POPULATION ECOLOGY OF THE MALLARD

VIII. Winter Distribution Patterns and Survival Rates of Winter-Banded Mallards

UNITED STATES DEPARTMENT OF THE INTERIOR
FISH AND WILDLIFE SERVICE / *RESOURCE PUBLICATION* 162

Resource Publications

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Library of Congress Cataloging-in-Publication Data
(Revised for vol. 8)

Population ecology of the mallard.

(v. 1–3: Resource publication of the Bureau of Sport Fisheries and Wildlife ; 105, 115, 119) (v. 4– : Resource publication of the Fish and Wildlife Service)
Beginning with v. 4 issued by the U.S. Fish and Wildlife Service.
Includes bibliographies.
Supt. of Docs. no. : I 49.66:105
Contents: v. 1. Anderson, D.R. and Henny, C.J. A review of previous studies and the distribution and migration from breeding areas—v. 2. Pospahala, R.S., Anderson, D.R., and Henny, C.J. Breeding habitat conditions, size of the breeding populations, and production indices — [etc.]—v. 8 Nichols, N.J. and Hines, J.E. Winter distribution patterns and survival rates of winter-banded mallards.
1. Mallard—Ecology—Collected works. 2. Bird populations—North America—Collected works. 3. Waterfowl management—North America—Collected works. 4. Birds—Ecology—Collected works. 5. Birds—North America—Ecology—Collected works. I. Anderson, David Raymond, 1942- . II. Resource publication (United States. Bureau of Sport Fisheries and Wildlife) ; 105, etc. III. Resource publication (U.S. Fish and Wildlife Service) ; 125, etc. IV. Series.
S914.A3 no. 105, etc 333.95'4'0973 s 72-603502
[QL696.A52] [639.9'7841]

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UNITED STATES DEPARTMENT OF THE INTERIOR
FISH AND WILDLIFE SERVICE
Resource Publication 162
Washington, D.C. • 1987

Contents

Page

Abstract . . . 1
Terminology and Definitions . . . 3
Sources of Data . . . 5
General Methods . . . 5
  Reference Area Delineation . . . 5
  Recovery Distribution Tests . . . 5
  Survival and Recovery Rate Estimation . . . 5
Reference Areas . . . 6
  Northwestern Pacific Flyway (20) . . . 6
  Central California (21) . . . 10
  Northeastern Pacific Flyway (22) . . . 10
  Southern Pacific Flyway (23) . . . 12
  Northern High Plains (24) . . . 13
  Central High Plains (25) . . . 13
  Southern High Plains (26) . . . 16
  Northern Low Plains (27) . . . 17
  Southern Low Plains (28) . . . 18
  Northwestern Mississippi Flyway (29) . . . 21
  Southern Mississippi Flyway (30) . . . 22
  Southern Lake States–Ohio River Valley (31) . . . 27
  Northeastern Atlantic Flyway (32) . . . 28
  Mid-Atlantic Flyway (33) . . . 29
  Southern Atlantic Flyway (34) . . . 31
Sources of Variation in Winter Distribution Patterns . . . 33
  Sex- and Age-specific Variation . . . 33
  Short-term Temporal Variation . . . 38
  Long-term Temporal Variation . . . 43
Sources of Variation in Survival and Recovery Rates . . . 46
  Age-specific Variation . . . 47
  Sex-specific Variation . . . 51
  Temporal Variation . . . 59
  Geographic Variation . . . 60
Comparison of Survival Estimates from Winter Versus Preseason Banding Data . . . 73
  Background . . . 73
  Methodology . . . 74
  Results and Discussion . . . 74
Summary . . . 75
Acknowledgments . . . 76
References . . . 77
Appendix A. Band Recovery Distributions of Winter-Banded Mallards . . . 85
Appendix B. Survival and Recovery Rate Estimates from Winter Banding Data . . . 126
Appendix C. Persons and Agencies That Have Banded More Than 1,000 Normal, Wild Mallards During the Winter Banding Period, 1922–1982 . . . 152

Population Ecology of the Mallard VIII. Winter Distribution Patterns and Survival Rates of Winter-Banded Mallards

by

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Abstract

In the present report we address questions about winter distribution patterns and survival rates of North American mallards, *Anas platyrhynchos.* Inferences are based on analyses of banding and recovery data from both winter and preseason banding periods. The primary wintering range of the mallard was divided into 45 minor reference areas and 15 major reference areas which were used to summarize winter banding data. Descriptive tables and figures on the recovery distributions of winter-banded mallards are presented.

Using winter recoveries of preseason-banded mallards, we found apparent differences between recovery distributions of young versus adult birds from the same breeding ground reference areas. However, we found no sex-specific differences in winter recovery distribution patterns. Winter recovery distributions of preseason-banded birds also provided evidence that mallards exhibited some degree of year-to-year variation in wintering ground location. The age- and sex-specificity of such variation was tested using winter recoveries of winter-banded birds, and results indicated that subadult (first year) birds were less likely to return to the same wintering grounds the following year than adults. Winter recovery distributions of preseason-banded mallards during 1950–58 differed from distributions in 1966–76. These differences could have resulted from either true distributional shifts or geographic changes in hunting pressure.

Survival and recovery rates were estimated from winter banding data. We found no evidence of differences in survival or recovery rates between subadult and adult mallards. Thus, the substantial difference between survival rates of preseason-banded young and adult mallards must result almost entirely from higher mortality of young birds during the approximate period, August–January. Male mallards showed higher survival rates than females, corroborating inferences based on preseason data. Tests with winter banding and band recovery data indicated some degree of year-to-year variation in both survival and recovery rates, a result again consistent with inferences from preseason data. Some evidence indicated geographic variation in survival rates; however, there were no consistent directional differences between survival rates of mallards from adjacent northern versus southern areas, or eastern versus western areas. In some comparisons, Central Flyway mallards exhibited slightly higher survival rates than mallards from other flyways.

Weighted mean estimates of continental survival rates were computed for the period 1960–77 from both winter banding data and preseason bandings of adults. Resulting estimates differed significantly for males, but not for females, and the magnitude of the difference between point estimates was relatively small, even for males. The direction of the difference between these estimates was predicted correctly from previous work on the effects of heterogeneous survival and recovery rates on band recovery model estimates. The similarity of survival estimates from these two independent data sets supports the belief that biases in these estimates are relatively small.

The Fish and Wildlife Service, in cooperation with the Canadian Wildlife Service, various State and Provincial wildlife and conservation departments, and private individuals, coordinates a number of extensive data collection programs directed at North American waterfowl populations. These programs were initiated as early as the 1920's (large-scale banding of mallards) and 1930's (annual winter surveys), and the most recent (Waterfowl Parts Collection Survey) became fully operational in 1961 (*see* Anderson and Henny 1972 for a history of these programs and Martin et al. 1979 for a recent description of them). Data resulting from these programs are used annually to assess population status and to guide decisions about management actions (e.g., setting annual hunting regulations). When such data are accumulated for a number of years, they can also be used to begin to address questions about the dynamics of waterfowl populations and the factors associated with variation in population parameters.

In the late 1960's researchers at the Fish and Wildlife Service Migratory Bird Populations Station in Laurel, Maryland, began work on a set of extensive analyses using the data which had been accumulated for the North American mallard, *Anas platyrhynchos*. The team of researchers, led by David R. Anderson, set seven objectives for their analyses (Anderson and Henny 1972). These objectives incorporated a number of different questions which required analysis of several different data bases. One of the reports relied heavily on data from the May Breeding Ground Survey and the July Production Survey (Pospahala et al. 1974), one relied primarily on data from the Waterfowl Harvest Survey, the Parts Collection Survey, and the Hunter Performance Survey (Martin and Carney 1977), and four relied on data from preseason bandings and band recoveries (Anderson and Henny 1972; Anderson 1975; Anderson and Burnham 1976; Munro and Kimball 1982). The only extensive data base on North American mallards that has not been analyzed in these seven reports is the information on winter or postseason bandings and band recoveries. These data form the basis for much of the present report. Other workers have used portions of the data reported here to examine recovery distributions, survival rates, and recovery rates of mallards banded during winter in selected geographic areas or time periods (Martinson 1966; Merrill 1967; Drewien 1968; Geis et al. 1969; Geis 1971; Funk et al. 1971; Hopper et al. 1978; Hyland and Gabig 1980; Rakestraw 1981).

We had four general objectives for our analyses and these correspond to four major sections of this report. The first objective was to develop a set of winter reference areas and to present descriptive data on band recovery distributions for mallards banded in these areas. Banding analyses based on data from individual banding stations are simply not practical (Anderson and Henny 1972), and it is necessary to delineate reference areas for use in summarizing banding data. These reference areas should be delineated so that birds banded within them exhibit similar band recovery distributions (and, by inference, movement patterns) and demographic characteristics (e.g., survival and recovery rates). Descriptive data on band recovery distributions of birds banded in these areas provide a good general picture of migration pathways, breeding grounds, and possible alternative wintering locations associated with the wintering ground reference areas.

The second objective was to draw inferences about certain potential sources of variation in winter distribution patterns of mallards. Specifically, we used tests with band recovery distributions to address hypotheses about age- and sex-specific variation, year-to-year variation and long-term temporal variation in winter distribution patterns of mallards.

The third objective was to estimate survival and recovery rates of winter-banded mallards and to investigate potential sources of variation in these rates. Hypotheses about sex-specific variation and temporal variation in these rates have previously been addressed using preseason banding and associated recovery data (Anderson 1975). We tested these same hypotheses using winter banding data in order to check the consistency of the results from these two independent data sources and to help us select the appropriate band recovery models and age-sex groupings to use in our other analyses. We also tested hypotheses about age-specific and geographic variation in survival and recovery rates that permit inferences unique to winter banding data.

The fourth objective was much more specific than the others and involved a comparison of survival rate estimates based on preseason and winter banding data. Work on animal population dynamics rarely permits the estimation of the same parameter using two extensive, but completely independent, data bases. We thus obtained continental estimates of mallard survival rates using both preseason and winter banding data and tested the hypothesis of no difference.

Finally, we note that while results associated with these four objectives provide ample material for this report, we have certainly not exhausted the questions that can and should be addressed using winter banding data. Despite recent interest, there remain outstanding questions concerning the ecology of waterfowl on the wintering grounds (Anderson and Batt 1983), and several of these can be addressed with winter banding data. As indicated previously, four of the seven reports in this series have used preseason banding and recovery data as their principal data source, and we have not attempted to duplicate all of these analyses using winter banding data. For example, although we present descriptive data on band recovery distributions and address questions about winter distribution patterns, we do not attempt an analysis of the distribution and derivation of the mallard harvest based on winter bandings, as was done with preseason data by Munro and Kimball (1982).

Analyses associated with the second and third objectives of our report led to inferences that both winter distribution patterns and survival rates of winter-banded mallards exhibited some degree of variation from year to year. Some of the most interesting questions in animal population ecology involve the investigation of environmental and other factors that may be associated with such yearly variation. For example, survival rates estimated from preseason banding data have been used to test hypotheses about whether variation in mallard survival is associated with variation in harvest rates (Anderson and Burnham 1976; Rogers et al. 1979; Anderson et al. 1982; Nichols and Hines 1983; Burnham and Anderson 1984; Burnham et al. 1984), population size (Anderson 1975), brood size (Anderson 1975), and several environmental variables (Anderson 1975; Nichols et al. 1982*a*). We are continuing this type of work using both preseason and winter banding data. We have also investigated factors associated with temporal variation in winter distribution patterns (Nichols et al. 1983).

Terminology and Definitions

The following terminology and definitions are not claimed to represent any sort of consensus among waterfowl biologists. Instead, they are "operational" in nature and apply strictly to this report.

Age at banding:

Preseason banding.

Adult—a bird known to have hatched before the calendar year of banding.

Young—a bird known to have hatched in the calendar year of banding. This category includes birds in the "juvenile," "local," and "immature" categories of Anderson and Henny (1972).

Winter banding.

Adult—a bird known to have hatched during some reproductive season prior to the most recent one and, thus, to have been exposed to two or more hunting seasons (i.e., a bird greater than 1 year old).

Subadult—a bird known to have hatched during the most recent reproductive season and, thus, to have been exposed only to its first hunting season (i.e., a bird less than 1 year old).

Banding period:

Preseason banding period—1 July through 30 September.

Winter (postseason) banding period—1 January through 28 (or 29) February. In some areas of the United States, relatively large numbers of mallards are banded during December. We restricted our analyses to January-February birds because the band recovery models used to estimate survival rates assume that banding takes place over a time period which is short, relative to the interval over which survival rate is to be estimated (Brownie et al. 1978). Mortality during the banding period is undesirable when using these models, and the winter has been hypothesized to be a period of possible high mallard mortality. Therefore, we were conservative and chose to restrict our analyses to the two months of greatest winter banding activity. This choice is also consistent with earlier continental analyses of winter-banded mallards (Geis 1971).

Hunting season (year *t*)—1 September (year *t*) through 15 February (year *t*+1). Except for some specific analyses using the winter recovery period, all analyses and tabulations in this report are based on recoveries occurring during the entire hunting season.

Hunting season shot (HSS) code—the number of the hunting season in which a bird is shot, where complete hunting seasons are numbered consecutively from the time of banding. A bird banded during either the winter or preseason banding period of year *t* and recovered in the hunting season of year *t*, is denoted HSS–1. A bird banded during either banding period in year *t* and recovered in the hunting season of year *t*+1, is denoted HSS–2. A bird banded during winter in year *t* and recovered later that same winter (i.e., in the hunting season of year *t*–1) is not recovered in its first complete hunting season and thus is denoted HSS–0.

Recovery—a banded bird reported to the Fish and Wildlife Service Bird Banding Laboratory (BBL) as shot or found dead.

Direct recovery—a banded bird recovered in the first complete hunting season after banding (HSS–1). Note that a bird banded in early January of year *t* and recovered later in that same month (January of year *t*) is not recovered in the first complete hunting season after banding (the first complete hunting season would extend from 1 September of year *t* until 15 February of year *t*+1). Such a recovery would be designated as HSS–0 and not considered a direct recovery. The hunting season of year *t* is considered to be the first complete hunting season for birds banded preseason in year *t*, regardless of the exact date of banding (e.g., even if banding occurs on 30 September).

Indirect recovery—a banded bird recovered in any hunting season following the first complete hunting season after banding (HSS–2, HSS–3,. . . HSS–N).

Recovery rate—the probability that a banded bird alive in the banding period of year *t*, will be shot or found dead during the hunting season of year *t* and its band reported to the BBL. Recovery rates of birds banded preseason are closely associated with the probability that a bird will be shot during the hunting season, given that it is alive at the beginning of the season (Henny and Burnham 1976). Recovery rates of birds banded preseason thus provide useful indices of harvest rates (Anderson 1975) and hunting intensity. In previous work, recovery rates of winter-banded birds have often been assumed to index harvest rates and hunting intensity also. However, recovery rates of winter-banded birds can be thought of as the product of two probabilities: the probability that (1) a banded bird alive during the winter banding period (January–February) of year *t* will survive until the beginning of the next hunting season (i.e., until 1 September, year *t*) and (2) a bird will be shot or found dead during that hunting season and its band reported to BBL, given that it is alive at the beginning of the season. Because of this substantial survival component, recovery rates from winter-banded birds are not very useful as indices of harvest rate or hunting intensity (*see* related discussions in Nichols et al. 1982*b*; Conroy and Eberhardt 1983).

Reference area—geographic areas used for summarizing banding and band recovery data. These areas represent groups of banding stations whose banded samples exhibit similar recovery distribution patterns. Preseason or breeding ground reference areas were developed and described by Anderson and Henny (1972). Winter reference areas were developed by us for use in this report.

Survival rate—the probability that a bird alive at the approximate midpoint of the banding period in year *t* will survive until the midpoint of the banding period in year *t*+1. Survival rate estimates for preseason-banded birds thus apply to the period 15 August, year *t*, to 15 August, year *t*+1. Estimates for winter-banded birds relate to the period 30 January, year *t*, to 30 January, year *t*+1.

Winter recovery period—1 December through 28 (or 29) February. This recovery period is used only to address specific questions about winter distribution patterns. It is not used in the estimation of survival and recovery rates.

Sources of Data

We used banding and recovery records of "normal wild" mallards banded during the preseason and winter periods, 1914–1977. Recovery records were further restricted to birds shot or found dead during the hunting season, 1914–1978. We used 1,087,171 preseason bandings and 180,739 associated recoveries. Most of our analyses using winter banding data were restricted to 874,493 bandings and 120,426 recoveries.

Winter Survey (in the text we indicate this survey with capitalization to distinguish it from other winter counts or estimates) data are used descriptively to provide a general indication of mallard abundance in wintering areas throughout the United States. This survey was initiated in 1933 and is now conducted each January by Fish and Wildlife Service personnel, assisted in the United States by State conservation departments and private individuals. In Canada, assistance is provided by the Canadian Wildlife Service, and in Mexico by the Direccion General de la Fauna Silvestre. Winter Survey results are published in the annual U.S. Fish and Wildlife Service Waterfowl Status Reports (e.g., Voelzer et al. 1982).

General Methods

Reference Area Delineation

The grouping together of banding stations to form winter reference areas was accomplished by using methods similar to those described by Anderson and Henny (1972) for preseason reference areas. We prepared more than 300 work maps showing the distribution of recoveries, by degree block, for each degree block in which mallards were banded during winter, 1950–1977. We then studied these degree block recovery distribution maps for similarities and differences and, mainly on the basis of this work, we constructed initial groupings of degree blocks. In some instances, we consulted the preseason recovery distribution maps of Anderson and Henny (1972) during this process. Although most of our emphasis in constructing these initial reference areas was on the examination of recovery distribution maps, we also considered both the political boundaries and the amount of winter banding data available for prospective areas. We then solicited comments and criticisms about these initial reference areas from the Fish and Wildlife Service Flyway Representatives, State waterfowl biologists, and other interested parties. We considered the suggested changes and further studied the recovery distribution maps; in several instances, changes were made. A final set of major and minor winter reference areas was established in this manner.

Recovery Distribution Tests

One section of this report is devoted to testing hypotheses about age-specific, sex-specific, and temporal variation in winter recovery distribution patterns of mallards. The specific methods and data sources for each of these tests are described in detail in that section. We frequently wanted to test for differences between band recovery distributions resulting from two different banded samples (e.g., adult males versus adult females banded in the same location at the same time). The location of each recovery is defined by its latitude and longitude (to the nearest 10-min coordinate), and we thus needed a test of the hypothesis that two bivariate samples belong to the same population. In these situations, we transformed longitude using the relation 1° longitude = (1° latitude) (cos λ), where λ is the latitude (*see* Raisz 1962), and used Mardia's test (Mardia 1967; Wheeler and Watson 1964; Mardia 1968, 1969*a*,*b*, 1972), treating ties as suggested by Robson (1968). Batschelet (1972, 1978) has provided explanations of Mardia's test for a biological readership, and Nichols and Haramis (1980) and Munro and Kimball (1982) describe its use with band recovery distribution data. For sufficient sample sizes, Mardia's test yields test statistics distributed as χ^2 with 2 *df* under the null hypothesis.

Survival and Recovery Rate Estimation

Survival and recovery rates of winter-banded mallards were estimated using banding and band recovery data in conjunction with the models summarized by Brownie et al. (1978; *see also* Seber 1970; Robson and Youngs 1971; Brownie and Robson 1976). Discussions of these estimation models for biologists are presented by Anderson

(1975) and Brownie et al. (1978). Reasons for preferring these models to previous estimation approaches used with waterfowl band recovery data are discussed by Eberhardt (1972), Seber (1972), Anderson (1975), Anderson and Burnham (1976) and Burnham and Anderson (1979). Like all estimation models, those described by Brownie et al. (1978) require a number of assumptions (Brownie et al. 1978; Pollock and Raveling 1982). Effects of specific assumption violations on resulting estimates have been studied by Anderson (1975), Nelson et al. (1980), Anderson and Burnham (1980), Munro and Kimball (1982), Pollock and Raveling (1982) and Nichols et al. (1982*b*), and the estimators have been found to be fairly robust to moderate deviations in several assumptions. In the present study, we tested several hypotheses about sources of variation in survival and recovery rates. Some of these were conducted by using tests between the different models of Brownie et al. (1978). These tests are referenced as they are used, and their test statistics are generally distributed as χ^2. Other tests involve contrasts of survival or recovery rates estimated from two different samples (e.g., areas, age-sex classes). These are conducted using z statistics which are described by Brownie et al. (1978) and distributed as Normal (0, 1) under the null hypothesis.

Reference Areas

Fifteen major reference areas and, within these, 45 minor reference areas were identified for use with mallard winter banding data (Table 1; Fig. 1). Although some North American mallards winter outside of these reference areas (Saunders and Saunders 1981; Sugden et al. 1974), the reference areas are believed to include >99% of the mallards wintering in North America. Table 2 provides a summary of numbers of mallards banded during winter and numbers of resulting hunting-season recoveries for the major reference areas and illustrates the substantial variation in available data among these areas. Band recovery distribution data (Appendix A) summarized by major (Figs. A-1 through A-15) and minor (Table A-1) reference areas provide a general picture of the breeding ground origins, migration routes, and alternate wintering grounds of mallards wintering in these areas.

The following sections provide summary descriptions of the major reference areas. These include general inferences based on band recovery distribution patterns, brief references to previous investigations of wintering mallards in these areas, and crude estimates of the proportions of North American mallards reported in the Winter Survey from these areas (1950–78).

Northwestern Pacific Flyway (20)

The Northwestern Pacific Flyway includes Washington, Oregon, northern California, northwestern Nevada, and the southwestern corner of British Columbia. On the average, about 9–13% of the total mallards reported in the Winter Survey during 1950–78 were found in this area. Band recovery distribution data (Fig. A-1; Table A-1) show that a large proportion of birds banded in this reference area were also recovered there. Recoveries also indicate that southeastern Alberta is an important breeding area for mallards wintering in the Northwestern Pacific Flyway. Other recoveries came from the Peace River in west-central Alberta, northern Idaho and western Montana, and throughout southern British Columbia. Important mallard wintering areas receiving a number of recoveries from the Northwestern Pacific Flyway include the Snake River in southern Idaho and the Central Valley of California.

The most important mallard wintering grounds in this reference area lie within the mid-Columbia and Snake river basins of Washington and Oregon (Fig. 2). Although mallards have long wintered in this region (Yocum 1951), they showed a substantial increase in numbers during the 1950's as a result of agricultural development and water manipulation projects (Lauckhart 1961; Chattin 1964; Buller 1975). For example, the Bureau of Reclamation's Columbia Basin Project developed 500,000 acres of farmland in east-central Washington between 1950 and 1960. Fall and winter mallard populations in this area reportedly increased from 200,000 to >700,000 during this period (Chattin 1964). The proportion of the Pacific Flyway winter mallard population associated with the Columbia Basin reportedly increased from about half to over two-thirds during the 1950's (Buller 1975). The wintering mallard population in

Table 1. *Major and minor reference areas and codes for winter banding data.*

Code	Major reference area	Code	Minor reference area
20	Northwestern Pacific Flyway	201	S British Columbia-W Washington
		202	E Washington-NE Oregon
		203	W Oregon-NW California
		204	SE Oregon-NE California-NW Nevada
21	Central California	211	Central California-W Nevada
22	Northeastern Pacific Flyway	221	W Idaho
		222	W Montana
		223	E Idaho-SW Wyoming
		224	NE Nevada-W Utah
		225	E Utah-W Colorado
23	Southern Pacific Flyway	231	S Nevada-S California-W Arizona
		232	E Arizona-W New Mexico
24	Northern High Plains	241	E Montana
		242	W North Dakota-W South Dakota
		243	N Wyoming
25	Central High Plains	251	SE Wyoming-W Nebraska
		252	NE Colorado
		253	SE Colorado
		254	S Central Colorado
		255	W Kansas
26	Southern High Plains	261	E New Mexico
		262	W Oklahoma-W Texas
27	Northern Low Plains	271	E South Dakota
		272	E Nebraska
		273	E Kansas
28	Southern Low Plains	281	E Oklahoma
		282	E Texas
29	Northwestern Mississippi Flyway	291	S Minnesota-N Iowa
		292	S Iowa-W Missouri
30	Southern Mississippi Flyway	301	W Arkansas
		302	E Arkansas-W Tennessee-NW Mississippi
		303	E Tennessee
		304	W Louisiana
		305	E Louisiana-SW Mississippi
		306	E Mississippi-Alabama
31	Southern Great Lakes-Ohio River Valley	311	N Illinois-N Indiana-SW Michigan
		312	SE Great Lakes Region
		313	SE Missouri-S Illinois-SW Indiana-W Kentucky
		314	SE Indiana-S Ohio-E Kentucky
32	Northeastern Atlantic Flyway	321	North-Atlantic States
33	Mid-Atlantic Flyway	331	Central Appalachian Region
		332	Mid-Atlantic States
		333	North Carolina
34	Southern Atlantic Flyway	341	Georgia-South Carolina
		342	Florida

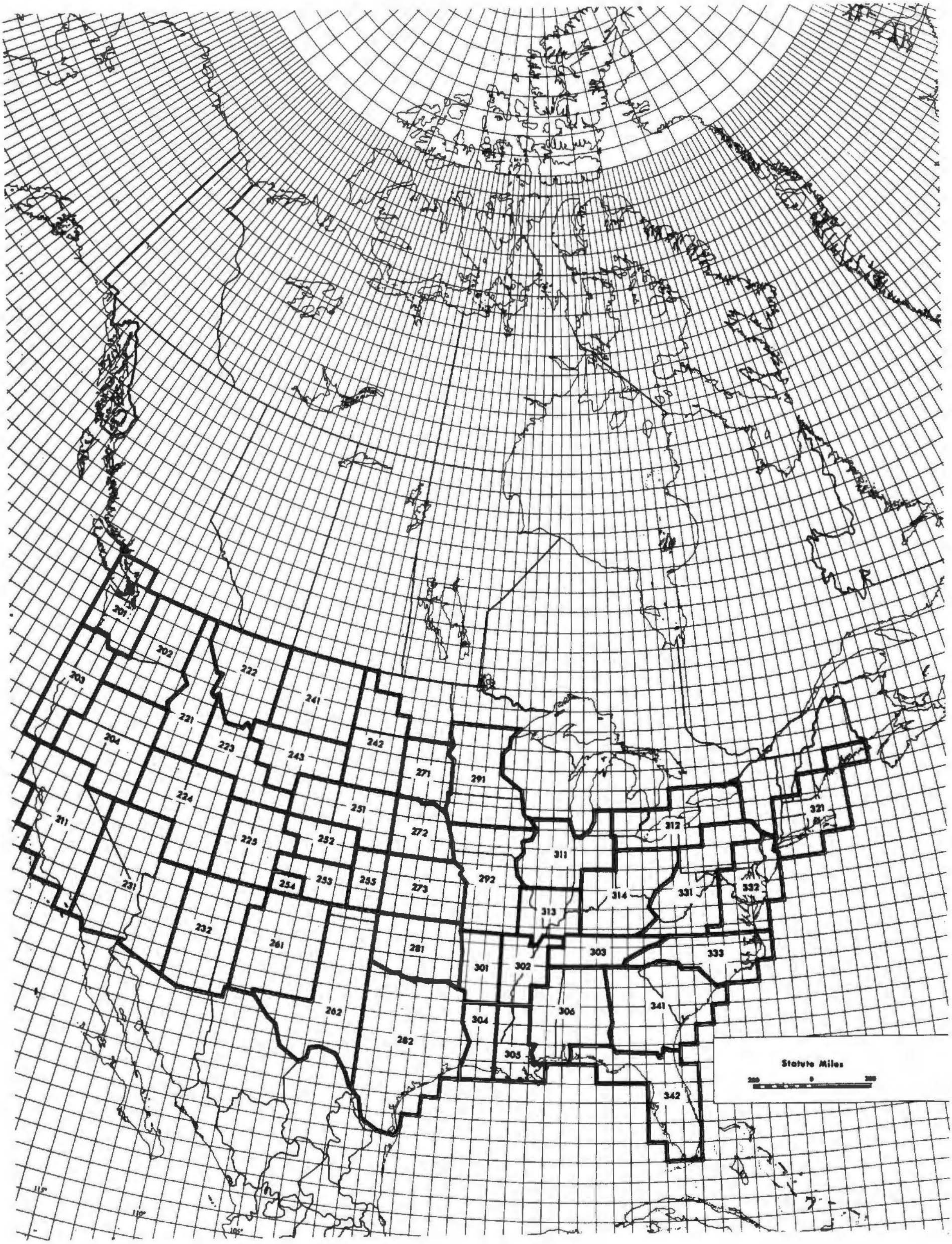

Fig. 1. Minor reference areas for winter-banded mallards.

the Columbia Basin peaked in 1964 and has exhibited a general decline since that time (Ball et al. 1979). Rabenberg (1982) presented evidence that the size of the wintering mallard population in the Columbia Basin is influenced by water conditions in Prairie–Parkland breeding areas during the preceding summer.

Mallards have long been the most numerous duck species wintering in the Columbia–Snake region (Yocum 1949, 1951; Buss and Wing 1966). In January of 1947 Yocum (1951) reported that mallards composed nearly 70% of the ducks counted in southeastern Washington, followed by American wigeon (*Anas americana*) at 24% and northern pintail (*Anas acuta*) at 5%. Buss and Wing (1966) reported that mallards constituted about 90% of the wintering waterfowl counted during their studies from 1955–65 along a portion of the Snake River in southeastern Washington.

Coastal regions of the Northwestern Pacific Flyway also hold many wintering mallards. The Puget Sound area of northwestern Washington is important to wintering waterfowl (Yocum 1951; Chattin 1964) and is reported to support 50,000 wintering mallards (Bellrose 1976). The Fraser River Delta and its associated tidal flats provide the largest wintering area for ducks in general (Leach 1972; Bellrose 1976; Vermeer and Levings 1977) and mallards in particular (Munro 1943) along coastal British Columbia. American wigeon, northern pintails, and mallards are the most numerous wintering duck species in this area (Leach 1972; Vermeer and Levings 1977). The three species make extensive use of agricultural lands in this area during winter (Hirst and Easthope 1981). Munro's (1943) earlier banding studies of mallards in this area led to his hypothesis that mallard populations contain relatively discrete units or groups of birds that breed and winter together.

The Willamette River Valley of western Oregon reportedly winters about 90,000 mallards (Bellrose 1976). This number appears to represent a substantial increase from earlier decades (Crawford 1938). The lakes and marshes of the Klamath Basin in southern Oregon and northern California

Fig. 2. Diked habitat in the Columbia River floodplain, Ridgefield National Wildlife Refuge, Washington. (*Photo courtesy of Susan Saul, U.S. Fish and Wildlife Service.*)

also support many wintering mallards. The Harney Basin in southern Oregon has an average peak wintering population of 4,500 mallards which appears to be closely associated with mallards of the Columbia and Snake river basins (Furniss 1974). Beer (1945) reported that the mallard was a common wintering species in his study area in southwestern Washington.

Central California

Central California is one of the smaller major reference areas, containing only the central portion of California and a small portion of west-central Nevada. However, about 4–8% of the mallards counted in Winter Surveys, 1950–78, were found in this reference area. Recoveries of mallards banded in central California during winter occurred mostly within this area (Fig. A-2; Table A-1). Many other recoveries came from the Klamath Basin of northern California and southern Oregon. Bands were also recovered in southeastern Alberta, the most important Canadian breeding area for mallards wintering in central California. Recoveries between California and southeastern Alberta were scattered throughout Oregon, Idaho, eastern Washington, and western Montana.

Most wintering waterfowl in this reference area are concentrated in California's Central Valley, extending nearly north and south through the central portion of the reference area. Agricultural development and extensive drainage, flood control, and water diversion projects have greatly reduced wetland acreages of the Central Valley in the last century. Of the total Central Valley wetland area existing in the late 1800's, an estimated 6% remains today (Gilmer et al. 1982). About 25% of Pacific Flyway mallards winter in the Central Valley (Gilmer et al. 1982). Additionally Bellrose (1976) reported that about 410,000 mallards winter in the marshes of the Central Valley and San Francisco Bay. Northern pintails and American wigeon are generally more abundant in California during winter than mallards, although in some years mallards outnumber American wigeon to become the second most numerous duck (Rienecker 1976).

The Central Valley is divided into three major regions: the Sacramento Valley in the north (Fig. 3), the San Joaquin Valley in the south (Fig. 4), and the Delta and Suisun Marsh areas in the center (Fig. 5) where the two river systems meet (Gilmer et al. 1982). Ground counts in January 1948 on a San Joaquin Valley study area indicated that mallards represented only 2% of the total duck population, ranking far below northern shovelers (*Anas clypeata*) at 41%, northern pintails at 31%, and green-winged teal (*Anas crecca*) at 24% (U.S.D.I. 1950). Mall (1969) reported 13,500 mallards using the Suisun Marsh during January 1961. This represented 6.5% of the total population, behind northern pintails (76.5%) and American wigeon (11.5%).

The numbers of mallards wintering in other portions of the Central California reference area are not nearly as great as in the Central Valley. Munro (1957) found many different Anatid species to be common winter residents of Morro Bay but reported the mallard to be rare in winter.

Northeastern Pacific Flyway (22)

The Northeastern Pacific Flyway reference area includes Idaho, Utah, northeastern Nevada, and the portions of Montana, Wyoming, and Colorado lying west of the Rocky Mountains. This reference area accounts for about 5–9% of the mallards counted in North America on Winter Surveys, 1950–78. Large numbers of band recoveries from this reference area occurred in southeastern Alberta, the major Canadian breeding area associated with these wintering grounds (Fig. A-3; Table A-1). Southwestern Saskatchewan also contributes some birds to this area. Recoveries suggested that the Columbia and Snake river basins of Washington and Oregon are important alternative wintering areas for Northeastern Pacific Flyway mallards. Additional recoveries were scattered primarily throughout the Central (especially the High Plains) and Pacific Flyways, and are found in such wintering areas as California's Central Valley and the Platte River Valley of Colorado and Nebraska.

The dramatic increases in numbers of wintering mallards in the Columbia and Snake river basins during the 1950's have been discussed (*see* section on Northwestern Pacific Flyway). The Snake River Valley of Idaho is part of the affected area and is now an important wintering area for mallards (Chattin 1964; Buller 1975). About 350,000 mallards winter in the Snake River Valley near Boise, Idaho, and another 90,000 winter farther east between Twin Falls and American Falls (Bellrose 1976).

Fig. 3. Gray Lodge Wildlife Area, managed by the California Department of Fish and Game, is situated in the Sacramento Valley near Gridley and is an important mallard wintering area. (*Photo by David S. Gilmer, U.S. Fish and Wildlife Service.*)

Fig. 4. The Grassland marshes near Los Banos comprise private duck clubs and provide some of the best waterfowl habitat in the San Joaquin Valley, California. (*Photo by David S. Gilmer, U.S. Fish and Wildlife Service.*)

Bellrose (1976) reported that 60,000 mallards winter at six locations in western Montana. Populations of 35,000–40,000 mallards wintered during each of the years 1937–39 in Montana's Flathead Valley, primarily at Pablo and Ninepipe National Wildlife Refuges (Girard 1941). Bellrose (1976) reported 3,600 wintering mallards in the mountain valleys of western Wyoming and 13,000 in the mountains of western Colorado. Hopper (1968) listed the Uncompahgre-Gunnison-Colorado River complex in western Colorado as one of four major waterfowl migration, wintering, and harvest regions in that State. He reported a wintering population there of about 25,000 ducks, most of which were mallards (Hopper 1968). Winter Survey data for 1950–78 indicated an average population of nearly 35,000 mallards in Utah. A large portion of the wintering mallards in Utah were found in the Great Salt Lake Valley (*see* Bellrose 1976).

Southern Pacific Flyway (23)

The Southern Pacific Flyway includes southern California, southern Nevada, Arizona, and far western New Mexico. This area contains less than 1% of the continental wintering mallard population. Relatively few mallards have been banded in this area (Table 2) because the wintering population is small. The largest numbers of band recoveries occurring outside the reference area were from Utah, particularly in the Great Salt Lake Valley and its surrounding marshes (Fig. A-4; Table A-1). Recoveries were also grouped in the Snake River Valley of Idaho. As with the rest of the Pacific Flyway, the principal Canadian breeding area contributing to these wintering grounds is southeastern Alberta.

Published information on wintering mallards in the Southern Pacific Flyway is scarce. Bellrose (1976) reported that a few thousand mallards winter in extreme southern California. Wintering mallards are found along the Colorado River in Arizona, Nevada, and California. Wintering mallards are also found along the Gila and Salt rivers in Arizona (Fleming 1959). Fleming (1959) suggested that species composition of the waterfowl kill in Arizona reflected relative species abundance, and reported that mallard and northern pintail are most frequently taken. He also noted one winter (1955–56) in which extremely cold weather in Northern States resulted in a peak mid-December population with 70% mallards (Fleming 1959).

Fig. 5. Grizzly Island, managed by the California Department of Fish and Game, is situated in the Suisun Marsh area adjacent to Suisun Bay. (*Photo by David S. Gilmer, U.S. Fish and Wildlife Service.*)

Northern High Plains (24)

The Northern High Plains reference area includes eastern Montana, western North and South Dakota, and northern Wyoming. Based on the Winter Survey, about 1–3% of North American mallards winter in this area. The valleys of the Platte and North and South Platte rivers appear to be important alternative wintering areas for Northern High Plains birds. Canadian band recoveries from mallards banded during winter in the Northern High Plains were concentrated in southeastern Alberta and southwestern Saskatchewan (Fig. A-5; Table A-1).

Recoveries also occurred throughout the Low Plains of the Central Flyway and the Mississippi Alluvial Valley of the Mississippi Flyway, while some recoveries occurred in the Pacific Flyway, especially in western Montana and the Columbia and Snake river basins.

Bellrose (1976) reported that 65,000 mallards winter in eastern Montana, and Funk et al. (1971) reported an average (1964–70) midwinter population of 56,500 birds. These wintering mallards are found along the Missouri, Yellowstone, and Bighorn rivers (Funk et al. 1971; Bellrose 1976). During 1964–70, an average of 2,600 mallards wintered in North Dakota, mostly below the Garrison Dam on the Missouri River (Funk et al. 1971; Bellrose 1976). About 35,000 mallards winter in northern Wyoming (Funk et al. 1971), mostly along the Bighorn and Wind rivers (Bellrose 1976; Funk et al. 1971). In western South Dakota, Funk et al. (1971) reported the average winter mallard population as 28,000, and Bellrose (1976) reported 30,000. Most of these birds winter along streams, springs, and lakes of the northern Black Hills (Drewien 1968; Buller 1964; Bellrose 1968). Drewien (1968) reported wintering mallard counts for the Black Hills ranging from 6,000 to 32,000 with an average of about 16,000. However, he reported that birds were more scattered and difficult to count during mild weather and suspected that the wide variation in the counts was due in part to weather conditions during the inventory period. Drewien (1968) analyzed band recovery data from mallards banded during winter in the Black Hills and concluded that the birds exhibited a strong tendency to return annually to this area to winter.

Central High Plains (25)

The Central High Plains reference area includes southeastern Wyoming, eastern Colorado, and western Nebraska and Kansas. About 7–10% of the total mallards reported in the Winter Surveys, 1950–78, were counted in this reference area. Since

Table 2. *Mallard banding and recovery totals by major reference area.*[a]

Major reference area	Bandings	Band recoveries
Northwestern Pacific Flyway (20)	85,350	14,232
Central California (21)	23,593	3,922
Northeastern Pacific Flyway (22)	67,778	9,798
Southern Pacific Flyway (23)	2,803	402
Northern High Plains (24)	52,567	5,763
Central High Plains (25)	170,216	20,090
Southern High Plains (26)	22,963	2,100
Northern Low Plains (27)	68,767	9,476
Southern Low Plains (28)	43,024	5,898
Northwestern Mississippi Flyway (29)	27,110	4,104
Southern Mississippi Flyway (30)	116,457	17,128
Southern Great Lakes–Ohio River Valley (31)	103,277	15,593
Northeastern Atlantic Flyway (32)	9,863	901
Mid-Atlantic Flyway (33)	50,154	6,807
Southern Atlantic Flyway (34)	30,571	4,212
Total	874,493	120,426

[a]Table includes mallards banded during January and February, 1922–1977, and recovered during 1 September–15 February, 1922–1978.

the 1960's, the State of Colorado has had the most intensive mallard winter banding program in North America, and the excellent sample sizes for this reference area reflect this effort (Table 2). Most Canadian recoveries were from southeastern Alberta and southwestern Saskatchewan, with southeastern Sakatchewan and southwestern Manitoba also contributing many birds (Fig. A-6; Table A-1). Many recoveries occurred throughout the rest of the Central Flyway, with more from the High Plains areas than from the Low Plains. Recoveries also occurred in the Mississippi Alluvial Valley and in the northeastern Pacific Flyway.

