is no evidence for this proposition and there are some indications that it may not hold. Stotts and Davis (1960) found that adult Black Ducks (Anas rubripes) came into breeding condition earlier than immatures, but presented no information on the hatching dates for either age group. At Kindersley two hens, each incubating eight eggs, were caught on 23 May 1957. One had hatched 10 July and the other 1 June 1956. Stage of incubation of the first clutch is unknown but the second was about two weeks incubated. There is no information on previous nesting attempts of these two birds in 1957.

The relative recovery rate method gives the following mortality rates for the second, third and fourth years: 49, 47 and 33 per cent for early-hatched birds and 51, 59 and 46 per cent for late-hatched. The difference in geometric means (47 and 52 per cent, respectively) is not statistically significant. However, the rate for late-hatched birds in the third year changed from 60 to 33 per cent between methods and for early-hatched birds in their second year from 36 to 59 per cent. The means for adult late-hatched Mallards remained about the same by each method (48 and 47 per cent) but for early-hatched it changed from 43 to 52 per cent.

From these data, it would appear that an early crop of Mallards will allow at least as high a proportion to be harvested as a late crop and yet will allow more birds to survive the first year. This ratio among survivors at the start of the second 1 September would be 1.3:1 based on first-year survival rates of 45 per cent and 36 per cent for early- and late-hatched birds, respectively. However, a proportionately higher loss among early- than late-hatched birds prior to 1 September would nullify this increase; a higher pre-hunting season loss among late-hatched Mallards would increase the ratio.

Annual losses among Kindersley Mallards

Average mortality of all Mallards in the first year was 60.9 per cent (Table 38). There are no directly comparable data but this rate is similar to that for Mallards that were probably banded as flying young elsewhere in North America (Table 39). The mean direct (hunting) recovery rate was 7.85 per cent. Corrected for an estimated reporting rate of 33 per cent, hunting mortality among Kindersley-raised Mallards would be 24 per cent of the population or 39 per cent of total mortality. Crissey (1964) stated that hunting mortality makes up approximately 82 per cent of the Mallard's annual mortality rate of 55 per cent in North America. This proportion can be approximated for Kindersley Mallards during their first year (1) if mortality between banding and 1 September was 50 per cent (data above indicated a 32 per cent loss between three and seven weeks of age), or (2) if the crippling loss in Canada was higher than that in the United States, or (3) if the local reporting rate was lower than for other Mallards. It is possible that a combination of natural mortality prior to 1 September and a lower reporting rate in the vicinity of the banding sites were important biases.

Mean adult mortality for the second through fourth age intervals was 48 and 49 per cent by the two methods. Adult mortality for other samples of North American Mallards has varied from 40 to 56 per cent (Table 39); a British sample averaged 65 per cent (Höhn, 1948) and one from New Zealand 56 per cent (Balham and Miers, 1959).

There is a suggestion in this and some other studies, e.g., Höhn (1948), Bellrose and Chase (1950), and Balham and Miers (1959) that adults suffer higher mortality during the first one or two years than later. If hunting were the major mortality factor, a reduced mortality rate through life might be attributed to the birds' learning to recognize and avoid areas or situations that produce heavy hunting pressure. A more logical explanation may be that birds consistently migrating to areas of low hunting pressure have higher survival rates and are represented in greater proportions in successive years.

Life expectancy has been calculated according to Paluden (1963) and is shown in Table 38. Life expectancy was 1.5 years from the first 1 September and showed little variation through the next four years. As stated earlier the oldest bird reported in this study was nine years old. Flower (1938) recorded a domestic Mallard in England that lived 17.5 years but the oldest Mallard on record is apparently a wild bird. The original copy of the 3-624 form which the U.S. Fish and Wildlife Service sends to hunters reporting bands states that there is a recovery of a Mallard more than 20 years old.

Differential vulnerability between adults and young

Moffatt (1935) apparently first suggested that young birds were more vulnerable than adults, on the basis of recovery rates of Canada Geese (*Branta canadensis*) banded in California. Bellrose et al. (1961) have suggested that comparative hunting recovery rates of different ages or sexes yield data on differential vulnerability. Such a comparison of adults and young Kindersley Mallards banded and recovered in the same years is presented in Table 40. Young birds have a higher recovery rate than adults in a ratio of 1.2:1 and it appears that the difference is the result of higher mortality in Canada where the ratio is 2.5:1 compared with 1:1 in the United States. These rates are probably a measure of survival to the hunting season, vulnerability to equal hunting pressure and differential hunting pressure as a result of differences in geographical and temporal distributions between the two age groups.

Differential mortality between males and females

First interval total mortality is shown as 58 per cent for males and 64 per cent for females; the difference is statistically significant (Table 41). The higher hunting loss in males may be because males present a larger target than females (Bellrose, 1953, Elder, 1955) and because hunters select drakes over hens (Bellrose et al., 1961). However, these explanations contradict the similar mean mortality rates after the first age interval: 48 per cent for males and 47 per cent for females by the dynamic method and 49 per cent for each sex by the relative recovery rate method. Bellrose and Chase (1950) in Illinois and Balham and Miers (1958) in New Zealand found adult females to have higher mortality rates than males (Table 39). A higher female mortality rate is supported by field observations during the breeding season when hens on nests and with broods are apparently killed at a greater rate than drakes. A partial explanation may also lie in differential geographical distribution of the sexes on migration. If adult females do suffer higher natural mortality than males, they may suffer a proportionately lower hunting mortality because of their migration routes and behaviour during the fall and winter.

Expectation of further life for birds living on their first 1 September was the same for both sexes (1.48 years for males and 1.43 for females); from their second 1 September, it was also similar (1.59 and 1.65, respectively).

Maintenance of the population

Survival data are summarized in Table 42. These data indicate that 1,000 breeding pairs of Mallards at Kindersley on 1 April were reduced to 530 breeding pairs one year later. Therefore, 470 new breeding pairs (940 young) had to be added to maintain the population. If mortality between 1 September and 1 April is 50 per cent of total mortality in the first year, then there would be a loss of approximately 89 per cent from eggs on 15 May to breeding birds on 1 April. The production of 940 first-year breeders would, therefore, require that 1,000 hens lay approximately 8,545 eggs or 8.5 eggs per hen. Keith (1961) found that the average clutch size for Mallard nests located before 15 May in southern Alberta was 9.6 eggs; he also found that all Mallard hens that lost nests to predation renested.

DISCUSSION

A Mallard brood makes its first trip before it is a day old, as the hen leads the ducklings to water along a route that varies from a few feet to more than a mile in length. Their first slough may serve only a few Mallard broods through the entire flightless period. Some movements exceeding two miles and involving several ponds probably occur before the young are eight weeks old. We do not know whether these journeys on foot are to the nearest sloughs, and we know little about their frequency, orientation and timing.

For at least a month after their first flight, Kindersley-raised Mallards remain within a few miles of their last brood slough. They begin to disperse in late September but dispersal is not random as has been suggested by Hochbaum (1955). Within 100 miles of the production areas the dominant movement is northward; from 100 to 300 miles it is northwest. It has been found that some experimental birds orient to a particular compass direction within a few minutes after release, regardless of the direction of migration or of trapping site (Matthews, 1963). Bellrose (1963) found that both migrating and wintering Mallards in Illinois were usually flying north or north-northwest when they were one mile from the release sites on clear days and nights. In discussing the relationship between initial orientation and normal migration routes in Illinois, Bellrose (ibid.) stated: "the oriented flight headings taken by Mallards were about 30° to the north of the reverse direction of their autumn migration to Illinois. The oriented headings were 10° west of the direction of their spring migration to Illinois." The significance of almost instantaneous orientation to the northwest and a movement in the same direction over a two-month period is yet to be determined. In the present study, if the first 100 miles of northward movement were not considered, the average proportions of the harvest to the northeast and northwest (14 and 86 per cent, respectively) approximate the proportions in the opposite directions in the United States (10 and 90 per cent), suggesting a fall extension of the spring migration directions. However, in four of the six years, there were no northeastern recoveries beyond 100 miles, while every year produced recoveries from the southwest.

It has been suggested that lack of suitable habitat might be a cause of this wandering (Hochbaum, 1955). However, this would not entirely explain the initial northward rather than the eventual southward movement. There are also indications that some birds move into areas deserted by others (Lensink, 1964) and that generally the flights are less than 300 miles regardless of their origin (Table 9). Mallard populations built up at Kindersley in September and October when Kindersley-raised birds were moving north.

The problems of relating distribution of hunting recoveries to distribution of the population was discussed earlier in relation to Saskatchewan. It will be realized that this was little more than suggestive of a method of investigation. The analysis of geographical distribution compared banded Mallards with all species of ducks, although hunters estimated that Mallards composed 74 to 81 per cent of their kill from 1959 through 1963. Also there was no measure of the proportion of birds harvested by regions for either group. The comparison of temporal distributions involved different periods when habitat conditions, population size and probably age ratios were different.

Through October most young Kindersley Mallards are distributed between their brood sloughs and Edmonton, Alberta. More July- than May-hatched birds are found in the vicinity of brood areas at this time, while the more distant birds were hatched in May.

In late October or early November, a weather system usually develops in the Prairie Provinces that initiates a migration involving millions of ducks. Some Kindersley Mallards move only to Montana and North Dakota while others may move to Louisiana and Texas within two or three days of the start of this storm. It would appear that the origin of these birds at Kindersley, rather than their location in Alberta at the time of this major migration, determines that they move southeast. A much higher proportion of Mallards raised in southeastern Alberta are reported from the Pacific Flyway (Lensink, 1964).