Eastern Colorado is an important mallard wintering area in this reference area (Figs. 6 and 7). Wagar (1946) cited reports of 1.5 million ducks on the Arkansas and Platte river drainages in January 1945 with as many as 300,000 mallards on a single reservoir. Hopper et al. (1978) reported an average of 270,000 mallards in January counts made during 1964–72 in eastern Colorado. The mallard was reported as the most numerous duck species in all seasons in Colorado (Grieb and Boeker 1954). Mallards are especially important during winter (Kinghorn 1949; Buller 1964), and they composed >90% of the total kill in sample areas of Grieb and Boeker (1954) and 95–98% of the total wintering duck population in eastern Colorado (Hopper et al. 1978). Eastern Colorado can be divided into three major waterfowl regions: South Platte River Valley, Arkansas River Valley, and San Luis Valley (Grieb and Boeker 1954; Hopper 1968).

The South Platte River Valley (Fig. 7) is the most important Colorado wintering area, containing concentrations of more than 400,000 ducks in some years (Hopper 1968; Grieb and Boeker 1954). Most (≥95%) wintering ducks in this area are mallards, with small numbers of green-winged teal, northern pintails, and American wigeon (Hopper 1968). Bellrose (1976) reported wintering mallard populations of 200,000 in this area. From one of the first extensive aerial surveys of wintering waterfowl, Kinghorn (1949) reported 25,000 and 104,000 ducks ("almost entirely" mallards), respectively, along the South Platte River in January 1948 and 1949. Hopper (1972) studied

Fig. 6. Areas of open water in iced-over reservoirs are concentration areas for wintering mallards in Colorado. (*Photo by James K. Ringelman, Colorado Division of Wildlife.*)

waterfowl use of potholes on the Bonny Reservoir and reported wintering waterfowl populations of as many as 45,000, primarily mallards. Ryder (1970) counted 1,000 ducks in December on his study area along the Cache la Poudre River near Fort Collins. Corn is an abundant food source, and resting habitat in the South Platte River Valley is provided by numerous lakes, reservoirs, and riverbottoms (Hopper 1968).

The Arkansas River Valley is the second most important waterfowl wintering area in eastern Colorado (Grieb and Boeker 1954; Hopper 1968). Midwinter duck (again, mostly mallards) counts for this area during 1948–66 averaged 82,000 birds and ranged up to 250,000 (Hopper 1968). Bellrose (1976) reported that about 100,000 mallards winter in the Arkansas River Valley. Kinghorn (1949) reported January counts of 2,000 ducks in 1948 and 78,000 ducks in 1949 along the Arkansas River. Winter duck concentrations in the Arkansas River Valley are associated with lakes, reservoirs, and riverbottoms in small-grain and corn production areas (Hopper 1968).

The San Luis Valley contains the largest breeding population but the smallest wintering population of ducks in eastern Colorado (Hopper 1968; Hopper et al. 1975). The size of the wintering duck population in this area is believed to be more dependent on weather conditions than in other Colorado wintering grounds (Hopper 1968; Hopper et al. 1975). Hopper et al. (1975) reported that January duck populations averaged 24,000 for 1955–63 and 34,000 for 1964–71, varying between 8,000 and 64,000. Mallards accounted for at least 90% of these birds (Hopper et al. 1975). Wintering ducks in this area occupy warmwater resting sites and feed in barley fields (Hopper et al. 1975). The Monte Vista National Wildlife Refuge is an important winter concentration area (Buller 1964).

Western Kansas and Nebraska are also important mallard wintering grounds within the Central High Plains reference area. Funk et al. (1971) reported an average midwinter inventory of 148,000 mallards for western Kansas during 1964–70. Major wintering grounds in western Kansas include the Arkansas and Cimarron rivers and

Fig. 7. Warmwater spring adjacent to the South Platte River in Colorado. (*Photo by James K. Ringelman, Colorado Division of Wildlife.*)

Lake McKinney (Buller 1964). Funk et al. (1971) reported an average midwinter mallard population of 171,000 in western Nebraska during 1964–70. Bellrose (1976) reported that 125,000 mallards wintered along the North Platte River and another 25,000 on the South Platte. Enders Reservoir and Lake McConaughy are additional concentration areas for wintering waterfowl in western Nebraska (Buller 1964). The 1964–70 midwinter mallard counts for southeastern Wyoming averaged 15,000 birds (Funk et al. 1971), primarily found along the North Platte River (Funk et al. 1971; Bellrose 1976).

Southern High Plains (26)

The Southern High Plains reference area includes eastern New Mexico and western Texas and Oklahoma. An average of 5–7% of the mallards counted in Winter Surveys, 1950–78, were found in this area. Large numbers of recoveries from birds banded in this reference area occurred just north of the area in the Central High Plains reference area (Fig. A-7; Table A-1). Other recoveries were scattered throughout the northern High Plains and the entire Low Plains. Recoveries in the Pacific Flyway were concentrated in western Colorado, the Great Salt Lake Valley of Utah, and the Snake River Basin in Idaho. Canadian recoveries were mostly from southeastern Alberta and southwestern Saskatchewan.

Texas is the second most important State in the Central Flyway for wintering mallards (Bellrose 1976), and the Texas Panhandle is the most important wintering area within the State (Buller 1964; Bellrose 1976). Bellrose (1976) reported about 300,000 wintering mallards in the Texas Panhandle, and Funk et al. (1971) reported average mallard counts during January of about 280,000 birds in west Texas for the period 1964–70. Buller (1964) reported more than 750,000 wintering mallards in the Texas Panhandle in 1956, a peak year. Other important wintering duck species in this area include the northern pintail, American wigeon, and green-winged teal (Bolen and Guthery 1982; Baldassarre and Bolen 1984). Petrides and Bryant (1951) reported that mallards were the most abundant wintering waterfowl species on Muleshoe National Wildlife Refuge in January 1950, composing 60% of the total population,

Fig. 8. Playa lake in the Southern High Plains of Texas (Castro County) is surrounded by intensive agricultural use (row crops and grazing) typical of the region. (*Photo courtesy of Eric G. Bolen and Paul N. Gray, Texas Tech University.*)

followed by northern pintails (25%), American wigeon (13%) and green-winged teal (3%). Soutiere et al. (1972) found that mallards were the most abundant ducks wintering on Buffalo Lake National Wildlife Refuge, followed by northern pintails and American wigeon. Wintering waterfowl in west Texas are found on the area's natural playa lakes (Fig. 8), artificial lakes and stockponds, and feed extensively in harvested cornfields (Buller 1964; Bolen et al. 1979; Bolen and Guthery 1982; Baldassarre and Bolen 1984). Moore (1980) studied duck use of playa lakes and suggested that mallards preferred lakes with open water interspersed with patches of emergent vegetation.

Eastern New Mexico contained an average wintering mallard population of 44,000 birds for the period 1964–70, according to Funk et al. (1971). Habitat for wintering waterfowl is associated with the middle Rio Grande and Pecos river valleys in the south and with lakes and reservoirs in the northeastern part of the State (Buller 1964). Merrill (1967) reported average winter mallard populations of 18,000 along the Rio Grande and 4,000 in northeastern New Mexico. Merrill (1967) reported that mallards are the most numerous wintering ducks in eastern New Mexico, composing 39% of the average wintering population (1956–66), followed by northern pintails (19%), American wigeon (12%), mergansers (*Mergus* sp; 9%), green-winged teal (8%), and gadwall (*Anas strepera*; 5%). Merrill (1967) analyzed banding and recovery data for mallards from eastern New Mexico and concluded that these birds showed little tendency to travel east of the High Plains and that they exhibited slightly higher mortality rates than other High Plains mallards. Leopold (1919), studying mallard sex ratios in the Rio Grande Valley near Albuquerque, concluded that mallards exhibit a differential sex migration with females arriving first on New Mexico wintering grounds.

Heitmeyer (1980) grouped waterfowl population data for three national wildlife refuges in Oklahoma, one of which (Optima) is in the Southern High Plains reference area. Mallards and American wigeon were first and second in abundance, respectively, on these refuges. Barclay (1976) surveyed ducks (mostly mallards) on Oklahoma reservoirs in January 1974 and reported nearly 1,700 birds on Carl Etling Reservoir in far western Oklahoma.

Northern Low Plains (27)

The Northern Low Plains reference area contains the eastern portions of South Dakota, Nebraska, and Kansas. The 1950–78 Winter Survey data indicate that about 7–10% of the total mallards counted are from this area. Canadian recoveries of mallards banded in the Northern Low Plains occurred in substantial numbers in southeastern Alberta, in southern Manitoba, and throughout southern Saskatchewan (Fig. A-8; Table A-1). Additionally, large numbers of recoveries were found throughout the Low Plains and in the northeastern portions of the High Plains (western North Dakota, South Dakota, and Nebraska). Many band recoveries also occurred in the eastern Mississippi Flyway, especially in the more southern States.

Kansas is the most important mallard wintering State in the Central Flyway (Bellrose 1976), most birds occuring in the eastern portion of the State. The numbers of ducks wintering in Kansas exhibited dramatic increases during the 1950's and 1960's (Buller 1975; Martinson 1975; Bellrose 1976). Water resource projects of the Bureau of Reclamation and the Corps of Engineers created numerous large reservoirs throughout the State. State and Federal management areas associated with these reservoirs have been planted with sorghum, corn, and other grains, making these areas very attractive to wintering waterfowl (Buller 1964, 1975). Buller (1975) reported a 10-fold increase in the number of wintering ducks in Kansas since 1950, and noted that mallards represented about 95% of the State's wintering population. Funk et al. (1971) reported that the winter mallard population averaged 448,000 in eastern Kansas during 1964–70. Also, Bellrose (1968) reported wintering populations of 20,000 mallards at the Quivira National Wildlife Refuge and Cheyenne Bottoms, 25,000 at the Jamestown Management Area, 20,000 on the Marais-des-Cygnes Management Area, and nearly 100,000 on the Neosho Management Area.

Funk et al. (1971) reported an average wintering mallard population in eastern South Dakota, 1964–70, of 198,000 birds. Most of these wintering birds were found along the Missouri River, with concentrations on the Big Bend and Little Bend portions of the river, Lake Andes, and Fort Randall and Gavins Point reservoirs (Buller 1964;

Bellrose 1976). Buller (1964) suggested that the size of the wintering mallard population in South Dakota was heavily dependent on the severity of winter weather.

The number of mallards estimated to winter in eastern Nebraska during 1964–70 was 81,000 (Funk et al. 1971). These birds were along the Platte River (Figs. 9 and 10) and on various reservoirs (e.g., Bellrose (1968) reported 14,000 wintering mallards on the Harlan County Reservoir) in this area (Buller 1964; Bellrose 1976). Wintering mallard numbers increased fivefold along the Platte River between 1979, a cold winter with 5,000 mallards, and 1980, a mild winter with 26,000 mallards (Jorde 1981). Corn stubble fields (Fig. 10) were the preferred agricultural habitat of these wintering mallards, and corn was the most frequent food item in the diet (Jorde et al. 1983).

Southern Low Plains (28)

The Southern Low Plains reference area includes eastern Oklahoma and eastern Texas. Winter Survey data indicate that about 3–4% of wintering mallards were counted in this reference area during 1950–78. The Canadian recoveries of mallards banded in this reference area were concentrated in southern Saskatchewan and southeastern Alberta, with some in southern Manitoba (Fig. A-9; Table A-1). United States recoveries were concentrated in the Low Plains. Smaller numbers of recoveries were found in the northern and central portions of the eastern High Plains and throughout the western Mississippi Flyway.

Funk et al. (1971) reported that the mallard population wintering in eastern Oklahoma during 1964–70 averaged nearly 196,000 birds. Heitmeyer (1980) reported about 200,000 mallards during early and late winter in 1978–79 and 1979–80, although this number included some birds from the High Plains of western Oklahoma. During 1978–79 and 1979–80 mallards were the most abundant wintering ducks in Oklahoma, with common mergansers (*Mergus merganser*) second in abundance, followed by American wigeon, gadwall,

Fig. 9. Mallard wintering habitat along the Platte River in Nebraska. (*Photo by Dennis G. Jorde, U.S. Fish and Wildlife Service.*)

green-winged teal, wood duck (*Aix sponsa*), ring-necked duck (*Aythya collaris*), common goldeneye (*Bucephala clangula*), and hooded merganser (*Mergus cucullatus*; Heitmeyer 1980). Buller (1964) wrote that the mallard accounted for half of the duck harvest in the State. Oklahoma, like Kansas, has seen a substantial increase in wetlands over the last three decades with the construction of reservoirs, lakes, and other flood control structures (e.g., Copelin 1961; Slimak 1975; Barclay 1976). Wintering mallards use these impoundments throughout the State and are found in large concentrations on some of the large reservoirs and on several State and Federal refuges (Copelin 1961; Bellrose 1968; Gorham 1975; Slimak 1975; Barclay 1976; Heitmeyer 1980; Gordon 1981). Bellrose (1968) reported that almost 160,000 mallards wintered on artificial reservoirs in Oklahoma. Barclay (1976) reported an average population in January of nearly 222,000 mallards on Oklahoma reservoirs during 1963-72, followed in abundance by American wigeon, green-winged teal, wood ducks, and lesser scaup (*Aythya affinis*). Heitmeyer and Vohs (1984) observed that mallards shift from large reservoirs during early winter to smaller wetlands—especially natural bottomland wetlands and rivers—in late winter.

Slimak (1975) surveyed waterfowl on wetlands within the Stillwater Creek Watershed in north-central Oklahoma during the winter of 1971-72. Mallards were the most common wintering waterfowl species, representing 35% of the total observed. Common mergansers were second in abundance at 31%, and northern pintails, lesser scaup, and ring-necked ducks followed, each representing 5-10% of all observations (Slimak 1975). Gordon (1981) studied condition, feeding, and behavior of mallards on Lake Carl Blackwell, a large reservoir within the Stillwater Creek Watershed, and estimated wintering populations of 250 and 800 mallards, respectively, in 1979 and 1980.

Gorham (1975) studied waterfowl use of U.S. Army Corps of Engineers reservoirs in far eastern Oklahoma. Aerial surveys of the studied reservoirs showed that mallards represented 78-96% of total ducks observed in January 1972 and 68% of the total duck kill during the 1971-72 hunting season (Gorham 1975).

Fewer mallards winter in eastern Texas than in the western part of the State, having averaged

Fig. 10. Corn stubble fields are preferred agricultural habitat along the Platte River in Nebraska. (*Photo by Dennis G. Jorde, U.S. Fish and Wildlife Service.*)

about 67,000 birds during 1964–70 (Funk et al. 1971). The Texas Gulf Coast often winters more than 2,000,000 waterfowl (Singleton 1953; Buller 1964). Unlike Low Plains wintering areas to the north, however, the mallard is not the most numerous wintering species there. According to a Texas Gulf Coast waterfowl survey (Heit 1948), mallards were the third most abundant duck species in January 1948, after northern pintails and redheads (*Aythya americana*). About 89,000 mallards were concentrated at Eagle Lake and surrounding rice fields, and in the marshes and rice fields east of Galveston Bay. Singleton (1953) reported mallard populations along the Texas Gulf Coast of 186,000, 163,000, 38,000, and 36,000 in January of 1949, 1950, 1951, and 1952, respectively. Singleton (1953) also noted larger numbers of northern pintails and redheads than mallards. In 1951 and 1952 American wigeon numbers approached those of mallards, and green-winged teal abundance exceeded mallard abundance in 1952 (Singleton 1953). Bellrose (1976) reported later that only about 15,000 mallards currently winter along the Texas Gulf Coast.

Bellrose (1968) estimated that 45,000 mallards wintered in eastern Texas north of the Gulf Coast. Siegler (1945) studied waterfowl on inland areas in the "timber belt" of far eastern Texas during 1939–1944. Wintering mallards were found on streams and lakes throughout this region and exceeded the combined numbers of all other species during December and January. Ring-necked ducks were second in abundance, and wood ducks and lesser scaup were also common wintering species (Siegler 1945). In January 1975, transect counts on a green-tree reservoir along the Angelina River showed a species composition of 70–75% mallards, 15–20% wood ducks, and 5–10% green-winged teal, ring-necked ducks, and northern shovelers (Allen and Halls 1978). Use of green-tree reservoirs by relatively large numbers of mallards was predicted for years of fair to high acorn (the most important mallard food item in these studies) production (Allen and Halls 1978; Allen 1980).

Fig. 11. Impounded wetlands on the Fountain Grove Wildlife Management Area in north-central Missouri 1949. (*Photo courtesy of Dale D. Humburg, Missouri Department of Conservation.*)

Hobaugh and Teer (1981) studied waterfowl usage of 55 lakes constructed for flood control in the upper Trinity River drainage of eastern Texas. In January 1977, 1,055 mallards (25% of the total ducks seen) were counted on these lakes, ranking second in abundance after ring-necked ducks (28% of the total count).

Northwestern Mississippi Flyway (29)

The Northwestern Mississippi Flyway includes southern Minnesota, all of Iowa, and all of Missouri except for the southeastern corner of the State. The 1950–78 Winter Survey data indicate that 4–6% of wintering mallards in North America were generally found in this area. Recoveries of birds banded during winter in this reference area were concentrated in the western Mississippi and eastern Central (Low Plains) Flyways (Fig. A-10; Table A-1). Southeastern Alberta, southern Saskatchewan, and southern Manitoba contained large numbers of recoveries from this reference area.

More than 210,000 mallards were reported in northern and western Missouri (Fig. 11), on the average, during Winter Surveys, 1950–78. Large wintering mallard concentrations are found along the Mississippi River between Hannibal, Missouri, and Alton, Illinois (Bellrose 1968). Bellrose (1968) reported that wintering mallard populations at Squaw Creek National Wildlife Refuge averaged 200,000. The population of mallards (the predominant species) at Squaw Creek numbered 50,000–75,000 in 1980, and twice that number in 1981 (Humburg et al. 1983). Winter Survey data for 1950–78 indicated average counts of about 101,000 mallards in Iowa. Most of these birds are found along the Missouri, Mississippi, and Des Moines rivers (Bellrose 1976).

Winter Survey data for Minnesota averaged only 12,000 mallards. For the years 1974, 1975, 1976, and 1977, Cooper and Johnson (1977) reported January waterfowl populations for the Twin Cities Metropolitan Area in Minnesota of

Fig. 12. Narrow riparian corridors will soon become agricultural ditches, Tensas River Basin, Louisiana. (*Photo courtesy of Kenneth J. Reinecke, U.S. Fish and Wildlife Service.*)

14,000, 18,000, 18,000, and 22,000, respectively, 95% of which were mallards. They reported mallards to be most abundant in the Minnesota River Valley, particularly on Black Dog Lake. Cooper and Johnson (1977) indicated that numbers of wintering mallards at the time of their study were much larger than those in earlier years (e.g., 10 mallards observed during winter from 1917 to 1937). They attributed the increase in wintering mallards to increases in open water (from heated water discharge, pumps, and water flow over dams) and food availability (waste grain) associated with human activity.

Southern Mississippi Flyway (30)

The Southern Mississippi Flyway reference area includes Arkansas, Tennessee, Louisiana, Mississippi, and Alabama. This area wintered about 26-30% of North American mallards (based on 1950-78 Winter Survey data), more than any other reference area. Of mallards banded here, recoveries were numerous throughout the Mississippi Flyway and throughout the Low Plains of the Central Flyway (Fig. A-11; Table A-1). Recoveries were also common in the Atlantic Flyway. Large numbers came from southeastern Alberta, southern Saskatchewan, and southern Manitoba, reflecting the importance of these three provinces as breeding areas of Southern Mississippi Flyway birds. Nearly all of the area that Gard (1979) labeled as the Lower Mississippi River Basin falls within this major reference area. Gard (1979) reported an average winter mallard population for this area of 1,700,000, or 58% of the Mississippi Flyway total. The loss of bottomland hardwood wintering habitat in this reference area (Figs. 12 and 13), is a matter of great concern (Forsythe and Gard 1980; Gard 1979; Heitmeyer and Fredrickson 1981; Osborne 1981; Reinecke 1981).

Winter Survey data indicate that Arkansas (Figs. 13, 14, and 15) usually winters more mallards than any other State (nearly 20% of the

Fig. 13. Results of channelization in the St. Francis River Basin, Arkansas. (*Photo courtesy of Kenneth J. Reinecke, U.S. Fish and Wildlife Service.*)

U.S. total). Bellrose (1976) reported 1,100,000 wintering mallards in Arkansas, including 150,000 at the Holla Bend National Wildlife Refuge, 400,000 in northeast Arkansas, and 300,000 in the Stuttgart, Arkansas, area (Bellrose 1968). Aerial surveys early in January 1957 showed 17% of Mississippi Flyway mallards in this State (Yancy et al. 1958), and Hunter (1978) suggested that Arkansas could "winter most of the mallards in the flyway." The Grand Prairie region surrounding Stuttgart and the associated White River Bottoms (Fig. 15) to the east is perhaps the most important mallard wintering area in North America, harboring large concentrations of mallards each year. The fields and flooded bottomlands of this region provide abundant food in the form of rice, acorns, and soybeans (Hawkins et al. 1946; Reinecke 1981). Mallards and wood ducks are the most important wintering ducks in many areas of the Mississippi Delta north of the Gulf Coast (Reinecke 1981).

Louisiana (Figs. 12, 16, and 17) is an important wintering State for many waterfowl species. Based on Winter Survey data, Louisiana usually contains less than 10% of the country's wintering mallards, although this figure has approached 20% in particular recent winters having especially low temperatures (*see also* Nichols et al. 1983). The survey data of Yancey et al. (1958) indicated that 15% of Mississippi Flyway mallards were found in Louisiana in early January, 1957. St. Amant (1959) reported that the mallard was the most important duck in the hunter's bag in Louisiana. In northern Louisiana, waterfowl are concentrated in the bottomlands of the Red River, in the Ouachita–Tensas system (Fig. 17), including Catahoula Lake, and in the cut-off lakes and barrow pits along the Mississippi River (St. Amant 1959). The mallard kill sometimes constitutes greater than 50% of the waterfowl bag in northern Louisiana (St. Amant 1959). Wills (1971) reported that northern pintails,

Fig. 14. Wintering mallard habitat in eastern Arkansas. (*Photo courtesy of Kenneth J. Reinecke, U.S. Fish and Wildlife Service.*)

mallards, teal, American wigeon, and gadwall were the most abundant ducks at Catahoula Lake. In south-central Louisiana, the Atchafalaya Basin is a fairly important waterfowl concentration area (St. Amant 1959), where the mallard is one of the most abundant species, along with wood ducks, blue-winged teal (*Anas discors*), lesser scaup, and gadwalls (Duke and Chabreck 1976). The mallard is the most important species in the Atchafalaya Basin harvest (Chabreck 1979). Palmisano (1973) reported a December 1970 population of 492,000 mallards in the coastal marshes and rice fields of southern Louisiana. Gadwalls, green-winged teal, American wigeon, and northern pintails were the only species reported to be more abundant than mallards in this coastal area (Palmisano 1973). The mallard is often the predominant bird in the coastal marsh harvest (St. Amant 1959; Chabreck 1979). In the 1958–59 wintering season on Rockefeller Refuge, Chabreck (1960) reported that mallards were fourth in abundance after northern pintails, blue-winged teal, and gadwall. On Rockefeller Refuge, mallards have concentrated in freshwater marshes and associated impoundments while other waterfowl species used both fresh and brackish marshes and impoundments (Chamberlain 1959; Chabreck et al. 1975). Dillon's (1959) study of mallards in southwestern Louisiana concluded that a high percentage of the State's mallards wintered on or near agricultural land, preferring rice fields to marshes for both feeding and loafing.

Winter Survey mallard counts for Tennessee (Fig. 18), Mississippi (Fig. 19), and Alabama average about 274,000, 214,000, and 45,000, respectively. Wintering mallards are concentrated along the Mississippi River in Tennessee and Mississippi, and along the Tennessee River in Tennessee and Alabama (Bellrose 1976). Bellrose (1968) reported that "in recent years" 300,000 mallards have wintered at the Cross Creeks and Tennessee National Wildlife Refuges, Tennessee, and at the Wheeler National Wildlife Refuge, Alabama. Steenis (1950) and Givens and Atkeson

Fig. 15. The White River Bottoms near Clarendon, Arkansas. This area contains some of the most important wintering mallard habitat in North America. (*Photo courtesy of Kenneth J. Reinecke, U.S. Fish and Wildlife Service.*)

Fig. 16. Flooded bottomland hardwoods and adjacent land cleared for agriculture in east-central Louisiana. (*Photo by Charles M. Smith, Louisiana Department of Wildlife and Fisheries.*)

Fig. 17. Tensas River bottomlands in northeastern Louisiana. (*Photo courtesy of Kenneth J. Reinecke, U.S. Fish and Wildlife Service.*)

Fig. 18. Mallard wintering habitat at Reelfoot Lake, Tennessee. (*Photo courtesy of Kenneth J. Reinecke, U.S. Fish and Wildlife Service.*)

Fig. 19. Winter flooding in the Upper Yazoo River Basin north of Greenwood, Mississippi. (*Photo courtesy of Kenneth J. Reinecke, U.S. Fish and Wildlife Service.*)

(1957) discussed waterfowl habitat management along the Tennessee River and associated impoundments created by the Tennessee Valley Authority, noting the importance of green-tree reservoirs and nonflooded farm crops for attracting mallards. The Mobile Bay Delta area in southern Alabama harbored large numbers of wintering mallards historically, but only small numbers winter there now. Bellrose (1968) reported that many of the mallards that once wintered in Mobile Bay now winter at the Noxubee National Wildlife Refuge in eastern Mississippi, which winters 60,000 mallards. Mallards were the most abundant wintering ducks on creek and hardwood swamp study areas in central Alabama, followed by wood ducks and American black ducks (*Anas rubripes*; Speake 1955, 1956). The mallard was third in abundance on impoundments after ring-necked ducks and scaup, during the 1953–54 winter (Speake 1955). On Eufaula National Wildlife Refuge in southeastern Alabama during the winters of 1967–68 and 1968–69 (Drake (1970) found that mallards were the most numerous waterfowl species followed by American wigeon, green-winged teal, ring-necked ducks, and northern pintails.

Southern Lake States–Ohio River Valley (31)

This reference area includes Illinois, Indiana, Kentucky, Ohio, southeastern Missouri, southern Michigan, a small portion of southern Ontario, western New York, and northwestern Pennsylvania. During 1950–78, about 9–13% of the mallards reported in the Winter Survey came from this reference area. Mallards banded in this area were recovered in large numbers throughout the entire Mississippi Flyway, the Low Plains of the Central Flyway, the southern Atlantic Flyway, and the Chesapeake Bay area (Fig. A-12; Table A-1). As with the other two Mississippi Flyway reference areas, many recoveries occurred in southeastern Alberta, southern Saskatchewan, and southern Manitoba.

Illinois generally has more wintering mallards than any other State in this reference area. In early January 1957, 30% of all Mississippi Flyway mallards were found in Illinois (Yancey et al. 1958). This represented nearly as many mallards as were counted in both Arkansas and Louisiana during that winter. In northern Illinois, 25,000 mallards were reported to winter on the Mississippi River near New Boston, Illinois, and 60,000 on the Illinois River above Peoria, Illinois (Bellrose 1968). Bellrose (1968) reported wintering mallard populations of 140,000 along the lower Illinois River near Havana, Illinois (Fig. 20), 200,000 along the Mississippi River between Hannibal, Missouri, and Alton, Illinois, and 150,000 in southern Illinois. Hawkins and Bellrose (1939) and Hawkins et al. (1939) noted that mallards composed 98% of the ducks in the Illinois River Valley in December 1938, and that they were also the species most frequently harvested by Illinois River duck clubs, exceeding the combined harvest of all other species. Waste corn is an important food of Illinois mallards (Anderson 1959), and its abundance contributes to the high wintering mallard populations in the State.

Winter Survey results (1950–78) suggest that Indiana winters about 158,000 mallards. A substantial portion of these wintering birds are concentrated along the Wabash and Ohio rivers in the southwestern corner of the State (Mumford 1954; Bellrose 1976). The Hovey Lake State Game Preserve in the Wabash Lowlands reportedly winters as many as 200,000 ducks (mostly mallards) in some years (Mumford 1954). Waste corn throughout this bottomland area is thought to be the major attraction for wintering mallards. Band recoveries and observations of mallards suggest that wintering birds may move back and forth between the Wabash Lowlands and neighboring areas in Kentucky and Illinois (Mumford 1954).

Southeastern Missouri reportedly winters about 40,000 mallards (Bellrose 1968). Taylor (1977) studied waterfowl use of moist-soil impoundments at Mingo National Wildlife Refuge in southeastern Missouri and found that mallards used deeper water sites in January–February than at other times of the year.

The Winter Survey averaged 77,000 mallards in Kentucky during 1950–78. These birds are distributed along the Ohio, Tennessee, and Cumberland rivers (Bellrose 1976). Ohio averaged 33,000 Winter Survey mallards. The birds occur in areas throughout the State including the Scioto and Ohio rivers (Bellrose 1976). Winner (1960) studied movements of black ducks and mallards on O'Shaughnessy Reservoir in central Ohio. He reported mid-January populations of 100–500 mallards and 150–1,000 American black ducks.

Winter Survey data indicate an average (1950–78) of only 10,000 wintering mallards in Michigan. Reed (1971) studied activity of mallards and American black ducks during winter on an inland sulfur spring and on a plume of heated effluent along the Lake Erie shore in southeastern Michigan. Peak use of these areas occurred during December–February when they provided the only ice-free water in the general area. In January, 1970, a peak of 6,000 mallards (90%) and American black ducks (10%) used the spring and effluent, and in January 1971, 8,000 birds (85% mallards) used the area (Reed 1971). These birds concentrated their feeding activity in corn fields.

Northeastern Atlantic Flyway (32)

The Northeastern Atlantic Flyway reference area includes Connecticut, Massachusetts, and Rhode Island, extreme southern Vermont, and coastal portions of New York, New Hampshire and Maine. Wintering mallard populations in this area are very small, averaging (1950–78) 0.1% of the birds in North America. Most recoveries of mallards banded here occurred in the reference area itself (Fig. A-13; Table A-1). Recoveries also occurred in New Jersey, along the St. Lawrence River in Quebec, and in southeastern Ontario and northern New York—especially along Lake Ontario.

Before 1900, the mallard was rare in the Northeastern Atlantic Flyway. The mallard has expanded its range eastward in recent decades and now breeds and winters in this reference area (Johnsgard 1961*a*, *b*; Heusmann 1974; Johnsgard and DiSilvestro 1976). The release of hand-reared mallards has hastened this expansion (Heusmann 1974; Heusmann and Burrell 1974). Data on long-term changes in black duck:mallard ratios in wintering populations were presented by Johnsgard (1961*b*) and by Johnsgard and DiSilvestro (1976). Heusmann (1974) reported 10,000 mallards wintering in Massachusetts in January 1973, mostly in inland park areas (Fig. 21). In January 1978, 2,100 were counted in coastal Massachusetts and 12,000 in inland parks (Heusmann 1983). Inferences about movements,

Fig. 20. Illinois River Valley habitat about 10 miles south of Havana, Illinois. This area has a long history of duck hunting. (*Photo courtesy of Stephen P. Havera, Illinois Natural History Survey.*)

harvest rates, and survival rates of wintering park mallards are provided by the banding analyses of Heusmann and Burrell (1974) and of Heusmann (1981, 1983). Cronan and Halla (1968) also noted an increase in the number of mallards wintering in New England. Bellrose (1976) noted that Maine, Vermont, and New Hampshire wintered only a "few hundred" mallards.

Mid-Atlantic Flyway (33)

The Mid-Atlantic Flyway reference area includes New Jersey (Fig. 22), Delaware, Maryland, Virginia (Fig. 23), North Carolina, West Virginia, and most of Pennsylvania. Winter Survey data (1950–1978) indicated that this reference area generally winters 1–2% of North American mallards. Recoveries of birds banded in this reference area occurred in other Atlantic Flyway States to the north (e.g., New York, Connecticut, Rhode Island, and Massachusetts) and south (e.g., South Carolina; Fig. A-14; Table A-1). Many recoveries occurred in southwestern Quebec and southeastern Ontario; fewer occurred in southern Manitoba and southeastern Saskatchewan. The northern States of the Mississippi Flyway also contained many recoveries; in addition, some recoveries occurred in the Mississippi Alluvial Valley and in eastern North Dakota.

The Chesapeake Bay is one of the most important and famous traditional waterfowl wintering areas in the Atlantic Flyway. Stewart (1962) reported that January mallard populations in the Upper Chesapeake Bay during 1953–58 varied from about 16,000 to 151,000 and averaged 69,000. The mean winter population represented 24% of the Atlantic Flyway population but less than 1% of the continental total. During 1953–58, mallards represented about 6% of the Upper Chesapeake Bay wintering waterfowl population, as did American wigeon, redheads, and ruddy ducks (*Oxyura jamaicensis*; Stewart 1962). Of greater abundance were canvasbacks (*Aythya valisineria*; 18%), Canada geese (*Branta canadensis*; 17%), American black ducks (12%), and scaup (*Aythya marila* and *A. affinis*; 10%). During this period the largest mallard concentrations were found along the Chester River and in the Blackwater–Nanticoke River area, with smaller numbers in the Eastern Bay, Choptank River, and Upper Eastern Shore

Fig. 21. Parks such as this one at Flax Pond in Lynn, Massachusetts, are important mallard wintering areas in the northeastern United States. (*Photo by H. W. Heusmann, Massachusetts Division of Fisheries and Wildlife.*)

areas. Stewart (1962) noted that mallards seemed to prefer shallow estuarine bays that had agricultural land adjacent for field feeding.

Munro and Perry (1981) examined recent data on Chesapeake Bay waterfowl populations and found that the number of mallards wintering in Maryland during 1972–80 (average, 26,000) was considerably lower than that during 1956–71 (average, 42,000). For the period 1956–80, mallards ranked fifth in abundance among wintering waterfowl in Maryland, after Canada geese, canvasbacks, American black ducks, and scaup (Munro and Perry 1981). Primrose (1980) studied wintering waterfowl on the Magothy River, Maryland, and in adjacent areas of the Chesapeake Bay and identified mallards as the most abundant dabbling duck species. The Virginia mallard population during recent winters has been higher (1972–80 average, 20,000) than that of previous years (1961–71 average, 8,000). During 1956–80, mallards ranked third in abundance among wintering waterfowl in Virginia after Canada geese and American black ducks (Munro and Perry 1981). Local areas with the greatest mallard abundance were the Chester River and the Pamunkey River in Maryland (1956–71) and Virginia (1961–71), respectively (Munro and Perry 1981).

The abundance of submerged aquatic vegetation in the Chesapeake Bay has declined in recent years (Kerwin et al. 1976; Bayley et al. 1978; Orth and Moore 1981, 1983; Munro and Perry 1981). This decline has been linked to decreases in Chesapeake Bay waterfowl populations (Bayley et al. 1978; Carter and Haramis 1980; Primrose 1980; Perry et al. 1981; Munro and Perry 1981). Wintering mallard numbers appeared to be related to abundance of submerged aquatic vegetation in some areas of the Chesapeake Bay, and it is possible that declines in Bay mallard numbers are similarly associated with declines in vegetation (Munro and Perry 1981).

Uhler (1956) wrote that the principal wintering species at the Patuxent Wildlife Research Center in Maryland were ring-necked ducks, mallards, American black ducks, and Canada geese, in order of abundance.

Bellrose (1968) reported that 18,000 mallards wintered in northern coastal North Carolina. Sincock (1965) studied wintering waterfowl populations on Back Bay, Virginia, and Currituck

Fig. 22. Salt marsh in coastal New Jersey provides wintering habitat for some mallards. (*Photo by Michael J. Conroy, U.S. Fish and Wildlife Service.*)

Sound, North Carolina, 1958–62. He computed "wintering waterfowl-days" to estimate winter food consumption. The mallard ranked ninth among ducks in average days for the period 1958–61, after American wigeon, ring-necked ducks, ruddy ducks, American black ducks, canvasbacks, northern pintails, redheads, and green-winged teal (Sincock 1965). Critcher (1949) reported winter mallard numbers on Currituck Sound through the 1940's ranging from 1,000 to 5,000 and averaging 2,500 birds. During most of these winters, canvasbacks, redheads, American wigeon, ruddy ducks, northern pintails, ring-necked ducks, American black ducks, and lesser scaup were more abundant than mallards (Critcher 1949).

New Jersey Winter Survey data for 1950–78 averaged about 9,000 mallards. Figley and Van Druff (1982) studied a suburban mallard population on a lagoon development in coastal New Jersey during 1972–1976. The average number of mallards during four winter counts in 1973 was 761 birds, considerably higher than the counts for buffleheads and American black ducks, the second and third most abundant nondomestic duck species. However, counts in adjacent salt marsh areas in January and February 1973 indicated that American black ducks were 11 to 26 times more abundant in these natural areas than mallards (Figley and Van Druff 1982).

Southern Atlantic Flyway (34)

The Southern Atlantic Flyway reference area includes South Carolina, Georgia, and Florida. Winter Survey data indicate that about 1–2% of North American mallards wintered in this reference area, on the average, during 1950–78. Recoveries of birds banded in this reference area occurred primarily in the Atlantic and Mississippi flyways (Fig. A-15; Table A-1). Atlantic Flyway areas north of this reference area that had fair numbers of recoveries include North Carolina, Chesapeake Bay, Delaware Bay, Lake Ontario, and Lake Erie. In the Mississippi Flyway, recoveries were concentrated in the Mississippi Alluvial Valley and the Great Lakes region. Some Central Flyway recoveries occurred in eastern North and South Dakota. Canadian recoveries were concentrated in southeastern Ontario and in southern Manitoba and Saskatchewan.

South Carolina is the most important State for wintering mallards in this reference area and, indeed, in the entire Flyway. Addy (1964) and

Fig. 23. Salt marsh habitat in coastal Virginia. (*Photo by Holliday H. Obrecht, U.S. Fish and Wildlife Service.*)

Bellrose (1976) noted that more than half of the Atlantic Flyway mallard population wintered in this State. Bellrose (1976) reported that 110,000 mallards wintered in southeastern South Carolina. The coastal plain of South Carolina includes three major drainage systems: Combahee, Ashepoo, and Edisto rivers; Santee and Cooper rivers along with lakes Moultrie and Marion; and Black, Pee Dee, and Waccamaw rivers (Kerwin and Webb 1972). Kerwin and Webb (1972) sampled ducks throughout these three drainages and studied their food habits. They reported that fresh and slightly brackish marshes were the most important feeding areas for dabbling ducks, but that corn was also an important food for mallards. On the tidal impoundments studied by Landers et al. (1976) in the Combahee, Ashepoo, and Edisto river drainage, mallards, green-winged teal, blue-winged teal, and northern pintails were the most abundant species. At Santee National Wildlife Refuge (Fig. 24) in the Santee–Cooper river drainage, mallards, wood ducks, American wigeon, northern pintails, American black ducks, and green-winged teal were the most important species (McGilvrey 1966). Rakestraw (1981) reported that mallards on the Santee National Wildlife Refuge were associated with two reservoirs, adjacent farmland, and extensive river bottoms. Conrad (1966), working along the lower Pee Dee and Waccamaw rivers, found that mallards, green-winged teal, northern pintails, American black ducks, and wood ducks were the most important species in that area. Important winter species on impoundments near Georgetown, South Carolina, included canvasbacks, ring-necked ducks, lesser scaup, redheads, mallards, American black ducks, northern pintails, American wigeon, gadwall, and northern shovelers (Alexander and Hair 1979).