Through November the birds have their widest distribution; they may be expected from Canada to the Gulf of Mexico and from the Pacific coast states to North Carolina. By the time winter officially arrives, most Kindersley-raised Mallards are south of 38° latitude and most of them winter in Arkansas. It appears that adult females from the same slough do not travel together and that ducklings from the same brood do not migrate together. However, there is a strong tendency for most young birds to use the same restricted migration and wintering areas every year. While males moved farther north than females, females moved farther south than males.

The average width of the route followed by most young Mallards was 250 miles and had three major resting areas along it. It would appear that birds arriving in Louisiana and Texas during the first three weeks of November move north to Arkansas in December, thus vacating an area little used by them in subsequent migrations.

The question of the latest recoveries occurring north of the most southerly reports is difficult to explain. After observing a northward flight of ducks in North Dakota, Mann (1950) suggested that local hunting pressure drove them north to Manitoba. Wetmore (1930) stated that "Mallards and Pintails in the Missouri River drainage move north and south regularly during winter with fluctuations in the southern limit of ice...". During the mass migrations referred to earlier, Bellrose and Sieh (1960) noted northbound ducks at the same altitude as the stream of southbound birds and suggested that they were "ducks which arrived at the Mississippi River at a point south of the desired one. These ducks would appear to have recognized their displacement from land marks, and used them as a means of returning to their haunts of other years". Baird and Nisbet (1960) explained a northwest flight of passerines on the Atlantic coast in fall as a correction for a drift to the southeast caused by wind. However, neither hunting pressure, ice conditions, erroneous terminus while migrating nor correction for wind drift would seem to fit a situation in which Mallards arrived at the Gulf of Mexico, spent some time there and then went north to Arkansas, if this did, in fact, occur.

A situation parallel to that for Mourning Doves (*Zenaidura macroura*) may exist. Aldrich (1952) postulated on the basis of banding data that doves began arriving in southern Florida late in September and then moved back to the northern part of the state and into Georgia by late November.

Most females return to Kindersley to breed in subsequent years, while the males, mating on migration and wintering areas with females from many parts of the breeding grounds, probably have a lower homing rate. There is need for more investigation of the homing rate of males. In subsequent fall migrations, more adults than young fly southwest and the proportion to the southwest apparently increases with each subsequent migration. Another explanation of the differential distribution of direct and indirect recoveries is that it is a measure of relative survival of young in different areas. If young birds are harvested at a low rate in the Pacific Flyway, a greater proportion should be alive to return there; if young Mallards were harvested at a high rate in the Central and Mississippi Flyways, a lower proportion would be available to return as adults. The shift indicated by band recoveries in this case would be passive (one group surviving better than the other) rather than active (a change in migration routes by adults). In spite of this actual or apparent shift, there is a strong tendency to home to migration and wintering areas.

Survival studies indicate that 53 per cent of the young survive from the age of three weeks to 1 September, that 39 per cent of the population on 1 September survives to 31 August and that 53 per cent of the adults survive each year thereafter. This and other studies at Kindersley indicate that each Mallard hen must lay an average of 8.5 eggs to maintain the population. Life expectancy on 1 September is 1.5 years for young birds, or one breeding season and two hunting seasons.

The construction of life tables based on band recoveries is assumed to fit into the first of three types of data listed by Deevey (1947): "cases where the age at death (dx) is directly observed for a large and reasonably random sample of the population." Deevey then cautions that this method "can be used only if one is prepared to assume that the population is stable in time, so that the actual age distribution and the life table age distribution are identical." Farner (1955) devotes most of his review of the role of bird banding in population dynamics to mortality and survival rates of stable populations or to those with irregular random fluctuations about a mean.

Conditions prevailing during this study indicate that these requirements may not have been met. The population of both breeding adult and young Mallards in the Kindersley district decreased from 1954 through 1959. This does not necessarily mean that Mallards breeding at Kindersley were experiencing greater mortality than natality. In the face of deteriorating breeding habitat, the birds may not have been returning to the area to breed.

SUMMARY

1. The objectives of this study were to determine dispersal of young wild Mallards and characteristics of their survival. The birds were produced in an area of mixed prairie in west-central Saskatchewan bounded by 51° and 52° N latitude and by 109° and 110° W longitude.

2. The methods used to catch and band ducklings and the procedures and problems involved in the banding technique and in recovery data based on hunting are described. From 1954 through 1959, 12,962 Mallards were

banded. There were 1,018 direct recoveries and 629 indirect recoveries in hunting seasons from 1954 through 1963.

3. Movements of more than 1.5 miles sometimes occur before Mallards reach flying age.

4. One recovered bird in eight was reported during the first autumn within 10 miles of the slough where it had been banded, probably indicating that the duck used its brood slough until its death.

5. Recoveries of young birds north of the banding sites exceeded those to the south for a radius of 10 to 300 miles, particularly in October. Reports from the northwest were more abundant than those from the northeast, there were more males than females recovered north of the banding sites, and the more distant birds were hatched before 9 June.

6. Almost one-third of the direct recoveries were from two 100-mile zones, one associated with the production area (0-100) and the other with the main wintering area (1401-1500). Recoveries beyond 200 miles between 138° and 142° from the banding sites averaged more than one-quarter of reports during the first migration.

7. One-third of the recoveries of juvenile Mallards was reported from Canada; their distribution within the United States, adjusted for differential band reporting rates and crippling losses, were: Mississippi Flyway, 56 per cent; Central, 36 per cent; Pacific, 6 per cent; Atlantic, 1 per cent. There was a steadily decreasing proportion reported from the Pacific Flyway each year.

8. Two provinces and five states accounted for 68 per cent of the direct recoveries. In order of decreasing importance they were: Saskatchewan, Arkansas, Alberta, Nebraska, Louisiana, Missouri and Texas. Twenty-nine other states from Atlantic to Pacific coasts and from Mexico were visited by these birds on their first migrations through six years. There was a positive correlation between the proportion of recoveries in Alberta and in Montana, North and South Dakota, combined. Birth place of the birds rather than their location at the time of migration apparently determined their migration routes.

9. The monthly harvest built up from a low in September to a peak in November and fell off in January to about the September level. There were large annual variations in each month except November. The highest weekly kill occurred in November in five of six years; in 1959 it occurred 6-12 October because of an unusually high harvest in Canada.

10. The harvest in September was not as large in Saskatchewan and Alberta as it was in October. The period of peak harvest in Louisiana and Texas occurred at the same time as that in Nebraska and Missouri and before that in Arkansas.

11. Most Kindersley Mallards moved from Canada with the major mass migrations of 1955, 1956 and 1957; these movements marked the beginning of the United States harvest.

12. Two-thirds of the recoveries between 85° and 114° W longitude occurred along a path that averaged 255 miles wide and was approximately 2,500 miles long from Kindersley into Alberta and then to the Gulf of Mexico. The following appeared to be major stopping areas: Kindersley-Wilkie, Saskatchewan; southern Nebraska-northern Missouri; east-central Arkansas; and southern Louisiana-Gulf coast of Texas.

13. Significantly more males than females were reported north of the banding sites and between 101 and 600 miles from Kindersley; more females were found from 1101 to 1600 miles away. There were no important differences in the monthly distribution of the sexes or in the direction of their first migration in the United States from the degree block of banding.

14. Early-hatched Mallards (hatched before 9 June) moved away from their brood sloughs earlier than late-hatched birds (hatched after 29 June) and they moved farther in Canada. Both groups were reported in equal proportions more than 1,600 miles from Kindersley, but older young were harvested in greater proportions than younger birds in Alberta and the three western flyways. The direction of migration was similar south of 49° latitude except that more early-hatched young flew southwest.

15. Neither young Mallards nor adult females from the same water areas migrated together. Young from the same brood also appeared to separate in migration.

16. Recoveries during the seven migrations after the first came from five provinces and 28 states. Two provinces and eight states accounted for more than two-thirds of the direct and indirect recoveries. The most noticeable difference between first and subsequent migrations was a reduction from 27 to 10 per cent in the proportion of recoveries from Saskatchewan. Adult Mallards did not move as far south and east as young birds and more adults, particularly females, migrated west.

17. Kindersley Mallards were reported from 291 degree blocks during their first migration and from a total of 224 during seven subsequent migrations. One degree block reported a total of seven migrations and three reported six migrations when all banded cohorts were combined.

18. Almost half of the birds reported during their first migration were from 26 degree blocks. Approximately 80 per cent of direct and indirect recoveries were from the 122 blocks with both types of recoveries, indicating a strong homing instinct to migration and wintering areas.

19. Banding data indicated a loss of 32 per cent between three and seven weeks of age. Losses between flying (8 weeks) and 1 September may have been small. A mortality of 61 per cent was calculated for the year following the first 1 September. Mean annual adult mortality was 47 per cent. Life expectancy on the first 1 September was 1.5 years and on the second 1 September was 1.6 years.

20. Young were found to have a recovery rate 1.2 times as high as adults, and all of the additional vulnerability occurred in Canada. Late-hatched Mallards experienced a significantly higher mortality rate

than early-hatched birds in their first year beginning 1 September. Females had a significantly higher mortality rate than males during this same period but both sexes had similar mortality rates in subsequent years.

21. This and other studies at Kindersley indicated a loss of 84 per cent between the fresh egg on 15 May and young on 1 September. These data indicate that a Mallard hen in the Kindersley district had to lay an average of 8.5 eggs to maintain the population.

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APPENDIX

TABLES

Table 1. Direct recovery rates for man- and dog-caught Mallards at Kindersley.