Winter Survey data for Georgia indicated an average (1950–78) of about 6,700 mallards. Bellrose (1968, 1976) reported that 5,000–7,000 mallards wintered in Florida. Chamberlain (1960) reported winter mallard counts for 1950–58 that ranged from 4,000 in 1950 to 83,000 in 1953 and averaged 34,000, or 2.4% of Florida's wintering waterfowl population. He stated that large mallard concentrations occurred only on ponds and lakes in northern Florida and that mallard occurrence

Fig. 24. Wintering mallard habitat on the Santee National Wildlife Refuge, South Carolina. (*Photo by Don Voros, U.S. Fish and Wildlife Service.*)

in central and southern Florida was inconsistent from year to year. Kushlan et al. (1982) summarized Christmas Bird Count data (1951–81) for an Everglades study area and reported that mallards occurred in 61% of the annual counts; the maximum number of birds seen was 45.

Sources of Variation in Winter Distribution Patterns

Questions about where North American mallards spend the winter and about sources of variation in their selection of wintering grounds are of interest from both management and biological points of view. A good general picture of the migration paths and wintering grounds for mallards from the various breeding areas throughout North America can be obtained from the band recovery distributions of winter-banded mallards (Appendix A; Martinson 1966; Geis 1971), the band recovery distributions of preseason-banded mallards in Anderson and Henny (1972), the data on distribution and derivation of the mallard harvest presented by Munro and Kimball (1982) and Geis (1971), and the distribution figures of Bellrose (1976). Band recovery distribution data for mallards banded during winter in specific locations are presented by Merrill (1967), Drewien (1968), Funk et al. (1971), Hopper et al. (1978), Hyland and Gabig (1980), Heusmann (1981), and Rakestraw (1981).

We use winter band recovery data from both preseason and winter bandings to investigate age-specific, sex-specific, and short- and long-term temporal variation in winter distribution patterns of North American mallards. The use of band recovery data to draw inferences about distribution patterns of birds has been discussed by Hickey (1951), Crissey (1955), Geis (1972), and Nichols et al. (1983). For the tests conducted here we believe that those involving age- and sex-specific variation yield the most reliable inferences, while those involving long-term temporal variation provide the most ambiguous results (*see* discussions under each test).

Sex- and Age-specific Variation

Background

Both the European and North American literature on mallards contain suggestions of differences between males and females in migration pathways and wintering areas. Nilsson (1976) summarized his own count data from Sweden as well as published data from throughout Europe, concluding that seasonal and regional variation in mallard sex ratios existed and that males tended to winter in more northern, continental, and exposed coastal areas than did females. Ogilvie and Cook (1971) earlier reported sex-specific differences in seasonal and geographic distributions of recoveries from mallards banded in Great Britain. Perdeck and Clason (1983) studied winter recoveries of mallards banded in the Netherlands and concluded that there was no difference in wintering area between the sexes. In North America, some workers have noted geographic differences in band recovery distributions from adult male and female mallards banded in specific areas during the preseason period (e.g., Gollop 1965; Anderson and Henny 1972; March and Hunt 1978; Weaver et al. 1979; Munro and Kimball 1982). Sex-specific differences have also been found in recovery distributions of young birds, but they appear to be much less pronounced than those of adults (Lensink 1964; Gollop 1965; Munro and Kimball 1982). North American workers have also examined other data sources, including counts, trap samples, and harvest samples, and concluded that there are sex-specific differences in migration and distribution patterns of mallards (Leopold 1919, 1920; Petrides 1944; Bellrose et al. 1961; Funk et al. 1971; Sugden et al. 1974). Bellrose et al. (1961) and Funk et al. (1971) presented evidence suggesting that male mallards in the Mississippi and Central flyways, respectively, may winter farther north than females. This tendency has been reported for a number of Anatid species in Europe and North America (*see* reviews in Nichols and Haramis 1980; Sayler and Afton 1981).

Several workers throughout North America have found differences between band recovery distributions of young versus adult mallards of the same sex banded preseason (Hickey 1951; Lensink 1964; Gollop 1965; March and Hunt 1978; Weaver et al. 1979; Munro and Kimball 1982). Bellrose et al. (1961) found regional variation in various estimates of mallard age ratios. Gollop (1965) presented evidence that adult female and young mallards from the same water areas near Kindersley, Saskatchewan, did not migrate together, and he suggested that young birds moved farther south and east than adults.

Table 3. *Age-sex class comparisons of direct winter recovery distribution patterns by reference area.*[a]

	Adult male vs. Young male				Adult male vs. Adult female				Adult female vs. Young female				Young male vs. Young female			
Reference area	n^c	χ^2	*df*	*P*	*n*	χ^2	*df*	*P*	*n*	χ^2	*df*	*P*	*n*	χ^2	*df*	*P*
Central Mackenzie (021)	-	-	-	-	-	-	-	-	-	-	-	-	36	1.57	2	0.46
SW Alberta (031)	33	3.20	2	0.20	-	-	-	-	-	-	-	-	136	10.48	8	0.23
NE Southern Alberta-SW Saskatchewan (041)	483	20.21	10	0.03	101	8.32	2	0.02	131	9.29	2	0.01	739	19.61	14	0.14
SE Saskatchewan (051)	44	3.47	2	0.18	-	-	-	-	-	-	-	-	88	0.01	2	1.00
SW Manitoba (061)	228	13.89	6	0.03	94	0.61	2	0.74	43	1.80	2	0.41	52	0.69	2	0.71
E Ontario-W Quebec (081)	339	19.07	6	0.00	49	4.64	2	0.10	124	5.17	4	0.27	930	13.78	18	0.74
W Washington (091)	-	-	-	-	-	-	-	-	-	-	-	-	49	5.94	2	0.05
N California (101)	406	30.76	12	0.00	-	-	-	-	-	-	-	-	131	5.47	4	0.24
E South Dakota (132)	-	-	-	-	63	1.71	2	0.43	-	-	-	-	-	-	-	-
W Minnesota (133)	68	0.08	2	0.96	-	-	-	-	-	-	-	-	176	4.55	6	0.60
Wisconsin-N Illinois (142)	-	-	-	-	102	0.36	4	0.99	-	-	-	-	-	-	-	-
Michigan-N Ohio-N Indiana (143)	-	-	-	-	-	-	-	-	-	-	-	-	143	3.03	4	0.55
Western Mid-Atlantic (151)	-	-	-	-	-	-	-	-	57	4.34	2	0.11	72	3.13	2	0.21
Total[d]	1,601	44.22	14	0.00	409	15.31	10	0.12	355	18.05	8	0.02	2,552	23.77	22	0.36

[a]These tests used samples of mallards banded preseason in the specified reference areas. The null hypothesis was that the geographic distribution of winter direct recoveries was equivalent for the two age-sex classes tested. Mardia's (1967) test was used.

[b]Preseason reference areas and codes of Anderson and Henny (1972).

[c]*n* denotes the number of recoveries included in the test.

[d]The total χ^2 value was computed as $-2 \sum_{i=1}^{m} \ln P_i$ with $2m$ degrees of freedom. P_i denotes the probability associated with reference area i of the m total areas.

Methodology

To address questions about sex- and age-specific variation in winter distribution patterns, we tested for differences in the winter band recovery distributions of mallards banded preseason in specific breeding areas during specific years. Only direct recoveries from the December–February period were used in this analysis. A minimum of 10 recoveries from each of the two age–sex classes in each comparison was required for inclusion in the analysis. Mardia's (1967) test was used to test the null hypothesis of equivalent winter band recovery distribution patterns. Two separate analyses were conducted for recoveries of birds banded (1) in specific preseason reference areas (Anderson and Henny 1972), and (2) in specific degree blocks. In each analysis, some banding areas were represented by several banded samples and tests (i.e., for some comparisons in some areas the sample size criterion was met by several specific banding years), while others were represented by only a single test. Summary test statistics for banding areas with more than one sample were obtained by summing the chi-square statistics and degrees of freedom associated with the individual year comparisons. Continental summary test statistics were computed using the probabilities associated with each banding area test statistic (summary statistic is computed as

$$-2 \sum_{i=1}^{m} \ln P_i$$

and is distributed as chi-square with $2m$ degrees of freedom where i denotes banding area, P_i denotes probability level, and m is the total number of reference areas; *see* Sokal and Rohlf 1969) and essentially give each banding area equal weight, regardless of the number of individual year comparisons in each area.

Results and Discussion

Results of the age–sex class comparisons of winter recovery distribution patterns are presented for the reference area analysis (Table 3) and, in summary form, for the degree block analysis (Table 4). The test for sex-specific variation in winter distribution pattern was provided by the young male versus young female and adult male versus adult female comparisons. Young male and female mallards from specific breeding areas exhibited very similar recovery distribution patterns the first winter after banding. The null hypothesis of similar distributions could not be rejected ($P > 0.10$) despite the large samples and resultant high power (relative to the other age–sex comparisons) of the test. The comparison of adult male versus adult female recovery distributions also yielded nonsignificant continental test statistics ($P > 0.10$), although the probability levels were lower than those resulting from the comparisons of young mallards (Tables 3 and 4).

Our results indicate that within an age class, male and female mallards exhibit similar band recovery distribution patterns. These results suggest that differences in total hunting season (fall and winter) recovery distribution patterns of adult males versus adult females found by other North American workers (Gollop 1965; Anderson and Henny 1972; March and Hunt 1978; Weaver et al. 1979; Munro and Kimball 1982) result mostly from differences in the timing of migration rather than in ultimate wintering ground destination. When we examined the mean latitudes of the adult winter recovery distributions compared in Table 3, we found that the mean for males was greater (farther north) than that for females in four of the six distributions. This is not significantly different from the proportion (three of six) expected under the null hypothesis. In the reference area (041) yielding the test statistic with the lowest probability level (Table 3), the mean latitude of the female recovery distribution was slightly north of that for males.

We were surprised by the apparent absence of sex-specific differences in winter band recovery distributions. Male mallards are generally thought to winter farther north than females, and Funk et al. (1971) presented "preliminary results" of January counts in the Central Flyway indicating "extremely high proportions of males" in the north to "nearly equal sex ratios" in the south. We believe it is interesting that European workers who have examined direct counts of wintering mallards (Nilsson 1976) have noted higher proportions of males in northern areas, whereas workers who have investigated winter band recovery distribution patterns (Perdeck and Clason 1983) have found no sex-specific differences.

There are several possible explanations for the apparent differences between our results and those of Funk et al. (1971). First, we note that while

December–February band recoveries provide a good sampling of most important mallard wintering areas, extreme northern wintering areas are not as well-represented in our recovery samples as are mid-latitude and southern areas. In some northern wintering areas hunting seasons occasionally ended before December during some years (Martin and Carney 1977), although such occurrences were relatively rare. Differences in sex-specific tendencies to winter in extreme northern areas may have gone undetected by our tests. It has also been suggested to us that perhaps the selectivity of hunters for the two sexes might vary by latitude in a manner that might obscure true distributional differences. Another possibility is that direct counts of birds may tend to sample different proportions of males and females at different latitudes. Male and female mallards exhibit differences in habitat selection within wintering areas (Jorde 1981; Ferguson et al. 1981; Rabenberg 1982; Heitmeyer and Vohs 1984), and these differences could result in different probabilities of the sexes appearing in aerial or ground counts of these areas (Rabenberg 1982). If either the relative availability of different habitats or the actual selection of habitat by the birds changed with latitude, then sex ratio data from such counts might be misleading.

The above scenarios concern the possibility that either winter band recovery distributions or direct counts are yielding misleading results. It is also possible that inferences resulting from both methodologies are correct, and that the apparent inconsistency results from the fact that they address slightly different questions. In the band recovery analyses we try to determine whether males and females from the same breeding grounds also winter in the same places. But direct counts are used to determine whether different sex ratios exist in different wintering areas, without respect to the breeding ground origin of the birds involved. If different areas throughout the mallard breeding range exhibit different sex ratios at the time of banding (i.e., July–September), then males and females of similar breeding ground origin could travel to the same wintering grounds and still produce latitudinal variation in sex ratio during the winter. It is also possible that males and females from certain breeding areas exhibit similar winter distributions whereas birds from other areas show large differences, and that our banded samples happened to come from the former group.

The apparent similarity of winter distribution patterns of the two sexes indicated by our analyses is consistent with a recent hypothesis of Hepp and Hair (1984). They emphasized the importance of pairing chronology to winter distribution of the sexes, and suggested that early-pairing Anatid species should exhibit less wintering ground segregation than late-pairing species. The mallard is generally thought to pair early (i.e., in fall and early winter; *see* Johnsgard 1960; Weller 1965; Barclay 1970), and our finding of similar winter distributions thus fits this prediction. Perdeck and Clason (1983) also suggested that early pair formation in the mallard may be responsible for the observed wintering ground similarity.

The test for age-specific variation in winter distribution pattern was provided by the adult male versus young male and adult female versus young female comparisons. Results of the female

Table 4. *Summary statistics for age–sex class comparisons of direct winter recovery distribution patterns by degree block of banding.*[a]

Comparison	Sample size: Degree blocks	Sample size: Recoveries	Test statistic[b]: χ^2	Test statistic[b]: *df*	Test statistic[b]: *P*
Adult male vs. young male	10	938	23.59	20	0.26
Adult female vs. young female	4	169	18.20	8	0.02
Adult male vs. adult female	7	547	19.21	14	0.16
Young male vs. young female	12	867	18.08	24	0.80

[a]These tests used samples of mallards banded preseason in specific degree blocks. The null hypothesis was that the geographic distribution of winter direct recoveries was equivalent for the two age–sex classes tested. Mardia's (1967) test was used.

[b] The total χ^2 value was computed as $-2 \sum_{i=1}^{m} \ln P_i$ with $2m$ degrees of freedom. P_i denotes the probability associated with degree block i of the m total blocks.

comparisons were unambiguous, as the continental test statistics in both the reference area and degree block analyses indicated rejection ($P < 0.05$) of the null hypothesis (Tables 3 and 4). However, only one of four reference area test statistics and one of four individual degree block test statistics were significant ($P < 0.10$). In the comparison of adult male versus young male distributions, the continental test statistic for the reference area analysis strongly indicated rejection ($P < 0.01$) of the null hypothesis (Table 3), while the continental test statistic for the degree block analysis was not significant (Table 4). In general, the degree block tests involved smaller banded samples than the reference area tests and were thus less powerful. However, the degree block tests have the advantage of precluding possible geographic variation in the banding locations of the groups being tested which might lead to incorrect inferences. For example, in a reference area test it would be possible for most of the young males to come from the eastern portion of the reference area and most of the adults from the western portion. If the winter recovery distribution patterns of the adults were found to be centered farther west than that of young birds, then we would not know whether this resulted from age-specific migration differences or from banding location differences. We examined the geographic banding distributions of young and adult males within each reference area for each year compared in Table 3 and concluded that in most instances they were very similar. This similarity, and the fact that 2 of the 10 individual degree block test statistics indicated significant rejection of the null hypothesis ($P = 0.02$, $P = 0.06$), lead us to tentatively conclude that there is a tendency (at least in some areas) for young and adult males to exhibit slight differences in wintering grounds.

Gollop (1965) and Martinson and Hawkins (1968) reported evidence from banded young broodmates and adult female mallards that adult and young birds often migrate independently, sometimes to different wintering grounds. In a discussion of mallard migration behavior, Bellrose and Crompton (1970) presented their "foster-parent hypothesis" which asserts that young birds become associated with groups of adults (often from different breeding areas) on premigration staging areas. Bellrose and Crompton (1970) suggested that these chance associations of young and adult birds from different breeding areas can result in the young birds following the adults to different wintering grounds from those of their parents. This hypothesis provides a potential explanation for our observed differences in young versus adult winter recovery distribution patterns. Young mallards may also be more responsive to environmental variables than adults when selecting wintering ground locations (*see* Nichols et al. 1983). Adult mallards may tend to return to the same wintering grounds as in previous years and thus attain any advantages associated with site familiarity. Young birds cannot realize potential advantages associated with wintering ground familiarity and might thus be more influenced by environmental factors. Young birds might also simply exhibit different physiological tolerances to certain climatic conditions than adults, and this could also lead to age-specific differences in winter distribution patterns.

If young from a particular breeding area tend to consistently reach staging areas (or attain migratory readiness on those areas) at the same time as adults from other specific breeding areas, then we might expect the winter recovery distributions of young birds to differ from those of adults of the same reference areas in some consistent manner (e.g., young consistently farther south and east than adults, as for the Kindersley mallards of Gollop 1965). We might also expect consistent differences between winter distributions of young and adult mallards, if the age classes respond differently to climatic conditions. For example, young birds might migrate farther south than adults if they were less able than adults to withstand stressful winter weather conditions (e.g., because of body size differences; *see* Calder 1974).

We compared the geographic centers of the adult and young recovery distributions used in Table 3. In 10 of the 25 comparisons represented in Table 3, the center of the adult recovery distribution was farther north than that of young mallards. Similarly, in 10 of the 25 comparisons, adults were recovered farther west than the young. These proportions are not significantly different from expectation under a null hypothesis of no consistent directional difference between adult and young recovery distribution centers. However, it still might be possible for adults and young from specific breeding areas (rather than continentally) to exhibit consistent wintering ground differences.

We considered this possibility for reference areas having three or more years of data represented in the analysis of Table 3.

No consistent differences occurred between wintering distributions of young and adult mallards banded in NE Southern Alberta–SW Saskatchewan (041; Table 3). During some years, young mallards were recovered substantially farther south and east than adults, but during other years adult recoveries were centered farther south and east. Winter recoveries of birds banded in specific degree blocks in this reference area also showed temporal variation in the difference between the age classes. Winter recoveries from SW Manitoba (061; Table 3) were available for males for 3 years and females for 1 year. The adult males were recovered farther east than the young during all 3 years. Winter recoveries from both adults and young from this reference area were massed around the lower Mississippi River Valley, but adult recoveries were consistently more prevalent (though still not numerous) in coastal areas of the mid-Atlantic States and the southeastern United States. Similarly, adult male recoveries from birds banded in E Ontario–W Quebec (081; Table 3) were consistently (3 years of data) more closely associated with the Atlantic coast than those of young males, which were found more frequently along the Ohio and Mississippi River valleys. However, there were no consistent differences between the recovery distributions of young and adult females from this area. Among birds banded in N California (101) young males were consistently (6 of 6 tested years) recovered slightly farther north than adult males, although the majority of recoveries from both groups occurred in the Central Valley of California.

Short-term Temporal Variation

Background

The mallard literature contains conflicting reports about whether or not birds return to the same wintering areas year after year. Similarities of first winter versus subsequent winter band recovery distribution patterns have led some workers to conclude that mallards generally tend to return to the areas in which they spend their initial winter (Munro 1943; Cartwright and Law 1952; Boyd and Ogilvie 1961; Crissey 1965; Gollop 1965; Martinson 1966; Drewien 1968). In fact, Munro (1943) concluded from his mallard studies in the Pacific Northwest that "... units of population remain together on the wintering ground in successive years and, presumably, visit the same localities to nest in summer." However, Pullianen (1963) and Nilsson (1973) noted variations in winter mallard counts in areas of Scandinavia and suggested that they were associated with winter weather conditions. Examinations of band recovery distributions of North American mallards led Lensink (1964) and Bellrose and Crompton (1970) to conclude that the direction of migration from breeding areas was constant from year to year for some populations, but that wintering ground latitude varied in response to weather and perhaps food availability. Bellrose and Crompton (1970; *see also*, Martinson 1966) suggested that such "flexible homing behavior" was characteristic of mallards in the Mississippi migration corridor (Bellrose 1968). Hopper et al. (1978) examined the winter recovery distributions of mallards banded during winter in Colorado and concluded that subadults exhibited "a relatively weak association with a particular migration route or wintering area."

Methodology

We used two general types of hypothesis tests to address questions about possible temporal variation in wintering areas of specific groups of mallards. We used Mardia's (1967) test (in conjunction with mallards banded preseason in specific years) to test the hypothesis that the distribution pattern of bands recovered during the first winter after banding (direct recoveries) was similar to that of bands recovered during subsequent winters (indirect recoveries). As in the previous analyses, we defined the winter recovery period as extending from December to February. A minimum of 10 recoveries from each of the two classes (direct and indirect) was required for inclusion in the analysis. Separate analyses were again conducted using (1) preseason reference areas and (2) specific degree blocks as the banding areas. Summary test statistics for specific areas and North America were computed in the same manner as for the age-sex class comparisons.

Additionally, we conducted tests directed at the possible age- and sex-specificity of temporal variation in winter distribution patterns, by using winter banding data and corresponding band recoveries. We examined the proportion of band recoveries from the first winter after banding

(December–February) occurring in the general area of banding, and asked whether these proportions differed among the age–sex classes for specific areas. Although tests based on single years of banding would have been preferable, we could not obtain enough recoveries in this manner. Therefore, we chose combinations of years for each banding area such that there were at least 20 total recoveries with at least 7 in each of the compared age–sex classes. Also, we limited the banding periods to years in which reasonable numbers of birds were banded in each of the age–sex classes being compared. In one analysis we used winter banding reference areas as both the banding and recovery areas of interest. In the other analysis we examined specific degree blocks of banding and computed the proportion of subsequent winter recoveries occurring in the banding block and the eight degree blocks immediately surrounding it. Conditional (conditioned on the number of recoveries for the tested groups) z statistics (Snedecor and Cochran 1967) were computed for each banding area. Composite statistics for all areas were computed as:

$$Z = \sum_{i=1}^{n} z_i / \sqrt{n}$$

where z_i is the statistic for banding area i, and n is the number of areas.

Results and Discussion

Significant ($P < 0.10$) differences were found between the direct and indirect winter recovery distribution patterns of male mallards (both adult and young) in both the reference area (Table 5) and degree block (Table 6) analyses. Nonsignificant test statistics were obtained for adult females in both analyses (Tables 5 and 6). The two analyses yielded conflicting results for young females, with the reference area analysis indicating a significant difference ($P = 0.03$), and the degree block analysis showing no difference ($P = 0.44$).

We are interested in using these tests of similarity of direct versus indirect recovery distribution patterns to draw inferences about temporal variation in winter distribution patterns of mallards. However, such tests could be affected by substantial changes in hunting regulations occurring in some portions of the wintering grounds but not in others. We examined hunting regulations in the periods and States of interest for banding areas that showed significant test statistics (Tables 5 and 6) and subjectively concluded that such major regulation changes were probably not important in influencing results of these tests. The significant test statistics thus suggest that mallards do not necessarily return to the same wintering areas every year. Such changes may indeed represent responses to weather or food availability, as hypothesized by Bellrose and Crompton (1970). Recently, we tested this hypothesis for mallards wintering in the Mississippi Alluvial Valley and concluded that environmental variables (e.g., winter temperature and water conditions) do influence distribution patterns in at least some winters (Nichols et al. 1983).

Although we did find evidence of temporal variation in winter distribution patterns, it is important to place this inference in proper perspective. In all age–sex classes there were a number of reference areas showing nonsignificant test statistics, and hence similar recovery distributions over the years (Tables 5 and 6). In most of the instances in which significant test statistics were obtained, the geometric centers of the direct and indirect recovery distributions were very close (often < 1 degree latitude or longitude), and plots of the distributions also had similar general appearances. We conclude that mallards exhibit some temporal variation in wintering grounds, but that such variation is relatively small and that mallards do indeed exhibit a tendency to return to general wintering areas year after year (*see also* Martinson 1966).

We used the tests of recoveries from winter bandings (Tables 7 through 11) to ask whether the degree of temporal variation that occurs in wintering areas is a function of age–sex class. The proportions of winter recoveries occurring in the general area of banding differed significantly ($P < 0.01$) for adult and subadult males in 2 of 10 reference areas (Table 7). In 9 of the 10 tested areas, the actual proportion of recoveries occurring in the banding reference area was greater for adult males than for subadult males, and the composite statistic for North America was significant (Table 7). In the degree block analysis, 5 of the 10 degree block test statistics were significant ($P < 0.10$), as was the continental statistic ($P < 0.01$), and proportions of recoveries in the area of interest were higher for adults in all 10 tests (Table 11). In the adult female versus subadult

Table 5. *Direct versus indirect winter recovery distribution test results by preseason reference area of banding.*[a]

	Male								Female							
	Adult				Young				Adult				Young			
Reference area	n[b]	χ^2	*df*	*P*	*n*	χ^2	*df*	*P*	*n*	χ^2	*df*	*P*	*n*	χ^2	*df*	*P*
SW Alberta (031)	437	18.94	12	0.09	91	1.24	2	0.54	–	–	–	–	44	0.09	2	0.96
NE Southern Alberta–SW Saskatchewan (041)	1,393	51.29	30	0.01	1,150	47.71	26	0.01	58	2.26	2	0.32	569	23.83	14	0.05
SE Saskatchewan (051)	193	7.93	6	0.24	119	4.40	4	0.35	–	–	–	–	61	3.15	2	0.21
SW Manitoba (061)	516	23.51	14	0.05	94	2.38	4	0.67	–	–	–	–	–	–	–	–
E Ontario–W Quebec (081)	161	3.06	4	0.55	1,163	81.61	18	0.00	–	–	–	–	538	19.18	14	0.16
N California (101)	1,216	22.89	30	0.82	377	14.43	12	0.27	–	–	–	–	–	–	–	–
Central California (102)	–	–	–	–	131	5.46	4	0.24	–	–	–	–	–	–	–	–
Idaho (111)	63	5.42	2	0.07	66	1.97	2	0.37	–	–	–	–	–	–	–	–
W Montana (112)	–	–	–	–	132	13.46	4	0.01	–	–	–	–	–	–	–	–
E Montana (121)	63	4.35	2	0.11	–	–	–	–	–	–	–	–	–	–	–	–
E North Dakota (131)	327	5.21	8	0.73	–	–	–	–	–	–	–	–	–	–	–	–
E South Dakota (132)	55	0.81	2	0.67	–	–	–	–	62	0.19	2	0.91	–	–	–	–
W Minnesota (133)	62	0.08	2	0.96	379	16.91	10	0.08	–	–	–	–	56	0.65	2	0.72
Wisconsin–N Illinois (142)	175	6.39	4	0.17	56	2.64	2	0.27	117	5.98	4	0.20	–	–	–	–
Michigan–N Ohio–N Indiana (143)	–	–	–	–	263	10.74	6	0.10	–	–	–	–	–	–	–	–
Western Mid-Atlantic (151)	–	–	–	–	78	2.10	2	0.35	–	–	–	–	61	7.71	2	0.02
NE United States (161)	–	–	–	–	100	14.76	4	0.01	–	–	–	–	23	4.34	2	0.11
Total[c]	4,661	39.34	24	0.03	4,199	98.96	28	0.00	237	5.66	6	0.46	1,352	25.70	14	0.03

[a]These tests used samples of mallards banded preseason in the specified reference areas. The null hypothesis was that the geographic distribution of winter direct recoveries was equivalent to that of winter indirect recoveries. Mardia's (1967) test was used.

[b]n denotes the number of recoveries included in the test.

[c]The total χ^2 value was computed as $-2 \sum_{i=1}^{m} \ln P_i$ with $2m$ degrees of freedom. P_i denotes the probability associated with reference area i of the m total areas.

Table 6. *Summary statistics for comparisons of direct versus indirect winter recovery distribution patterns by degree block of banding.*[a]

Age–sex class	Sample size: Degree blocks	Sample size: Recoveries	Test statistic[b]: χ^2	*df*	*P*
Adult male	21	4,076	57.47	42	0.06
Adult female	4	347	3.84	8	0.87
Young male	21	1,802	77.71	42	0.00
Young female	7	504	14.16	14	0.44

[a]These tests used samples of mallards banded preseason in specific degree blocks. The null hypothesis was that the geographic distribution of winter direct recoveries was equivalent to that of winter indirect recoveries. Mardia's (1967) test was used.

[b]The total χ^2 value was computed as $-2 \sum_{i=1}^{m} \ln P_i$ with $2m$ degrees of freedom. P_i denotes the probability associated with degree block i of the m total blocks.

female comparisons, one of four areas showed a significant ($P < 0.01$) test statistic in both the reference area and degree block analyses (Tables 8 and 11). An examination of the actual recovery proportions, especially for the degree block analysis, suggests larger proportions of adults near the banding area (Tables 8 and 11). The composite test statistic for the reference area analysis approached significance ($P = 0.16$; Table 8), and that for the degree block analysis was significant ($P < 0.01$; Table 11). The composite test statistic for the reference area analysis with adult males and females was barely significant ($P = 0.10$; Table 9), but the degree block analysis showed no

Table 7. *Comparison of first winter recoveries from winter-banded adult and subadult males occurring in and out of the reference area of banding.*

Reference area	Years	Subadults: Total recoveries	Subadults: Proportion in reference area	Adults: Total recoveries	Adults: Proportion in reference area	Test statistic: *z*	Test statistic: *P*[a]
E Utah–W Colorado (225)	1974–77	25	0.72	18	0.78	-0.43	0.67
W North Dakota–W South Dakota (242)	1969–76	36	0.39	55	0.78	-3.99	0.00
SE Wyoming–W Nebraska (251)	1968–69	16	0.75	23	0.87	-0.93	0.35
NE Colorado (252)	1968–77	179	0.56	220	0.83	-5.85	0.00
SE Colorado (253)	1968–77	17	0.53	27	0.63	-0.66	0.51
E New Mexico (261)	1968–77	43	0.74	40	0.78	-0.33	0.74
E Arkansas–W Tennessee–NW Mississippi (302)	1971–77	29	0.62	72	0.63	-0.04	0.97
E Tennessee (303)	1968–77	42	0.19	41	0.29	-1.09	0.28
SE Missouri–S Illinois–SW Indiana–W Kentucky (313)	1972–77	44	0.18	52	0.14	0.63	0.53
Georgia–South Carolina (341)	1973–77	27	0.67	37	0.68	-0.08	0.94
Totals and mean proportions		458	0.54	585	0.64	-4.04	0.00

[a]Probabilities correspond to a 2-tailed *z*-test.

Table 8. *Comparison of first winter recoveries from winter-banded adult and subadult females occurring in and out of the reference area of banding.*

Reference area	Years	Subadults: Total recoveries	Subadults: Proportion in reference area	Adults: Total recoveries	Adults: Proportion in reference area	Test statistic: z	Test statistic: P[a]
NE Colorado (252)	1968–77	58	0.50	63	0.78	-3.31	0.00
E New Mexico (261)	1969–77	11	0.73	10	0.60	0.62	0.54
W Arkansas– W Tennessee– NW Mississippi (302)	1971–77	16	0.69	12	0.58	0.57	0.57
Georgia–South Carolina (341)	1973–77	22	0.73	27	0.82	0.72	0.47
Totals and mean proportions		107	0.66	112	0.70	-1.42	0.16

[a]Probabilities correspond to a 2-tailed z-test.

indication of a difference (Table 11). No evidence of a sex-specific difference was found for subadults in either analysis (Tables 10 and 11).

Although these test results are certainly not unequivocal, we suggest that they reflect a greater tendency of adult mallards to return to traditional wintering areas. The tests provided a fairly clear indication of greater temporal variation in winter distribution patterns of subadult versus adult males. Subadult females also appeared to exhibit greater variation than adult females, although the evidence was not as clear as that for males. These results are consistent with those of Hopper et al. (1978) and with their hypothesis that "these inexperienced birds may be influenced more easily than adults to stray in their second year when coming in contact with birds utilizing different migration routes and wintering areas" (Hopper et al. 1978).

The tests using recoveries of winter bandings provided little evidence in adult birds of a sex-specific difference in tendency to return to general wintering areas and no evidence in young birds. This lack of a difference between adult males and adult females initially does not seem to fit well with the results of Tables 5 and 6, which suggested temporal variation in winter distribution patterns of adult males, but not for adult females. However, all tests with adult females are characterized by very small sample sizes and consequent low power. We have no evidence to suggest that adult males

Table 9. *Comparison of first winter recoveries from winter-banded adult males and females occurring in and out of the reference area of banding.*

Reference area	Years	Males: Total recoveries	Males: Proportion in reference area	Females: Total recoveries	Females: Proportion in reference area	Test statistic: z	Test statistic: P[a]
W North Dakota– W South Dakota (242)	1969–76	55	0.78	8	0.38	2.26	0.02
NE Colorado (252)	1968–77	220	0.83	63	0.78	0.85	0.40
SE Colorado (253)	1968–76	25	0.64	11	0.55	0.53	0.60
E New Mexico (261)	1969–77	38	0.76	10	0.60	0.96	0.34
W Arkansas– W Tennessee– NW Mississippi (302)	1971–77	72	0.63	12	0.58	0.27	0.79
Georgia–South Carolina (341)	1972–77	49	0.67	33	0.76	-0.84	0.40
Totals and mean proportions		459	0.72	137	0.61	1.65	0.10

[a]Probabilities correspond to a 2-tailed z-test.

Table 10. *Comparison of first winter recoveries from winter-banded subadult males and females occurring in and out of the reference area of banding.*

Reference area	Years	Males: Total recoveries	Males: Proportion in reference area	Females: Total recoveries	Females: Proportion in reference area	Test statistic: z	Test statistic: P[a]
W North Dakota–W South Dakota (242)	1971–77	35	0.46	7	0.43	0.14	0.89
SE Wyoming–W Nebraska (251)	1966–76	52	0.67	10	0.40	1.63	0.10
NE Colorado (252)	1964–77	235	0.56	83	0.48	1.19	0.23
E New Mexico (261)	1966–77	52	0.75	14	0.79	−0.29	0.77
W Arkansas–W Tennessee–NW Mississippi (302)	1967–77	69	0.68	41	0.73	−0.57	0.57
E Tennessee (303)	1967–77	48	0.25	18	0.17	0.77	0.44
Georgia–South Carolina (341)	1967–77	73	0.69	52	0.71	−0.32	0.75
Totals and mean proportions		564	0.58	225	0.53	0.96	0.34

[a]Probabilities correspond to a 2-tailed z-test.

and females do not exhibit similar degrees of variation in winter distribution patterns.

Long-term Temporal Variation

Background

Mallards can rapidly exploit new wintering habitats, and this sometimes results in relatively rapid, but long-lasting, shifts in wintering ground locations. Such shifts are not only of interest biologically but are also important and sometimes controversial from management and political perspectives (Yancey 1976). Some of the more dramatic local shifts of the past three decades resulted from the creation of "new" habitats. For example, extensive water-control developments and subsequent grain production along the Columbia and Snake rivers in Oregon, Washington, and Idaho produced a nearly fourfold

Table 11. *Summary statistics for comparisons of the proportions of recoveries occurring near the degree block of banding.*[a]

Comparison (A vs. B)	Sample size: Degree blocks	Sample size: Recoveries	Prop. A> Prop. B[b]	Test statistic: z[c]	Test statistic: P[d]
Adult male vs. subadult male	10	797	10	6.25	0.00
Adult female vs. subadult female	4	153	4	2.58	0.01
Adult male vs. adult female	6	430	2	−0.02	0.98
Subadult male vs. subadult female	7	639	5	0.86	0.39

[a]The recovery area of interest included the degree block of banding and the eight degree blocks immediately surrounding it.
[b]Number of degree blocks in which the proportion of recoveries near the banding block was greater for age–sex class A than for class B.
[c]Positive z indicates a greater proportion of recoveries near the banding block for age–sex class A.
[d]Probabilities correspond to a 2-tailed z-test.

Table 12. *Comparison of direct winter recovery distribution patterns of mallards banded preseason 1950-58 versus 1966-76.*[a]

	Male								Female							
	Adult				Young				Adult				Young			
Reference area	n[b]	χ^2	*df*	*P*	n	χ^2	*df*	*P*	n	χ^2	*df*	*P*	n	χ^2	*df*	*P*
Central MacKenzie (021)	30	2.05	2	0.36	79	4.83	2	0.09	–	–	–	–	65	0.95	2	0.62
NE British Columbia-NW Alberta (022)	–	–	–	–	58	2.61	2	0.27	26	2.07	2	0.35	63	1.18	2	0.55
SW Alberta (031)	239	0.34	2	0.84	166	6.53	2	0.04	37	2.16	2	0.34	109	1.51	2	0.47
NE Southern Alberta-SW Saskatchewan (041)	578	15.40	2	0.00	585	11.27	2	0.00	161	7.93	2	0.02	460	3.08	2	0.21
SE Saskatchewan (051)	199	21.44	2	0.00	139	4.33	2	0.11	–	–	–	–	119	2.38	2	0.30
SW Manitoba (061)	363	7.93	2	0.02	253	0.99	2	0.61	107	10.69	2	0.00	183	0.52	2	0.77
E Ontario-W Quebec (081)	–	–	–	–	653	2.95	2	0.23	–	–	–	–	401	5.21	2	0.07
W Washington (091)	–	–	–	–	101	5.28	2	0.07	42	7.11	2	0.03	66	18.40	2	0.00
E Washington (092)	–	–	–	–	89	11.82	2	0.00	–	–	–	–	90	10.00	2	0.01
W Oregon (093)	–	–	–	–	57	1.98	2	0.37	27	1.05	2	0.59	41	2.87	2	0.24
E Oregon (094)	94	0.87	2	0.65	128	17.27	2	0.00	53	1.43	2	0.49	82	4.74	2	0.09
N California (101)	579	7.68	2	0.02	382	1.82	2	0.40	180	4.40	2	0.11	136	9.18	2	0.01
Central California (102)	76	10.40	2	0.01	232	27.62	2	0.00	54	7.39	2	0.02	118	16.17	2	0.00
Idaho (111)	79	4.16	2	0.12	83	5.57	2	0.06	–	–	–	–	42	2.33	2	0.31
Utah (114)	35	0.83	2	0.66	–	–	–	–	–	–	–	–	–	–	–	–
E Montana (121)	76	2.97	2	0.23	40	4.49	2	0.11	–	–	–	–	–	–	–	–
S Central Colorado (127)	–	–	–	–	–	–	–	–	57	4.95	2	0.08	64	3.39	2	0.14
E North Dakota (131)	204	3.08	2	0.21	78	1.48	2	0.49	–	–	–	–	47	9.82	2	0.01
E South Dakota (132)	–	–	–	–	44	0.69	2	0.71	–	–	–	–	61	2.83	2	0.24
W Minnesota (133)	134	1.02	2	0.60	260	10.44	2	0.01	88	4.30	2	0.12	199	5.43	2	0.07
E Minnesota-E Iowa (141)	–	–	–	–	79	1.87	2	0.39	–	–	–	–	–	–	–	–
Michigan-N Ohio-N Indiana (143)	–	–	–	–	291	4.80	2	0.09	–	–	–	–	235	0.17	2	0.92
Western Mid-Atlantic (151)	–	–	–	–	197	18.00	2	0.00	81	6.14	2	0.05	169	14.23	2	0.00
Chesapeake Bay Region (152)	–	–	–	–	37	1.34	2	0.51	–	–	–	–	–	–	–	–
NE United States (161)	–	–	–	–	171	3.95	2	0.14	–	–	–	–	140	14.42	2	0.00
Total	2,686	78.17	26	0.00	4,202	151.93	46	0.00	913	59.62	24	0.00	2,890	129.35	42	0.00

[a]These tests used samples of mallards banded preseason in the specified reference areas. The null hypothesis was that the geographic distribution of winter direct recoveries was equivalent for the banding periods 1950–58 and 1966–76. Mardia's (1967) test was used.

[b]n denotes the number of recoveries included in the test.

increase in mallards wintering in this area during the 1950's and early 1960's (Buller 1975; Ball et al. 1979). Reservoir construction and other water resource projects are believed to be largely responsible for the substantial increases in mallards wintering in Kansas over the last two decades (Buller 1975).

At the continental level, Anderson and Henny (1972) compared mallard recovery distributions of the 1950's with those of the 1960's for some breeding reference areas. Although they noted some differences, it is difficult to interpret their results in terms of wintering grounds, because their recovery data spanned the entire hunting season. Johnsgard (1961*b*) used Audubon Society Christmas count data to conclude that mallards were increasing relative to black ducks in Eastern States and that the mallard was "invading the East." He suggested that these changes were caused by increases in breeding habitat resulting from changes in land-use patterns. Mallard harvest estimates provide some evidence that proportionally more mallards are now being shot in Southern States than in previous decades Martin and Carney 1977; MBMO files; but *see* Yancey 1976).