	Recovery rate		Number banded[a]	
Year	Man-caught	Dog-caught	Man-caught	Dog-caught
1954	9.8%	4.8%	315	82
1955	7.9[b]	13.1	203	320
1956	10.2	10.6	352	1263
1957	7.0	7.2	2564	2347
1958	8.5	7.7	1278	2362
1959	6.0	4.8	100	965
Total	7.81	7.84	4812	7339

[a] The total of both categories each year does not equal the number banded each year because a third category - birds not specifically designated as man- or dog-caught - has been omitted.

[b] Difference is significant at 0.05 level.

Table 2. Comparison of distribution of direct recoveries from man-caught and dog-caught Mallards. 95 per cent confidence limits in per cent are given for man-caught segment.[a] Nonfitting segments are underlined. (Lock-on bands excluded in 1957.)

Miles		1954 Man	1954 Dog	1955 Man	1955 Dog	1956 Man	1956 Dog	1957 Man	1957 Dog	1958 Man	1958 Dog	1959 Man	1959 Dog	Total Man	Total Dog
0- 100	No.	12	2	1	16	7	37	42	33	30	54	1	25	93	167
	%	23-60%	50%	0-30%	38%	9-38%	27%	21-37%	25%	21-40%	30%	17%	42-70%	22-32%	31%
101- 600		0	0	2	5	2	10	32	34	13	18	1	6	50	73
		0-12%	0%	2-40%	12%	1-19%	7%	14-28%	25%	7-21%	10%	17%	6-27%	11-20%	14%
601-1100		6	0	6	6	7	25	25	30	21	32	3	5	68	98
		8-39%	0%	15-68%	14%	9-38%	19%	10-23%	22%	14-30%	18%	50%	4-25%	16-25%	18%
1101-1600		8	1	6	11	16	44	45	32	29	53	1	7	105	148
		12-46%	25%	16-68%	26%	29-64%	33%	22-39%	24%	20-39%	29%	17%	7-30%	25-36%	27%
1601-2100		5	1	1	4	4	19	8	5	15	24	0	3	33	56
		6-35%	25%	0-32%	10%	3-24%	14%	2- 9%	4%	9-24%	13%	0%	1-19%	7-14%	10%
Sample		31	4	16	42	36	135	152	134	108	181	6	46	349	542
September		1	0	1	4	3	13	13	12	4	15	1	7	23	51
		0-20%	0	0-32%	10%	2-24%	10%	5-15%	9%	1-10%	8%	17%	7-31%	5-12%	10%
October		7	1	1	12	5	20	48	44	31	46	1	21	93	144
		12-48%	50%	0-32%	31%	5-32%	16%	24-41%	33%	22-41%	26%	17%	33-64%	22-33%	28%
November		7	1	10	13	13	44	54	54	49	63	3	10	136	185
		12-48%	50%	36-85%	33%	22-58%	35%	28-45%	40%	38-59%	36%	50%	12-39%	34-45%	35%
December		10	0	4	8	9	36	23	17	16	36	1	5	63	102
		20-60%	0%	8-53%	21%	13-44%	29%	9-22%	13%	9-25%	20%	17%	4-25%	15-25%	20%
January		2	0	0	2	6	13	12	6	5	17	0	2	25	40
		1-25%	0%	0-21%	5%	7-34%	10%	4-14%	5%	2-11%	10%	0%	0-16%	5-12%	8%
Sample		27	2	16	39	36	126	150	133	105	177	6	45	340	522

[a]Except for 1959 where the man-caught segment was too small.

Table 3. Direct and indirect recovery data for Mallards wearing lock-on bands and standard control bands. All birds banded in 1957.

Type of band	Number banded	Recoveries in years following banding						Total
		0-1	1-2	2-3	3-4	4-5	5-6	
Lock-on	695[a]	53[a]	25	9	11	0	1	99
Standard	706	50	22	10	6	1	1	90
		Per cent of total recoveries						**Total recovery**
Lock-on		54	25	9	11	0	1	14.2
Standard		56	24	11	7	1	1	12.7

[a]These totals do not agree with Table 6 because the present table includes only lock-on and butt-end bands that were used alternately. The numbers of lock-on and butt-end bands are not identical in this table because adults and injured birds have been omitted from each sample.

Table 4. Some duck hunting regulations in Saskatchewan and Alberta.

		1954	1955	1956	1957	1958	1959
Saskatchewan							
Season:	North[a]	S13-N20	S 1-N30	S 1-N30	S 2-N30	S 1-N29	S 7-N28
	South[a]	S18-D17	S 7-D15	S12-D20	S 7-D14	S 6-D13[b]	S14-N28[b]
Game Bird Licences		52,672	54,951	57,898	57,797	56,657	43,947
Daily Bag Limit		10	15	15	15	12	7
Alberta							
Season:	North[c]	S18-D 4	S 1-N30	S 1-N30	S 2-N30	S 1-N29	S 1-N28
	South[c]	S18-D 4	S 7-D10	S12-D15	S 7-D14	S 6-D13	S19-N28
Game Bird Licences		62,112	64,892	75,715	84,497	99,228	92,859
Daily Bag Limit		8	10	10	10	10	7

[a]Distance from banding sites: North 200-660 miles; South 0-430.

[b]In 1958 seven lakes in western Saskatchewan were open only from S6-S26. In 1959 fourteen lakes each with 500-yard buffer zone were not open in western Saskatchewan.

[c]Distance from banding sites: North 310-790 miles; South 0-320.

Table 5. Some duck hunting regulations for the Pacific, Central and Mississippi Flyways, 1954-1959. Data included: Season dates, duck stamps, daily bag.

	1954		1955		1956		1957		1958		1959		Distance from Kindersley (miles)
PACIFIC FLYWAY													
Arizona	023-J10		028-J15		028-J15		012-J14		011-J13		07-J8		1010-1410
	9,100	10	10,200	6	9,300	6	10,100	5	9,300	5	7,100	5	
California	09-J10		015-J15		013-J15		012-J14		011-J13		07-J8		830-1380
	176,900	10	180,200	7	180,300	7	183,000	6	161,100	6	114,500	5	
Idaho	016-J3		013-D31		013-D31		05-J7		04-J6		07-J8		350- 750
	37,400	9	35,600	6	34,900	6	32,800	5	33,700	5	28,300	5	
Nevada	08-J10		015-J15		013-J15		05-J14		011-J13		09-J8		700-1180
	9,700	10	11,100	6	11,300	6	11,200	5	11,200	5	9,300	5	
Oregon	016-J3		022-J9		013-D31		012-J14		011-J13		07-J8		520- 970
	70,700	9	69,900	6	65,300	6	68,300	5	59,500	5	51,300	5	
Utah	08-D26		015-J2		013-D31		05-J7		04-J6		07-J8		670-1030
	32,300	9	33,000	6	32,000	6	32,100	5	32,500	5	24,800	5	
Washington	016-J3		015-J2		013-D31		013-J15		012-J14		07-J8		390- 770
	80,700	9	80,800	6	86,000	6	80,400	5	80,500	5	66,400	5	
CENTRAL FLYWAY													
Colorado	N1-D30		025-J7		025-J7		018-D31		010-J7		026-D14		730-1070
	32,500	5	39,100	5	36,300	5	42,500	5	41,900	4	31,500	4	
Kansas	021-D19		09-D22		07-D20		012-D25		011-J8		017-D15		830-1250
	48,800	5	62,700	5	46,800	5	73,100	5	71,000	4	53,900	3	

Table 5 (continued)

	1954		1955		1956		1957		1958		1959		Distance from Kindersley (miles)
CENTRAL FLYWAY													
Montana	09-D7		08-D21		06-D19		05-D18		011-D24		016-D4		180- 510
	33,200	5	35,100	5	34,000	5	37,000	5	34,200	5	24,800	4	
Nebraska	08-D6		08-D21		05-D18		05-D18		01-D29		010-D8		650-1050
	59,500	5	58,300	5	56,500	5	67,000	5	64,600	4	49,900	3	
New Mexico	N12-J10		N2-J15		N2-J15		N2-J15		N2-J15		N20-J8		1010-1400
	10,100	5	10,500	5	8,900	5	10,200	5	8,800	5	5,700	4	
North Dakota	01-N29		01-D14		01-D14		01-D14		01-D14		07-N25		300- 710
	44,600	5	44,900	5	44,300	5	47,100	5	39,400	5	26,500	4	
Oklahoma	027-D25		022-J4		019-J1		019-J1		018-J15		020-D18		1070-1460
	38,400	5	52,600	5	44,400	5	50,000	5	43,300	4	31,600	3	
South Dakota	01-N29		01-D14		01-D14		05-D18		01-D29		07-D5		470- 880
	49,300	5	40,400	5	43,400	5	49,800	5	42,800	4	32,200	3	
Texas	N5-J3		N2-J15		N2-J15		N1-J14		N1-J14		N13-J1		1100-1900
	151,900	5	169,200	5	166,300	5	167,400	5	145,100	5	107,000	4	
Wyoming	010-D8		018-D31		011-D24		011-D24		011-D24		016-D14		450- 770
	10,300	5	10,900	5	10,400	5	11,300	5	10,600	5	7,800	3	
MISSISSIPPI FLYWAY													
Alabama	N17-J10		N7-J15		N7-J15		N7-J15		N7-J15		N25-J3		1580-1910
	15,900	4	18,700	4	20,200	4	17,200	4	16,300	4	10,700	4	
Arkansas	N17-J10		N7-J15		N7-J15		N7-J15		N7-J15		N30-J8		1290-1590
	46,200	4	58,100	4	55,100	4	59,100	4	59,200	4	38,900	4	