Methodology

We addressed the question of whether or not there have been long-term shifts in mallard winter distribution patterns by testing for differences in first year winter band recovery distributions between the two periods, 1950–58 and 1966–76. These periods are separated by the drought years of 1959 and the early 1960's. We used Mardia's (1967) test in conjunction with direct recoveries of birds banded in specific breeding areas during these periods. A minimum of 10 recoveries during each of the two time periods was required for the analysis. Separate analyses were again conducted on birds banded in specific (1) breeding reference areas and (2) degree blocks. Continental summary test statistics were computed by summing chi-square statistics and their associated degrees of freedom.

Results and Discussion

A number of reference areas for each age–sex class showed significant ($P < 0.10$) differences between winter recovery distribution patterns occurring during the two periods, and the continental test statistics for all age–sex classes were highly significant ($P < 0.01$; Table 12). Shifts in banding locations within reference areas could have caused these differences, but the significant ($P < 0.05$) summary statistics in the degree block analysis suggest that this was not the case (Table 13). As in our tests for short-term temporal variation, changes in hunting regulations in certain parts of the wintering grounds could have been partially responsible for the observed differences. Again, the actual centers of the recovery distributions were generally very close, despite the significant test statistics.

We used the centers of the recovery distributions from the two periods to look for major directional shifts in wintering distributions at the continental level. Mean latitude of the 1966–76 recovery distribution was farther south than that of the 1950–58 distribution in 13 of 23 reference areas for young males (not significantly different from that expected under a null hypothesis of equal numbers of differences in each direction, $P > 0.10$, 2-tailed binomial test), 13 of 20 reference areas for young females ($P > 0.10$), 9 of 13 for adult males ($P > 0.10$), 5 of 12 for adult females ($P > 0.10$), and 40 of 68 for all age–sex classes combined ($P > 0.10$). Mean longitude of the 1966–76 recovery distribution was farther east than that of the 1950–58 distribution in 7 of 23 reference areas for young males ($P = 0.09$), 9 of 21 for young females ($P > 0.10$), 9 of 13 for adult males ($P > 0.10$), 4 of 12 ($P > 0.10$) for adult females, and 29 of 69 for all age–sex classes combined ($P > 0.10$). Thus, we did not find evidence of a consistent directional shift in winter distribution patterns at the continental level.

There is probably no reason to expect mallards throughout North America to exhibit wintering ground shifts in the same direction. Instead, we would expect shifts to occur in response to such factors as habitat changes in the potential wintering areas associated with particular breeding grounds. We examined the recovery distribution centers for the two periods, 1950–58 and 1966–76, for groups of breeding reference areas that share common wintering grounds in broad regions of North America. This examination suggested that birds from the prairie breeding reference areas of Canada and the United States (reference areas 031, 041, 051, 061, 121, 131, 132, and 133; Anderson and Henny 1972) generally exhibited more southerly winter recovery distributions in 1966–76 than in 1950–58. Among these reference areas, the mean latitude of the 1966–76 winter recovery distribution pattern was farther south than that of 1950–58 in 6 of 8 areas for young males ($P > 0.10$, 2-tailed binomial test), 7 of 7 areas for young females ($P = 0.02$), 6 of 7 areas for adult males ($P > 0.10$), 3 of 4 areas for adult females ($P > 0.10$), and 22 of 26 for all classes combined ($P < 0.01$).

We believe that interpreting results of the long-term temporal variation analyses is more difficult than interpreting results of the short-term temporal variation and sex- and age-specific variation analyses. This difficulty results from the greater possibility that long-term temporal variation in winter band recovery distribution patterns reflects changes in geographic patterns of hunting pressure, as well as changes in actual distribution patterns of mallards. We conclude that winter band recovery distributions, and probably actual mallard distribution patterns, differed between the tested periods. Because of the substantial changes that have occurred in important areas of mallard wintering habitat in the last three decades, we expected some change in distribution patterns. However, we found no evidence of a general tendency for mallards from specific breeding areas to winter farther eastward in recent years. Therefore, recent increases in wintering mallard populations in the east probably result from increases in eastern breeding populations (Johnsgard 1961*b*), rather than simply from eastward shifts in wintering grounds. Finally, we found evidence that winter band recovery distributions of prairie-banded mallards are centered farther south now than in the 1950's, a result consistent with mallard harvest survey data, but we do not know whether this is a result of hunting pressure changes, mallard distribution changes, or both.

Sources of Variation in Survival and Recovery Rates

Survival rates, reproductive rates, and rates of migration in and out of a population are the fundamental parameters that determine the rate of population change. For population management, we would like to obtain estimates of these parameters and, more important, to learn something of the functional relationships affecting them (Martin et al. 1979). Survival rate estimates based on preseason banding data have some advantages over estimates based on winter bandings. A bird banded during winter must survive the period between winter and the beginning of the next hunting season (i.e., 30 January–1 September) to have a chance of being recovered. The period between banding and the beginning of the hunting season is much shorter for a bird banded preseason (i.e., 15 August–1 September), and a bird's probability of surviving it is thus much higher. For this reason, birds banded preseason generally have higher recovery rates (*see Terminology and Definitions*) than birds banded during winter. The precision of the Brownie et al. (1978) survival rate estimates is directly dependent on recovery rate; therefore, survival estimates based on preseason bandings tend to be more precise than those based on winter bandings. Nichols et al. (1982*b*) studied the effects of heterogeneity of survival and recovery rates on band recovery model estimates and concluded that the resulting bias in survival

Table 13. *Summary statistics for comparisons of direct winter recovery distributions of mallards banded preseason 1950–58 versus 1966–76, by degree block of banding.*[a]

Age–sex class	Sample size		Test statistic		
	Degree blocks	Recoveries	χ^2	*df*	*P*
Adult male	11	1,623	49.26	22	0.00
Adult female	4	305	18.63	8	0.02
Young male	9	1,249	43.02	18	0.00
Young female	10	817	59.18	20	0.00

[a]These tests used samples of mallards banded preseason in the specified degree blocks. The null hypothesis was that the geographic distribution of winter direct recoveries was equivalent for the two time periods tested. Mardia's (1967) test was used.

rate estimates would probably be larger and more difficult to detect with winter banding data. Survival rate estimates based on winter bandings also are not as useful as those based on preseason bandings for some tests of the compensatory versus additive mortality hypotheses (cf. Anderson and Burnham 1976). The problem arises because we do not know when any density-dependent compensatory changes in nonhunting mortality might occur. Compensatory changes in response to the hunting season of year t could occur either before or after the anniversary date (30 January, year $t+1$) of our survival rate estimates. If such changes occur before the anniversary date, then they will be reflected in the survival estimate for year t, $\hat{S}_t$. However, if they occur after the anniversary date, then $\hat{S}_t$ will reflect harvest in hunting season t and compensatory changes in nonhunting mortality occurring in response to the hunting season of year $t-1$ (*see* related discussion in Conroy and Eberhardt 1983). The ability to interpret results of any test for a relationship between survival rates and harvest rates or some other indicator of hunting intensity would be severely limited.

Despite these disadvantages, however, survival rate estimates based on winter bandings should provide important insights into the biology and management of mallard populations. For example, we should be better able to associate a banded sample with a particular set of hunting regulations if banding is done in the winter. Winter-banded birds have probably spent a substantial portion of the hunting season in the general area in which they are banded, and certain questions about the relationship between survival rates and area-specific regulations can be better addressed in this situation than with preseason bandings. Furthermore, winter bandings of known-age birds can provide insight into the timing of age-specific mortality that cannot be obtained by preseason banding alone. Finally, because preseason and winter bandings provide independent estimates of adult survival rate, they can be used in comparisons to gain insight into the accuracy of these estimates.

Survival and recovery rate estimates for mallards (all ages combined) banded during winter are presented by minor reference area in Appendix B. When interpreting these estimates, it is important to recall the definition of recovery rate. These recovery rate estimates are not comparable to those based on preseason data and are not necessarily closely associated with harvest rates or hunting intensity. The subsequent tests dealing with sources of variation in survival and recovery rates are based on the estimates in Appendix B.

Age-specific Variation

Background

Information about the age-specificity of survival and recovery rates of winter-banded birds is useful in making inferences about the timing of age-specific mortality. Young mallards banded preseason have lower survival rates than adults (Anderson 1975). If winter-banded subadults were found to have lower survival rates than winter-banded adults, then we could infer that birds less than 1 year old experience greater mortality than adults (> 1 year old) during the period, 30 January–15 August. However, if winter-banded subadults and adults exhibit the same survival rates, then we would infer that the greater mortality risks experienced by young preseason-banded birds relative to adults must all occur during the general period 15 August–30 January.

Until the mid-1960's, mallards banded during winter were typically classified as adults because no reliable techniques were available for determining age of birds in the field. Preseason aging criteria based on tail feather appearance and cloacal examination were known to be invalid for winter work (Hochbaum 1942; Kortright 1942). In the late 1950's, S. M. Carney developed a technique for aging mallard wings (Carney and Geis 1960; Carney 1964), and this led to the initiation of the Parts Collection Survey (Martin and Carney 1977). In the winter of 1964 (December 1963–February 1964), Hopper and Funk (1970) began using Carney's technique to determine ages of banded mallards in Colorado. The wing technique was validated (Hopper and Funk 1970) for field use and is now in common use in winter banding operations throughout North America.

Two analyses dealing with the question of age-specificity of survival and recovery rates in winter-banded mallards have already been published. Hopper et al. (1978) analyzed the data set from Colorado, 1964–1972, and found no evidence that survival or recovery rates differed between subadults and adults. Rakestraw (1981) analyzed data from mallards banded during winter at the Santee National Wildlife Refuge, South Carolina, and also found no evidence of age-specificity in these rates. However, Anderson (1975) used an entirely different test with preseason-banded mallards and suggested that second-year birds may "have at least a slight tendency to have different survival or recovery rates" than either first-year birds or birds in their third (or later) year of life. A number of variables associated with reproduction have been shown to differ between first-year and older female mallards (Krapu and Doty 1979). Because of the mortality risks believed to be associated with reproduction in mallards (Sargeant 1972; Johnson and Sargeant 1977; Bailey 1981), these age-specific reproductive differences may result in corresponding mortality differences. It is also relevant that age-specificity of population parameters has been noted in some wintering diving ducks. G. M. Haramis (personal communication) recently completed a large-scale capture–recapture experiment on wintering canvasbacks in Chesapeake Bay and found that subadult birds had lower survival rates than adults. Longwell and Stotts (1959) banded diving ducks (*Aythyini*) during the winter in Chesapeake Bay, 1952–1957, and found higher recovery rates for subadult lesser scaup and canvasbacks than for adults.

Methodology

Because aging techniques for winter mallards are relatively new, there has been some confusion about the proper age codes to assign these birds. Age code "5" is defined (U.S. Fish and Wildlife Service 1976) as "A bird known to have hatched in the calendar year preceding the year of banding and in its second calendar year of life." This definition corresponds to our definition of "subadult" for winter-banded birds, and most banders are believed to have applied this age code appropriately. However, confusion exists about which age codes to assign winter-banded "adults." The appropriate age code for these birds is "6": "A bird known to have hatched earlier than the calendar year preceding the year of banding; year of hatch otherwise unknown" (U.S. Fish and Wildlife Service 1976). However, we are aware of some instances in which adults in January–February banding operations were assigned age code "1," defined as "A bird known to have hatched before the calendar year of banding" (U.S. Fish and Wildlife Service 1976). Age code "1" is the correct assignment for an adult banded preseason, and even for an adult banded in December, but it is not appropriate for an adult banded in January–February. Age code "1" actually includes both winter-banded adults and subadults by our definitions of these categories, and thus provides no information on the age of winter-banded birds. In the following analyses we used age code "5" birds as subadults and age code "6" birds as adults.

We used these samples of aged, winter-banded birds to test the null hypothesis that subadults and adults have similar survival and recovery rates versus the alternative hypothesis that survival or recovery rates, or both, differ between the two age classes. We used the test of model H_0 versus H_1 described by Brownie et al. (1978). Model H_0 assumes that survival and recovery rates vary from one year to the next but that they are the same for adults and subadults (i.e., the model assumes no age-specificity). Model H_1 also assumes year-specific survival and recovery rates but additionally assumes age-specificity of these rates. We only performed the H_0 versus H_1 test on data sets that adequately fit model H_1, as assessed by a goodness-of-fit test (Brownie et al. 1978). Sex-specific H_0 versus H_1 tests were conducted on data from each reference area. These test statistics are distributed as χ^2, and composite test statistics (over all reference areas) were obtained by summing the reference area statistics and their degrees of freedom.

Results and Discussion

Estimates of adult and subadult survival and recovery rates under model H_1 are presented in Tables 14 and 15, together with χ^2 statistics for the H_0 versus H_1 test. Of the 19 male and female data sets only 2 showed any evidence ($P < 0.10$) of age-specificity in survival and recovery rates. In both instances the mean adult survival rate was somewhat higher than that for subadults. The composite test statistics provided no evidence of any age-specificity. We examined the mean estimates of survival and recovery rates to determine if the two age classes exhibited consistent differences. Of the 19 data sets, 7 (binomial probability, P_B, of obtaining a result this extreme if there were no consistent differences between the two age classes is $P_B = 0.36$) exhibited higher survival rates for the adults, and 12 ($P_B = 0.36$) showed higher recovery rates for adults (Tables 14 and 15). We conclude that there is no evidence of a difference between survival and recovery rates of adult and subadult winter-banded mallards. We are thus able to pool these age categories and to also include birds of unknown age in all subsequent analyses.

Among preseason-banded mallards, adults have higher survival rates than young, with the difference being more pronounced in males (Anderson 1975). The absence of age-specific survival rate differences in winter-banded birds suggests that this difference in mortality risk must occur during the interval separating the preseason and winter banding periods (i.e., during 15 August–30 January). Because this period includes the hunting season and because young mallards banded preseason have higher harvest rates than adults (Anderson 1975), one might be tempted to conclude that the additional hunting mortality experienced by young mallards is the basis for the difference in survival rates between the age groups. However, there is little evidence of a relation between annual survival rates and harvest rates of young (or adult) mallards (Anderson and Burnham 1976; Rogers et al. 1979; Anderson et al. 1982; Nichols and Hines 1983; Burnham and Anderson 1984; Burnham et al. 1984), considerably weakening the hypothesis that hunting is largely responsible for the difference between young and adult survival rates. Even if this evidence is ignored and it is assumed that hunting mortality is additive (Anderson and Burnham 1976), the difference between estimated kill rates of young and adult mallards is not large enough to account for the entire difference in annual survival rate estimates (Anderson 1975). Nonhunting mortality rates must also differ age-specifically.

Rakestraw (1981) suggested that the energetic demands associated with the autumn molt and migration may result in greater physiological stress in young mallards than in adults. A "cost" or increased mortality risk associated with migration is implicitly or explicitly assumed in most hypotheses dealing with the evolution of avian migration (Lack 1944, 1954; Cohen 1967; Cox 1968; von Haartman 1968; Gauthreaux 1978; Greenberg 1980). Little direct evidence of such a cost has been accumulated, but Ketterson and Nolan (1976) speculated that potential risks include increased predation in unfamiliar stopover sites, severe weather, and difficulty in finding sufficient food in unfamiliar locations. Greenberg (1980) argued that young birds are much more affected by such migrational risks than adults, and has postulated "heavy juvenile mortality associated with first migrations." There is no direct

Table 14. *Results of testing the hypothesis that subadult and adult winter-banded male mallards have similar survival and recovery rates.*[a]

Reference area	Banding years	$\bar{\hat{S}}$	$\bar{\hat{S}}'$	$\bar{\hat{f}}$	$\bar{\hat{f}}'$	*df*	χ^2	*P*
W North Dakota–W South Dakota (242)	1969–76	0.675	0.778	0.038	0.037	16	15.19	0.51
N Wyoming (243)	1974–76	1.066	1.522	0.025	0.046	6	9.65	0.14
NE Colorado (252)	1968–77	0.754	0.761	0.041	0.037	19	20.62	0.36
SE Colorado (253)	1968–77	0.753	0.869	0.028	0.028	19	12.67	0.86
E New Mexico (261)	1968–77	0.670	0.708	0.040	0.038	19	9.10	0.97
E Oklahoma (281)	1972–74	0.907	0.813	0.033	0.032	6	5.39	0.49
E Texas (282)	1973–75	0.684	0.555	0.034	0.043	6	3.02	0.81
S Iowa–W Missouri (292)	1968–73	0.699	0.677	0.045	0.051	12	24.53	0.02
E Arkansas–W Tennessee–NW Mississippi (302)	1971–77	0.707	0.801	0.041	0.039	13	18.30	0.15
Georgia–South Carolina (341)	1973–77	0.623	0.702	0.051	0.055	9	7.96	0.54
All areas						125	126.43	0.45

[a]Mean adult and subadult survival rates are denoted $\bar{S}$ and $\bar{S}'$, respectively, and mean adult and subadult recovery rates are denoted $\bar{f}$ and $\bar{f}'$. These estimates are based on model H_1 (Brownie et al. 1978). Test statistic is based on the test of model H_0 vs. H_1 (Brownie et al. 1978).

evidence of high nonhunting mortality among young mallards during fall migration, and such evidence probably would be difficult and expensive to obtain. However, we do note that young mallards appear to exhibit greater flexibility in wintering-ground location than adults and that the young seem to be more responsive to environmental cues when migrating south and selecting wintering areas (Nichols et al. 1983). This suggests either that young are more susceptible to adverse environmental conditions than adults or that adults attain substantial advantages from migration route and wintering ground fidelity. Either situation could produce an age-specific difference in survival probability during fall migration and early winter.

Because recovery rates of winter-banded birds reflect both January–August survival and harvest rate or hunting intensity, it is often difficult to draw specific inferences from these recovery rate estimates. However, if the survival rates of winter-banded adults and subadults are the same and if we can assume no major differences in the timing of mortality (i.e., when mortality occurs during the year), then if the two ages experience similar recovery rates we can infer that harvest rates and vulnerability to hunting are probably also similar for the two ages.

We recognize that the similarity of adult and subadult survival and recovery rates could be used to argue against the practice of aging winter-banded mallards. However, we concur with Hopper et al. (1978) and recommend that aging be continued. Our age-specific comparisons of winter distribution patterns and similar work by Hopper et al. (1978) suggest that differences do exist in the wintering grounds and possibly the migration routes of subadults versus adults. Any major changes that might occur either in mortality risks or hunting intensity in specific areas would thus tend to affect ages differentially, depending on the age-specific differences in use of the affected areas. The practice of aging birds in winter banding operations will permit the periodic testing of hypotheses about age-specificity and prevent our overlooking any age-specific differences that might occur in the future. We do suggest that sample sizes for winter banding programs designed to estimate survival rate, be developed assuming that age classes will be pooled. If age-specific differences are later found to exist, then future experiments can be designed accordingly.

Finally, we discourage any attempts to generalize our results on age-specificity to other waterfowl species. Anatids appear to exhibit substantial variation in life history characteristics (Patterson 1979), and differences in degree of age-specificity of population parameters are expected. The finding of different survival and recovery rates for subadult and adult diving ducks on the

Table 15. *Results of testing the hypothesis that subadult and adult winter-banded female mallards have similar survival and recovery rates.*[a]

Reference area	Banding years	$\bar{\hat{S}}$	$\bar{\hat{S}}'$	$\bar{\hat{f}}$	$\bar{\hat{f}}'$	*df*	χ^2	*P*
E Utah–W Colorado (225)	1974–77	0.511	0.455	0.027	0.023	7	6.98	0.43
W North Dakota–W South Dakota (242)	1971–73	0.463	0.558	0.022	0.018	6	3.61	0.73
NE Colorado (252)	1968–77	0.635	0.698	0.019	0.020	19	25.86	0.13
SE Colorado (253)	1970–76	0.528	0.483	0.011	0.018	14	9.43	0.80
E New Mexico (261)	1969–77	0.523	0.373	0.027	0.026	17	11.30	0.84
E Oklahoma (281)	1972–74	0.230	0.566	0.031	0.019	6	4.02	0.67
S Iowa–W Missouri (292)	1968–72	0.704	0.771	0.022	0.024	10	13.65	0.19
E Arkansas–W Tennessee–NW Mississippi (302)	1971–77	0.627	0.879	0.026	0.025	13	12.61	0.48
Georgia–South Carolina (341)	1973–77	0.531	0.448	0.044	0.032	9	15.35	0.08
All areas						101	102.81	0.40

[a]Mean adult and subadult survival rates are denoted $\bar{S}$ and $\bar{S}'$, respectively, and mean adult and subadult recovery rates are denoted $\bar{f}$ and $\bar{f}'$. These estimates are based on model H_1 (Brownie et al. 1978). Test statistic is based on the test of model H_0 vs. H_1 (Brownie et al. 1978).

Chesapeake Bay (G. M. Haramis, personal communication; Longwell and Stotts 1959) illustrates this possibility.

Sex-specific Variation

Background

Early studies on mallard population dynamics disagreed on whether survival and harvest rates differed between the sexes (Munro 1943; Bellrose and Chase 1950; Hickey 1952*a*). Geis et al. (1969) used the methods of Hickey (1952*b*) to estimate survival rates of mallards banded during winter throughout North America and generally found higher survival and recovery rates among males. Anderson (1975) applied the estimation and hypothesis-testing methodologies of Brownie et al. (1978) to mallards banded preseason and concluded that adult males have higher survival and recovery rates than adult females. Young males had higher recovery rates than young females, but no sex-specific difference in survival rates of young birds was found. Anderson (1975) suggested that young males may actually have slightly higher survival rates than young females, and that his finding of no difference probably resulted from small sample sizes. Males and females have been treated separately in applications of the Brownie et al. (1978) band recovery models to winter bandings of mallards (Hopper et al. 1978; Hyland and Gabig 1980; Rakestraw 1981). Female survival and recovery rate estimates appeared lower than those for males in these three studies, and Rakestraw (1981) tested and rejected the hypothesis of equal survival and recovery rates of the two sexes.

Methodology

For each minor reference area, we selected sets of years having adequate banding and recovery data for both males and females. We used the contingency table test of Brownie et al. (1978) to test the null hypothesis of no difference between survival and recovery rates of the two sexes. A statistic was computed for each minor reference area, and a composite statistic was computed by summing these individual statistics and their associated degrees of freedom. This test involved both survival and recovery rates. We were also interested in asking questions about sex-specific differences in each of these parameters, separately. Sex-specific comparisons of survival rates and recovery rates were thus conducted using z statistics (Brownie et al. 1978) in conjunction with the parameter and variance estimates of Appendix B. These tests were restricted to mean survival and recovery rate estimates for males and females, corresponding to exactly the same years. A statistic was computed for each minor reference area, and a composite statistic was computed as

$$Z = \sum_{i=1}^{n} z_i \,/\sqrt{n}$$

where z_i is the z statistic associated with reference area i and n is the number of reference areas tested. Like z, Z is distributed as Normal (0, 1) under the null hypothesis.

Results and Discussion

Results of the contingency table tests of Brownie et al. (1978) indicated strong rejection of the null hypothesis in virtually every data set in all reference areas, and the composite statistic was highly significant ($P < 0.01$; Table 16). These results indicated a sex-specific difference in either survival rates, recovery rates, or both. When mean survival rate estimates over comparable time periods were tested, significant ($P < 0.10$) differences were found in 23 of the 59 data sets (Table 17). Of the 59 data sets, male survival rate estimates were higher than female estimates in 55, a result which would be extremely unlikely (binomial probability, $P_B < 0.01$) if there was no tendency for males to have higher survival rates. The composite Z statistic was highly significant ($P < 0.01$), and the overall mean survival rate estimate for males was nearly 0.11 greater than that for females (Table 17). The comparisons of mean recovery rates showed significant differences in 38 of the 59 data sets (Table 18). Male recovery rate estimates were larger than those for females in all but 5 of the 59 data sets ($P_B < 0.01$). The composite Z statistic was highly significant ($P < 0.01$), and the overall mean estimate for males was 0.015 greater than that for females (Table 18). We conclude that both survival and recovery rates of winter-banded mallards are greater for males than females. This conclusion is consistent with that of Anderson (1975) based on preseason-banded mallards, and with the analyses of Hopper

Table 16. *Results of testing the hypothesis that male and female winter-banded mallards have similar survival and recovery rates.*[a]

Reference area	Year	χ^2	*df*	*P*
S British Columbia–W Washington (201)	1933–36	14.99	10	0.13
	1960–62	26.50	10	0.00
E Washington–NE Oregon (202)	1949–57	184.60	24	0.00
	1958–77	434.15	39	0.00
W Oregon–NW California (203)	1951–70	252.46	39	0.00
SE Oregon–NE California–NW Nevada (204)	1950–52	17.76	7	0.01
	1957–64	76.66	20	0.00
	1966–69	61.84	11	0.00
Central California–W Nevada (211)	1953–68	243.17	35	0.00
	1971–77	90.51	13	0.00
W Idaho (221)	1950–53	57.63	13	0.00
	1958–61	49.83	11	0.00
	1966–77	117.21	23	0.00
W Montana (222)	1949–52	28.37	12	0.00
	1964–70	109.84	18	0.00
E Idaho–SW Wyoming (223)	1963–77	151.80	29	0.00
NE Nevada–W Utah (224)	1966–70	43.69	13	0.00
E Utah–W Colorado (225)	1974–77	33.75	7	0.00
S Nevada–S California–W Arizona (231)	1963–68	40.03	15	0.00
E Montana (241)	1964–67	150.57	11	0.00
W North Dakota–W South Dakota (242)	1940–43	9.02	10	0.53
	1969–77	146.79	17	0.00
N Wyoming (243)	1964–67	53.44	13	0.00
	1969–72	31.14	9	0.00
	1974–76	19.70	6	0.00
SE Wyoming–W Nebraska (251)	1964–76	291.93	26	0.00
NE Colorado (252)	1945–52	420.73	22	0.00
	1964–77	984.20	27	0.00
SE Colorado (253)	1949–52	117.29	14	0.00
	1966–77	204.36	23	0.00
S Central Colorado (254)	1950–52	56.07	11	0.00
	1961–64	38.67	14	0.00

Table 16. *Continued*

Reference area	Year	χ^2	*df*	*P*
W Kansas (255)	1936–38	13.84	12	0.31
	1966–68	63.90	11	0.00
	1972–75	47.16	8	0.00
E New Mexico (261)	1966–77	181.09	23	0.00
W Oklahoma–W Texas (262)	1972–77	19.67	11	0.05
E South Dakota (271)	1951–55	42.81	13	0.01
	1960–67	144.17	21	0.00
E Nebraska (272)	1952–57	52.91	15	0.00
	1966–74	166.11	20	0.00
E Kansas (273)	1930–32	7.57	8	0.48
	1963–70	184.89	21	0.00
	1974–77	44.66	7	0.00
E Oklahoma (281)	1939–45	27.57	17	0.05
	1947–57	131.55	26	0.00
	1966–77	270.03	23	0.00
E Texas (282)	1964–68	32.32	12	0.00
	1973–77	33.93	9	0.00
S Minnesota–N Iowa (291)	1971–77	23.90	13	0.03
S Iowa–W Missouri (292)	1952–57	25.59	15	0.04
	1963–73	232.73	24	0.00
E Arkansas–W Tennessee–NW Mississippi (302)	1950–58	53.47	20	0.00
	1963–77	493.57	29	0.00
E Tennessee (303)	1953–55	9.35	7	0.23
	1959–73	416.39	33	0.00
	1975–77	16.16	5	0.01
E Louisiana–SW Mississippi (305)	1954–57	29.29	11	0.00
E Mississippi–Alabama (306)	1955–61	19.67	16	0.24
	1963–72	135.47	23	0.00
	1975–77	18.16	5	0.00
N Illinois–N Indiana–SW Michigan (311)	1958–61	16.00	12	0.19
	1963–70	137.11	21	0.00
	1972–74	45.48	8	0.00
SE Great Lakes Region (312)	1961–77	97.56	33	0.00
SE Missouri–S Illinois–SW Indiana–W Kentucky (313)	1922–24	6.23	9	0.72
	1955–72	693.45	37	0.00
	1975–77	34.01	5	0.00

Table 16. *Continued*

Reference area	Year	χ^2	*df*	*P*
SE Indiana-S Ohio-E Kentucky (314)	1967-74	97.40	18	0.00
North-Atlantic States (321)	1963-76	46.67	28	0.01
Mid-Atlantic States (332)	1954-57	53.81	13	0.00
	1958-77	358.31	39	0.00
North Carolina (333)	1955-57	8.76	9	0.46
	1961-73	64.97	28	0.00
	1975-77	2.45	5	0.78
Georgia-South Carolina (341)	1963-77	419.46	29	0.00
Total		9,578.30	1,304	0.00

[a]*See* Brownie et al. (1978).

Table 17. ***Results of testing the hypothesis that male and female winter-banded mallards have similar mean survival rates.***

		Mean survival rate estimate				
Reference area	Years	Males	Females	Difference	*z*	*P*[a]
E Washington-NE Oregon (202)	1949-56	0.608	0.524	0.084	3.13	0.00
	1958-76	0.633	0.619	0.014	0.60	0.55
W Oregon-NW California (203)	1951-69	0.599	0.550	0.049	1.28	0.20
SE Oregon-NE California-NW Nevada (204)	1950-51	0.686	0.421	0.265	1.39	0.16
	1957-63	0.678	0.583	0.095	1.38	0.17
	1966-68	0.688	0.559	0.129	0.87	0.39
Central California-W Nevada (211)	1949-50	0.554	0.522	0.032	0.19	0.85
	1953-67	0.642	0.594	0.048	1.68	0.09
	1971-76	0.617	0.543	0.074	1.02	0.31
W Idaho (221)	1950-52	0.765	0.588	0.177	1.89	0.06
	1958-60	0.791	0.481	0.310	2.67	0.01
	1966-76	0.635	0.631	0.004	0.05	0.96
W Montana (222)	1964-69	0.672	0.642	0.030	0.51	0.61
E Idaho-SW Wyoming (223)	1963-76	0.735	0.738	-0.003	-0.02	0.99
NE Nevada-W Utah (224)	1966-69	0.629	0.516	0.113	1.12	0.26
E Utah-W Colorado (225)	1974-76	0.700	0.551	0.149	1.53	0.13

Table 17. *Continued.*

Reference area	Years	Mean survival rate estimate: Males	Females	Difference	z	P[a]
S Nevada–S California–W Arizona (231)	1963–67	0.658	0.698	-0.040	-0.30	0.77
E Montana (241)	1964–66	0.660	0.485	0.175	1.32	0.19
W North Dakota–W South Dakota (242)	1969–76	0.689	0.547	0.142	2.83	0.00
SE Wyoming–W Nebraska (251)	1965–75	0.686	0.617	0.069	1.96	0.05
NE Colorado (252)	1964–76	0.730	0.620	0.110	6.26	0.00
SE Colorado (253)	1949–51	0.669	0.605	0.064	1.12	0.26
W Kansas (255)	1972–74	0.739	0.357	0.382	3.09	0.00
E New Mexico (261)	1966–76	0.684	0.559	0.125	2.33	0.02
W Oklahoma–W Texas (262)	1972–76	0.798	0.624	0.174	0.84	0.40
E South Dakota (271)	1951–54	0.623	0.447	0.176	2.27	0.02
	1960–66	0.686	0.538	0.148	3.70	0.00
E Nebraska (272)	1952–56	0.637	0.525	0.112	2.52	0.01
	1966–73	0.707	0.649	0.058	1.31	0.19
E Kansas (273)	1930–31	0.661	0.913	-0.252	-0.94	0.35
	1965–69	0.691	0.623	0.068	0.96	0.34
E Oklahoma (281)	1939–44	0.535	0.486	0.049	0.83	0.41
	1947–56	0.584	0.579	0.005	0.12	0.91
	1966–76	0.730	0.611	0.119	2.35	0.02
E Texas (282)	1973–76	0.671	0.510	0.161	0.85	0.39
S Minnesota–N Iowa (291)	1971–76	0.667	0.507	0.160	1.40	0.16
S Iowa–W Missouri (292)	1952–56	0.682	0.555	0.127	1.32	0.19
	1963–72	0.683	0.586	0.097	2.49	0.01
E Arkansas–W Tennessee–NW Mississippi (302)	1963–76	0.686	0.591	0.095	3.58	0.00
E Tennessee (303)	1959–72	0.626	0.553	0.073	2.71	0.01
	1975–76	0.724	0.361	0.363	1.96	0.05
W Louisiana (304)	1976	0.555	0.177	0.378	2.52	0.01
E Louisiana–SW Mississippi (305)	1939–40	0.457	0.543	-0.086	-0.44	0.66
	1954–56	0.642	0.564	0.078	0.53	0.60
	1976	0.628	0.468	0.160	0.59	0.55

Table 17. *Continued.*

Reference area	Years	Mean survival rate estimate: Males	Females	Difference	z	P^a
E Mississippi-Alabama (306)	1955–60	0.679	0.493	0.186	1.87	0.06
	1963–71	0.645	0.630	0.015	0.16	0.87
N Illinois-N Indiana-SW Michigan (311)	1958–60	0.656	0.482	0.174	1.33	0.18
	1963–69	0.648	0.556	0.092	1.99	0.05
SE Great Lakes Region (312)	1961–76	0.650	0.486	0.164	2.33	0.02
SE Missouri-S Illinois-SW Indiana-W Kentucky (313)	1922–23	0.485	0.429	0.056	0.40	0.69
	1963–71	0.677	0.561	0.116	7.05	0.00
SE Indiana-S Ohio-E Kentucky (314)	1967–73	0.662	0.588	0.074	1.30	0.19
North-Atlantic States (321)	1963–75	0.654	0.585	0.069	1.30	0.19
Mid-Atlantic States (332)	1954–56	0.573	0.563	0.010	0.10	0.92
	1958–76	0.664	0.552	0.112	5.13	0.00
North Carolina (333)	1955–56	0.622	0.501	0.121	0.67	0.50
	1961–68	0.647	0.536	0.111	1.15	0.25
	1975–76	0.612	0.511	0.101	0.35	0.73
Means and composite z		0.656	0.550	0.106	12.30	0.00

[a]Probabilities correspond to a 2-tailed z-test.

Table 18. *Results of testing the hypothesis that male and female winter-banded mallards have similar mean recovery rates.*

Reference area	Years	Mean recovery rate estimate: Males	Females	Difference	z	P^a
E Washington-NE Oregon (202)	1949–57	0.069	0.050	0.019	4.86	0.00
	1958–76	0.066	0.037	0.029	12.38	0.00
W Oregon-NW California (203)	1951–69	0.090	0.068	0.022	4.80	0.00
SE Oregon-NE California-NW Nevada (204)	1950–52	0.065	0.054	0.011	0.57	0.57
	1957–63	0.069	0.047	0.022	2.80	0.01
	1966–68	0.069	0.053	0.016	1.07	0.29
Central California-W Nevada (211)	1949–50	0.061	0.017	0.044	3.57	0.00
	1953–67	0.059	0.038	0.021	6.75	0.00
	1971–76	0.098	0.051	0.047	4.74	0.00

Table 18. *Continued.*

Reference area	Years	Mean recovery rate estimate		Difference	z	P[a]
		Males	Females			
W Idaho (221)	1950–53	0.051	0.047	0.004	0.61	0.54
	1958–61	0.039	0.027	0.012	1.95	0.05
	1966–77	0.054	0.033	0.021	5.03	0.00
W Montana (222)	1964–69	0.038	0.028	0.010	2.87	0.00
E Idaho-SW Wyoming (223)	1963–76	0.042	0.029	0.013	3.89	0.00
NE Nevada-W Utah (224)	1966–69	0.064	0.041	0.023	3.35	0.00
E Utah-W Colorado (225)	1974–76	0.038	0.023	0.015	3.00	0.00
S Nevada-S California-W Arizona (231)	1963–67	0.069	0.041	0.028	2.73	0.01
E Montana (241)	1964–66	0.027	0.018	0.009	1.50	0.13
W North Dakota-W South Dakota (242)	1969–77	0.042	0.022	0.020	7.15	0.00
SE Wyoming-W Nebraska (251)	1965–76	0.038	0.016	0.022	11.21	0.00
NE Colorado (252)	1964–76	0.040	0.021	0.019	16.04	0.00
SE Colorado (253)	1949–52	0.034	0.034	-0.000	-0.12	0.90
W Kansas (255)	1972–74	0.034	0.016	0.018	3.14	0.00
E New Mexico (261)	1966–76	0.039	0.023	0.016	4.83	0.00
W Oklahoma-W Texas (262)	1972–77	0.021	0.014	0.007	1.62	0.11
E South Dakota (271)	1951–54	0.062	0.043	0.019	2.15	0.03
	1960–66	0.024	0.018	0.006	2.95	0.00
E Nebraska (272)	1952–56	0.077	0.070	0.007	0.99	0.32
	1966–73	0.048	0.023	0.025	7.35	0.00
E Kansas (273)	1930–32	0.140	0.096	0.044	1.33	0.18
	1965–70	0.037	0.022	0.015	4.97	0.00
E Oklahoma (281)	1939–44	0.073	0.062	0.011	1.39	0.16
	1947–56	0.077	0.056	0.021	3.68	0.00
	1966–77	0.040	0.021	0.019	8.79	0.00
E Texas (282)	1973–77	0.038	0.029	0.009	1.21	0.23
S Minnesota-N Iowa (291)	1971–76	0.046	0.029	0.017	2.36	0.02

Table 18. *Continued.*

Reference area	Years	Mean recovery rate estimate		Difference	z	P^a
		Males	Females			
S Iowa–W Missouri (292)	1952–57	0.073	0.049	0.024	2.49	0.01
	1963–72	0.042	0.025	0.017	6.26	0.00
E Arkansas–W Tennessee–NW Mississippi (302)	1963–77	0.044	0.030	0.014	7.68	0.00
E Tennessee (303)	1959–72	0.053	0.036	0.017	5.82	0.00
	1975–76	0.040	0.034	0.006	0.65	0.52
W Louisiana (304)	1976–77	0.032	0.024	0.008	1.23	0.22
E Louisiana–SW Mississippi (305)	1939–41	0.033	0.033	0.000	0.00	1.00
	1954–56	0.061	0.061	0.000	-0.02	0.99
	1976	0.044	0.029	0.015	1.68	0.09
E Mississippi–Alabama (306)	1955–60	0.049	0.055	-0.006	-0.66	0.51
	1963–71	0.050	0.033	0.017	3.41	0.00
N Illinois–N Indiana–SW Michigan (311)	1958–61	0.061	0.053	0.008	0.57	0.57
	1963–70	0.057	0.038	0.019	3.80	0.00
SE Great Lakes Region (312)	1961–76	0.051	0.035	0.016	2.37	0.02
SE Missouri–S Illinois–SW Indiana–W Kentucky (313)	1922–23	0.129	0.109	0.020	0.56	0.58
	1963–71	0.048	0.035	0.013	7.45	0.00
SE Indiana–S Ohio–E Kentucky (314)	1967–73	0.063	0.044	0.019	2.65	0.01
North-Atlantic States (321)	1963–76	0.043	0.033	0.010	2.29	0.02
Mid-Atlantic States (332)	1954–56	0.054	0.061	-0.007	-0.54	0.59
	1958–76	0.050	0.038	0.012	6.05	0.00
North Carolina (333)	1955–57	0.079	0.076	0.003	0.11	0.92
	1961–69	0.046	0.034	0.012	1.53	0.13
	1975–76	0.025	0.027	-0.002	-0.17	0.86
Means and composite z		0.054	0.039	0.015	26.39	0.00

[a]Probabilities correspond to a 2-tailed z-test.

et al. (1978), Hyland and Gabig (1980), and Rakestraw (1981) using winter-banded mallards.

Bellrose and Chase (1950) and Bellrose et al. (1961) suggested that hen mallards suffer greater mortality risks during the breeding and nesting periods than do males. Recent field studies have provided strong evidence of high mammalian predation rates on nesting hen mallards (Sargeant 1972; Johnson and Sargeant 1977) and substantial female mortality during the reproductive season (L. M. Cowardin and D. S. Gilmer, personal communication). In many bird species, females are more susceptible to periods of winter stress than males (Ketterson and Nolan 1976; Nichols and Haramis 1980; Sayler and Afton 1981), and this has been noted in some Anatids (Harrison and Hudson 1964). Jorde (1981) studied wintering mallards along the Platte River, Nebraska, and noted that females lost weight in early winter when males were gaining weight, and that they spent more time feeding than males. It is possible that such sex-specific differences translate into greater mortality risks for female mallards during winter. This is still speculation, however, whereas the evidence for greater female losses during the breeding season is now very convincing. Our analysis of winter banding data provides no information on the timing or causes of greater female mortality risks.

Harvest rates estimated from preseason-banded mallards are consistently higher for males than females (Anderson 1975; Nichols and Hines, unpublished data). Therefore, if winter-banded males and females have equal probabilities of surviving the period 30 January–15 August, we would expect higher recovery rates for males. If females have lower probabilities of surviving this period than males, as suggested above, then this would produce an even greater difference in recovery rates. The observed greater recovery rates of winter-banded males was thus expected based on sex-specific differences in harvest and survival rates.

Temporal Variation

Background

Survival rates are expected to exhibit some degree of variation over time in all natural animal populations. Some of the most interesting questions in animal population ecology deal with factors that cause such variation. We suspect that a number of mallard mortality risks vary in intensity from year to year. Waterfowl hunting regulations and estimates of the mallard hunting kill have varied substantially over the past two decades (Martin and Carney 1977). Anderson (1975) has demonstrated widespread variation in recovery rates (indices to harvest rate) (Henny and Burnham 1976) of preseason-banded mallards, and some of this variation has been associated with major changes in hunting regulations (Martin et al. 1979; Rogers et al. 1979; Kirby et al. 1983).

Mortality risks associated with environmental factors probably also exhibit year-to-year variation. There is some evidence for prairie breeding areas that mallard survival rates vary in response to changes in number of spring wetlands and mallard:pond ratios (Nichols et al. 1982*a*). Environmental conditions on the wintering grounds also vary from year to year. Winter temperatures and precipitation may affect mallard distribution patterns in winter (Nichols et al. 1983), and might also be expected to influence mortality risks.

It is important to recognize that temporal variation in risks associated with particular mortality sources does not necessarily imply temporal variation in annual survival rates (Anderson and Burnham 1976). For example, if mortality risks during some of the year act in a strongly density-dependent manner, then these risks may effectively prevent the translation of mortality from other sources into a change in annual survival rate. The recent inability to find a relation between mallard harvest and survival rates (Anderson and Burnham 1976; Rogers et al. 1979; Anderson et al. 1982; Nichols and Hines 1983; Burnham and Anderson 1984; Burnham et al. 1984) provides some evidence for the existence of such a mechanism of compensatory mortality. The hypothesis of temporal variation in annual survival rates is thus not as trivial as it might appear at first. Even if it were trivial biologically, however, it would still be important to detect temporal variation in survival rates before going on to investigate causes of this variation.

We are also interested in whether temporal variation occurs in recovery rates of winter-banded birds. This interest is not associated with recovery rates, per se, but with a desire to choose the most appropriate models for estimating survival rates (Brownie et al 1978).

Methodology

We first tested the hypothesis that survival and recovery rates are constant from year to year versus the alternative that one or both of these parameters exhibit temporal variation. We conducted this test on data sets corresponding to minor reference areas, using the Model 3 goodness-of-fit test (Brownie et al. 1978). Test statistics are distributed as χ^2, and we obtained composite statistics for each sex by summing these statistics and their associated degrees of freedom over all data sets.

We next conducted goodness-of-fit tests for Models 1 and 2 of Brownie et al. (1978). Model 1 assumes year-specific survival and recovery rates (Brownie et al. 1978; Seber 1970; Robson and Youngs 1971), while Model 2 assumes year-specific recovery rates but survival rates that are constant over time (Brownie et al. 1978). If the Model 1 goodness-of-fit statistic exhibited reasonable ($P > 0.01$) fit, then we also conducted a likelihood ratio test of Model 2 versus Model 1 (Brownie et al. 1978). This is essentially a test of the hypothesis that survival rates are constant over time. Test statistics for all three tests are distributed as χ^2, and we obtained composite statistics for each sex by summing these statistics and their associated degrees of freedom over all data sets.

Results and Discussion

The Model 3 goodness-of-fit test indicated rejection ($P < 0.05$) in 40 of 70 data sets for winter-banded males and 27 of 72 data sets for females (Table 19). Both composite statistics were highly significant ($P < 0.01$). Model 3 thus provided an inadequate description for nearly half of the examined data sets. The larger sample sizes of the male data sets, and the resulting greater test power, were probably largely responsible for the larger number of rejections in males. We conclude that survival or recovery rates, or both, exhibited year-to-year variation in a substantial number of data sets for winter-banded mallards.

The Model 2 goodness-of-fit statistic was significant ($P < 0.05$) in 15 of 69 data sets for males (Table 20) and 7 of 61 data sets for females (Table 21). The composite statistics were highly significant ($P < 0.01$) for both sexes. The Model 2 versus Model 1 likelihood ratio test indicated rejection of Model 2 in favor of Model 1 for 16 of 63 data sets for male mallards (Table 20) and 10 of 60 data sets for females (Table 21). Both composite statistics were again significant ($P < 0.05$). Model 2, with constant survival rates, thus appeared to provide an adequate description for a large proportion of the examined data sets. In the remaining data sets, survival rate must be modeled as varying from year to year. Again, the larger sample sizes and greater test power for males resulted in more rejections of the constant-survival model. When considering these results it is important to remember that the power of the Model 2 versus Model 1 test is generally low (Brownie and Robson 1974), especially for the low recovery rates that characterize winter-banded mallards. We conclude that mallards probably exhibit some year-to-year variation in survival rates, but that in many instances survival rates can be modeled as a constant.

The Model 1 goodness-of-fit test was significant ($P < 0.05$) in 13 of 69 data sets for males (Table 20) and 14 of 61 for females (Table 21). In some of the data sets for which the model was rejected, examination of the contributions of particular cells to the total χ^2 values indicated that single anomalous years were responsible for the rejection. Thus, Model 1 adequately described most of the data sets despite significant composite statistics for both sexes.

Geographic Variation

Background

There are a number of factors associated with different mortality risks that would be expected a priori to exhibit geographic variation. Hunting pressure, winter weather conditions, composition and density of predator communities, quantity and quality of available food resources, distances between breeding and wintering grounds, and population densities of competitors and conspecifics all have potential effects on mallard mortality and would be expected to vary geographically. Anderson (1975) found little evidence of geographic variation in survival rates of preseason-banded mallards, but suggested that large sampling variances may have obscured any existing differences. He further suggested that mallards banded in central breeding areas tended to have higher survival rates than those banded

Table 19. *Results of testing the hypothesis that survival and recovery rates of winter-banded mallards are constant from year to year.*[a]

Reference area	Males				Females			
	Years	*df*	χ^2	*P*	Years	*df*	χ^2	*P*
S British Columbia-W Washington (201)	1970-72	12	12.4	0.42	1933-36	13	23.7	0.03
					1960-62	8	10.3	0.25
E Washington-NE Oregon (202)	1948-57	86	234.6	0.00	1949-57	50	81.0	0.00
	1958-77	147	390.2	0.00	1958-77	113	200.5	0.00
W Oregon-NW California (203)	1951-70	127	218.5	0.00	1951-70	91	115.8	0.04
SE Oregon-NE California-NW Nevada (204)	1949-52	17	12.0	0.80	1950-52	6	5.2	0.52
	1957-64	65	129.2	0.00	1957-64	22	38.8	0.02
	1966-69	28	45.2	0.02	1966-69	10	22.3	0.01
Central California-W Nevada (211)	1949-51	12	11.4	0.49	1949-51	10	6.8	0.75
	1953-68	131	187.0	0.00	1953-68	84	89.2	0.33
	1971-77	21	52.0	0.00	1971-77	19	40.6	0.00
W Idaho (221)	1950-54	37	34.5	0.59	1950-53	16	33.6	0.01
	1958-62	36	60.6	0.01	1958-61	10	8.0	0.63
	1964-77	75	116.4	0.00	1966-77	42	56.6	0.07
W Montana (222)	1964-70	62	147.4	0.00	1949-52	17	21.7	0.20
					1964-70	33	26.8	0.77
E Idaho-SW Wyoming (223)	1963-77	94	155.3	0.00	1963-77	54	93.9	0.00
NE Nevada-W Utah (224)	1966-70	32	30.8	0.53	1966-70	18	27.1	0.08
E Utah-W Colorado (225)	1974-77	8	11.2	0.19	1974-77	8	6.0	0.65
S Nevada-S California-W Arizona (231)	1963-68	29	31.4	0.35	1963-68	23	49.2	0.00
E Montana (241)	1959-62	9	9.7	0.38	1964-67	10	9.0	0.53
	1964-67	23	65.1	0.00				
	1970-73	19	18.5	0.44				
W North Dakota-W South Dakota (242)	1940-43	12	15.4	0.22	1969-77	29	21.2	0.85
	1965-77	73	177.9	0.00				
N Wyoming (243)					1964-67	18	52.8	0.00
					1969-72	8	7.7	0.47
SE Wyoming-W Nebraska (251)	1964-77	93	213.8	0.00	1965-76	56	44.8	0.86
NE Colorado (252)	1945-53	99	289.1	0.00	1945-52	59	106.7	0.00
	1964-77	102	456.0	0.00	1964-77	84	131.1	0.00
SE Colorado (253)	1949-52	38	53.5	0.05	1949-52	26	31.6	0.21
	1966-77	72	144.1	0.00	1966-77	45	62.5	0.04

Table 19. *Continued.*

	Males				Females			
Reference area	*Years*	*df*	χ^2	*P*	Years	*df*	χ^2	*P*
S Central Colorado (254)					1950–52	14	17.1	0.25
					1961–64	19	41.2	0.00
W Kansas (255)	1972–75	16	31.8	0.01	1966–68	16	8.5	0.93
					1972–75	5	2.1	0.84
E New Mexico (261)	1966–77	69	105.8	0.00	1966–77	46	57.3	0.12
W Oklahoma–W Texas (262)	1971–77	24	28.9	0.22	1972–77	12	8.7	0.73
E South Dakota (271)	1951–55	34	41.5	0.18	1951–55	15	17.8	0.27
	1960–67	84	142.4	0.00	1960–67	39	46.0	0.20
E Nebraska (272)	1952–57	48	55.8	0.21	1952–57	27	31.3	0.26
	1966–74	67	102.3	0.00	1966–74	44	43.1	0.51
E Kansas (273)	1930–32	9	14.9	0.09	1930–33	8	9.1	0.33
	1965–70	54	104.8	0.00	1963–70	33	40.9	0.16
					1974–77	7	9.5	0.22
E Oklahoma (281)	1939–45	37	50.7	0.07	1939–45	24	18.0	0.80
	1947–57	77	93.2	0.10	1947–57	45	52.2	0.22
	1966–77	74	86.7	0.15	1964–77	51	63.0	0.12
E Texas (282)	1964–68	25	23.3	0.56	1973–77	7	12.8	0.08
	1972–77	15	14.6	0.48				
S Minnesota–N Iowa (291)	1971–77	23	33.0	0.08	1971–77	13	10.2	0.67
S Iowa–W Missouri (292)	1952–58	39	44.9	0.24	1952–57	16	13.1	0.66
	1963–73	94	188.9	0.00	1963–73	51	55.6	0.31
W Arkansas (301)	1963–67	32	85.2	0.00				
E Arkansas–W Tennessee–NW Mississippi (302)	1950–58	54	78.5	0.02	1963–77	80	168.1	0.00
	1959–77	133	294.9	0.00				
E Tennessee (303)	1959–73	136	312.4	0.00	1953–55	6	5.6	0.47
	1975–77	4	7.8	0.10	1959–73	86	117.5	0.01
					1975–77	3	2.0	0.58
E Louisiana–SW Mississippi (305)	1938–41	16	36.0	0.00	1939–41	10	21.2	0.02
	1954–57	22	20.6	0.55	1954–57	10	16.4	0.09
E Mississippi–Alabama (306)	1955–61	37	52.2	0.05	1955–61	16	16.3	0.43
	1963–72	72	127.0	0.00	1963–72	44	88.3	0.00
	1975–77	3	1.1	0.79				
N Illinois–N Indiana–SW Michigan (311)	1956–61	40	99.5	0.00	1958–61	12	4.8	0.96
	1963–74	89	143.5	0.00	1963–70	43	46.4	0.33
					1972–74	8	5.7	0.68
SE Great Lakes Region (312)	1961–77	83	88.0	0.33	1961–77	19	30.1	0.05

Table 19. *Continued.*

Reference area	Males				Females			
	Years	*df*	χ^2	*P*	Years	*df*	χ^2	*P*
SE Missouri-S Illinois-SW Indiana-W Kentucky (313)	1922-24	10	17.2	0.07	1922-24	10	15.7	0.11
	1955-72	135	518.9	0.00	1963-71	57	108.4	0.00
	1975-77	4	10.0	0.04	1975-77	4	19.6	0.00
SE Indiana-S Ohio-E Kentucky (314)	1967-74	47	73.0	0.01	1967-74	29	43.2	0.04
North-Atlantic States (321)	1962-77	72	112.0	0.00	1963-76	46	79.8	0.00
Mid-Atlantic States (332)	1954-57	21	40.1	0.01	1954-57	16	18.1	0.32
	1958-77	160	224.0	0.00	1958-77	112	147.8	0.01
North Carolina (333)	1955-58	14	13.0	0.53	1955-57	9	6.3	0.71
	1961-73	69	84.7	0.10	1961-73	44	69.1	0.01
	1975-77	3	5.3	0.15	1975-77	3	0.6	0.91
Georgia-South Carolina (341)	1955-59	17	28.2	0.04	1963-77	77	111.4	0.01
	1961-77	116	210.2	0.00				
Totals		3,737	7,170.0	0.00		2,213	3,122.3	0.00

[a]Results from the goodness-of-fit test for Model 3 (Brownie et al. 1978).

Table 20. *Results of testing the hypothesis that both recovery and survival rates of winter-banded male mallards vary from year to year versus the hypothesis that recovery rates vary from year to year but survival is constant.*

Reference area	Years	Fit of Model 1			Fit of Model 2			Model 2 vs. Model 1		
		df	χ^2	*P*	*df*	χ^2	*P*	*df*	χ^2	*P*
S British Columbia-W Washington (201)	1970-72	6	2.31	0.89	7	2.3	0.94	1	0.0	0.8
E Washington-NE Oregon (202)	1948-57	60	70.1	0.18	71	83.9	0.14	8	17.7	0.02
	1958-77	107	141.6	0.01	127	177.0	0.00	18	33.2	0.02
W Oregon-NW California (203)	1951-70	89	103.7	0.14	109	139.3	0.03	18	28.6	0.05
SE Oregon-NE California-NW Nevada (204)	1949-52	6	4.1	0.67	8	5.1	0.75	2	1.4	0.50
	1957-64	46	56.1	0.15	52	62.9	0.14	6	8.3	0.22
	1966-69	17	18.1	0.39	17	31.1	0.02	2	10.3	0.01
Central California-W Nevada (211)	1949-51	7	5.6	0.59	8	6.1	0.64	1	0.5	0.47
	1953-68	99	94.9	0.60	114	111.5	0.57	14	19.1	0.16
	1971-77	11	11.1	0.43	15	17.6	0.28	5	7.4	0.19

Table 20. *Continued*

Reference area	Years	Fit of Model 1			Fit of Model 2			Model 2 vs. Model 1		
		df	χ^2	*P*	*df*	χ^2	*P*	*df*	χ^2	*P*
W Idaho (221)	1950–54	21	21.0	0.46	26	25.7	0.48	3	3.9	0.27
	1958–62	18	26.8	0.08	22	38.5	0.02	3	12.9	0.00
	1964–77	46	52.1	0.25	61	66.2	0.30	12	15.7	0.20
W Montana (222)	1949–52	12	35.4	0.00	17	50.2	0.00	–	–	–
	1964–70	41	55.8	0.06	47	73.3	0.01	5	18.1	0.00
E Idaho- SW Wyoming (223)	1963–77	65	65.7	0.45	78	87.8	0.21	13	21.3	0.07
NE Nevada–W Utah (224)	1966–70	14	19.6	0.14	18	21.2	0.27	3	1.4	0.70
E Utah–W Colorado (225)	1974–77	3	6.1	0.11	5	7.9	0.16	2	2.7	0.26
S Nevada–S California–W Arizona (231)	1963–68	14	22.2	0.07	19	25.8	0.14	4	2.9	0.57
E Montana (241)	1959–62	2	1.1	0.57	5	2.9	0.72	2	2.6	0.27
	1964–67	14	19.7	0.14	16	21.3	0.17	2	1.8	0.42
	1970–73	10	7.4	0.69	12	7.3	0.84	2	0.0	0.98
W North Dakota–W South Dakota (242)	1940–43	4	9.4	0.05	6	10.4	0.11	2	1.8	0.42
	1965–77	49	62.8	0.09	60	78.7	0.05	11	18.5	0.07
SE Wyoming–W Nebraska (251)	1964–77	59	57.9	0.52	76	79.5	0.37	12	24.5	0.02
NE Colorado (252)	1945–53	48	77.4	0.00	67	83.2	0.09	–	–	–
	1964–77	77	106.7	0.01	89	126.0	0.01	12	25.8	0.01
SE Colorado (253)	1949–52	21	43.9	0.00	23	44.2	0.00	–	–	–
	1966–77	49	81.0	0.00	59	105.7	0.00	–	–	–
W Kansas (255)	1972–75	9	13.8	0.13	11	15.5	0.16	2	1.3	0.5
E New Mexico (261)	1966–77	44	42.1	0.56	56	58.2	0.40	10	17.7	0.06
W Oklahoma–W Texas (262)	1971–77	13	11.4	0.58	18	14.1	0.72	5	3.0	0.70
E South Dakota (271)	1951–55	18	25.4	0.11	21	30.5	0.08	3	2.8	0.43
	1960–67	54	49.3	0.65	59	59.4	0.46	6	13.3	0.04
E Nebraska (272)	1952–57	29	32.2	0.31	33	33.7	0.43	4	1.7	0.78
	1966–74	45	45.1	0.47	54	63.4	0.18	7	17.3	0.02
E Kansas (273)	1930–32	2	5.1	0.08	2	5.0	0.08	1	0.5	0.47
	1965–70	36	42.7	0.21	40	42.9	0.35	4	1.6	0.80
E Oklahoma (281)	1939–45	23	33.0	0.08	27	34.5	0.15	5	1.8	0.88
	1947–57	47	44.0	0.60	58	53.0	0.66	9	7.8	0.55
	1966–77	53	44.7	0.78	63	58.9	0.62	10	17.7	0.06

Table 20. *Continued.*

Reference area	Years	Fit of Model 1			Fit of Model 2			Model 2 vs. Model 1		
		df	χ^2	*P*	*df*	χ^2	*P*	*df*	χ^2	*P*
E Texas (282)	1964–68	13	16.9	0.21	17	19.0	0.33	3	1.7	0.64
	1972–77	5	8.8	0.12	11	9.4	0.58	4	1.1	0.90
S Minnesota–N Iowa (291)	1971–77	12	7.4	0.83	17	9.9	0.91	5	2.5	0.78
S Iowa–W Missouri (292)	1952–58	23	23.4	0.44	26	35.7	0.10	5	13.5	0.02
	1963–73	71	90.2	0.06	80	103.1	0.04	9	10.4	0.32
W Arkansas (301)	1963–67	18	18.5	0.43	22	22.1	0.45	3	3.8	0.28
E Arkansas–W Tennessee–	1950–58	30	34.3	0.27	40	42.9	0.35	7	13.3	0.07
NW Mississippi (302)	1959–77	88	81.6	0.67	114	108.9	0.63	17	26.8	0.06
E Tennessee (303)	1959–73	98	123.3	0.04	114	166.5	0.00	13	50.0	0.00
	1975–77	1	0.5	0.47	2	4.1	0.13	1	3.6	0.06
E Louisiana–	1938–41	4	2.1	0.71	6	8.7	0.19	2	6.6	0.04
SW Mississippi (305)	1954–57	12	13.9	0.31	13	15.9	0.25	2	3.8	0.15
E Mississippi–Alabama	1955–61	21	25.3	0.24	26	38.5	0.05	5	10.9	0.05
(306)	1963–72	52	60.0	0.21	60	65.4	0.30	8	6.9	0.55
N Illinois–N Indiana–	1956–61	25	39.8	0.03	30	48.8	0.02	4	9.9	0.04
SW Michigan (311)	1963–74	65	67.5	0.39	77	81.8	0.33	10	20.1	0.03
SE Great Lakes Region (312)	1961–77	51	53.2	0.39	66	68.1	0.40	15	22.2	0.10
SE Missouri–S Illinois–	1922–24	4	11.8	0.02	5	13.8	0.02	1	4.4	0.04
SW Indiana–	1955–72	97	111.9	0.14	116	154.2	0.01	16	45.7	0.00
W Kentucky (313)	1975–77	1	8.4	0.00	2	9.0	0.01	–	–	–
SE Indiana–S Ohio– E Kentucky (314)	1967–74	31	47.7	0.03	38	49.0	0.11	6	4.4	0.62
North-Atlantic States (321)	1962–77	44	37.7	0.74	60	62.6	0.39	14	17.9	0.21
Mid-Atlantic States	1954–57	11	18.9	0.06	13	18.4	0.14	2	1.0	0.60
(332)	1958–77	117	135.0	0.13	137	155.8	0.14	18	19.1	0.39
North Carolina (333)	1955–58	6	5.0	0.54	7	7.7	0.36	2	2.6	0.27
	1961–73	39	51.3	0.09	50	58.1	0.20	11	11.2	0.43
Georgia–South Carolina	1955–59	3	8.8	0.03	7	10.3	0.17	3	3.0	0.39
(341)	1961–77	87	131.9	0.00	101	146.2	0.00	–	–	–
Totals		2,417	2,903.5	0.00	2,933	3,595.6	0.00	415	683.3	0.00

Table 21. *Results of testing the hypothesis that both recovery and survival rates of winter-banded female mallards vary from year to year versus the hypothesis that recovery rates vary from year to year but survival is constant.*

		Fit of Model 1			Fit of Model 2			Model 2 vs. Model 1		
Reference area	Years	*df*	χ^2	*P*	*df*	χ^2	*P*	*df*	χ^2	*P*
S British Columbia-	1933–36	2	5.4	0.07	4	5.4	0.25	2	0.0	0.98
W Washington (201)	1960–62	4	8.8	0.07	5	8.7	0.12	1	0.0	0.96
E Washington–NE Oregon (202)	1949–57	28	39.2	0.08	34	41.0	0.19	7	3.0	0.89
	1958–77	72	102.8	0.01	90	117.2	0.03	18	18.1	0.45
W Oregon–NW California (203)	1951–70	58	61.0	0.37	71	73.3	0.40	18	22.7	0.20
SE Oregon–NE California-	1950–52	1	3.8	0.05	2	4.3	0.12	1	0.8	0.37
NW Nevada (204)	1957–64	9	10.8	0.29	13	9.6	0.73	6	3.1	0.79
	1966–69	5	6.6	0.25	5	13.1	0.02	2	7.8	0.02
Central California-	1949–51	3	3.6	0.31	4	3.7	0.45	1	0.0	0.84
W Nevada (211)	1953–68	49	48.5	0.50	63	66.3	0.36	14	15.9	0.32
	1971–77	5	13.1	0.02	12	11.9	0.45	5	8.8	0.12
W Idaho (221)	1950–53	8	12.5	0.13	10	13.8	0.18	2	2.5	0.28
	1966–77	22	18.9	0.65	33	38.7	0.23	10	18.9	0.04
W Montana (222)	1949–52	8	12.9	0.12	10	14.2	0.16	2	1.7	0.42
	1964–70	16	14.8	0.54	19	15.8	0.67	5	6.7	0.24
E Idaho–SW Wyoming (223)	1963–77	23	21.6	0.54	38	51.2	0.07	13	25.9	0.02
NE Nevada–W Utah (224)	1966–70	8	11.7	0.17	13	18.4	0.14	3	4.0	0.26
E Utah–W Colorado (225)	1974–77	3	3.7	0.29	5	3.7	0.59	2	0.2	0.91
S Nevada–S California–W Arizona (231)	1963–68	6	15.8	0.01	12	22.1	0.04	4	7.1	0.13
E Montana (241)	1964–67	1	4.3	0.04	3	4.7	0.19	2	0.6	0.75
W North Dakota–W South Dakota (242)	1969–77	14	9.2	0.82	21	13.5	0.89	7	2.9	0.90
N Wyoming (243)	1964–67	4	9.4	0.05	7	9.5	0.22	2	1.0	0.60
SE Wyoming–W Nebraska (251)	1965–76	29	19.2	0.92	43	25.4	0.99	10	6.7	0.75
NE Colorado (252)	1945–52	38	58.0	0.02	43	60.5	0.04	6	5.4	0.50
	1964–77	55	57.5	0.38	68	68.4	0.46	12	10.9	0.54
SE Colorado (253)	1949–52	14	12.7	0.55	16	20.9	0.18	2	7.0	0.03
	1966–77	20	28.7	0.09	31	45.0	0.05	10	19.2	0.04

Table 21. *Continued.*

Reference area	Years	Fit of Model 1 *df*	Fit of Model 1 χ^2	Fit of Model 1 *P*	Fit of Model 2 *df*	Fit of Model 2 χ^2	Fit of Model 2 *P*	Model 2 vs. Model 1 *df*	Model 2 vs. Model 1 χ^2	Model 2 vs. Model 1 *P*
S Central Colorado (254)	1950–52	7	5.8	0.57	8	6.6	0.58	1	1.0	0.32
	1961–64	6	10.1	0.12	11	15.5	0.16	2	7.0	0.03
W Kansas (255)	1936–38	4	10.0	0.04	6	16.0	0.01	1	10.0	0.00
	1966–68	6	4.7	0.58	7	5.2	0.63	1	0.7	0.40
E New Mexico (261)	1966–77	19	21.3	0.32	29	33.0	0.28	10	12.4	0.26
E South Dakota (271)	1951–55	4	1.9	0.76	7	3.8	0.80	3	2.4	0.49
	1960–67	21	23.3	0.33	30	31.3	0.40	6	5.8	0.44
E Nebraska (272)	1952–57	14	17.7	0.22	18	19.4	0.37	4	1.6	0.81
	1966–74	26	28.6	0.33	32	32.6	0.44	7	4.9	0.67
E Kansas (273)	1963–70	10	16.9	0.08	22	16.6	0.79	6	2.2	0.90
E Oklahoma (281)	1939–45	11	11.1	0.43	15	13.9	0.53	5	3.3	0.66
	1947–57	27	37.8	0.08	33	45.1	0.08	9	12.2	0.20
	1964–77	23	20.4	0.62	37	33.8	0.62	12	18.9	0.09
S Minnesota–N Iowa (291)	1971–77	1	6.2	0.01	6	8.8	0.18	5	2.4	0.79
S Iowa–W Missouri (292)	1952–57	2	5.5	0.06	8	8.7	0.37	4	2.4	0.66
	1963–73	25	40.4	0.03	35	48.6	0.06	9	7.9	0.55
E Arkansas–W Tennessee–NW Mississippi (302)	1963–77	52	56.1	0.32	66	77.8	0.15	13	16.7	0.21
E Tennessee (303)	1959–73	55	66.7	0.13	68	75.6	0.25	13	11.0	0.61
E Louisiana–SW Mississippi (305)	1939–41	2	1.6	0.46	5	8.1	0.15	1	7.1	0.01
	1954–57	2	2.2	0.33	4	5.0	0.29	2	2.5	0.29
E Mississippi–Alabama (306)	1955–61	3	7.1	0.07	7	10.1	0.18	5	2.8	0.74
	1963–72	21	33.1	0.04	33	44.0	0.10	8	17.0	0.03
N Illinois–N Indiana–SW Michigan (311)	1963–70	28	23.8	0.69	34	26.2	0.83	6	6.1	0.42
	1972–74	3	4.0	0.26	4	4.3	0.37	1	0.3	0.59
SE Missouri–S Illinois–SE Indiana–W Kentucky (313)	1922–24	3	9.4	0.02	5	10.7	0.06	1	0.7	0.40
	1963–71	38	46.3	0.17	45	56.7	0.11	8	10.0	0.27
	1975–77	1	0.1	0.76	2	4.4	0.11	1	4.7	0.03
SE Indiana–S Ohio–E Kentucky (314)	1967–74	14	23.7	0.05	19	26.9	0.11	6	4.6	0.60
North-Atlantic States (321)	1963–76	21	32.4	0.05	33	39.0	0.22	12	8.0	0.78
Mid-Atlantic States (332)	1954–57	7	1.7	0.97	9	2.2	0.99	2	0.6	0.75
	1958–77	74	103.8	0.01	92	116.4	0.04	18	12.0	0.85

Table 21. *Continued.*

Reference area	Years	Fit of Model 1			Fit of Model 2			Model 2 vs. Model 1		
		df	χ^2	*P*	*df*	χ^2	*P*	*df*	χ^2	*P*
North Carolina (333)	1955–57	1	3.9	0.05	1	2.9	0.09	1	0.0	0.94
	1961–73	11	28.1	0.00	28	43.0	0.04	-	-	-
Georgia–S Carolina (341)	1963–77	46	52.4	0.24	63	67.1	0.34	13	14.0	0.37
Totals		1,093	1,372.6	0.00	1,497	1,739.6	0.00	363	414.1	0.03

in eastern breeding areas but also noted that this apparent difference was not large.

Efforts to develop mallard management units have led to the investigation of possible differences in survival rates between mallards banded in different areas of the Central and Mississippi flyways. Funk et al. (1971) suggested that survival rates were higher for mallards banded during winter in the High Plains (our major reference areas 24, 25, and 26) than for birds banded in the Low Plains (major reference areas 27 and 28), although they stated that larger sample sizes were needed for more reliable results. Hyland and Gabig (1980) found no difference among mean survival rates of mallards banded during winter, 1963–76, in the High Plains, the Low Plains and the Western Mississippi Flyway (major reference area 29, and portions of reference areas 30 and 31). However, they did find evidence of lower female survival rates in the Western Mississippi Flyway during the period, 1963–68 (Hyland and Gabig 1980).

Methodology

We computed weighted mean survival rate estimates for specific geographic areas using the following general equation:

$$\hat{\hat{S}}_W = \sum_{j=1}^{n} \frac{\left(\dfrac{\hat{\hat{S}}_j}{\hat{SE}(\hat{S}_j)}\right)}{\left(\sum_{j=1}^{n} \dfrac{1}{\hat{SE}(\hat{S}_j)}\right)}$$

where $\hat{\hat{S}}_W$ is the weighted mean estimate, j denotes an individual data set or sub-area, n denotes the number of data sets or sub-areas used to compute $\hat{\hat{S}}_W$, and $\hat{S}_j$ and $\hat{SE}(\hat{S}_j)$ denote the estimated mean and standard error, respectively, of the survival rate for data set or sub-area j. The sampling variance of $\hat{\hat{S}}_W$ is estimated as:

$$\hat{var}\,(\hat{\hat{S}}_W) = \frac{n}{\left(\sum_{j=1}^{n} \dfrac{1}{\hat{SE}(\hat{S}_j)}\right)^2}$$

Our choice of the $\hat{SE}\,(\hat{S}_j)$ as a basis for weighting the survival rate estimates can certainly be challenged. Reasonable alternatives not only exist, but can be shown to be more appropriate in certain situations. If substantial variation existed among the true survival rates of the data sets or geographic sub-areas over which weighted means were computed, then it might have been more appropriate to weight each data set by the number of birds each set represented (e.g., perhaps based on Winter Survey results). After examining the estimates in Appendix B, the results of tests for temporal variation in survival rates presented in this report and by Anderson (1975) and Rogers et al. (1979), and the results of tests for geographic variation in survival rates presented by Anderson (1975), we concluded that substantial variation probably did not exist. Despite this apparent lack of variation, however, we still would have strongly considered the use of Winter Survey data as weights if we had been able to obtain mallard counts for each minor reference area. Although State totals for Winter Survey results are available for the past 40 years, many minor reference areas do not follow State boundaries. With the help of the Fish and Wildlife Service Flyway Representatives and various State agency personnel, we were able to obtain winter mallard counts for a number of minor reference areas for some years. However, we were not able to obtain even a nearly complete data set, and we were forced to abandon the idea of using Winter Survey data in this manner. Another alternative for weighting survival rate estimates involves the use of $\widehat{var}(\hat{S}_j)$ rather than $\widehat{SE}(\hat{S}_j)$. In situations where the true $var(\hat{S}_j)$ are known, the use of the $var(\hat{S}_j)$ produces weighted means with optimal statistical properties. However, we did not know the true $var(\hat{S}_j)$ but had only estimates, and we were hesitant to use such an "extreme" weighting system (extreme in the sense of producing very large differences in contributions of different $\hat{S}_j$) based on these estimates. Instead we chose an ad hoc approach and used the $\widehat{SE}(\hat{S}_j)$, thus weighting by an estimator of precision, but one which produced less variation in the contributions of the different $\hat{S}_j$.

We were interested in survival rate estimates by major reference area and flyway for the period 1960–77. We first used the individual data sets (sets of consecutive years for which survival rate estimates could be obtained, from Appendix B) to compute a weighted mean survival rate, $\hat{\bar{S}}_W$ for each minor reference area. We then used these minor reference area estimates to compute a weighted mean, $\hat{\bar{S}}_W$, for each major reference area. These major reference area estimates were in turn used to compute a weighted mean for each flyway.

We were interested in whether reference areas with low male survival rates also had low female survival rates and vice versa. We computed a Pearson product-moment correlation coefficient

Table 22. *Weighted mean survival rate estimates for winter-banded mallards by major reference area and Flyway 1960–77.*[a]

	Males		Females	
Reference area or Flyway	$\hat{\bar{S}}$	$\widehat{SE}(\hat{\bar{S}})$	$\hat{\bar{S}}$	$\widehat{SE}(\hat{\bar{S}})$
Northwestern Pacific Flyway (20)	0.653	0.028	0.576	0.058
Central California (21)	0.616	0.036	0.559	0.051
Northeastern Pacific Flyway (22)	0.671	0.013	0.589	0.034
Southern Pacific Flyway (23)	0.658	0.069	0.698	0.116
Pacific Flyway	0.656	0.013	0.591	0.027
Northern High Plains (24)	0.648	0.021	0.498	0.043
Central High Plains (25)	0.736	0.011	0.602	0.015
Southern High Plains (26)	0.700	0.025	0.573	0.055
Northern Low Plains (27)	0.694	0.014	0.600	0.025
Southern Low Plains (28)	0.688	0.021	0.596	0.052
Central Flyway	0.699	0.008	0.583	0.013
Northwestern Mississippi Flyway (29)	0.679	0.018	0.565	0.037
Southern Mississippi Flyway (30)	0.599	0.026	0.504	0.027
Southern Great Lakes-Ohio River Valley (31)	0.675	0.021	0.556	0.018
Mississippi Flyway[b]	0.656	0.012	0.542	0.014
Northeastern Atlantic Flyway (32)	0.630	0.033	0.585	0.043
Mid-Atlantic Flyway (33)	0.653	0.044	0.544	0.038
Southern Atlantic Flyway (34)	0.665	0.015	0.539	0.019
Atlantic Flyway[b]	0.654	0.014	0.551	0.017

[a]Minor reference area survival rate estimates were weighted by the inverse of their estimated standard errors.
[b]Note that a segment of western New York and northwestern Pennsylvania occurs in major reference area 31, and that data from this area contribute to the Mississippi Flyway means rather than those of the Atlantic Flyway.

and tested the null hypothesis of no relationship between male and female survival rates from the same areas (Snedecor and Cochran 1967). Geographic variation in survival rates from major reference areas was investigated using two series of tests. The first series tested the hypothesis of no difference between survival rates from adjacent eastern and western reference areas. The second series used adjacent northern and southern reference areas in similar tests. These tests used z statistics (Brownie et al. 1978). Variation in survival rates among all pairs of flyways was also tested with z statistics. Weighted mean survival rate and associated variance estimates, $\hat{\bar{S}}_W$ and $var(\hat{\bar{S}}_W)$, for the period 1960–77, were used in all comparisons.

Results and Discussion

Weighted mean survival rate estimates and their standard errors are presented by major reference area and flyway in Table 22. Major reference area estimates for males varied from 0.599 to 0.736, with most estimates falling in the interval 0.65–0.70. Female mallard estimates ranged from 0.498 to 0.698, but most estimates fell between 0.54 and 0.60. The relationship between male and female survival rate estimates from the same reference areas was positive but not significant (Pearson $r = 0.38$, 13 *df*, $0.10 < P < 0.20$). The weighted mean flyway estimates were very similar within sexes, with the absolute difference between the highest and lowest estimates being less than 0.05 (Table 22).

The comparisons of adjacent eastern and western major reference areas showed five significant ($P < 0.10$) differences for males and two for females (Table 23). Males from the Central High Plains (25) and females from the Northern High Plains (27) appeared to have higher survival rates than their counterparts in the Northeastern Pacific Flyway (22). Males from the Central High Plains (25) also exhibited higher survival rates than those from the Northern Low Plains (27). However, Northern Low Plains (27) males and females showed higher survival rates than those from the Northern High Plains (24). Thus, although there does seem to be some geographic variation in survival rate within the Central Flyway, there is no evidence of consistently higher survival rates in the High Plains reference areas. This inference is consistent with conclusions of Hyland and Gabig (1980).

Males from the Southern Mississippi Flyway (30) had the lowest point estimate of survival rate of all the reference areas (Table 22). This estimate was significantly ($P < 0.05$) lower than those of males from both the Southern Low Plains (28) and the Southern Atlantic Flyway (34; Table 23). However, examination of the estimates that went into the $\hat{\bar{S}}_W$ for the Southern Mississippi Flyway (30) shows that two contributing minor reference areas, W Louisiana (304) and E Mississippi–Alabama (306), had very low survival rate estimates for the 1960–77 period (*see* Tables B-60, B-61, B-64, B-65). These estimates were imprecise and thus obtained relatively small weights when $\hat{\bar{S}}_W$ was computed, but their contributions were still sufficient to yield the low Southern Mississippi Flyway (30) estimate. Survival rate estimates for the two contributing minor reference areas having good banding data, W Arkansas–W Tennessee–NW Mississippi (302) and E Tennessee (303), were not at all low ($\hat{\bar{S}}_W = 0.66$ and 0.68). In addition, survival rate estimates from bandings in Louisiana that occurred too recently (1978–82) to be included in this report were high (C. Kimball, personal communication). We thus reject the idea that male mallards in the Southern Mississippi Flyway (30) exhibit substantially lower survival rates than mallards elsewhere.

We know of no biological hypotheses that would predict an east–west gradient in mallard survival rates throughout North America. The results of these tests (Table 23) provided no indications that any trend of this kind exists.