Table 5 (continued)

	1954		1955		1956		1957		1958		1959		Distance from Kindersley (miles)
MISSISSIPPI FLYWAY													
Illinois	022-D15		015-D23		013-D21		019-D27		018-D26		030-D8		1100-1450
	110,500	4	125,200	4	117,700	4	119,000	4	108,500	4	85,900	4	
Indiana	029-D22		022-D30		020-D28		026-J3		025-J2		N6-J8[a]		1260-1500
	39,700	4	48,800	4	47,700	4	50,600	4	41,500	4	31,100	3	
Iowa	015-D8		08-D16		06-D14		05-D13		04-D12		020-D8		830-1170
	57,000	4	52,200	4	57,500	4	59,000	4	54,800	4	51,000	3	
Kentucky	N17-J10		N7-J15		N3-J11		N7-J15		N7-J15		N30-J8		1430-1680
	15,000	4	17,900	4	18,600	4	19,500	4	17,200	4	9,600	4	
Louisiana	N1-J10		N5-J15		N1-J15		N2-J15		N1-J15		N20-J8		1520-1900
	88,200	4	106,300	4	102,700	4	102,200	4	91,800	4	66,700	4	
Michigan	01-N24		01-D9		01-D9		01-D9		01-D9		07-N15		950-1430
	129,900	4	146,200	4	140,600	4	128,100	4	110,300	4	77,600	4	
Minnesota	02-N25		08-D16		06-N29		05-D13		04-D12		07-N25		590-1030
	143,900	4	132,000	4	150,600	4	151,200	4	147,900	4	118,600	3	
Mississippi	N17-J10		N5-J15		N1-J15		N2-J15		N1-J15		N20-J8		1510-1840
	17,300	4	20,600	4	20,600	4	19,400	4	19,400	4	13,800	3	
Missouri	022-D15		028-J5		026-J3		025-J2		024-J1		N6-D25		1010-1460
	58,600	4	75,800	4	72,900	4	76,800	4	73,200	4	53,900	3	
Ohio	018-D11		010-D26		010-D22		015-D26		015-J1		016-D12		1370-1620
	38,700	4	47,100	4	46,700	4	45,100	4	43,000	4	28,000	4	

Table 5 (continued)

	1954		1955		1956		1957		1958		1959		Distance from Kindersley (miles)
MISSISSIPPI FLYWAY													
Tennessee	N17-J10		N7-J15		N7-J15		N7-J15		N7-J15		N30-J8		1450-1740
	33,800	4	39,200	4	41,400	4	42,200	4	38,700	4	21,200	4	
Wisconsin	02-N25		01-D9		01-D9		01-D9		01-D9		07-N25		870-1210
	127,400	4	131,100	4	130,300	4	115,200	4	109,900	4	100,700	3	

[a]Split season.

Table 6. Number of Mallards banded and recovered by years[a].

Year of banding:	1954	1955	1956	1957[b]	1958	1959	Total
Number banded	592	699	1767	4987	3842	1105	12962
Direct recoveries	50	72	188	352	303	53	1018
Indirect recoveries	27	43	119	263	153	24	629

[a]Only experimental, uninjured flightless young wearing standard or lock-on bands are included.

[b]Includes the following lock-on bands: 765 banded, 61 direct recoveries and 47 indirect recoveries.

Table 7. Percentage distribution of direct recoveries in four quadrants within 300 miles of brood sloughs, 1954-1959 combined.

A: By 10-day period and distance (all years combined)

	North-west	North-east	South-west	South-east	Total	10-100	101-200	201-300
1-10 Sept.	-	-	0.5	0.5	0.9	0.9	-	-
11-20 "	1.4	2.3	0.5	1.4	5.4	5.4	-	-
21-30 "	3.2	2.3	0.9	2.3	8.6	6.3	1.8	0.5
1-10 Oct.	10.4	10.9	0.9	1.8	24.0	19.0	5.0	-
11-20 "	11.8	7.7	1.4	1.4	22.2	15.8	5.9	0.5
21-30 "	8.1	3.6	2.7	5.9	20.4	10.9	6.3	3.2
31 Oct.-9 Nov.	4.1	1.4	2.3	2.7	10.4	4.5	4.5	1.4
10-19 Nov.	0.9	0.5	2.3	2.7	6.3	1.8	3.2	1.4
20-29 "	-	-	0.5	0.9	1.4	0.5	-	0.9
30 Nov.-9 Dec.	-	-	0.5	-	0.5	-	-	0.5
Sample With date-unusable records added								
Total	38.3	28.6	12.1	21.0		66.9	25.4	7.7
Sample	95	71	30	52	248	166	63	19

B: By year and distance

Direction:	Northwest			Northeast			Southwest			Southeast			
Distance (miles):	10-100	101-200	201-300	10-100	101-200	201-300	10-100	101-200	201-300	10-100	101-200	201-300	Sample
	%	%	%	%	%	%	%	%	%	%	%	%	
Year													
1954	21	-	-	43	-	-	7	-	-	29	-	-	14
1955	20	-	13	20	7	-	13	-	-	20	-	7[a]	15
1956	41	4	-	19	-	-	4	-	-	26	7[a]	-	27
1957	14	21	4	27	-	-	5	6	3[a]	6	10[a]	5[a]	110
1958	26	10	3	28	7	-	10	3	3[a]	7	3	-	61
1959	24	19	-	24	-	-	5	-	-	29	-	-	21
Average	21	14	3	27	2	-	6	4	2	13	6	2	248

[a]Includes recoveries from U.S.A.

Table 8. Percentage distributions of harvest of Kindersley-banded and all Saskatchewan Mallards by weeks.

Kindersley Mallards 1954-1959		Saskatchewan Mallards		
Week	Per cent	Week[a]	Per cent	Years
1- 7 Sept.	2.1	3-12 Sept.	2.4	1959-1962
8-14 "	8.1	9-19 "	6.1	1959-1963
15-21 "	6.8	16-26 "	9.2	"
22-28 "	8.5	23 Sept.- 3 Oct.	12.6	"
29 Sept.- 5 Oct.	14.5	30 Sept.-10 Oct.	16.7	"
6-12 Oct.	23.0	7-15 Oct.	18.1	1960-1963
13-19 "	13.6	14-22 "	13.0	"
20-26 "	10.2	21-29 "	8.3	"
27 Oct. - 2 Nov.	7.2	28 Oct. - 4 Nov.	4.8	1961-1963
3- 9 Nov.	3.4	4- 9 Nov.	3.0	1963
10-23 "	2.5	11 Nov. - 7 Dec.	5.7	"
Sample: 235		2.0 million (if data usable every week for all five years).		

[a]Each period includes only one full week for each year indicated.

Table 9. Direct recoveries of Mallards showing approximate periods of northward movement.

No.	Banding area	Age Sex	Dates: Re-covered	Dates: Banded	Distance Direc-tion	Authority
1[a]	Prince, Sask.	ImmF	13 Sept.	4 Sept/49	495 WNW	Cartwright and Law, 1952
2	Smiley, Sask.	Ad M	18 Sept.	28 Aug/57	110 NW	Dzubin, in press
3	Orland Park, Ill.	ImmF	20 Sept.	13 Aug/44	280 NW	Mann et al., 1947
4	" " "	ImmF	20 Sept.	7 Aug/44	125 NW	" "
5	" " "	ImmF	21 Sept.	5 Aug/44	370 NW	" "
6	" " "	ImmF	22 Sept.	17 Aug/44	480 NW	" "
7	" " "	ImmM	24 Sept.	3 Aug/44	390 NW	" "
8	" " "	ImmM	25 Sept.	5 Aug/44	120 NW	" "
9	Smiley, Sask.	ImmM	28 Sept.	2 Sept/57	140 NW	Dzubin, in press
10	Orland Park, Ill.	ImmF	28 Sept.	6 Aug/44	350 NNE	Mann et al., 1947
11[a]	" " "	? F	29 Sept.	17 Sept/44	175 NW	" "
12	" " "	ImmM	1 Oct.	4 Sept/44	235 NW	" "
13[a]	Smiley, Sask.	ImmM	3 Oct.	21 Sept/58	200 NW	Dzubin, in press
14[a]	Orland Park, Ill.	Ad M	19 Oct.	7 Oct/44	215 ENE	Mann et al., 1947
15	Brooks, Alta.	Ad F	20 Oct.	3 Oct/45	425 NW	Cartwright and Law, 1952
16	Smiley, Sask.	ImmM	25 Oct.	4 Oct/57	180 NW	Dzubin, in press
17	" "	Ad F	26 Oct.	3 Oct/59	185 NW	" "
18[a]	Orland Park, Ill.	ImmM	28 Oct.	26 Oct/44	370 NW	Mann et al., 1947
19[a]	Smiley, Sask.	ImmM	31 Oct.	17 Oct/59	95 NW	Dzubin, in press
20[a]	Orland Park, Ill.	ImmM	3 Nov.	30 Oct/45	175 NW	Mann et al., 1947
21	" " "	? F	19 Nov.	1 Nov/43	110 NE	" "
22	" " "	Ad M	6 Dec.	15 Nov/44	210 NE	" "
23[a]	" " "	ImmM	22 Nov.	19 Nov/45	90 NW	" "

[a]Records with 14 or fewer days between banding and recovery.

Table 10. Percentage distribution of direct recoveries by mileage zones, month and direction, 1954-1959 combined.