The comparisons of adjacent northern and southern major reference areas showed three significant ($P < 0.05$) differences for males and one for females (Table 24). Males and females from the Central High Plains (25) showed higher survival rates than their counterparts from the Northern High Plains (24). Males from the Southern Mississippi Flyway (30) appeared to have lower survival rates than those from both reference areas to the north, Northwestern Mississippi Flyway (29) and Southern Great Lakes–Ohio River Valley (31; Table 24). Again, however, for the reasons provided above, we doubt that the Southern Mississippi Flyway (30)

Table 23. *Results of testing the hypothesis of no difference between survival rates of mallards from adjacent eastern and western reference areas, 1960–77.*

Reference areas compared (east vs. west)	Males			Females		
	$\hat{S}_E-\hat{S}_W$[a]	z	P[b]	$\hat{S}_E-\hat{S}_W$[a]	z	P[b]
Northeastern Pacific Flyway (22) vs. Northwestern Pacific Flyway (20)	0.02	0.59	0.56	0.01	0.18	0.86
Southern Pacific Flyway (23) vs. Central California (21)	0.04	0.53	0.60	0.14	1.10	0.27
Northern High Plains (24) vs. Northeastern Pacific Flyway (22)	-0.02	-0.96	0.34	-0.09	-1.66	0.10
Central High Plains (25) vs. Northeastern Pacific Flyway (22)	0.06	3.75	0.00	0.01	0.37	0.71
Southern High Plains (26) vs. Southern Pacific Flyway (23)	0.04	0.58	0.56	-0.13	-0.98	0.33
Northern Low Plains (27) vs. Northern High Plains (24)	0.05	1.84	0.07	0.10	2.06	0.04
Northern Low Plains (27) vs. Central High Plains (25)	-0.04	-2.30	0.02	-0.00	-0.07	0.94
Southern Low Plains (28) vs. Southern High Plains (26)	-0.01	-0.36	0.72	0.02	0.30	0.76
Northwestern Mississippi Flyway (29) vs. Northern Low Plains (27)	-0.01	-0.66	0.51	-0.04	-0.79	0.43
Southern Mississippi Flyway (30) vs. Southern Low Plains (28)	-0.09	-2.69	0.01	-0.09	-1.56	0.12
Southern Great Lakes-Ohio River Valley (31) vs. Northwestern Mississippi Flyway (29)	-0.00	-0.14	0.89	-0.01	-0.23	0.82
Mid-Atlantic Flyway (33) vs. Southern Great Lakes-Ohio River Valley (31)	-0.02	-0.46	0.65	-0.01	-0.29	0.77
Southern Atlantic Flyway (34) vs. Southern Mississippi Flyway (30)	0.07	2.24	0.03	0.03	1.07	0.28

[a]$\hat{S}_E-\hat{S}_W$ denotes the difference between the weighted mean survival rate estimates of mallards from the eastern and western reference areas, respectively.
[b]Probabilities correspond to a 2-tailed z-test.

survival rates are really substantially lower than those for adjacent northern reference areas.

It is possible to develop some biologically-motivated hypotheses about expected north-south differences in survival rates. Certainly birds in northern wintering areas would be exposed to more severe weather conditions than birds in southern areas, and this could result in lower survival rates in northern areas. However, any risk associated with migration distance (Ketterson and Nolan 1976; Greenberg 1980) might be greater for birds wintering in the south. Gauthreaux (1978) suggested that the more dominant individuals migrate the shortest distances between breeding and wintering areas. This hypothesis might lead to the prediction of higher survival rates for birds in northern wintering areas. In any case, there seemed to be no consistent differences between survival rates of mallards in adjacent northern versus southern wintering areas (Table 24).

The tests comparing survival rates among the four flyways were very powerful because of the precision of the flyway weighted means (*see* $\hat{SE}(\hat{\bar{S}})$ in Table 22). Male mallards in the Central Flyway appeared to show higher survival rates than those in the other three flyways (Table 25). Similarly, Central Flyway females had higher survival rates than Mississippi Flyway females (Table 25). No other survival rate differences were noted between any pairs of flyways. Even for the comparisons with

Table 24. *Results of testing the hypothesis of no difference between survival rates of mallards from adjacent northern and southern reference areas, 1960–77.*

Reference areas compared (north vs. south)	Males			Females		
	$\hat{\bar{S}}_N-\hat{\bar{S}}_S$[a]	z	P[b]	$\hat{\bar{S}}_N-\hat{\bar{S}}_S$[a]	z	P[b]
Northwestern Pacific Flyway (20) vs. Central California (21)	0.04	0.81	0.42	0.02	0.23	0.82
Northeastern Pacific Flyway (22) vs. Southern Pacific Flyway (23)	0.01	0.19	0.85	-0.11	-0.91	0.36
Northern High Plains (24) vs. Central High Plains (25)	-0.09	-3.70	0.00	-0.10	-2.29	0.02
Central High Plains (25) vs. Southern High Plains (26)	0.04	1.32	0.19	0.03	0.52	0.60
Northern Low Plains (27) vs. Southern Low Plains (28)	0.01	0.23	0.82	0.00	0.08	0.94
Northwestern Mississippi Flyway (29) vs. Southern Mississippi Flyway (30)	0.08	2.57	0.01	0.06	1.33	0.18
Southern Great Lakes-Ohio River Valley (31) vs. Southern Mississippi Flyway (30)	0.08	2.30	0.02	0.05	1.60	0.11
Northeastern Atlantic Flyway (32) vs. Mid-Atlantic Flyway (33)	-0.02	-0.43	0.67	0.04	0.72	0.47
Mid-Atlantic Flyway (33) vs. Southern Atlantic Flyway (34)	-0.01	-0.26	0.79	0.00	0.10	0.92

[a]$\hat{\bar{S}}_N-\hat{\bar{S}}_S$ denotes the difference between the weighted mean survival rate estimates of mallards from the northern and southern reference areas, respectively.
[b]Probabilities correspond to a 2-tailed z-test.

significant test statistics, the absolute differences between the survival rate point estimates were relatively small (Table 22).

When taken together, results of these analyses (Tables 22–25) indicate some degree of geographic variation in survival rates of mallards wintering throughout North America. However, we believe that such variation is relatively small. We found no consistent directional gradients in mallard survival rates. We did find some evidence that survival rates of Central Flyway mallards may be slightly higher than those of birds from some other areas.

Comparison of Survival Estimates from Winter Versus Preseason Banding Data

Background

Biological organisms seldom, if ever, exactly follow the assumptions underlying any statistical estimation model. We can only hope that a particular data set has resulted from a process that is approximated by the selected model well enough to yield reasonably accurate estimates. There are several methods by which we can obtain an idea of how reasonable this hope is. One method is through the use of goodness-of-fit tests and tests between different models. However, such tests often lack power for small to medium-sized band recovery data sets, especially for certain alternatives (Brownie and Robson 1974; Nichols et al. 1982*b*). Results of such tests with winter-banded mallards are provided in the section of this report dealing with temporal variation in survival rates. The accuracy of population parameter estimates can be also evaluated using these and related estimates in population projection models (for mallards *see* Anderson 1975 and Martin et al. 1979). Comparison of attributes of the projected population with what is known about the "real" population provides an indication of how reasonable the parameter estimates are. The most recent effort of this type with mallards led to the conclusion that either continental survival estimates (based on preseason banding data) or age-ratio estimates, or both, were biased high (Martin et al. 1979).

Another method for assessing estimate accuracy involves a comparison of two estimates of the same parameter. When working with parameter estimates for natural animal populations, it is rare to have two independent estimates of the same parameter believed a priori to be comparable in both accuracy and precision. Estimates of adult mallard survival rate based on preseason and winter bandings thus provide a unique opportunity for comparison.

Recently, there has been a great deal of speculation and discussion about the "representativeness" of the annual samples of banded mallards. Banded mallards represent a subset of North American mallards. If this subset differs from all other mallards with respect to survival rate, then our estimates of survival rate will not pertain to the population of interest and will be biased in this sense. Banded mallards might have different survival probabilities from other North American

Table 25. *z statistics for testing the hypothesis of no difference between survival rates of mallards from different Flyways, 1960–77.*[a]

		Flyway 2			
Sex	Flyway 1	Pacific	Central	Mississippi	Atlantic
Male	Pacific		−2.87[c]	−0.16	0.10
	Central			3.00[c]	2.78[c]
	Mississippi				0.11
Female	Pacific		0.24	1.61	1.27
	Central			2.10[b]	1.52
	Mississippi				−0.39

[a]A positive z statistic reflects a higher survival rate in Flyway 1 than Flyway 2, and a negative z statistic reflects a higher survival rate in Flyway 2.
[b]$P < 0.05$, 2-tailed test.
[c]$P < 0.01$, 2-tailed test.

mallards if trapping and banding affects survival, if trapping methods are only effective on a subset of birds with atypical survival rates, or if trapping stations tend to be located in geographic areas inhabited by mallards with atypical survival rates. If trapping and banding affect survival rates of mallards, then we would expect to find frequent rejections of Model 1 in our tests of Model 1 versus Model 0 (Brownie et al. 1978), and this seldom happened in our analyses of winter banding data. If samples of birds banded during either the preseason or winter periods are nonrepresentative as a result of either differential trap effectiveness or geographic location of trapping stations, then we might expect to see differences in survival rate estimates based on bandings from these different periods of the year. For example, various aspects of mallard biology that might affect tendency to be trapped (e.g., physiological condition, pair status, general behavior, and activity patterns) are expected to differ between July–September and January–February. We believe it is unlikely (nevertheless possible) that the same atypical subset of birds appears in traps at these different times of the year. We believe it is even more unlikely that the geographic locations sampled most heavily in both the preseason and winter periods are frequented by the same atypical subset of mallards. Certainly, some areas with preseason mallards are not well sampled, but it is unlikely that mallards in these areas also happen to choose poorly sampled wintering grounds. Thus, we believe that the comparison of survival rates estimated from preseason and winter bandings will provide insight about the representativeness of banded samples.

Nichols et al. (1982*b*) investigated the effects of heterogeneity of survival and recovery rates on band recovery model estimates. They suggested that heterogeneity in survival rates of winter-banded birds would tend to produce a positive relationship between survival and recovery rates, while preseason-banded birds would be expected to exhibit either a negative relationship or no relationship at all. They investigated effects of these relationships on survival rate estimates (*see also* Pollock and Raveling 1982) and concluded that winter bandings would likely produce positively-biased survival rate estimates in the case of heterogeneous survival and recovery rates (Nichols et al. 1982*b*). Estimates based on preseason bandings would be likely to exhibit either a smaller positive bias or a negative bias (Pollock and Raveling 1982; Nichols et al. 1982*b*). Therefore, if heterogeneity exists in mallard banding data, we would expect survival estimates based on winter bandings to be higher than those based on preseason bandings.

In previous comparisons, Hyland and Gabig (1980) noted that survival rate estimates of mallards banded during winter in the Central Flyway were considerably higher than those based on preseason bandings (Anderson 1975). They suggested that "more work is needed" to determine the cause of this difference.

Methodology

Weighted mean survival rate estimates for adult mallards banded preseason were computed for each preseason minor reference area (Anderson and Henny 1972), using the methodology described for investigating geographic variation in survival rate. These estimates were then used to compute a weighted mean continental estimate and associated variance for each sex, over the period 1960–77. Continental survival rate estimates based on winter bandings were computed in the same way. For each sex we tested the null hypothesis of no difference between the estimates using a z statistic (Brownie et al. 1978).

Results and Discussion

The continental weighted mean survival rate estimates based on winter and preseason banding data were similar for both sexes (Table 26). The estimates based on winter bandings were somewhat higher and the difference was highly significant ($P < 0.01$) for males but not for females (Table 26). Despite this significant difference, we were encouraged by the similarity of the estimates. Considering the difficulty of estimating parameters for natural animal populations, we find this degree of correspondence between estimates based on completely independent data sets surprisingly good. This comparison provided no evidence that the banded samples are not representative of North American mallards.

The direction of the differences between the estimates was that expected based on our work on the effects of heterogeneity on band recovery model estimates (Nichols et al. 1982*b*). Of course, the winter estimates might be higher than the preseason estimates for some reason we have not yet considered, but the correspondence is still encouraging. The magnitude of the difference between the estimates suggests that the degree of heterogeneity of survival and recovery probabilities is not large.

Summary

For this report we used nearly 2,000,000 bandings from both preseason and winter periods, and more than 300,000 associated recoveries, to provide descriptive information on recovery distribution patterns and to address questions about winter distribution and survival rates of mallards. Detailed work maps were prepared to show the band recovery distributions of mallards banded during winter in specific degree blocks throughout North America. We used these work maps in conjunction with ancillary information from many sources to delineate 45 minor winter reference areas that represented 15 major reference areas.

Band recovery distribution summaries for mallards banded during winter in these reference areas are presented in Appendix tables and figures. These summaries provide a general picture of the breeding grounds, migration pathways and possible alternative wintering locations of mallards from the different wintering ground reference areas. Our brief descriptions of the major reference areas included information from the recovery distribution summaries, average estimates of the proportion of total Winter Survey mallards reported from these areas, and information from published reports on wintering mallards and other waterfowl in the areas.

Tests involving winter band recoveries of mallards banded during the preseason and winter periods were used to draw inferences about winter distribution patterns of mallards. Age- and sex-specific variation in wintering ground location was examined by testing for differences between winter recovery distributions of birds banded in particular preseason reference areas. Within each age class, males and females from the same breeding reference areas exhibited similar winter recovery distributions. Similar tests based on winter recovery distributions of mallards banded preseason as young versus adults, however, provided some evidence of age-specific differences within each sex. The "foster-parent hypothesis" of Bellrose and Crompton (1970) and the hypothesis that young mallards are more responsive than adults to environmental variables when selecting wintering grounds provided two possible explanations for this age-specific variation in wintering ground location.

We tested for possible year-to-year variation in wintering ground location of specific groups of mallards by comparing direct versus indirect winter recovery distribution patterns for mallards banded in specific preseason reference areas. Evidence of differences between these direct versus indirect recovery distributions was obtained for males of both ages and for young females. There was no evidence of a difference for adult females, but sample sizes, and hence power, were low for this group. We concluded that mallards probably exhibited some temporal variation in wintering ground location but that such variation was relatively small. We tested for potential age- and sex-specificity of temporal variation in wintering ground location by comparing proportions of winter recoveries of winter-banded birds that occurred near the original banding site. Both male and female mallards banded as subadults during winter exhibited less tendency to be recovered near

Table 26. *Results of testing the hypothesis of no difference between weighted mean continental estimates of survival rate for mallards banded in the winter versus preseason periods, 1960–1977.*

	Winter banding		Preseason banding			
Sex	$\hat{S}$	$\widehat{SE}(\hat{S})$	$\hat{S}$	$\widehat{SE}(\hat{S})$	z	P^a
Males	0.675	0.0054	0.641	0.0053	4.49	0.00
Females	0.567	0.0081	0.554	0.0077	1.16	0.25

[a] Probabilities correspond to a 2-tailed z-test.

the area of banding during the following winter than did adults. There was little evidence of a sex-specific difference within either age class.

Possible long-term shifts in winter distribution patterns were examined by comparing first-year winter band recovery distributions of mallards banded in preseason reference areas during 1950–58 versus 1966–76. Significant differences were found between the winter recovery distributions in the two time periods for all four age–sex classes. However, the actual centers of the recovery distributions were generally close, indicating that the observed differences were not large. It is not clear whether the differences resulted from shifts in winter distribution patterns or from geographic changes in hunting pressure.

Survival and recovery rates of winter-banded mallards were estimated using the models and algorithms of Brownie et al. (1978) and are presented in the Appendix tables. Survival rate for winter-banded birds corresponds to the probability that a bird alive at about 30 January in year t will survive until 30 January of year $t+1$. Recovery rate for winter-banded birds represents the probability that a banded bird alive at 30 January of year t survives to the subsequent hunting season, is shot, and its band reported to the Bird Banding Laboratory. Recovery rate thus includes both the probability of surviving the period from 30 January until the beginning of the next hunting season and the probability of being shot during the hunting season and having the band reported. Because of this substantial survival component, recovery rates of winter-banded birds are not necessarily good indices to harvest rates as are recovery rates for preseason-banded birds.

We found no evidence of differences between survival and recovery rates of subadult versus adult mallards banded in the winter. This finding leads to the inference that the substantial difference between survival rates of young and adult mallards banded preseason (Anderson 1975) must result from increased mortality of young birds during the approximate period, 15 August–30 January. Young birds appear to experience greater hunting and nonhunting mortality during this period. We recommend that the aging of mallards in winter banding operations be continued.

We found strong evidence of a sex-specific difference between survival and recovery rates of winter-banded mallards. Survival rates of males were consistently higher than those of females from the same areas, a result consistent with inferences based on preseason bandings (Anderson 1975). Male recovery rates were also higher than those of females. This difference was expected because of the higher harvest rates (Anderson 1975) and survival rates of males.

The hypothesis of constant survival and recovery rates was generally rejected for winter-banded mallards. Test statistics based on all data sets indicated that mallard survival rates exhibited some degree of variation from year to year. However, in many individual data sets, survival rate could be effectively modeled as a constant. Model 1 of Brownie et al. (1978), with year-specific survival and recovery rates, provided an adequate description of most of the winter banding data sets. Results of these tests for temporal variation were generally consistent with those based on preseason-banded mallards.

Weighted mean survival rate estimates were computed for major reference areas and flyways. Comparisons of survival rates for adjacent eastern versus western reference areas and northern versus southern reference areas, provided evidence that some geographic variation in survival rates does exist. However, these tests provide no evidence of consistent directional differences. Some of the flyway comparisons indicated higher survival rates of mallards banded in the Central Flyway, but the estimated magnitudes of these differences were small.

Weighted mean continental survival rate estimates were obtained from preseason and winter banding data. Estimates based on winter banding data were slightly higher, and the difference was statistically significant for males but not females. The direction of the difference was consistent with predictions based on previous work on the effects of heterogeneous survival and recovery rates on band recovery model estimates. The similarity of the estimates from these two independent data sets supports our belief that biases in these estimates are relatively small.

Acknowledgments

The banding data on which this report is based resulted from the work of many individuals associated with State and Federal agencies and private organizations. We gratefully acknowledge the efforts of all mallard banders and parent organizations, and thank them for providing us with an excellent data base. Individuals and agencies that have banded more than 1,000 mallards during the winter period are listed in Appendix C.

We acknowledge the substantial efforts of David R. Anderson, leader of the original research team that investigated the population ecology of the mallard, and author of five of the first seven monographs in this report series. We believe that these seven reports constitute the most comprehensive investigation of the population ecology of any continentally-distributed animal population in the world. We drew heavily on the results of these previous reports and benefited greatly from the methodologies that were developed during their preparation. In particular, the band recovery models and associated computer programs developed by David R. Anderson, Cavell Brownie, Kenneth P. Burnham, and Douglas S. Robson were extremely useful in all our work dealing with survival and recovery rates.

When this study was initiated, we were members of the Migratory Bird and Habitat Research Laboratory. Fant W. Martin, former Director of the Laboratory and H. Franklin Percival, former Chief of the Migratory Game Bird Section, were very helpful in providing not only administrative assistance, but also technical advice, background information, and general encouragement and support. We now work for Patuxent Wildlife Research Center, where we have benefited from the administrative help and support of John G. Rogers and, especially, Thomas J. Dwyer. Richard S. Pospahala of the Migratory Bird Management Office provided background information, technical advice, and considerable insight into mallard population ecology and was very helpful throughout the study. Fish and Wildlife Service Flyway Representatives James C. Bartonek, Warren W. Blandin, Kenneth E. Gamble, and Harvey W. Miller provided advice, helped solicit comments from State biologists on the winter reference areas, and compiled Winter Survey data for some of these areas. In addition, we have benefited from discussions, technical advice, and other assistance provided by the following persons: David R. Anderson, Robert J. Blohm, Kenneth P. Burnham, Samuel M. Carney, Michael J. Conroy, Paul H. Geissler, G. Michael Haramis, Gary L. Hensler, Gary R. Hepp, George M. Jonkel, Charles F. Kimball, Ronald E. Kirby, Jerry R. Longcore, Elwood M. Martin, R. Kahler Martinson, Lois M. Moyer, Robert E. Munro, Kenneth J. Reinecke, Robert I. Smith, Michael F. Sorenson, S. Lynne Stokes, Robert H. Traxler, and Byron K. Williams.

Donald Coyne, William M. Cygan, and Robert Navitski provided computer programming assistance in the early stages of our work. Peggy C. Bowley, John M. Heiss, Carol A. Samuel, and Regina M. Wilcox assisted in preparing band recovery distribution maps. Regina M. Wilcox typed the entire manuscript and assisted in numerous other ways, and we are especially grateful for her patience and expert help.

We thank the following persons for help in providing the photographs used in this report: Richard M. Hopper and James K. Ringelman, Colorado Division of Wildlife; Stephen P. Havera, Illinois Natural History Survey; Joe L. Herring and Charles M. Smith, Louisiana Department of Wildlife and Fisheries; H. W. Heusmann, Massachusetts Division of Fisheries and Wildlife; Dale D. Humburg, Missouri Department of Conservation; Eric G. Bolen and Paul N. Gray, Texas Tech University; Michael J. Conroy, David S. Gilmer, Dennis G. Jorde, Erwin E. Klaas, Gary L. Krapu, Holliday H. Obrecht, Karl Parker, Kenneth J. Reinecke, Susan Saul, Charles W. Shaiffer, and Don Voros, U.S. Fish and Wildlife Service. Our special thanks go to Alison G. LaRochelle for contributing the artwork appearing on the front cover.

Finally, we thank David R. Anderson, I. J. Ball, Michael J. Conroy, Gary R. Hepp, Douglas H. Johnson, Kenneth J. Reinecke, and an anonymous referee for reviewing and providing comments on the entire manuscript.

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Appendix A

Band Recovery Distributions of Winter-banded Mallards

Figs. A-1 through A-15 and Table A-1 include data on the recovery distributions of mallards banded during winter in major and minor reference areas, respectively, 1950–1977. This Appendix includes data from normal, wild mallards banded during January–February and shot or found dead during any subsequent hunting season (i.e., HSS—1, HSS—2, . . ., HSS—N recoveries), 1950–1978. In Figs. A-1 through A-15, bandings are summarized by major reference area and recoveries are shown by degree block of recovery. The reference area of banding is outlined in black. All sex and age classes are combined in Figs. A-1 through A-15. In Table A-1, bandings are summarized by minor reference area of banding and recoveries by State or Province and Flyway of recovery. Recovery data in Table A-1 are summarized by age and sex class.

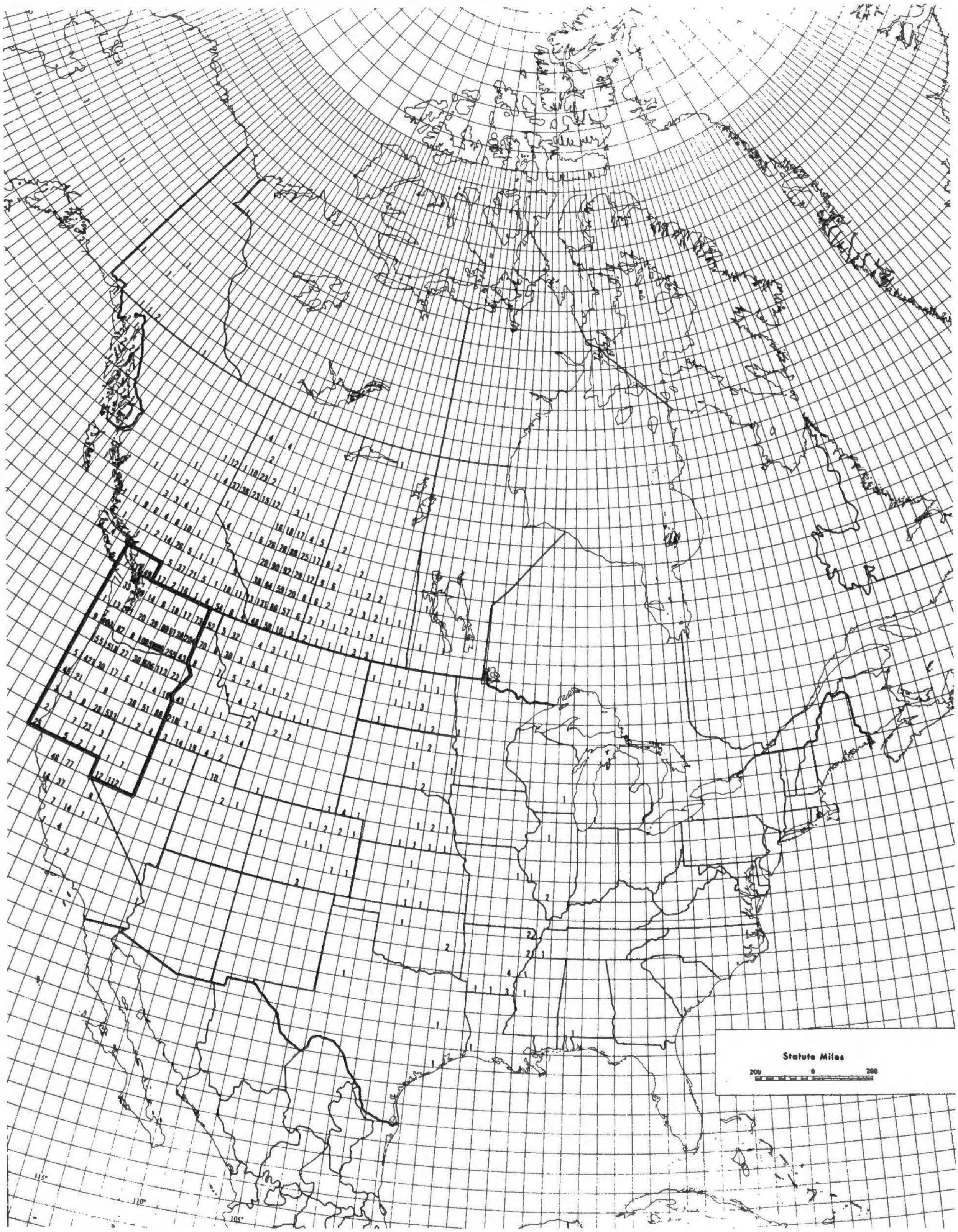

Fig. A-1. Distribution of recoveries from mallards banded during winter, 1950–1977, in the *Northwestern Pacific Flyway* and recovered in subsequent hunting seasons. All age and sex classes are combined.

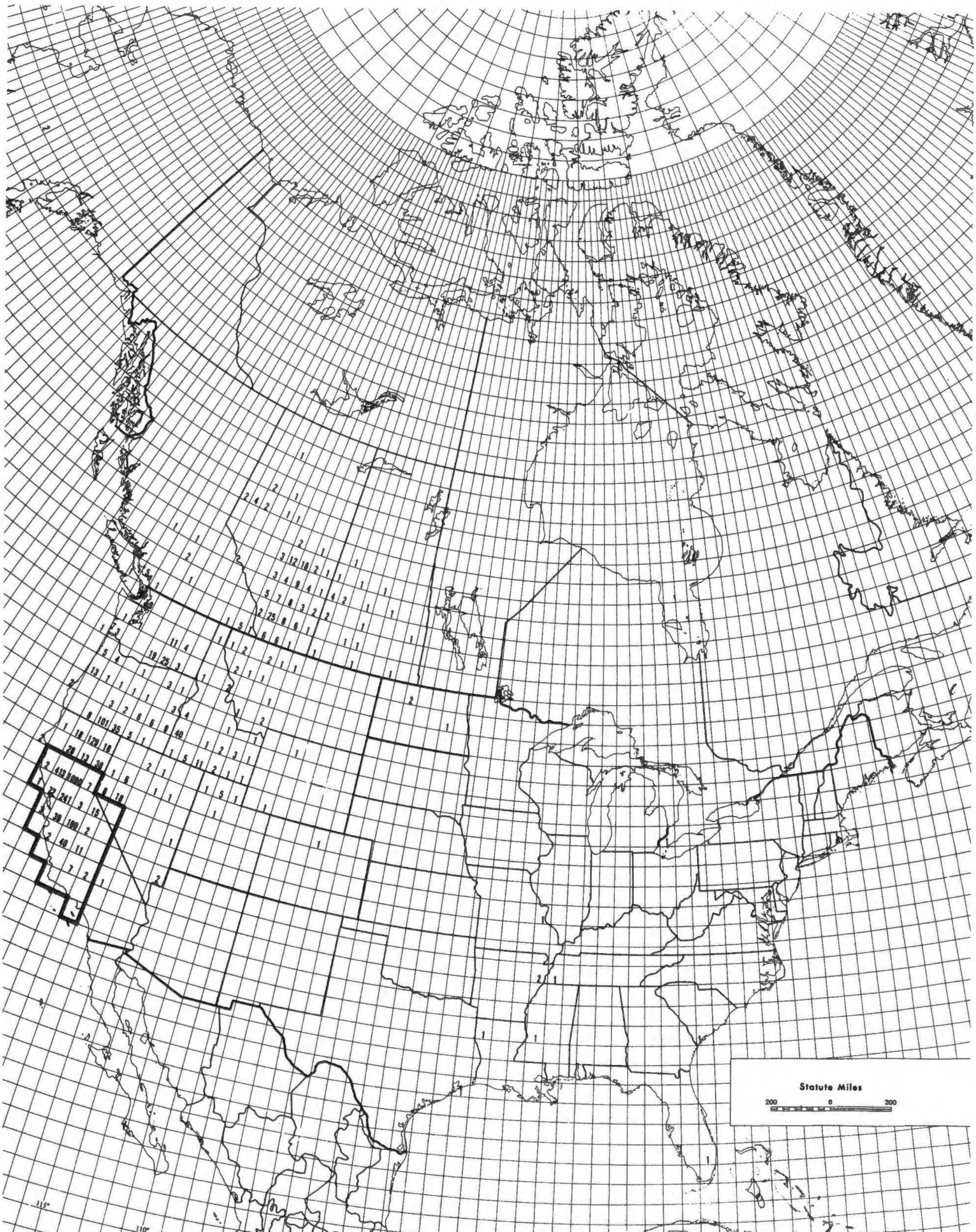

Fig. A-2. Distribution of recoveries from mallards banded during winter, 1950–1977, in *Central California* and recovered in subsequent hunting seasons. All age and sex classes are combined.

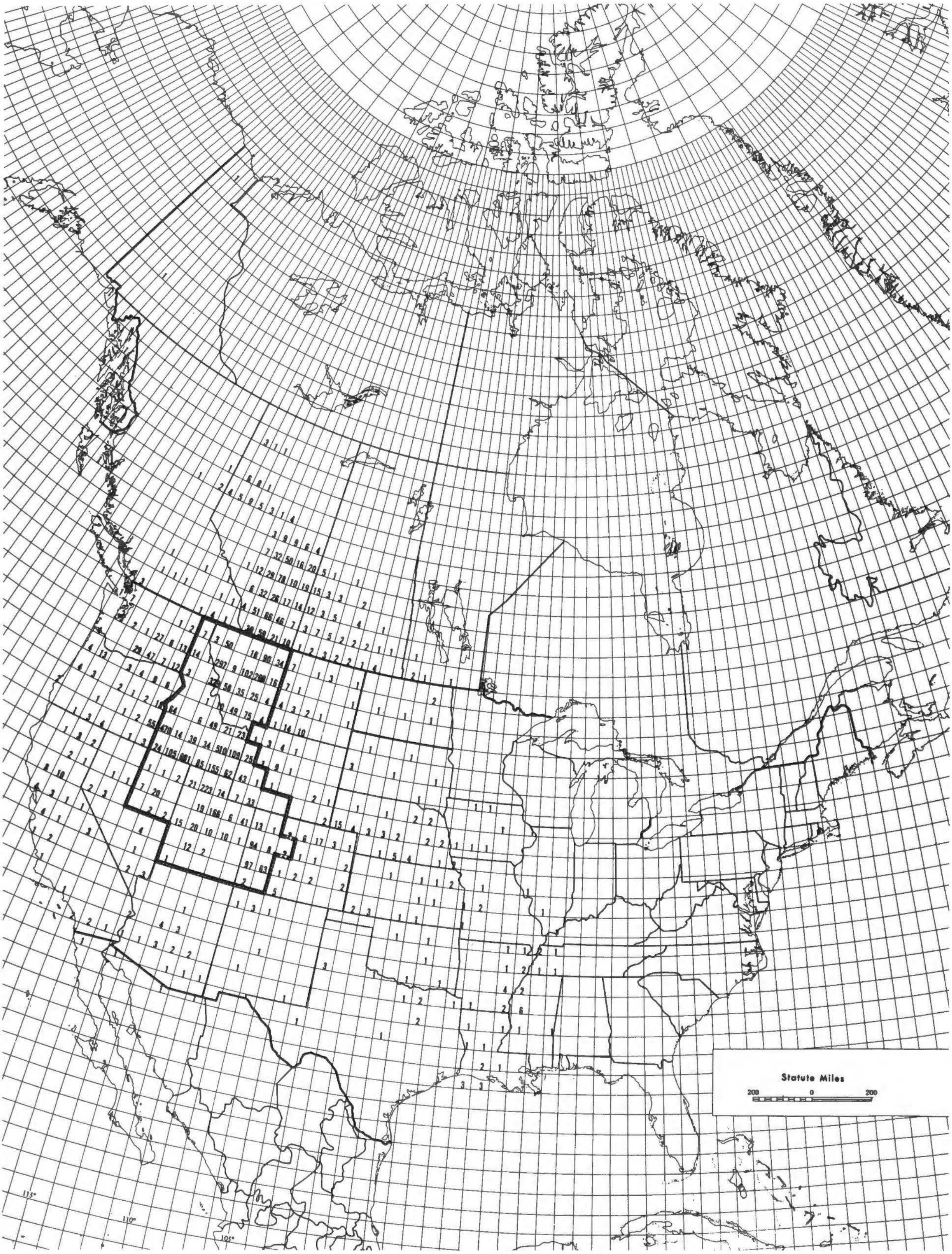

Fig. A-3. Distribution of recoveries from mallards banded during winter, 1950–1977, in the *Northeastern Pacific Flyway* and recovered in subsequent hunting seasons. All age and sex classes are combined.

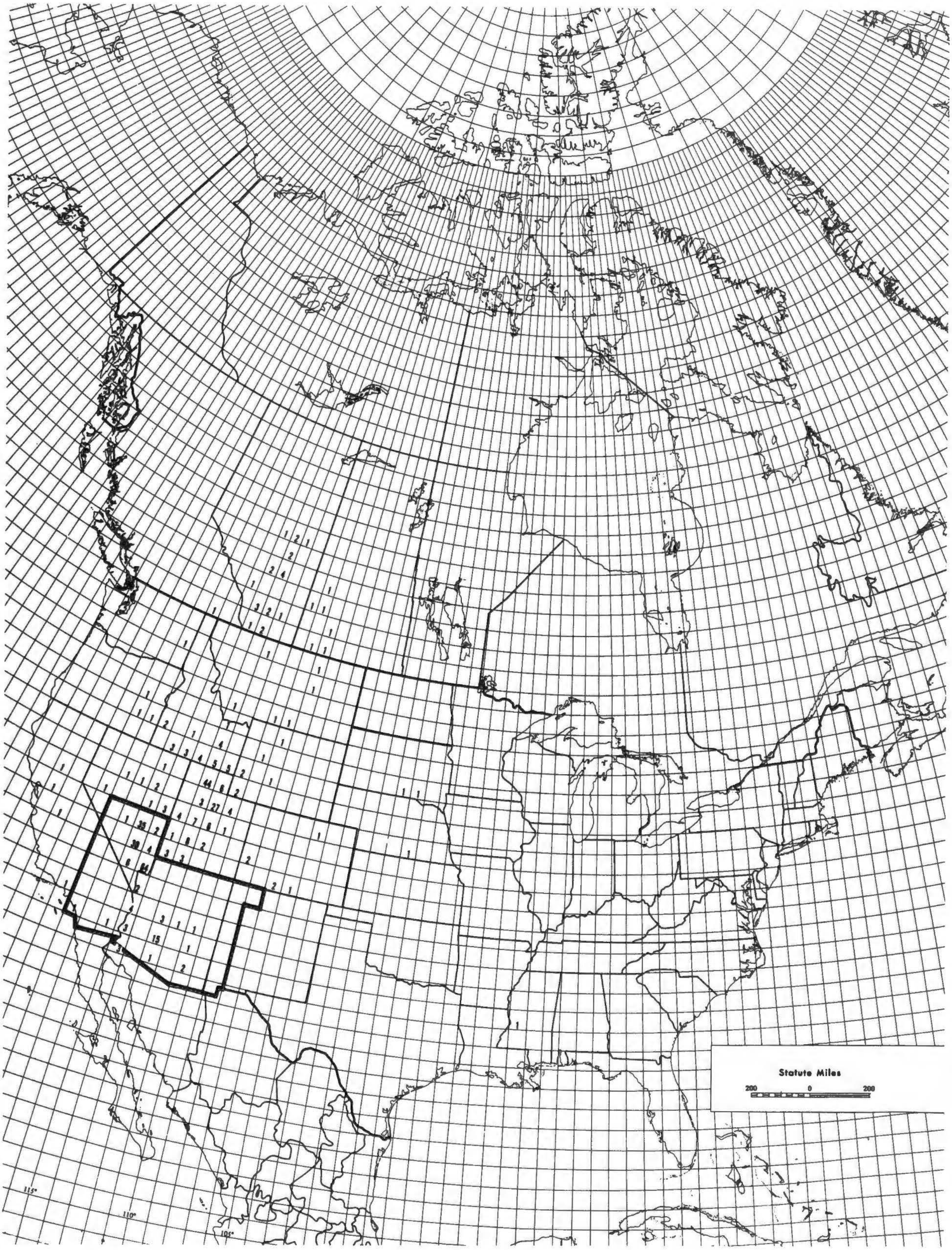

Fig. A-4. **Distribution of recoveries from mallards banded during winter, 1950–1977, in the *Southern Pacific Flyway* and recovered in subsequent hunting seasons. All age and sex classes are combined.**

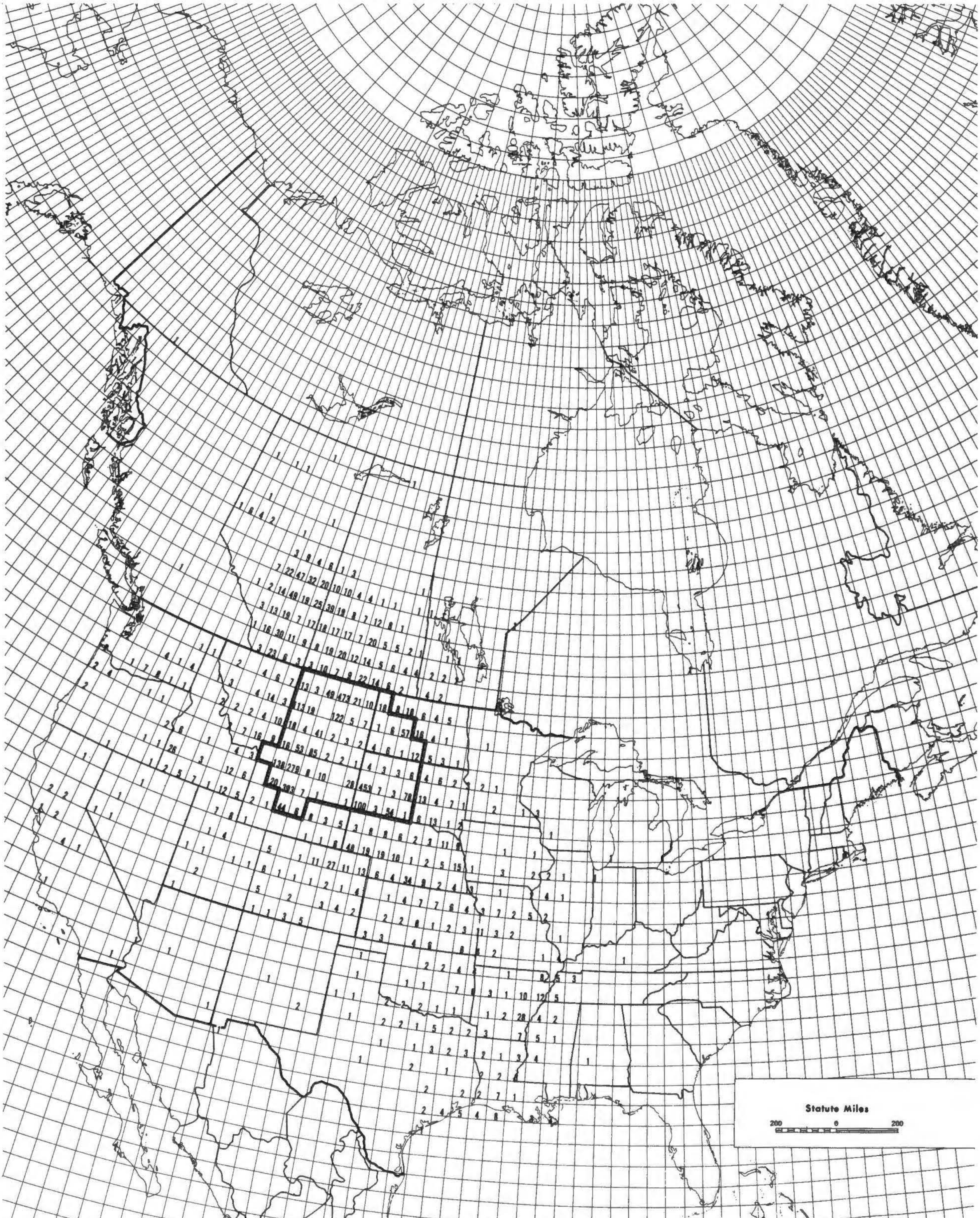

Fig. A-5. Distribution of recoveries from mallards banded during winter, 1950–1977, in the *Northern High Plains* and recovered in subsequent hunting seasons. All age and sex classes are combined.

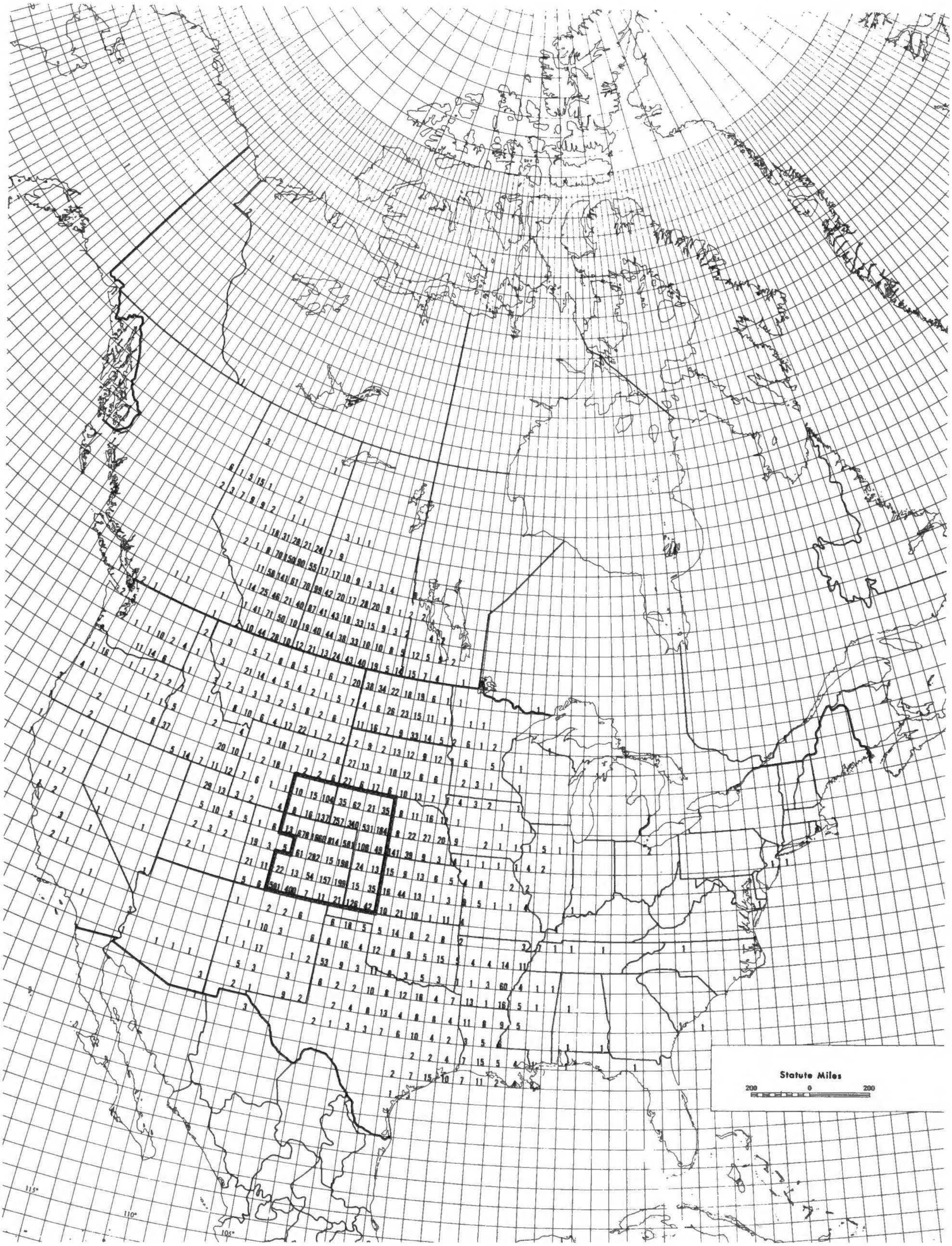

Fig. A-6. Distribution of recoveries from mallards banded during winter, 1950–19[illegible]7, in the *Central High Plains* and recovered in subsequent hunting seasons. All age and sex classes are combined.

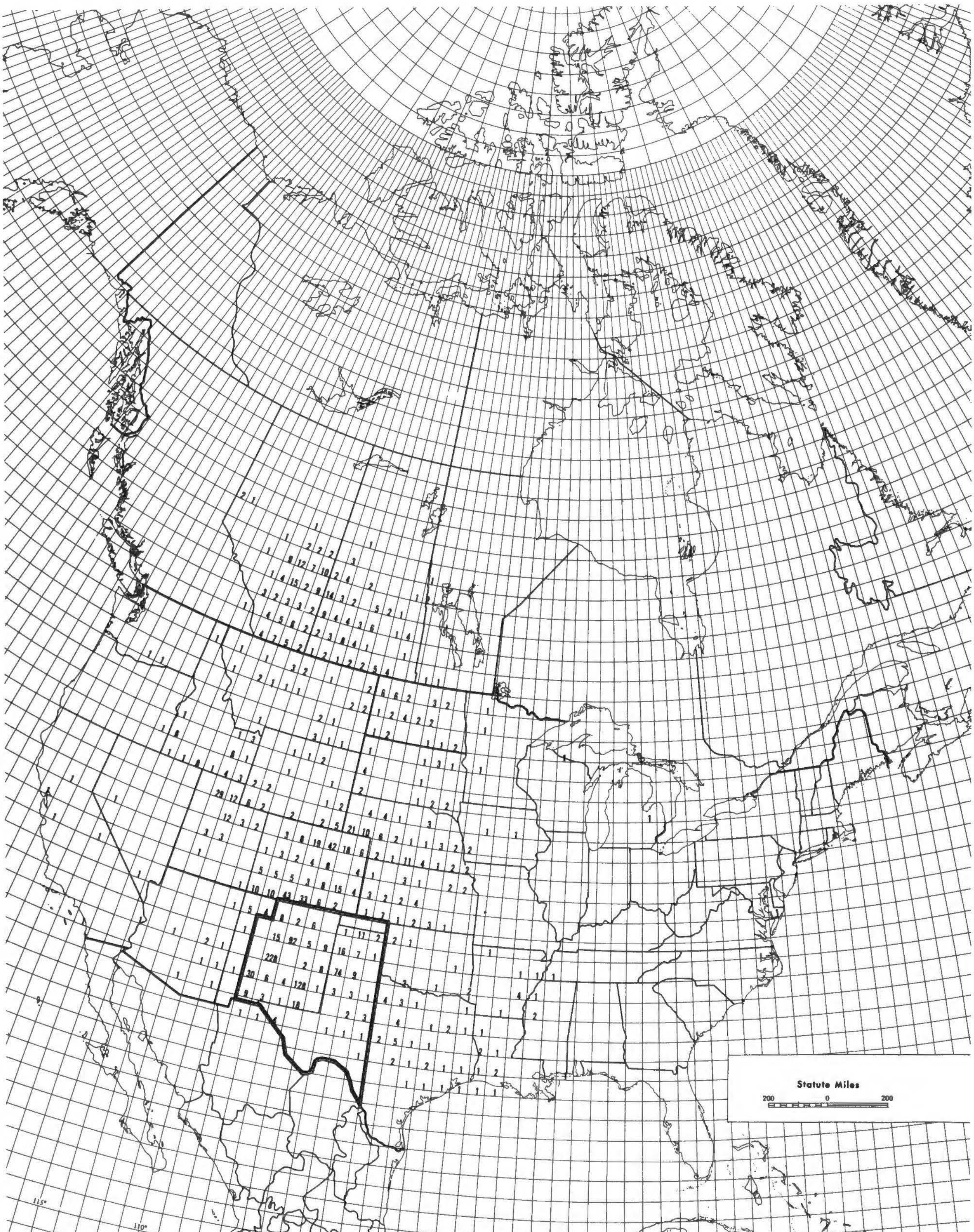

Fig. A-7. Distribution of recoveries from mallards banded during winter, 1950–1977, in the *Southern High Plains* and recovered in subsequent hunting seasons. All age and sex classes are combined.

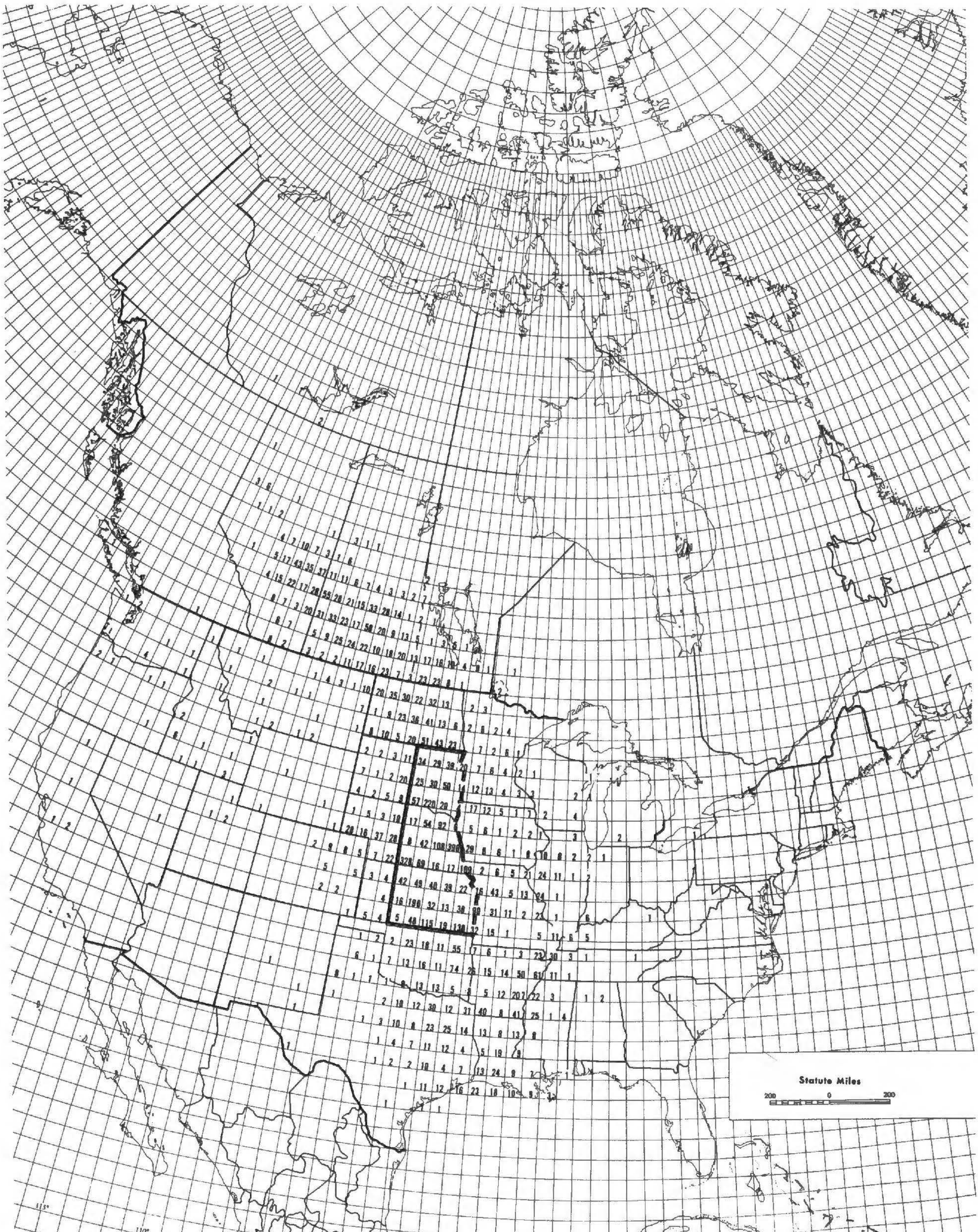

Fig. A-8. Distribution of recoveries from mallards banded during winter, 1950–1977, in the *Northern Low Plains* and recovered in subsequent hunting seasons. All age and sex classes are combined.

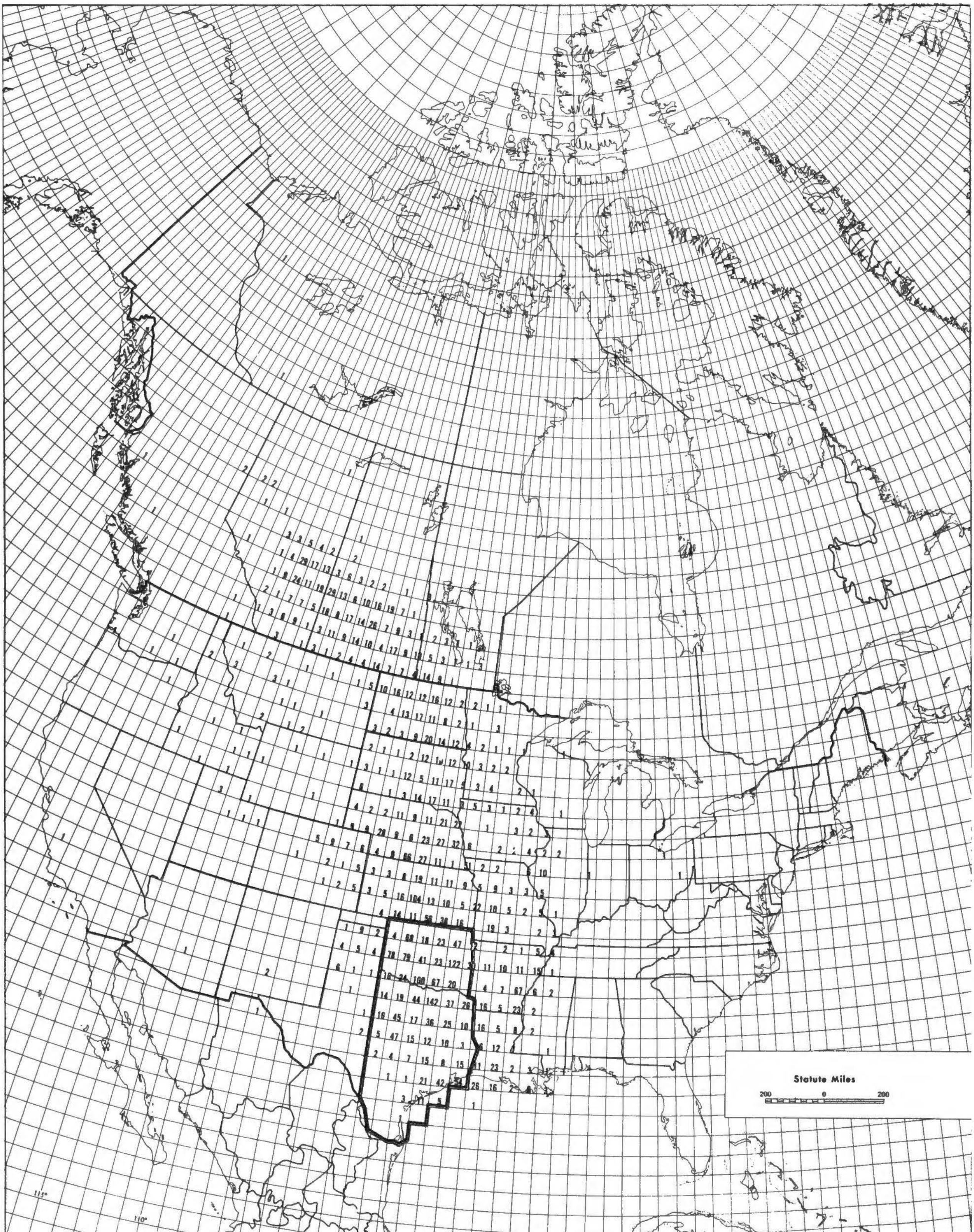

Fig. A-9. Distribution of recoveries from mallards banded during winter, 1950–1977, in the *Southern Low Plains* and recovered in subsequent hunting seasons. All age and sex classes are combined.

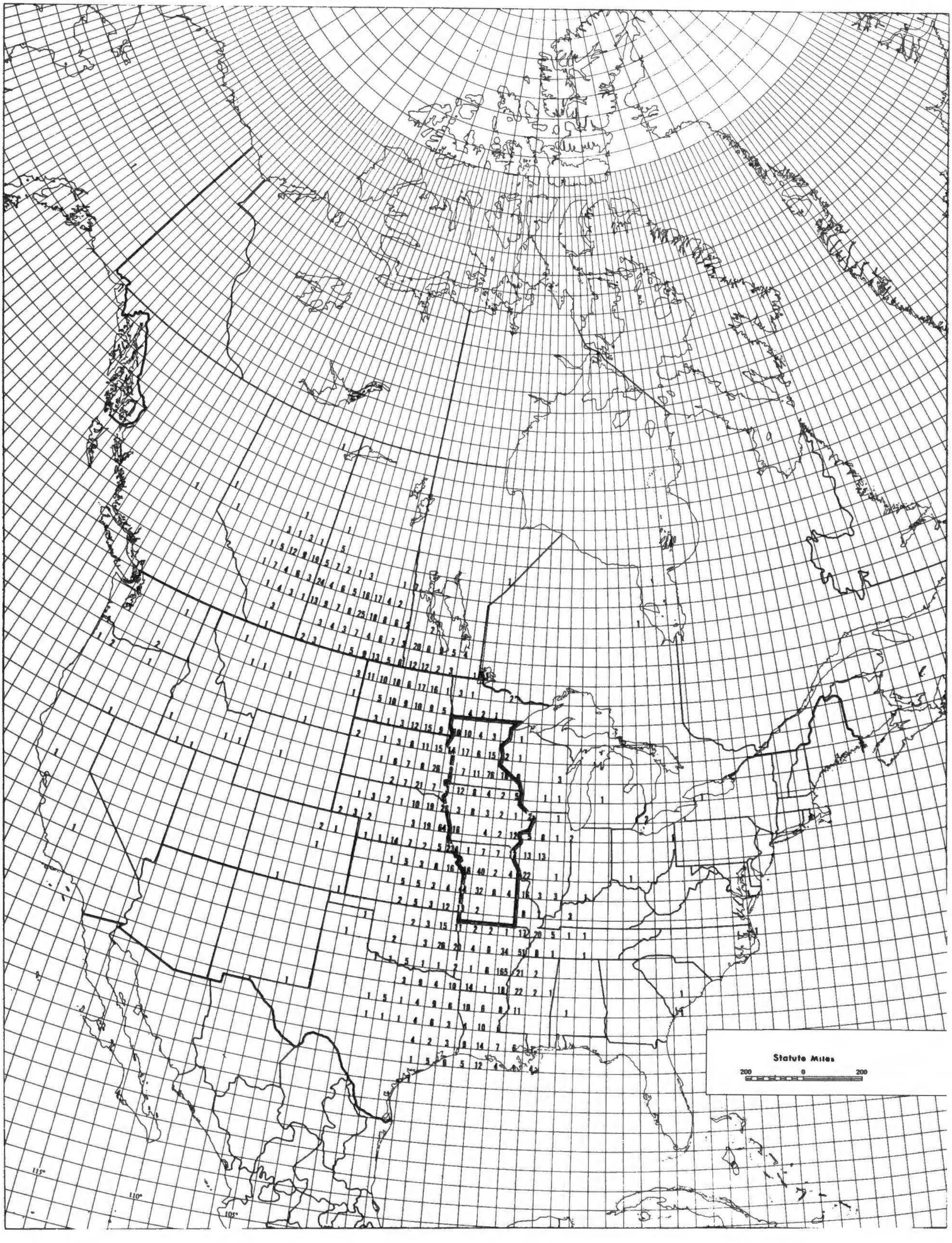

Fig. A-10. Distribution of recoveries from mallards banded during winter, 1950–1977, in the *Northwestern Mississippi Flyway* and recovered in subsequent hunting seasons. All age and sex classes are combined.

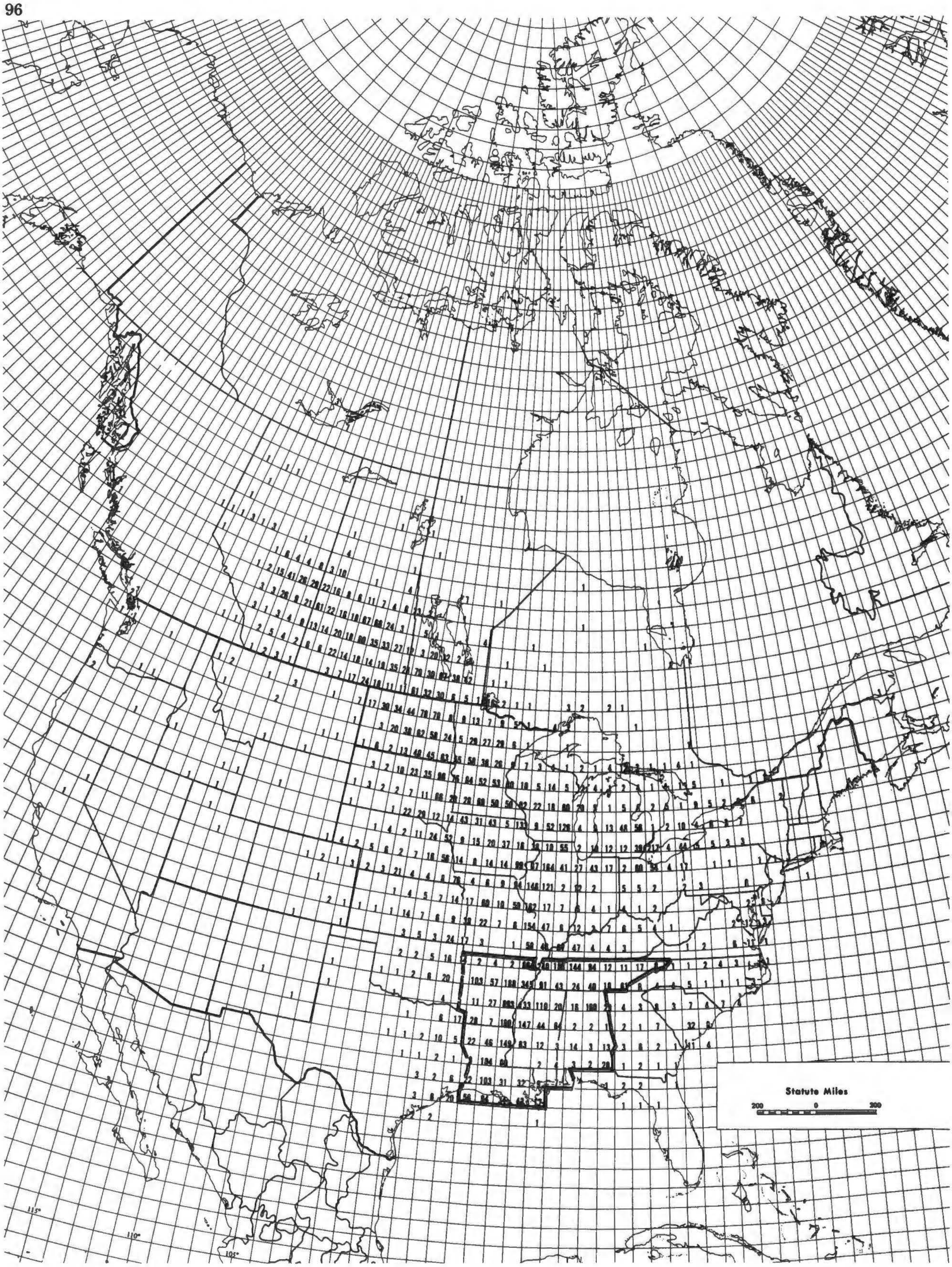

Fig. A-11. Distribution of recoveries from mallards banded during winter, 1950–1977, in the *Southern Mississippi Flyway* and recovered in subsequent hunting seasons. All age and sex classes are combined.

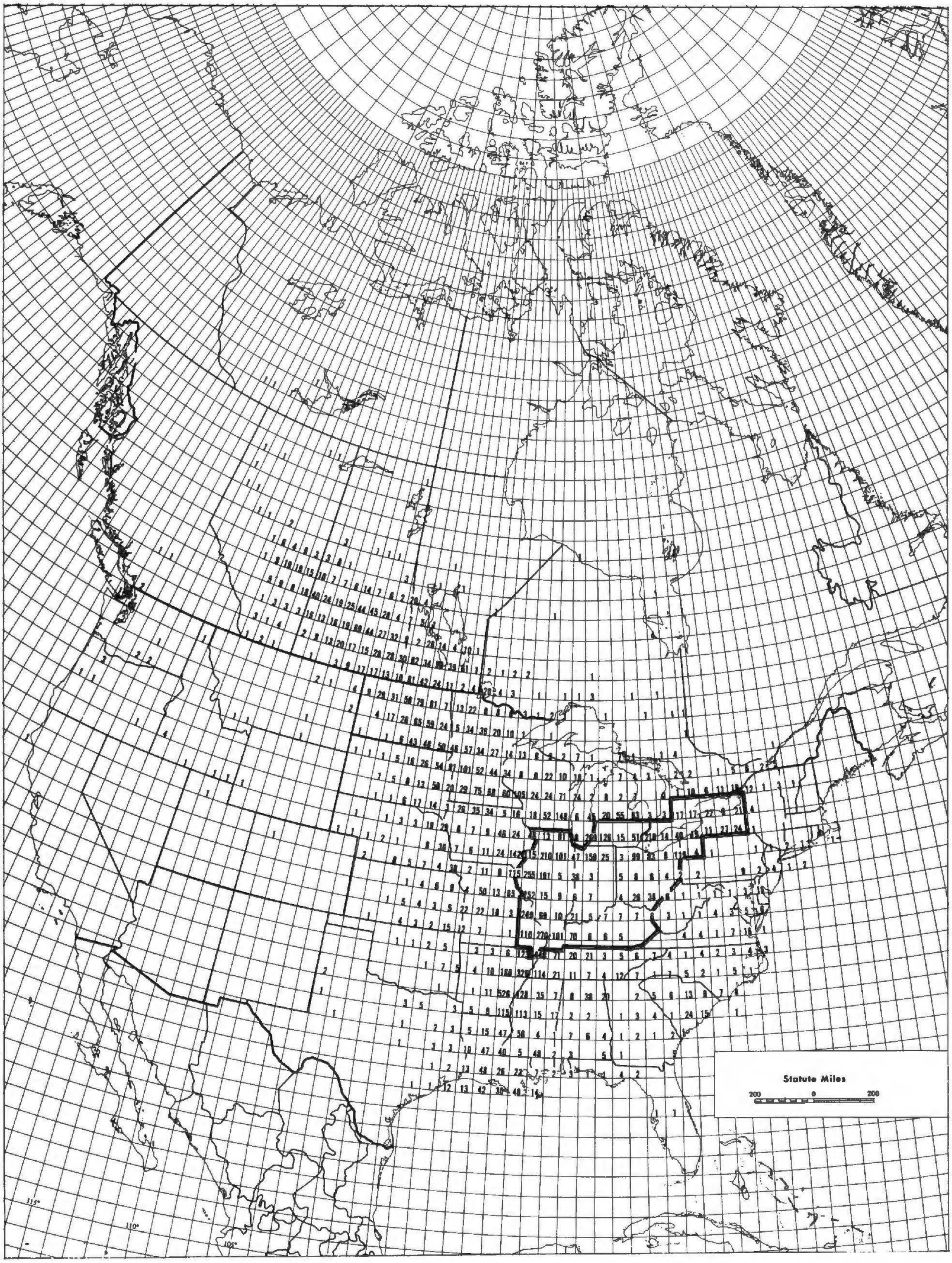

Fig. A-12. Distribution of recoveries from mallards banded during winter, 1950–1977, in the *Southern Great Lakes–Ohio River Valley* and recovered in subsequent hunting seasons. All age and sex classes are combined.

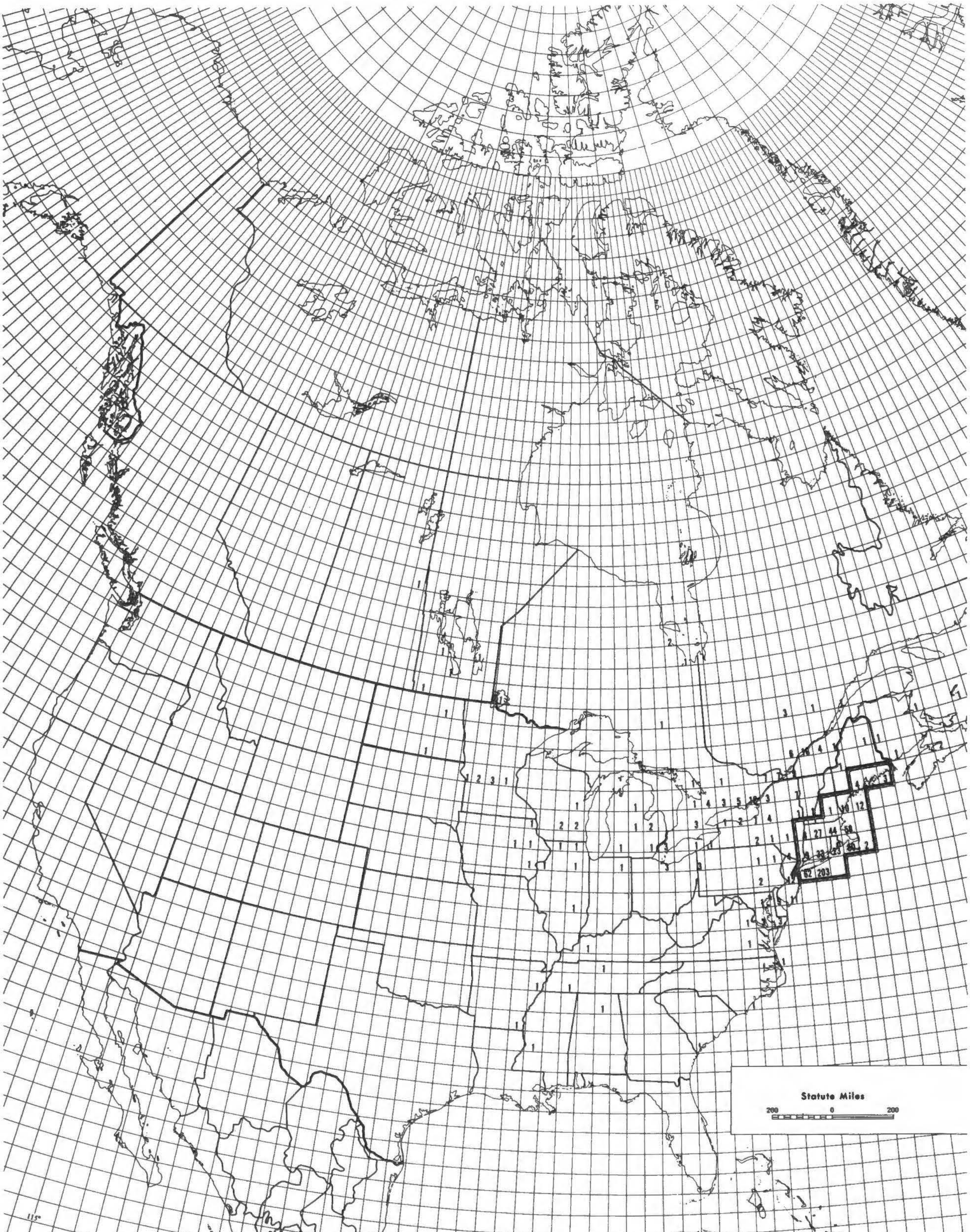

Fig. A-13. Distribution of recoveries from mallards banded during winter, 1950–1977, in the *Northeastern Atlantic Flyway* and recovered in subsequent hunting seasons. All age and sex classes are combined.

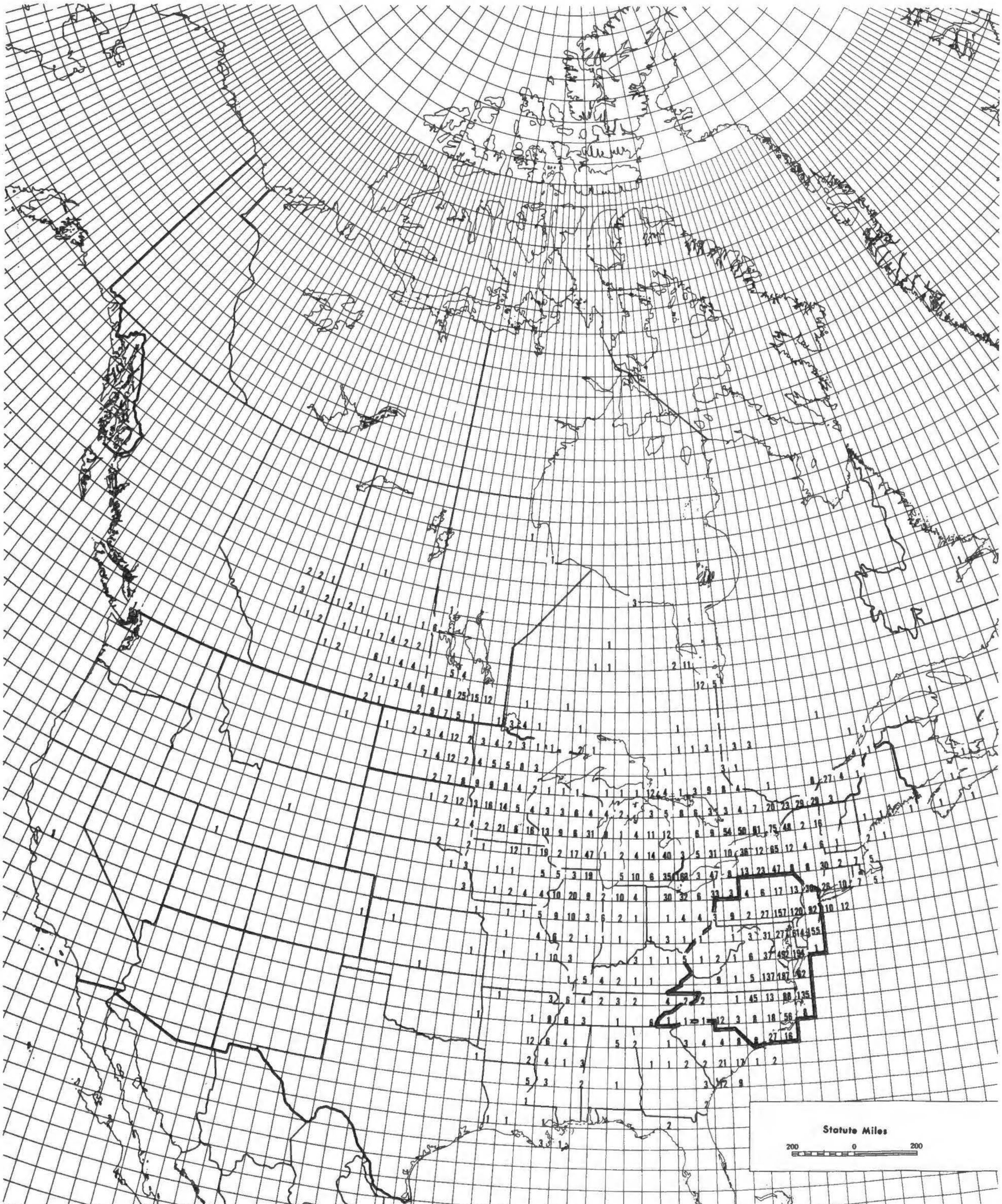

Fig. A-14. Distribution of recoveries from mallards banded during winter, 1950–1977, in the *Mid-Atlantic Flyway* and recovered in subsequent hunting seasons. All age and sex classes are combined.

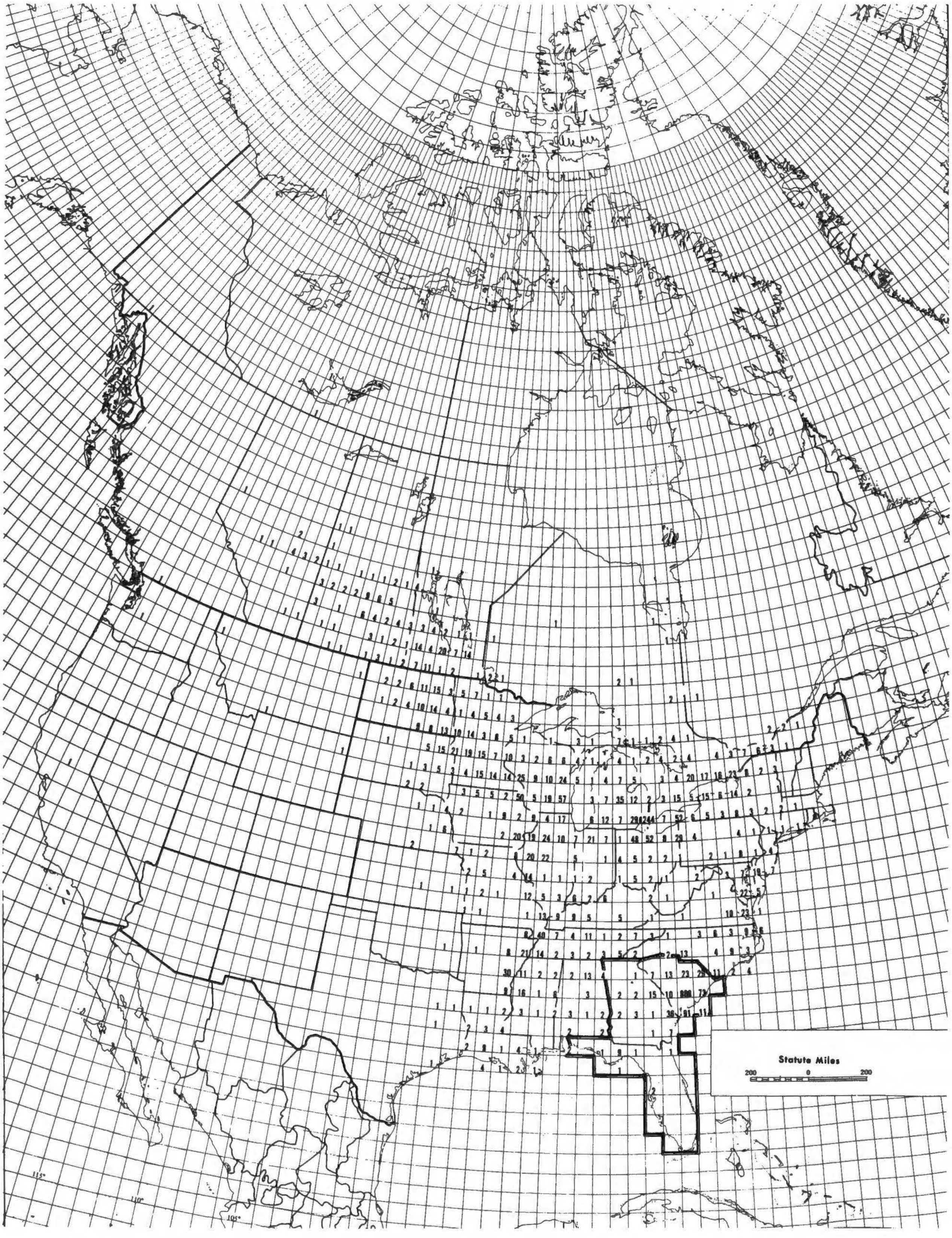

Fig. A-15. Distribution of recoveries from mallards banded during winter, 1950–1977, in the *Southern Atlantic Flyway* and recovered in subsequent hunting seasons. All age and sex classes are combined.

TABLE A-1. DISTRIBUTION OF HUNTING SEASON BAND RECOVERIES (EXPRESSED AS PERCENT) FROM MALLARDS BANDED DURING WINTER, 1950-1977, IN MINOR REFERENCE AREAS.