Miles		September	October	November	December	January	Total[a]
0- 10		5.0	7.0	0.4	-	-	12.4
11- 100	N	1.9	9.0	0.6	-	-	11.7
	S	1.1	2.4	0.8	-	-	4.6
101- 600	N	0.3	3.6	0.8	-	-	4.6
	S	0.3	3.2	4.0	1.2	0.2	9.1
601-1100	S	-	1.4	12.4	5.5	0.4	19.9
1101-1600	S	-	0.4	13.0	9.5	4.9	27.5
1601-2100	S	-	-	5.3	3.5	1.7	10.1
Total		8.7	27.0	37.3	19.7	7.2	100

Sample: 980 for monthly distribution; 1,018 for distance.

[a]Includes 38 recoveries that could not be assigned to specific months.

Table 11. Percentage distribution of direct recoveries by direction, distance and month, 1954-1959 combined, Canada excluded.

A: Direction - Distance

Compass direction:	237°-183°	182°-173°	172°-153°	152°-133°	132°-113°	Total
Distance (Miles)						
201- 600	2.7	2.1	1.1	2.6	2.0	10.5
601-1100	6.9	0.3	4.4	16.8	2.6	31.0
1101-1600	0.8	0.3	2.4	33.7	5.5	42.7
1601-2100	-	-	4.0	11.1	0.6	15.7
Total	10.4	2.7	11.9	64.3	10.7	100

Sample 655

B: Direction - Month

	237°-183°	182°-173°	172°-153°	152°-133°	132°-113°	Total
October	0.5	0.6	0.5	3.3	1.3	6.2
November	3.8	1.3	6.6	33.4	7.1	52.2
December	4.7	0.8	4.1	19.2	1.6	30.4
January	0.9	0.2	0.9	8.7	0.5	11.2

Sample 634

Table 12. Relationship of direct recoveries northwest of the banding sites to those beyond 200 miles southward.

Direction	Number of recoveries per thousand birds banded 1956	1957	1958
Northwest:			
11-300 miles	7	8	6
101-300 miles	0.6	5	2
South:			
237°-183°	8	4	5
182°-153°	11	8	6
152°-137°	50	27	35
No. banded	1,767	4,987	3,842

Table 13. Unadjusted and adjusted annual percentage distribution of direct Mallard recoveries excluding Mexico.

A: Unadjusted	1954	1955	1956	1957	1958	1959	Average
Canada	36.0	31.9	26.7	38.6	34.1	62.3	35.7
U. S. A.	64.0	68.1	73.3	61.4	65.9	37.7	64.3
Within U. S. A.:							
Pacific	12.5	12.2	9.5	9.3	8.0	5.0	9.2
Central	43.8	36.7	32.1	47.7	39.2	40.0	40.6
Mississippi	40.6	51.0	56.9	43.1	51.8	50.0	49.3
Atlantic	3.1	-	1.5	-	1.0	5.0	0.9
Sample U. S. A.	32	49	137	216	199	20	653
B: Adjusted for differential reporting rate[a,b]							
Canada	34.5	30.3	24.7	36.8	32.0	60.0	33.7
U. S. A.	65.5	69.7	75.3	63.2	68.0	40.0	66.3
C: Adjusted for differential reporting rate[a,b] and crippling loss[c]:							
Pacific	Not	9.3	7.0	7.1	6.0	3.6	6.8
Central	avail-	33.2	28.2	43.3	35.[illegible]	34.7	36.3
Mississippi	able	57.6	63.5	49.6	58.0	57.4	56.1
Atlantic		-	1.4	-	0.9	4.3	0.8

[a]Based on Bellrose (1955).
[b]Based on Geis and Atwood (1961).
[c]Based on Crissey (1957, 1958, 1960).

Table 14. Percentage distribution of direct recoveries of Mallards banded as flightless young from six areas south of 55° in western Canada, 1950-1961.

Banding area: Source:	B. C. Lensink (1964)	Alberta Lensink (1964)	Sask. Lensink (1964)	Manitoba Lensink (1964)	Kindersley[a] Present study	Redvers[a] Stoudt (1961)
Recovery Area:						
CANADA	63%	57%	41%	58%	36%	38%
Alberta	-	54	4	-	9	-
Br. Columbia	63	T[b]	-	-	-	-
Manitoba	-	T	1	53	-	10
Ontario	-	-	T	-	-	-
Saskatchewan	-	2	36	5	27	28
PACIFIC	36(97)[c]	20(47)	3 (5)	-	6 (9)	-
Arizona	-	T	T	-	T	-
California	2	5	T	-	2	-
Idaho	3	5	T	-	2	-
Nevada	-	T	T	-	T	-
Oregon	6	4	T	-	1	-
Utah	-	T	T	-	T	-
Washington	25	4	T	-	T	-
CENTRAL	-	12(28)	20(34)	10(24)	26(41)	21(34)
Colorado	-	2	T	-	1	-
Kansas	-	T	3	2	4	2
Montana	-	3	2	T	4	-
Nebraska	-	2	4	T	6	3
New Mexico	-	T	T	-	T	-
North Dakota	-	T	3	4	2	10
Oklahoma	-	1	1	-	2	1
South Dakota	-	T	3	2	3	2
Texas	-	2	4	1	4	3
Wyoming	-	T	T	-	T	-
MISSISSIPPI	1 (3)	11(26)	35(59)	31(74)	32(50)	41(66)
Alabama	-	T	T	T	T	T
Arkansas	-	5	12	9	12	12
Illinois	-	T	3	3	2	1
Indiana	-	T	T	T	T	T
Iowa	-	T	2	4	2	3
Kentucky	-	T	T	-	T	T
Louisiana	1	2	7	4	6	7
Michigan	-	-	T	T	T	-
Minnesota	-	T	2	3	T	5
Mississippi	-	T	2	1	2	1

Table 14 (continued)

Banding area: Source: Recovery Area:	B. C. Lensink (1964)	Alberta Lensink (1964)	Sask. Lensink (1964)	Manitoba Lensink (1964)	Kindersley[a] Present study	Redvers[a] Stoudt (1961)
MISSISSIPPI						
Missouri	-	1	4	4	5	6
Ohio	-	T	T	T	T	-
Tennessee	-	T	1	1	1	3
Wisconsin	-	T	T	1	-	T
ATLANTIC	-	-	T	2(5)	T	T
Florida	-	-	T	T	T	-
Georgia	-	-	T	T	T	-
Maryland	-	-	T	T	-	-
New York	-	-	T	-	-	-
North Carolina	-	-	T	-	T	-
Pennsylvania	-	-	T	-	-	-
South Carolina	-	-	T	T	T	T
Virginia	-	-	T	-	-	-
MEXICO	-	-	T	-	T	-
SAMPLE	111	995	3,367	314	1,018	218

[a]Both in Saskatchewan, banded from 1954 through 1959.

[b]T = trace, less than 1.0%.

[c]Canadian recoveries excluded.

Table 15. Annual percentage of direct recoveries in Alberta compared to those in the northern part of the Central Flyway and in the Pacific Flyway.

	1956	1955	1958	1957
Alberta	2.7	5.6	8.6	13.1
Montana, North and South Dakota	3.8	7.0	8.0	13.6
Pacific Flyway	6.9	8.3	5.3	5.7
Sample	188	72	303	352

Table 16. Percentage distribution of direct recoveries by seven-day periods for seven areas, 1954-1959 combined.

	Sask.	Alta.	Nebr.	Mo.	Ark.	La.	Texas
1- 7 Sept.	2.1	x	-	-	-	-	-
8-14 "	8.1	2.4	-	-	-	-	-
15-21 "	6.8	2.4	-	-	-	-	-
22-28 "	8.5	6.1	-	-	-	-	-
29 Sept.- 5 Oct.	14.5[a]	8.5	x	-	-	-	-
6-12 Oct.	23.0	18.3	1.7	-	-	-	-
13-19 "	13.6	17.1	x	-	-	-	-
20-26 "	10.2	14.6	1.7	x	-	-	-
27 Oct.- 2 Nov.	7.2	12.2	10.2	10.4	-	x	x
3- 9 Nov.	3.4	11.0	11.9	8.3	7.2	15.5	2.4
10-16 "	2.1	6.1	20.3	25.0	9.0	17.2	17.1
17-23 "	0.4	1.2	20.3	18.8	11.7	12.1	17.1
24-30 "	x[b]	x	10.2	8.3	9.9	3.4	12.2
1- 7 Dec.	x	x	8.5	12.5	10.8	5.2	4.9
8-14 "	x	x	8.5	4.2	5.4	12.1	7.3
15-21 "	x	x	3.4	4.2	6.3	5.2	19.5
22-28 "	-	-	1.7	6.3	9.9	10.3	7.3
29 Dec.- 4 Jan.	-	-	1.7	2.1	11.7	6.9	7.3
5-11 Jan.	-	-	-	x	12.6	10.3	2.4
12-15 "	-	-	-	-	5.4	1.7	2.4
Sample	235	82	59	48	111	58	41

[a]Peak periods are underlined.

[b]Hunting season open at least part of week for at least one year. Saskatchewan season dates are for southern area only.

Table 17. Geographical distribution of direct recoveries each day from 6-19 November 1958.

Distance in miles between banding and recovery points.

Date	6	7	8	9	11[a]	12	13	15[a]	16	17	18	19
Saskatchewan	25 South	-	-	-	21 North	-	-	-	-	-	-	-
Alberta	-	-	-	-	75 South	-	-	170 South	-	-	-	-
Montana	-	-	-	309	-	398	-	-	-	350	-	-
Washington	-	-	-	460	-	-	-	-	-	-	-	-
South Dakota	-	-	-	-	-	-	-	-	530[b]	-	650	-
Utah	-	-	-	-	-	-	-	690	750	850	-	-
Colorado	-	-	-	-	-	-	-	820	820	-	-	-
Oregon	-	-	-	-	-	-	-	-	-	850	-	-
Nebraska	-	-	840	880[b]	-	-	-	890[b]	-	-	970	-
Minnesota	-	-	-	-	-	-	-	-	-	-	920	-
Kansas	970	-	-	1090	-	-	-	-	-	1080	-	-
Iowa	-	-	-	-	-	-	-	1020	-	1010	920	-
Illinois	-	1240	-	-	-	-	-	-	-	-	-	1180
Missouri	-	-	1350	1310[b]	1202	-	-	1280	-	-	-	-
Oklahoma	-	-	-	-	-	-	-	1350	-	-	-	-
Kentucky	-	-	-	1480	-	-	-	-	-	-	-	-
Tennessee	-	-	1450	-	1498	-	-	-	-	-	-	-
Arkansas	-	1430	1490[b]	1510[b]	-	1440	-	1470	-	-	1510	-
Mississippi	-	1604	-	-	-	-	-	-	-	-	-	-
Texas	-	-	-	-	-	-	1690	1670	-	-	-	-
Louisiana	1750[b]	1790	1820	-	-	-	-	1710	1790[c]	-	1780	-
South Carolina	-	-	-	-	-	-	-	1970	-	-	-	-
Range	1725	550	980	1208	1519	1042	-	1800	1260	730	1130	260
Sample	4	4	6	10	4	2	1	12	7	5	7	2

[a]No recoveries were reported for 10 or 14 November.

[b]Two recoveries. The mileage used in such cases is that which gave the greatest range.

[c]Three recoveries.

Table 18. Percentage distribution of direct recoveries in Canada and the United States in relation to the major migrations of 1955, 1956, 1957.

	1955			1956			1957		
Date of Mig.:	31 Oct.-3 Nov.			6-8 November			23-25 October		
Rel. to Mig.:	Before	During	After	Before	During	After	Before	During	After
Canada	95.4	4.5	0	90.0	2.0	8.0	75.2	5.6	19.2
Sample		22			50			125	
United States	4.2	6.3	89.6	4.6	0	95.4	1.9	3.3	94.8
Sample		48			130			213	
Total harvest	32.9	5.7	61.4	28.2	0.6	71.3	29.0	4.1	66.9
Sample		70			181			338	
Montana-North Dakota	0	0	100	25	0	75	10	10	80
Sample		5			4			30	

Earliest recoveries beyond 900 miles:

1955				1956				1957			
Date	State	Dist. miles	H.P.[a]	Date	State	Dist. miles	H.P.[a]	Date	State	Dist. miles	H.P.[a]
24 Oct.	Kan.	970	E	by 2 Nov.	Ill.	1202	L	23 Oct.	Ia.	910	L
28 Oct.	Nebr.	930	M	3 Nov.	Nebr.	900	E	24 Oct.	Nebr.	940	M
1 Nov.	Nebr.	1030	L	3 Nov.	Nebr.	930	L	25 Oct.	Ia.	1040	L
2 Nov.	Mo.	1140	M	9 Nov.	Kan.	1110	L	27 Oct.	Cal.	1150	M
2 Nov.	Mo.	1180	M	9 Nov.	Ia.	1120	L	27 Oct.	Mo.	1260	M
4 Nov.	Mo.	1130	E	10 Nov.	Ill.	1197	L	27 Oct.	Mich.	1310	E
5 Nov.	Ia.	900	M	10 Nov.	Tex.	1710	M				
5 Nov.	Ia.	1000	M								
6 Nov.	La.	1730	L								

[a]Hatching period - E: 12 May-8 June; M: 9-29 June; L: 30 June-11 August.

Table 19. Temporal distribution of two-thirds of the direct recoveries by successive groups of latitudes, 1954-1959 combined.

55° to 52°	1-30 October
52° to 51°	15 September to 20 October
51° to 46°	21 October to 19 November
46° to 40°	31 October to 29 November
40° to 35°	10 November to 9 December
35° to 31°	30 November to 8 January
31° to 28°	10 November to 9 December

Table 20. Age and sex composition of Mallard samples caught with cannon net traps at Kindersley in 1961 and 1962.

	Adult		Immature		
	Male	Female	Male	Female	Sample
1961: 14 Sept.-13 Oct.	84.4%	9.6%	3.0%	3.0%	738
1962: 9 Sept.- 9 Nov.	76.4	12.9	6.9	3.9	1385

Table 21. Percentage distribution of direct recoveries of each sex by distance, month and direction, 1954-1959 combined.

		September		October		November		December		January		Total[a]	
Miles	Dir.	M	F	M	F	M	F	M	F	M	F	M	F
0- 10		4.6	5.5	6.1	8.2	0.2	0.7	-	-	-	-	10.6	14.5[b]
11- 100	N	2.1	1.8	9.7	8.2	0.9	0.2	-	-	-	-	12.9	10.2
	S	1.1	1.1	2.3	2.6	1.3[b]	0.2	-	-	-	-	5.1	4.1
101- 600	N	0.2	0.4	4.7[b]	2.2	1.1	0.4	-	-	-	-	6.0[b]	3.0
	S	0.4	0.2	4.0	2.2	4.4	3.5	1.3	1.1	0.2	0.2	10.2	7.9
601-1100	S	-	-	1.1	1.8	12.3	12.6	7.2	3.5	0.6	0.2	21.5	18.1
1101-1600	S	-	-	0.2	0.7	11.8	14.3	7.8	11.5[b]	4.7	5.1	24.2	31.3[b]
1601-2100	S	-	-	-	-	4.9	5.7	3.2	3.8	1.7	1.8	9.5	10.9
Total[c]		8.3	9.1	28.1	25.8	36.8	38.0	19.5	19.9	7.2	7.3	100	100

[a]Sample for distance: 549 males and 469 females.

[b]Proportions significantly different at 0.05% level.

[c]Sample for months: 527 males and 453 females.

Table 22. Percentage distribution of direct recoveries of early- and late-hatched[a] Mallards by distance, month and direction, 1954-1959 combined.

Miles	Dir.	September E	September L	October E	October L	November E	November L	December E	December L	January E	January L	Total[b] E	Total[b] L
0- 10		2.1[c]	10.8[c]	3.3[c]	15.7[c]	-	1.3	-	-	-	-	5.2	27.4[c]
11- 100	N	2.5	1.8	6.6	10.8	1.2	-	-	-	-	-	10.8	12.2
	S	1.7	-	0.8	3.1	0.4	-	-	-	-	-	2.8	3.8
101- 600	N	0.8	-	3.7	1.8	1.2	0.9	-	-	-	-	5.6	2.5
	S	0.8	-	3.3	2.2	4.1	4.0	2.1	1.3	0.4	-	11.6	7.2
601-1100	S	-	-	2.9	1.3	14.5	11.7	7.0	3.1	0.4	0.4	25.1[c]	16.5
1101-1600	S	-	-	0.4	-	15.3	11.7	11.2	5.8	6.2	3.1	32.3[c]	21.9
1601-2100	S	-	-	-	-	3.7	5.4	1.7	2.7	1.7	0.9	6.8	8.4
Total[d]		7.9	12.6	21.1	35.0[c]	40.5	35.0	21.9[c]	13.0	8.7	4.5	100	100

[a]Early-hatched: 12 May-8 June; late-hatched: 30 June-11 August.

[b]Sample for distance: 251 early-hatched and 237 late-hatched.

[c]Proportions significantly different at 0.05% level.

[d]Sample for months: 242 for early-hatched and 223 for late-hatched.

Table 23. Percentage distribution[a] of direct recoveries of early- and late-hatched Mallards by country and flyway, 1954-1959 combined.

	Early-hatched		Late-hatched	
Canada	28.3%		47.3%	
United States	71.7		52.7	
Pacific Flyway		8.8		3.8
Central "		27.9		23.6
Mississippi "		33.5		24.5
Atlantic "		0.8		0.8
Mexico	0.8		-	
Sample	251		237	

[a]Unadjusted data.

Table 24. Percentage distribution of direct recoveries from Marengo Slough and the entire banding block, 1954, 1956, 1957 and 1958 combined.

	Canada	Pacific	Central	Mississippi	Atlantic
Marengo Slough (87 recoveries)	39.1%	4.6%	28.7%	26.4%	1.1%
51° x 109° (893 recoveries)	33.8	6.5	26.6	32.0	1.0

Table 25. Direct recoveries showing dispersal of adult females from individual sloughs.

Banding data			Recovery data	
Status	Locality	Date	Date	Locality
A. With young	Alsask	16 July 1958	13 Oct.	At banding slough
			13 Oct.	160 mi. northeast
B. Moulting	Hoosier	22 July 1957	1 Dec.	Washington
			5 Dec.	Illinois
C. Moulting	Beaufield	21 July 1958	17 Nov.	Mississippi
			18 Nov.	Minnesota
			19 Nov.	California
D. Moulting	Flaxcombe	25 July 1958	11 Nov.	Louisiana
			11 Nov.	California
			6 Dec.	Nebraska
			7 Dec.	Oregon

Table 26. Distribution of direct recoveries from individual broods.

Brood	Brood size	Sex	Date	Place	Distance (miles)	Direction from banding site	Flying date
A	7[a]	M	12 Sept. 1956	Alberta	14	NW	17 Aug.±
		F	Dec. 1956	Oklahoma	1360	152°	"
		M	26-30 Dec.1956	Oregon	610	229°	"
B	7[a]	M	1-7 Jan. 1957	Arkansas	1480	139°	31 July±
		F	Fall 1956	California	1080	216°	"
C	4[a]	F	6 Dec. 1956	Florida	2010	138°	6 Aug.±
		M	23 Dec. 1956	Louisiana	1680	147°	"
D	4[a]	M	12 Oct. 1956	Saskatchewan	Banding	slough?	4 Oct.±
		M	12 Oct. 1956	Saskatchewan	"	"	"
		F	8 Dec. 1956	Oregon	550	222°	"
E	7	M	24 Sept. 1956	Saskatchewan	Banding	slough?	10 Sept.±
		M	24 Sept. 1956	Saskatchewan	"	"	"

[a]Assumed to be a brood (see text, page 37).

Table 27. Percentage distribution (unadjusted) of direct and indirect recoveries in successive fall migrations by country and flyway.

Recoveries:	Direct	Indirect							
Migration:	1st	Ave.	2nd	3rd	4th	5th	6th	7th	8th
Years:	54-59	55-63	55-60	56-61	57-62	58-63	59-63	60-63	61-63
Area									
Canada	35.7	20.5	19.8	19.4	15.1	25.0	50.0	26.7	25.0
United States	64.1	79.5	80.2	80.6	84.9	75.0	50.0	73.3	75.0
Mexico	0.2	-	-	-	-	-	-	-	-
Flyways									
Pacific	5.9	10.5	7.0	11.8	18.6	15.6	-	26.7	25.0
Central	26.0	34.3	35.4	33.3	37.2	20.1	20.0	40.0	25.0
Mississippi	31.6	33.9	37.5	33.3	27.9	31.3	30.0	6.7	25.0
Atlantic	0.6	0.8	0.3	2.1	1.2	-	-	-	-
Sample	1018	629	328	144	86	32	20	15	4

Table 28. Percentage distribution of direct and indirect recoveries by province and state, all years combined.

	First migration		Subsequent migrations	
Area	Per cent	Rank	Per cent	Rank
Saskatchewan	26.9	1	9.7	4
Arkansas	11.7	2	14.0	1
Alberta	8.7	3	9.5	2
Nebraska	6.1	4	8.9	3
Louisiana	5.7	5	4.1	7
Missouri	4.7	6	4.0	9
Texas	4.0	7	4.1	7
Montana	3.8	8	2.1[a]	17
Kansas	3.6	9	4.5	6
South Dakota	3.3	10	5.2	5
Illinois	2.3[a]	11	4.0	9
Total	78.5		68.0	
Sample	1018		629	

[a]Omitted from total.

Table 29. Percentage distribution of direct and indirect recoveries by 5° segments of latitude, all years combined.

Latitude:	North of 54°	49°-54°	44°-49°	39°-44°	34°-39°	29°-34°	25°-29°	Sample
Direct	0.4	35.3	9.2	21.3	20.5	12.9	0.4	1018
Indirect	1.1	19.4	14.8	28.7	26.8	9.1	0.3	628[a]

[a]One record could not be assigned to a specific degree of latitude.

Table 30. Percentage distribution of direct and indirect recoveries by country and flyway, 1956, 1957 and 1958.

	1956			1957			1958		
	Direct	Indirect		Direct	Indirect		Direct	Indirect	
	A	B	C	A	B	C	A	B	C
Canada	26.6	17.6	10.7	38.6	23.2	20.3	34.0	19.0	20.1
United States	68.9	82.3	89.3	61.4	76.8	79.7	65.7	81.0	79.9
Mexico	0.5	-	-	-	-	-	0.3	-	-
Flyways									
Pacific	6.9	13.4	14.3	5.7	9.9	10.8	5.3	8.5	6.0
Central	23.4	31.9	46.4	29.3	35.0	35.1	25.7	35.3	32.6
Mississippi	41.4	36.1	25.0	26.4	31.2	33.8	34.0	36.6	40.8
Atlantic	1.1	0.8	3.6	-	0.8	-	0.7	0.7	0.5
Sample	188	119	28	352	263	74	303	153	184

A Recoveries during first migration for young Mallards banded in column year.

B Includes all indirect (adult) recoveries from the same cohort as the direct recoveries.

C Includes all indirect recoveries in the column year, all cohorts combined.

Table 31. Percentage distribution by sex of recoveries of young Mallards on their first and subsequent migrations and of adults on their first migration by country and flyway.

	Males					Females				
Recovery:	Dir.	Indir.	Dir.	Indir.	Dir.	Dir.	Indir.	Dir.	Indir.	Dir.
Period:	1954-1959	1955-1963	1958	1958	1958	1954-1959	1955-1963	1954-1958	1955-1958	1954-1958
Recovery age:	Young	Adult	Young	Adult	Adult	Young	Adult	Young	Adult	Adult
Canada	38.4[a]	18.8	36.5[a]	21.1	12.5	32.4[a]	22.9	30.6[a]	20.7	20.8
U. S. A.	61.6	81.2[a]	63.5	78.9[a]	87.5	67.2	77.1[a]	68.9	79.3[a]	79.2
Mexico	-	-	-	-	-	0.4	-	0.5	-	-
Flyways										
Pacific	6.0	9.5[a]	6.5	5.5	13.6[a]	5.8	12.2[a]	6.1	11.7[a]	18.9
Central	25.3	36.2[a]	24.1	32.1	37.5	26.9	30.6	27.9	31.5	22.6
Mississippi	29.9	34.7	32.9	41.3	36.4	33.7	33.5	34.2	35.1	37.7
Atlantic	0.4	0.8	0	0	0	0.9	0.8	0.7	0.9	0
Sample	549	380	170	109	88	469	249	442	111	53

[a]Difference is statisically significant at 0.05 level; designation is on higher of two adjacent comparable values.

Table 32. Percentage distribution of direct and indirect recoveries by month, country and flyway, all years combined.

	September		October		November		December		January	
Area	Dir.	Indir.	Dir.	Indir.	Dir.	Indir.	Dir.	Indir.	Dir.	Indir.
Canada	8.7	6.1	23.6	10.9	3.6	2.1	-	-	-	-
U. S. A.	-	-	3.4	11.9	33.7	37.1	19.6	23.6	7.1	8.2
Mexico	-	-	-	-	-	-	0.1	-	0.1	-
Total	8.7	6.1	27.0	22.8	37.3	39.2	19.7	23.6	7.2	8.2
Flyways										
Pacific	-	-	0.1	1.1	2.1	3.2	2.8	4.4	0.6	1.8
Central	-	-	3.3	7.5	15.5	19.1	6.4	6.5	1.0	1.8
Mississippi	-	-	0.6	3.3	15.7	14.9	10.3	12.3	5.4	4.4
Atlantic	-	-	-	-	0.4	-	0.1	0.2	0.1	0.4
Sample	85	35	265	130	366	223	193	135	71	47

Total recoveries: direct 980; indirect 571.

Table 33. Comparison of frequency of first and subsequent migrations and recoveries by degree blocks. Maximum of six first migrations.

		No. migrations			No. of recoveries				Percentage of recoveries	
					Direct		Indirect			
Block	Location	1st	Subsequent	Ave.	Total	Ave.	Total	Ave.	Dir.	Indir.
52°x109°	Sask.	6	2		33		8			
51x109	"	6	6		188		19			
51x108	"	6	1	3.4	18	62.8	3	14.8	30.7	11.8
51x110	Alta.	6	3		21		4			
34x 91	Ark.	6	5		54		40			
40x 95	Nebr.-Ia.-Mo.	5	3		15		7			
39x 90	Ill.-Mo.	5	1		9		3			
35x 91	Ark.	5	3	2.2	11	15.2	9	8.2	7.5	6.5
35x 90	Ark.	5	3		26		20			
30x 92	La.	5	1		15		2			
16 Blocks		4	-	2.2	107	6.7	66	4.1	10.5	10.5
26 "		3	-	1.7	134	5.2	78	3.0	12.9	12.4
70 "		2	-	1.0	183	2.6	102	1.5	18.5	16.2
169 "		1	-	0.6	204	1.2	130	0.8	19.9	20.7
102 "		0	-	1.2	0	0	137	1.3	-	21.8

Table 34. Relationship of frequency of migration to direct and indirect recoveries. Maximum of eight migrations.

		Migrations			Recoveries				Percentage of recoveries	
			First		Indirect		Direct			
Block	Location	Total	Total	Ave.	Total	Ave.	Total	Ave.	Dir.	Indir.
51°x109°	Sask.	7	6		19		188		18.5	3.0
53x113	Alta.	6	3)		9)		5)			
53x112	"	6	3)	4.0	13)	20.7	10)	23.0	6.8	9.9
34x 91	Ark.	6	6)		40)		54)			
43x117	Ore.	5	1)		4)		2)			
40x104	Colo.	5	2)		4)		5)			
40x 98	Nebr.	5	4)	2.4	5)	5.2	5)	3.6	1.8	4.1
40x 90	Ill.	5	2)		7)		3)			
32x 92	La.	5	3)		6)		3)			
22 Blocks		4	22	1.0	142	6.5	153	7.0	15.0	22.6
50 "		3	48	1.0	144	2.9	174	3.7	17.1	22.9
94 "		2	81	0.9	138	1.4	204	2.2	20.0	22.0
218 "		1	131	0.6	97	0.4	212	1.0	20.8	15.4

Table 35. Direct recovery rates of three- and seven-week-old Mallards banded in three periods from 1956 through 1959.

	Approx. age in weeks	Banding period: Before 14 July	14 July to 3 August	After 3 August	Total
Per cent recovered	3	6.0	8.2	6.9	6.9
	7	10.2	8.6	8.8	8.8
Number banded	3	1021	793	390	2204
	7	98	1191	696	1985

Table 36. Mortality rates of early- and late-hatched[a] Mallards based on hunting recoveries beginning 1 September.

A: Early-hatched

Year banded	Number banded	Recoveries in years following banding 0-1	1-2	2-3	3-4	4-5	5-6	6-7	7-8	Total shot	First interval mortality of each banded cohort 0-4	0-7
1954	22	1	1	-	-	-	-	-	1	3	50.00	33.33
1955	231	18	10	2	2	-	1	-	-	33	56.25	54.55
1956	410	47	17	13	2	3	-	1	-	83	57.32	56.63
1957	1547	120	49	22	22	1	2	5	x	221	56.07	-
1958	790	62	21	13	5	0	1	x	x	102	61.38	-
1959	79	3	1	1	-	-	x	x	x	5	60.00	-
Totals	3079	251	99	51	31	4	4	6	1	447	57.57	55.46
Number eligible:		of 3079	of 3079	of 3079	of 3079	of 3079	of 3000	of 2210	of 663			
Per cent of bands recovered		8.15	3.22	1.66	1.01	0.13	0.13	0.27	0.15	14.72		
Mortality rate:		55.37	49.03	49.58	59.81	19.09	23.59	64.21	100.00			

Mean (1-2 through 4-5): 48.05 per cent

B: Late-hatched

Year banded	Number banded	0-1	1-2	2-3	3-4	4-5	5-6	6-7	7-8	Total shot	0-4	0-7
1954	157	11	1	0	6	1	-	-	-	19	57.89	57.89
1955	163	16	5	3	0	-	-	-	-	24	66.67	66.67
1956	552	58	14	8	8	3	-	1	2	94	63.74	61.70
1957	530	37	9	4	-	-	-	1	x	51	74.00	-
1958	1085	75	20	7	3	4	3	x	x	112	68.81	-
1959	518	23	8	2	2	1	x	x	x	36	63.89	-
Totals	3005	220	57	24	19	9	3	2	2	336	66.87	63.43
Number eligible:		of 3005	of 3005	of 3005	of 3005	of 3005	of 2487	of 1402	of 872			
Per cent of bands recovered		7.32	1.90	0.80	0.63	0.30	0.12	0.14	0.23	11.44		
Mortality rate:		63.99	46.12	36.03	44.40	37.97	24.53	37.77	100.00			

Mean (1-2 through 4-5): 42.75 per cent

[a]Early-hatched before 9 June; late-hatched after 29 June.

Table 37. Proportion of total mortality attributable to hunting in the 0-1 age interval for early- and late-hatched Mallards.

	Total mortality	Direct recovery rate	Hunting mortality[a]	Hunting Proportion
Early-hatched	55.37%	8.15%	24.45%	44%
Late-hatched	63.99%	7.32%	21.96%	35%

[a]Adjusted for reporting rate and crippling loss.

Table 38. Life table for Mallards banded as flightless young at Kindersley, Saskatchewan.

A: Dynamic method

Age interval (starts 1 Sept.)	Actual number of hunting recoveries	Corrected number of hunting recoveries[a]	Number dying in age group out of 1000 at the start of first interval	Number surviving at beginning of each interval out of 1000	Age composition of a population at start of interval	Mortality rate per 1000 alive at beginning of interval	Expectation of further life to those attaining the interval (in years)
0-1	1018	1018	609	1000	548	609	1.5
1-2	328	328	196	391	214	501	1.6
2-3	144	144	86	195	107	441	1.6
3-4	86	86	52	109	60	477	1.5
4-5	32	32	19	57	31	333	1.4
5-6	20	22	13	38	21	342	1.1
6-7	15	24	15	25	14	600	0.8
7-8	4	17	10	10	5	1000	0.5
Total	1647	1671	1000	1825	1000	-	

B. Relative recovery rate method

	Number of recoveries during each period											
Years	2-8	1-8	3-8	2-8	4-8	3-8	5-8	4-8	6-8	5-8	7-8	6-8
Recoveries	629	1647	301	629	157	301	71	157	39	71	19	39
Birds eligible	12962		12962		12962		12962		11857	12962	8015	11857
Rec. rate	.485	1.27	.232	.485	.121	.232	.055	.121	.033	.055	.024	.033
Mort. rate	38.19		47.84		52.16		45.45		60.00		72.73	

[a]Recoveries added to last three age intervals because of incomplete data for birds banded from 1957 through 1959. Additions are proportionate to recovery rates for these three intervals from 1954 through 1956.

Table 39. Mortality rates of wild, normal Mallards from various sources.

Banding data				Recovery data				Mortality rate		
Age	Sex	Locality	Period	Starting date	Max. inter-vals	Method	No.	0-1	Mean Ad.	Source
Flightless young	M	Kindersley, Sask.	June-Aug. 1954-1959	1 Sept.	8	Shot	930	58	48	Present study
" "	F	" "	" "	"	8	"	717	64	47	" "
" "	M&F	Finland	Summer ?	?	6+	?	133	83	50	Koskimies, 1956[a]
Flying young	M	Illinois	Su-Fall 1939-1944	1 Sept.	8	Shot[b]	2361[c]	55	44	Bellrose & Chase, 1950[a]
" "	M	New Zealand	Jan.-Mar. 1949-1955	1 May	7	Shot	362	66	51	Balham & Miers, 1959[a]
Young	M&F	Alaska-Ore.-Mich.	To 1 Sept. to 1939	1 Sept.	10	"	163	68	50	Hickey, 1952[a]
"	M&F	Wisconsin	July-Sept. 1949-1953	?	7	"	222	75	58	Hunt *et al.*, 1958
"	M&F	Manitoba	July-Oct. 1938-1950	1 Sept.	13	Shot?	381	70	-	Brakhage, 1953
"	M&F	England	May-Aug. to 1946	?	11	Shot[b]	271	88	58	Höhn, 1948[a]
Adults	M	Illinois	Su-Fall 1939-1944	1 Sept.	8	Shot[b]	3245[c]	36	40	Bellrose & Chase, 1950[a]
"	M	New Zealand	Jan.-Mar. 1949-1955	1 May	7	Shot	165	48	51	Balham & Miers, 1959[a]
"	M&F	England	? to 1946	?	11	Shot[b]	305	65	65	Höhn, 1948[a]
Unaged	M&F	Mo. & Ill.	? 1922-1928	1 Sept.	17	Shot[b]	1230	-	47	Hickey, 1952[a]
"	F	Illinois	Su-Fall 1939-1944	1 Sept.	8	Shot[b]	1609[c]	46	48	Bellrose & Chase, 1950[a]
"	M	B.C.-Oregon	? 1926-1935	1 Sept.	17	Shot	1762	-	49	Hickey, 1952[a]
"	M&F	Washington	Preseason, 1947-1954	?	5+	Shot	844	73	56	Lauckhart, 1956
"	F	New Zealand	Jan.-Mar. 1948-1955	1 May	8	"	361	60	56	Balham & Miers, 1959[a]

[a]At least partly recalculated.
[b]Mostly shot; Illinois data includes birds found dead.
[c]Adjusted for birds being available during different portions of hunting season.
[d]Hickey, 1952 (p. 67): hunting season began 1 August.

Table 40. Differential vulnerability between adult and young Mallards.

	Fraction reported[a]	Adults[b]		Young[b]	
		Unadjusted	Adjusted	Unadjusted	Adjusted
Canada	.511	22	43	198	387
Pacific	.608	22	36	38	63
Central	.506	45	89	165	326
Mississippi	.421	52	124	208	494
Atlantic	.549	0	0	3	5
Total U. S.		119	249	414	888
Total N. A.		141	292	612	1275
Number banded		2156		7768	

Recovery rates adjusted for nonreporting:

Area	Adult	Young	Differential vulnerability (adult:young)
United States	11.55%	11.43%	1.01:1.00
Canada	1.99	4.98	1.00:2.50
North America	13.54	16.41	1.00:1.21

[a]From Bellrose (1955) and Geis and Atwood (1961).

[b]Males for both adult and young were banded in 1958; females from 1954 through 1958.

Table 41. Mortality rates of male and female Mallards calculated by dynamic method.

Age interval:	0-1	1-2	2-3	3-4	4-5	5-6	6-7	7-8	Total
A: Males									
No. recoveries	549	199	83	59	18	10	10	2	930
No. banded (eligible)	6523	6523	6523	6523	6523	5989	4059	1532	
Per cent recovered	8.42	3.05	1.27	0.90	0.28	0.17	0.25	0.13	14.47
Mortality rate	58.2	50.4	42.3	52.0	33.8	30.8	65.8	100	
B: Females									
No. recoveries	469	129	61	27	14	10	5	2	717
No. banded	6408	6408	6408	6408	6408	5838	3937	1490	
Per cent recovered	7.32	2.01	0.95	0.42	0.22	0.17	0.13	0.13	11.35
Mortality rate	64.5	49.9	47.0	39.2	33.8	39.6	50.2	100	

Table 42. Temporal distribution of mortality among Kindersley Mallards.

Stage of development	Approximate date	Number survivors	Per cent mortality	Cumulative mortality	Source
Eggs laid	15 May	10,000	36	-	Dzubin (in press)
Eggs hatched	15 June	6,400	54	36	" "
Young at 10 days	25 June	2,944	47	71	" "
Young at flying (56 days)	17 August and 1 September	1,560	61	84	Present study
Flying young and adult	2nd 1 September	608	47	94	" "
Adults	3rd 1 September	322	47	97	" "
Adults	4th 1 September	171	47	98	" "
Adults	5th 1 September	91	47	99	" "