	ADULTS		SUBADULTS		UNKNOWN AGE		TOTAL
	MALES	FEMALES	MALES	FEMALES	MALES	FEMALES	BIRDS
BANDED IN: S BRITISH COLUMBIA-W WASHINGTON							
RECOVERED IN:							
MISSOURI					.3		.2
MISSISSIPPI FLYWAY					.3		.2
WASHINGTON	25.0				66.6	72.8	67.5
OREGON					8.0	6.8	7.4
IDAHO						.5	.2
CALIFORNIA					.6		.4
PACIFIC FLYWAY	25.0				75.1	80.1	75.4
ALASKA					2.1	1.6	1.8
YUKON					.3	.5	.4
BRITISH COLUMBIA	50.0	100.0		100.0	18.3	17.3	19.4
ALBERTA	25.0				3.3	.5	2.4
SASKATCHEWAN					.6		.4
ALASKA AND CANADA	75.0	100.0		100.0	24.6	19.9	24.4
TOTAL (PERCENT)	100.0	100.0		100.0	100.0	100.0	100.0
TOTAL RECOVERIES	4	7		1	338	191	541
BANDED IN: E WASHINGTON-NE OREGON							
RECOVERED IN:							
MINNESOTA					.0		.0
MICHIGAN					.0	.1	.0
IOWA					.0		.0
ILLINOIS					.0		.0
MISSOURI						.1	.0
ARKANSAS					.1	.2	.1
TENNESSEE					.0	.1	.0
LOUISIANA					.0		.0
MISSISSIPPI						.1	.0
ALABAMA						.1	.0
MISSISSIPPI FLYWAY					.3	.5	.3
EASTERN MONTANA					.0	.1	.0
NORTH DAKOTA					.2		.1
SOUTH DAKOTA					.1	.1	.1
EASTERN WYOMING					.1		.0
NEBRASKA			1.4		.2	.1	.1
EASTERN COLORADO					.1	.2	.2
KANSAS					.1		.1
OKLAHOMA					.0		.0
TEXAS					.0	.1	.0
CENTRAL FLYWAY			1.4		.8	.5	.7
WASHINGTON	50.0	87.5	73.2	57.1	56.7	56.9	56.9
OREGON	22.2		5.6	7.1	16.6	13.1	15.6
IDAHO					5.7	4.9	5.4
WESTERN MONTANA			1.4	7.1	1.3	1.5	1.3
CALIFORNIA					1.3	.9	1.2
NEVADA					.1	.1	.1
UTAH					.1	.2	.1
WESTERN COLORADO					.0		.0
ARIZONA						.1	.0
PACIFIC FLYWAY	72.2	87.5	80.3	71.4	81.7	77.6	80.6
ALASKA					.1	.1	.1
YUKON						.2	.1
BRITISH COLUMBIA	5.6		1.4	7.1	2.6	5.8	3.4
DISTRICT OF MACKENZIE						.1	.0
ALBERTA	22.2	12.5	16.9	21.4	13.8	14.1	13.9
SASKATCHEWAN					.8	.9	.8
MANITOBA					.0	.1	.1
ONTARIO						.1	.0
ALASKA AND CANADA	27.8	12.5	18.3	28.6	17.2	21.5	18.3
TOTAL (PERCENT)	100.0	100.0	100.0	100.0	100.0	100.0	100.0
TOTAL RECOVERIES	18	8	71	14	5125	1704	6940
BANDED IN: W OREGON-NW CALIFORNIA							
RECOVERED IN:							
MINNESOTA						.1	.0
WISCONSIN					.0		.0
MICHIGAN						.2	.1
ILLINOIS					.1		.1
ARKANSAS					.1	.1	.1
MISSISSIPPI FLYWAY					.3	.4	.3
EASTERN MONTANA					.1		.1
NORTH DAKOTA					.1	.1	.1

TABLE A-1. DISTRIBUTION OF HUNTING SEASON BAND RECOVERIES (EXPRESSED AS PERCENT) FROM MALLARDS BANDED DURING WINTER, 1950-1977, IN MINOR REFERENCE AREAS--CONTINUED.

	ADULTS		SUBADULTS		UNKNOWN AGE		
	MALES	FEMALES	MALES	FEMALES	MALES	FEMALES	TOTAL BIRDS
BANDED IN: W OREGON-NW CALIFORNIA							
RECOVERED IN:							
SOUTH DAKOTA					.0	.2	.1
EASTERN WYOMING					.0		.0
NEBRASKA					.1	.1	.1
EASTERN COLORADO					.0		.0
KANSAS						.1	.0
OKLAHOMA					.0		.0
TEXAS						.1	.0
CENTRAL FLYWAY					.5	.6	.5
WASHINGTON		50.0			26.1	25.3	25.9
OREGON					55.4	51.6	54.1
IDAHO					1.2	1.1	1.1
WESTERN MONTANA					.5	.6	.5
CALIFORNIA	100.0	50.0			1.6	2.2	1.8
UTAH					.0		.0
PACIFIC FLYWAY	100.0	100.0			84.8	80.7	83.5
ALASKA					.4	.4	.4
YUKON					.1		.1
BRITISH COLUMBIA					4.4	7.8	5.5
DISTRICT OF MACKENZIE						.1	.0
ALBERTA					9.1	9.3	9.1
SASKATCHEWAN					.4	.7	.5
ALASKA AND CANADA					14.4	18.3	15.6
TOTAL (PERCENT)	100.0	100.0			100.0	100.0	100.0
TOTAL RECOVERIES	1	2			2257	1022	3282
BANDED IN: SE OREGON-NE CALIFORNIA-NW NEVADA							
RECOVERED IN:							
NORTH DAKOTA						.7	.2
NEBRASKA					.1		.1
EASTERN COLORADO					.1		.1
TEXAS					.1		.1
CENTRAL FLYWAY					.3	.7	.4
WASHINGTON					7.3	11.2	8.0
OREGON		25.0			57.3	52.6	55.5
IDAHO	6.7				4.9	3.7	4.6
WESTERN MONTANA					1.5	.7	1.3
WESTERN WYOMING					.1		.1
CALIFORNIA	6.7	25.0			12.8	3.0	10.7
NEVADA	86.7	50.0			8.9	14.9	11.2
UTAH					.4		.3
PACIFIC FLYWAY	100.0	100.0			93.1	86.2	91.8
ALASKA					.1		.1
BRITISH COLUMBIA					1.0	1.5	1.1
ALBERTA					5.3	10.4	6.3
SASKATCHEWAN					.2	1.1	.4
ALASKA AND CANADA					6.6	13.1	7.8
TOTAL (PERCENT)	100.0	100.0			100.0	100.0	100.0
TOTAL RECOVERIES	15	4			988	268	1275
BANDED IN: CENTRAL CALIFORNIA-W NEVADA							
RECOVERED IN:							
FLORIDA					.0		.0
ATLANTIC FLYWAY					.0		.0
MISSOURI						.1	.0
ARKANSAS					.0	.1	.1
TENNESSEE						.1	.0
LOUISIANA		16.7					.0
MISSISSIPPI						.1	.0
MISSISSIPPI FLYWAY		16.7			.0	.5	.2
NORTH DAKOTA					.1		.1
EASTERN WYOMING					.0		.0
EASTERN COLORADO					.0	.1	.1
TEXAS					.0		.0
CENTRAL FLYWAY					.3	.1	.2
WASHINGTON					2.5	5.4	3.3
OREGON					6.2	11.2	7.5
IDAHO	40.0	16.7			2.4	2.7	2.5
WESTERN MONTANA					.6	.4	.6
WESTERN WYOMING					.0	.2	.1
CALIFORNIA	40.0	66.7			80.9	67.1	77.3
NEVADA					1.8	2.2	1.9
UTAH	20.0				.1	.5	.3
PACIFIC FLYWAY	100.0	83.3			94.6	89.7	93.3

TABLE A-1. DISTRIBUTION OF HUNTING SEASON BAND RECOVERIES (EXPRESSED AS PERCENT) FROM MALLARDS BANDED DURING WINTER, 1950-1977, IN MINOR REFERENCE AREAS--CONTINUED.

	ADULTS		SUBADULTS		UNKNOWN AGE		TOTAL
	MALES	FEMALES	MALES	FEMALES	MALES	FEMALES	BIRDS
BANDED IN: CENTRAL CALIFORNIA-W NEVADA							
RECOVERED IN:							
ALASKA					.1	.1	.1
BRITISH COLUMBIA					.3	1.2	.6
ALBERTA					4.1	7.0	4.9
SASKATCHEWAN					.5	1.2	.7
ONTARIO						.1	.0
ALASKA AND CANADA					5.1	9.7	6.3
TOTAL (PERCENT)	100.0	100.0			100.0	100.0	100.0
TOTAL RECOVERIES	5	6			2340	815	3166
BANDED IN: W IDAHO							
RECOVERED IN:							
IOWA					.1		.1
ILLINOIS					.1	.2	.1
MISSOURI					.2	.2	.2
ARKANSAS					.2	.6	.3
TENNESSEE					.1		.0
LOUISIANA					.1		.1
MISSISSIPPI	2.0						.0
MISSISSIPPI FLYWAY	2.0				.8	1.1	.8
EASTERN MONTANA			2.6		.6	.2	.6
NORTH DAKOTA					.3		.2
SOUTH DAKOTA					.2	.2	.2
EASTERN WYOMING					.2		.2
NEBRASKA	5.9				.8		.7
EASTERN COLORADO				4.0	.4		.3
KANSAS			2.6		.4	.4	.4
EASTERN NEW MEXICO					.1		.0
OKLAHOMA					.1	.2	.1
TEXAS					.1		.1
CENTRAL FLYWAY	5.9		5.1	4.0	3.1	1.1	2.8
WASHINGTON		5.0	2.6	4.0	2.6	4.0	2.9
OREGON	2.0				4.8	4.4	4.5
IDAHO	76.5	60.0	71.8	68.0	64.1	59.2	63.5
WESTERN MONTANA			5.1		3.9	4.2	3.8
WESTERN WYOMING			2.6		.2		.2
CALIFORNIA					1.0	2.1	1.2
NEVADA		5.0			.6	1.1	.7
UTAH	2.0	5.0	2.6	4.0	3.3	2.5	3.1
WESTERN COLORADO					.1		.1
ARIZONA					.1	.6	.2
PACIFIC FLYWAY	80.4	75.0	84.6	76.0	80.8	78.1	80.2
ALASKA					.1		.0
YUKON						.2	.0
BRITISH COLUMBIA					.5	.4	.4
DISTRICT OF MACKENZIE					.1		.0
ALBERTA	9.8	20.0	7.7	12.0	13.2	17.9	14.0
SASKATCHEWAN	2.0	5.0	2.6	8.0	1.5	1.1	1.6
MANITOBA					.1	.2	.1
ALASKA AND CANADA	11.8	25.0	10.3	20.0	15.4	19.8	16.2
TOTAL (PERCENT)	100.0	100.0	100.0	100.0	100.0	100.0	100.0
TOTAL RECOVERIES	51	20	39	25	1712	475	2322
BANDED IN: W MONTANA							
RECOVERED IN:							
NORTH CAROLINA						.3	.1
ATLANTIC FLYWAY						.3	.1
MINNESOTA						.3	.1
IOWA	2.4				.1	.3	.2
ILLINOIS	2.4				.1		.1
MISSOURI					.2		.2
KENTUCKY					.1		.1
ARKANSAS	2.4				.2	.3	.3
TENNESSEE					.1		.1
LOUISIANA					.4	.3	.4
MISSISSIPPI					.5	.3	.4
ALABAMA					.1		.1
MISSISSIPPI FLYWAY	7.1				1.7	1.5	1.7
EASTERN MONTANA	2.4			4.5	1.7	.6	1.5
SOUTH DAKOTA					.1		.1
EASTERN WYOMING					.4		.3
NEBRASKA					1.3	.9	1.2
EASTERN COLORADO					.4	.6	.4
KANSAS					.1		.1
OKLAHOMA					.1		.1

TABLE A-1. DISTRIBUTION OF HUNTING SEASON BAND RECOVERIES (EXPRESSED AS PERCENT) FROM MALLARDS BANDED DURING WINTER, 1950-1977, IN MINOR REFERENCE AREAS--CONTINUED.

	ADULTS		SUBADULTS		UNKNOWN AGE		TOTAL
	MALES	FEMALES	MALES	FEMALES	MALES	FEMALES	BIRDS
BANDED IN: W MONTANA							
RECOVERED IN:							
TEXAS	2.4			4.5	.2		.3
CENTRAL FLYWAY	4.8			9.1	4.4	2.1	3.9
WASHINGTON	2.4	20.0	6.3		3.4	4.0	3.6
OREGON					1.5	2.4	1.6
IDAHO	9.5		3.8	4.5	5.6	5.5	5.5
WESTERN MONTANA	61.9	80.0	81.3	77.3	69.2	65.7	69.1
WESTERN WYOMING						.3	.1
CALIFORNIA					.7	.3	.6
UTAH					.5	.3	.5
WESTERN COLORADO					.1		.1
WESTERN NEW MEXICO					.1		.1
PACIFIC FLYWAY	73.8	100.0	91.3	81.8	81.1	78.4	80.9
BRITISH COLUMBIA			1.3		.5	.6	.5
ALBERTA	11.9		7.5	9.1	11.0	16.4	11.7
SASKATCHEWAN	2.4				1.3	.6	1.1
MANITOBA					.1		.1
QUEBEC					.1		.1
ALASKA AND CANADA	14.3		8.8	9.1	12.9	17.6	13.5
TOTAL (PERCENT)	100.0	100.0	100.0	100.0	100.0	100.0	100.0
TOTAL RECOVERIES	42	5	80	22	1489	329	1967
BANDED IN: E IDAHO-SW WYOMING							
RECOVERED IN:							
MISSOURI					.1		.1
ARKANSAS					.1		.1
LOUISIANA					.1		.1
MISSISSIPPI FLYWAY					.3		.2
EASTERN MONTANA		6.7			.5	.3	.5
SOUTH DAKOTA					.3		.2
EASTERN WYOMING					1.2	1.0	1.1
NEBRASKA					.4	.7	.4
EASTERN COLORADO	3.6				.5	.3	.5
EASTERN NEW MEXICO					.1		.1
OKLAHOMA					.1	.3	.1
TEXAS					.1		.1
CENTRAL FLYWAY	3.6	6.7			3.0	2.7	3.0
IDAHO	67.9	60.0	100.0		66.5	63.7	65.9
WESTERN MONTANA	3.6				5.9	6.2	5.8
CALIFORNIA					.5	.3	.5
WESTERN COLORADO					.1		.1
ARIZONA	3.6				.3	.3	.3
WASHINGTON					1.2	1.4	1.2
OREGON					.6	.7	.6
WESTERN WYOMING		6.7			7.2	3.1	6.2
NEVADA					.1	1.0	.3
UTAH	7.1	13.3			3.9	3.8	4.0
PACIFIC FLYWAY	82.1	80.0	100.0		86.3	80.5	85.0
BRITISH COLUMBIA	3.6	6.7				.7	.3
ALBERTA	7.1	6.7			9.2	13.7	10.0
SASKATCHEWAN	3.6				1.1	2.4	1.4
MANITOBA					.1		.1
ALASKA AND CANADA	14.3	13.3			10.4	16.8	11.8
MEXICO					.1		.1
MEXICO					.1		.1
TOTAL (PERCENT)	100.0	100.0	100.0		100.0	100.0	100.0
TOTAL RECOVERIES	28	15	2		1100	292	1437
BANDED IN: NE NEVADA-W UTAH							
RECOVERED IN:							
MISSOURI					.2		.2
MISSISSIPPI FLYWAY					.2		.2
EASTERN MONTANA					.7	.7	.7
SOUTH DAKOTA					.2		.2
EASTERN WYOMING					.7		.5
NEBRASKA					.5		.3
EASTERN COLORADO					.7		.5
TEXAS						.7	.2
CENTRAL FLYWAY					2.8	1.4	2.4
WASHINGTON					.5		.3
OREGON					.2		.2
IDAHO	30.0	28.6			9.8	7.1	9.7
WESTERN MONTANA					.9	.7	.9

TABLE A-1. DISTRIBUTION OF HUNTING SEASON BAND RECOVERIES (EXPRESSED AS PERCENT) FROM MALLARDS BANDED DURING WINTER, 1950-1977, IN MINOR REFERENCE AREAS--CONTINUED.

	ADULTS		SUBADULTS		UNKNOWN AGE		
	MALES	FEMALES	MALES	FEMALES	MALES	FEMALES	TOTAL BIRDS
BANDED IN: NE NEVADA-W UTAH							
RECOVERED IN:							
CALIFORNIA					2.1	2.9	2.2
NEVADA					5.4	9.3	6.1
UTAH	70.0	57.1		100.0	70.7	70.7	70.6
WESTERN COLORADO					.2		.2
ARIZONA					2.3	2.9	2.4
PACIFIC FLYWAY	100.0	85.7		100.0	92.3	93.6	92.7
BRITISH COLUMBIA						.7	.2
ALBERTA		14.3			3.0	3.6	3.2
SASKATCHEWAN					1.2	.7	1.0
ALASKA AND CANADA		14.3			4.2	5.0	4.4
MEXICO					.5		.3
MEXICO					.5		.3
TOTAL (PERCENT)	100.0	100.0		100.0	100.0	100.0	100.0
TOTAL RECOVERIES	10	7		2	427	140	586
BANDED IN: E UTAH-W COLORADO							
RECOVERED IN:							
MISSOURI	.5						.2
LOUISIANA			.7	1.5			.3
MISSISSIPPI FLYWAY	.5		.7	1.5			.5
EASTERN MONTANA		1.9	2.0	1.5		2.9	1.1
SOUTH DAKOTA	.5						.2
EASTERN WYOMING	1.6	2.8	1.3		1.2		1.4
NEBRASKA	2.7						.8
EASTERN COLORADO	3.8	4.6	8.0		6.2	2.9	4.8
KANSAS	.5	.9					.3
EASTERN NEW MEXICO	.5	.9					.3
TEXAS			.7				.2
CENTRAL FLYWAY	9.7	11.1	12.0	1.5	7.4	5.7	9.1
WASHINGTON				1.5	1.2	2.9	.5
OREGON	.5			1.5			.3
IDAHO	5.4	6.5	8.0	6.2	3.7		5.8
WESTERN MONTANA	2.7		2.0		1.2		1.4
WESTERN WYOMING	1.6	1.9	2.7	1.5	1.2		1.8
CALIFORNIA						2.9	.2
UTAH	8.1	13.0	8.7	6.2	32.1	28.6	13.1
WESTERN COLORADO	62.9	53.7	58.0	70.8	48.1	48.6	58.2
ARIZONA	1.1		.7				.5
WESTERN NEW MEXICO			1.3	1.5	1.2		.6
PACIFIC FLYWAY	82.3	75.0	81.3	89.2	88.9	82.9	82.4
BRITISH COLUMBIA	.5	.9					.3
ALBERTA	4.8	10.2	4.0	6.2	2.5	8.6	5.6
SASKATCHEWAN	1.6	2.8	2.0	1.5	1.2		1.8
MANITOBA	.5					2.9	.3
ALASKA AND CANADA	7.5	13.9	6.0	7.7	3.7	11.4	8.0
TOTAL (PERCENT)	100.0	100.0	100.0	100.0	100.0	100.0	100.0
TOTAL RECOVERIES	186	108	150	65	81	35	625
BANDED IN: S NEVADA-S CALIFORNIA-W ARIZONA							
RECOVERED IN:							
MISSISSIPPI					.4		.3
MISSISSIPPI FLYWAY					.4		.3
EASTERN COLORADO	12.5				.8		.8
EASTERN MONTANA		20.0				2.3	1.0
SOUTH DAKOTA						.8	.3
EASTERN WYOMING					.4	1.5	.8
NEBRASKA						.8	.3
CENTRAL FLYWAY	12.5	20.0			1.2	5.3	3.0
WASHINGTON						.8	.3
OREGON					.8	.8	.8
IDAHO	12.5				8.1	4.5	6.9
WESTERN MONTANA					1.2		.8
WESTERN WYOMING					.4	2.3	1.0
CALIFORNIA		20.0			2.4	.8	2.0
NEVADA	25.0	20.0		50.0	34.1	45.9	37.8
UTAH	25.0				34.6	26.3	31.0
WESTERN COLORADO					.8		.5
ARIZONA		20.0		50.0	7.7	9.0	8.4
PACIFIC FLYWAY	62.5	60.0		100.0	90.2	90.2	89.3
BRITISH COLUMBIA					.4		.3
ALBERTA		20.0			6.5	3.8	5.6
SASKATCHEWAN	25.0				.8	.8	1.3
ALASKA AND CANADA	25.0	20.0			7.7	4.5	7.1

TABLE A-1. DISTRIBUTION OF HUNTING SEASON BAND RECOVERIES (EXPRESSED AS PERCENT) FROM MALLARDS BANDED DURING WINTER, 1950-1977, IN MINOR REFERENCE AREAS--CONTINUED.

	ADULTS		SUBADULTS		UNKNOWN AGE		
	MALES	FEMALES	MALES	FEMALES	MALES	FEMALES	TOTAL BIRDS
BANDED IN: S NEVADA-S CALIFORNIA-W ARIZONA							
RECOVERED IN:							
MEXICO					.4		.3
MEXICO					.4		.3
TOTAL (PERCENT)	100.0	100.0		100.0	100.0	100.0	100.0
TOTAL RECOVERIES	8	5		2	246	133	394
BANDED IN: E MONTANA							
RECOVERED IN:							
VIRGINIA					.1		.1
ATLANTIC FLYWAY					.1		.1
MINNESOTA					.2	.5	.3
WISCONSIN						.5	.1
IOWA					.1		.1
ILLINOIS					.5		.5
MISSOURI					.8	1.0	.8
ARKANSAS					1.3	.5	1.2
TENNESSEE					.3		.3
LOUISIANA					.9		.8
MISSISSIPPI					.1	.5	.2
ALABAMA						.5	.1
MISSISSIPPI FLYWAY					4.3	3.3	4.2
EASTERN MONTANA					59.3	53.1	58.5
NORTH DAKOTA					1.5	1.9	1.5
SOUTH DAKOTA					1.9	2.9	2.1
EASTERN WYOMING					1.3	1.4	1.3
NEBRASKA					3.6	2.4	3.5
EASTERN COLORADO					1.4	1.0	1.4
KANSAS					1.0	.5	1.0
EASTERN NEW MEXICO					.1		.1
OKLAHOMA					.7		.6
TEXAS					.9	1.9	1.0
CENTRAL FLYWAY					71.7	65.1	70.8
WASHINGTON					.9	1.4	1.0
OREGON					.2		.2
IDAHO					2.6	1.9	2.5
WESTERN MONTANA					3.0	1.9	2.9
WESTERN WYOMING					.1		.1
CALIFORNIA					.3	1.0	.4
NEVADA					.2		.2
UTAH					.4	1.0	.5
WESTERN COLORADO					.1		.1
WESTERN NEW MEXICO					.1		.1
PACIFIC FLYWAY					8.0	7.2	7.9
ALASKA						.5	.1
DISTRICT OF MACKENZIE					.1		.1
ALBERTA					7.3	10.5	7.7
SASKATCHEWAN					8.2	13.4	8.9
MANITOBA					.4		.3
ALASKA AND CANADA					15.9	24.4	17.0
TOTAL (PERCENT)					100.0	100.0	100.0
TOTAL RECOVERIES					1346	209	1555
BANDED IN: W NORTH DAKOTA-W SOUTH DAKOTA							
RECOVERED IN:							
MINNESOTA	.3		.3	1.9	.4		.3
WISCONSIN					.2		.1
MICHIGAN					.1		.1
IOWA	1.6	1.6	.8	1.9	.6		.8
ILLINOIS	1.3	1.6	.3		.6	.5	.7
MISSOURI	2.5		.8	1.9	1.4	4.4	1.7
KENTUCKY		1.6					.1
ARKANSAS	3.5	1.6	2.5		4.1	4.4	3.5
TENNESSEE	.3		.5		.2		.3
LOUISIANA	3.2	3.2	1.1	3.8	.9	2.7	1.7
MISSISSIPPI	1.9		.3	1.9	.2	.5	.6
ALABAMA					.1		.1
MISSISSIPPI FLYWAY	14.6	9.5	6.6	11.3	8.9	12.6	9.9
EASTERN MONTANA	1.0		1.1	1.9	1.6	1.1	1.3
NORTH DAKOTA	11.4	11.1	13.2	11.3	4.5	5.5	8.0
SOUTH DAKOTA	37.5	33.3	50.0	43.4	47.5	37.2	44.6
EASTERN WYOMING	1.0	1.6	.8		1.6	2.2	1.3
NEBRASKA	6.0	6.3	5.2	7.5	11.9	6.0	8.6
EASTERN COLORADO	2.2	4.8	1.1		1.9	1.6	1.8
KANSAS	3.8	4.8	3.3	5.7	2.7	2.7	3.2
OKLAHOMA	1.3		.3		2.0		1.2

TABLE A-1. DISTRIBUTION OF HUNTING SEASON BAND RECOVERIES (EXPRESSED AS PERCENT) FROM MALLARDS BANDED DURING WINTER, 1950-1977, IN MINOR REFERENCE AREAS--CONTINUED.

	ADULTS		SUBADULTS		UNKNOWN AGE		TOTAL
	MALES	FEMALES	MALES	FEMALES	MALES	FEMALES	BIRDS
BANDED IN: W NORTH DAKOTA-W SOUTH DAKOTA							
RECOVERED IN:							
TEXAS	1.3	1.6	1.1		1.4	1.1	1.2
CENTRAL FLYWAY	65.4	63.5	76.1	69.8	75.1	57.4	71.2
WASHINGTON	1.0	1.6	.3		.4	.5	.5
OREGON	.6	3.2			.1		.3
IDAHO	1.9		.3	1.9	.4	.5	.7
WESTERN MONTANA	1.3		.3	1.9	.4	.5	.6
CALIFORNIA					.2		.1
UTAH					.1		.1
WESTERN COLORADO	.3						.1
PACIFIC FLYWAY	5.1	4.8	.8	3.8	1.6	1.6	2.2
BRITISH COLUMBIA					.2		.1
DISTRICT OF MACKENZIE	.3						.1
ALBERTA	4.4	9.5	7.7	7.5	5.8	14.8	7.1
SASKATCHEWAN	9.5	11.1	8.2	7.5	7.9	10.4	8.6
MANITOBA	.6	1.6	.5		.2	3.3	.7
ONTARIO					.1		.1
ALASKA AND CANADA	14.9	22.2	16.5	15.1	14.4	28.4	16.6
TOTAL (PERCENT)	100.0	100.0	100.0	100.0	100.0	100.0	100.0
TOTAL RECOVERIES	315	63	364	53	806	183	1784
BANDED IN: N WYOMING							
RECOVERED IN:							
MARYLAND					.1		.1
ATLANTIC FLYWAY					.1		.1
MINNESOTA	.5						.1
IOWA	.5						.1
ILLINOIS					.2	.4	.2
MISSOURI					.1	.8	.2
ARKANSAS	.5			16.7	.4		.4
TENNESSEE					.2	.4	.2
LOUISIANA					.4		.3
MISSISSIPPI FLYWAY	1.6			16.7	1.3	1.6	1.3
EASTERN MONTANA	6.5		4.9		4.5	7.3	5.1
NORTH DAKOTA	.5				.5	2.4	.8
SOUTH DAKOTA		3.2			.5	.4	.4
EASTERN WYOMING	54.6	54.8	61.7	50.0	58.5	47.8	56.4
NEBRASKA	3.2		2.5		2.0	1.2	2.0
EASTERN COLORADO	5.4	3.2	1.2		2.3	1.6	2.5
KANSAS					.5	.4	.4
EASTERN NEW MEXICO			1.2		.1		.1
OKLAHOMA	.5				.3	.4	.3
TEXAS	1.1				.5		.4
CENTRAL FLYWAY	71.9	61.3	71.6	50.0	69.6	61.6	68.5
WASHINGTON	.5	3.2	2.5		.7	.8	.8
OREGON	.5				.3	.4	.3
IDAHO	3.2	3.2	1.2		3.0	4.1	3.1
WESTERN MONTANA	3.2		3.7		3.1	3.7	3.1
WESTERN WYOMING	.5		2.5		.5		.5
CALIFORNIA	.5				.4	.8	.4
NEVADA					.1		.1
UTAH	3.2		3.7		1.3	.4	1.4
WESTERN COLORADO	1.1	3.2			.4	2.4	.8
ARIZONA	.5					.8	.2
PACIFIC FLYWAY	13.5	9.7	13.6		9.6	13.5	10.8
ALASKA					.1		.1
YUKON					.1		.1
ALBERTA	9.7	19.4	7.4	33.3	11.7	18.4	12.5
SASKATCHEWAN	3.2	9.7	7.4		7.2	4.5	6.4
MANITOBA					.2	.4	.2
ALASKA AND CANADA	13.0	29.0	14.8	33.3	19.3	23.3	19.2
MEXICO					.1		.1
MEXICO					.1		.1
TOTAL (PERCENT)	100.0	100.0	100.0	100.0	100.0	100.0	100.0
TOTAL RECOVERIES	185	31	81	6	1040	245	1588
BANDED IN: SE WYOMING-W NEBRASKA							
RECOVERED IN:							
NEW YORK	.2						.0
MARYLAND					.1		.0
GEORGIA					.1		.0
ATLANTIC FLYWAY	.2				.2		.1
MINNESOTA	.3	2.7			.4	1.1	.5

TABLE A-1. DISTRIBUTION OF HUNTING SEASON BAND RECOVERIES (EXPRESSED AS PERCENT) FROM MALLARDS BANDED DURING WINTER, 1950-1977, IN MINOR REFERENCE AREAS--CONTINUED.

	ADULTS		SUBADULTS		UNKNOWN AGE		TOTAL
	MALES	FEMALES	MALES	FEMALES	MALES	FEMALES	BIRDS
<u>BANDED IN: SE WYOMING-W NEBRASKA</u>							
RECOVERED IN:							
IOWA			.8		.4	.5	.3
ILLINOIS	.3				.1		.1
ARKANSAS	2.0	1.4			.9	.5	1.1
LOUISIANA	.2	2.0			.4	1.6	.5
MISSISSIPPI	.3				.2		.2
ALABAMA	.2						.0
WISCONSIN	.2	.7			.1		.1
MISSOURI	.5		.8		.1	.5	.3
TENNESSEE		.7			.4		.2
MISSISSIPPI FLYWAY	3.9	7.4	1.5		3.1	4.2	3.5
EASTERN MONTANA	1.2	1.4	.4		.6	1.1	.8
NORTH DAKOTA	2.5	1.4	2.3	5.9	2.7	3.7	2.6
SOUTH DAKOTA	1.7	.7	1.1		1.8	3.2	1.7
EASTERN WYOMING	3.1	2.7	.8		8.6	7.4	5.5
NEBRASKA	52.8	43.9	70.7	70.6	53.1	41.6	53.8
EASTERN COLORADO	7.9	4.7	4.9		6.0	7.9	6.4
KANSAS	3.1	3.4	1.1	2.9	2.2	2.1	2.4
EASTERN NEW MEXICO	.5						.1
OKLAHOMA	1.2	1.4			1.0	.5	.9
TEXAS	2.5	2.7	1.5		1.0	2.6	1.7
CENTRAL FLYWAY	76.6	62.2	82.7	79.4	77.0	70.0	76.0
WASHINGTON	.3	2.0	.4		.3	.5	.4
OREGON	.2				.3	2.1	.4
IDAHO	.5	.7			.6		.4
WESTERN MONTANA	.8	1.4			.6	.5	.6
WESTERN WYOMING	.2					.5	.1
CALIFORNIA		.7					.0
UTAH	.3				.4		.3
WESTERN COLORADO	.2				.2		.1
PACIFIC FLYWAY	2.3	4.7	.4		2.5	3.7	2.4
ALASKA		.7					.0
BRITISH COLUMBIA	.5		.4				.2
DISTRICT OF MACKENZIE					.1	.5	.1
ALBERTA	7.9	13.5	7.5	11.8	8.3	15.3	9.1
SASKATCHEWAN	8.3	10.8	6.4	8.8	8.3	5.3	8.0
MANITOBA	.3	.7	1.1		.6	1.1	.6
ALASKA AND CANADA	17.0	25.7	15.4	20.6	17.3	22.1	18.0
TOTAL (PERCENT)	100.0	100.0	100.0	100.0	100.0	100.0	100.0
TOTAL RECOVERIES	642	148	266	34	968	190	2249
<u>BANDED IN: NE COLORADO</u>							
RECOVERED IN:							
PENNSYLVANIA		.1					.0
VIRGINIA					.0		.0
SOUTH CAROLINA		.1					.0
ATLANTIC FLYWAY		.3			.0		.0
MINNESOTA	.4	.3	.1	.6	.0	.5	.2
WISCONSIN	.0				.0	.2	.0
IOWA	.4	.3		.4	.2	.3	.2
ILLINOIS	.2	.4			.2	.2	.2
INDIANA					.0		.0
OHIO						.2	.0
MISSOURI	.3	.6			.2	.7	.3
KENTUCKY			.1				.0
ARKANSAS	1.2	1.9	.5	.4	.4	1.1	.8
TENNESSEE	.0	.1					.0
LOUISIANA	.6	1.5	.3	.6	.8	1.1	.7
MISSISSIPPI	.2	.3	.1		.1		.1
ALABAMA	.0						.0
MISSISSIPPI FLYWAY	3.3	5.3	1.1	1.9	2.1	4.2	2.7
EASTERN MONTANA	1.2	1.1	1.1	.6	.9	2.5	1.1
NORTH DAKOTA	1.6	3.3	1.9	1.9	2.4	4.1	2.3
SOUTH DAKOTA	1.8	2.0	.4	1.3	2.0	2.1	1.6
EASTERN WYOMING	1.9	3.2	1.8	1.7	1.8	2.5	2.0
NEBRASKA	11.9	8.9	7.0	7.3	15.1	18.5	11.8
EASTERN COLORADO	50.8	39.5	64.8	59.0	51.5	34.8	51.9
KANSAS	2.0	2.8	1.8	1.1	2.2	2.3	2.1
EASTERN NEW MEXICO	.4	.1	.3	.2	.3		.3
OKLAHOMA	.8	1.3	.3	.9	.6	1.5	.8
TEXAS	2.4	3.3	1.0	2.0	1.1	2.3	1.8
CENTRAL FLYWAY	74.7	65.6	80.5	76.0	77.9	70.4	75.6
WASHINGTON	.8	1.3	.1	.6	.3	.5	.5
OREGON	.4	.6		.4	.2	.2	.3
IDAHO	1.5	1.9	.5	.7	.9	.7	1.1
WESTERN MONTANA	.9	1.3	.9	.6	.6	.7	.8

TABLE A-1. DISTRIBUTION OF HUNTING SEASON BAND RECOVERIES (EXPRESSED AS PERCENT) FROM MALLARDS BANDED DURING WINTER, 1950-1977, IN MINOR REFERENCE AREAS--CONTINUED.

	ADULTS		SUBADULTS		UNKNOWN AGE		TOTAL BIRDS
	MALES	FEMALES	MALES	FEMALES	MALES	FEMALES	
BANDED IN: NE COLORADO							
RECOVERED IN:							
WESTERN WYOMING	.1	.1	.1	.2	.1	.2	.1
CALIFORNIA	.3	.4	.3	.2	.2	.2	.2
NEVADA					.0	.2	.0
UTAH	.6	.8	.3	.4	.2	.2	.4
WESTERN COLORADO	.4	.3	.3	.4	.4	.7	.4
ARIZONA	.1		.1		.0		.1
PACIFIC FLYWAY	5.1	6.6	2.6	3.4	3.0	3.3	3.9
ALASKA		.3					.0
BRITISH COLUMBIA	.2	.6	.1	.2	.1		.2
DISTRICT OF MACKENZIE			.1			.2	.0
ALBERTA	9.4	14.7	8.7	13.2	8.3	12.7	9.9
SASKATCHEWAN	6.8	6.2	6.5	5.2	8.0	7.5	7.0
MANITOBA	.4	.4	.5	.2	.5	1.6	.5
ONTARIO	.0						.0
QUEBEC			.1				.0
ALASKA AND CANADA	16.8	22.2	15.8	18.8	16.9	22.1	17.7
MEXICO	.0						.0
MEXICO	.0						.0
TOTAL (PERCENT)	100.0	100.0	100.0	100.0	100.0	100.0	100.0
TOTAL RECOVERIES	2242	787	1533	537	2458	612	8170
BANDED IN: SE COLORADO							
RECOVERED IN:							
GEORGIA					.2		.1
ATLANTIC FLYWAY					.2		.1
MINNESOTA					.4	.5	.2
IOWA	.3	.9		1.5	.2	.5	.3
ILLINOIS					.7	.5	.3
MISSOURI		1.7	.3		.2	2.2	.6
KENTUCKY						.5	.1
ARKANSAS	2.0		.3	1.5	1.1	1.6	1.1
LOUISIANA	1.7	3.4	.7		.4	2.2	1.2
MISSISSIPPI	.3		.3		.2		.2
ALABAMA	.3						.1
MISSISSIPPI FLYWAY	4.6	6.0	1.7	3.0	3.3	8.1	4.1
EASTERN MONTANA	1.0	.9	1.0	1.5	1.3	2.2	1.3
NORTH DAKOTA	1.0	2.6	4.0		3.9	5.4	3.2
SOUTH DAKOTA	3.0	6.0	1.7	1.5	2.2	2.7	2.6
EASTERN WYOMING	3.3	2.6	1.0		2.2	2.7	2.2
NEBRASKA	11.2	12.1	9.3	4.5	13.9	15.7	12.0
EASTERN COLORADO	39.6	20.7	48.2	40.9	34.5	24.3	36.3
KANSAS	3.0	4.3	2.7	1.5	4.6	5.9	3.8
EASTERN NEW MEXICO	.7		1.0	1.5	.4	.5	.6
OKLAHOMA	.7	3.4	1.7	3.0	2.2	1.6	1.8
TEXAS	5.3	2.6	2.7	7.6	5.0	5.9	4.6
CENTRAL FLYWAY	68.6	55.2	73.1	62.1	70.1	67.0	68.4
WASHINGTON	1.0		.3		.4	.5	.5
OREGON	1.3		.3		.2		.4
IDAHO	1.7	2.6	.3	1.5	.9	1.1	1.1
WESTERN MONTANA	1.3	1.7	1.0		.9	1.1	1.0
WESTERN WYOMING		.9	.3			.5	.2
CALIFORNIA		.9	.3	1.5			.2
NEVADA	.3						.1
UTAH	.7		.7	1.5	.7		.6
WESTERN COLORADO	2.0	.9	.3		.4	.5	.8
PACIFIC FLYWAY	8.3	6.9	3.7	4.5	3.5	3.8	4.9
BRITISH COLUMBIA	.3				.2		.1
ALBERTA	8.9	22.4	10.6	18.2	11.7	14.1	12.4
SASKATCHEWAN	6.9	8.6	10.0	10.6	10.2	5.4	8.7
MANITOBA	2.3	.9	1.0	1.5	.9	1.6	1.3
ALASKA AND CANADA	18.5	31.9	21.6	30.3	23.0	21.1	22.6
TOTAL (PERCENT)	100.0	100.0	100.0	100.0	100.0	100.0	100.0
TOTAL RECOVERIES	303	116	301	66	461	185	1432
BANDED IN: S CENTRAL COLORADO							
RECOVERED IN:							
MINNESOTA					.1		.1
IOWA					.1		.1
OHIO					.1		.1
MISSOURI	1.4				.1	.3	.2
ARKANSAS					.1	.5	.2
TENNESSEE					.3		.2
LOUISIANA						.5	.2
MISSISSIPPI FLYWAY	1.4				.9	1.3	1.0

TABLE A-1. DISTRIBUTION OF HUNTING SEASON BAND RECOVERIES (EXPRESSED AS PERCENT) FROM MALLARDS BANDED DURING WINTER, 1950-1977, IN MINOR REFERENCE AREAS--CONTINUED.

	ADULTS		SUBADULTS		UNKNOWN AGE		TOTAL
	MALES	FEMALES	MALES	FEMALES	MALES	FEMALES	BIRDS
<u>BANDED IN: S CENTRAL COLORADO</u>							
RECOVERED IN:							
EASTERN MONTANA			2.7		.5	1.3	.8
NORTH DAKOTA					.6	.8	.6
SOUTH DAKOTA					.9	.3	.6
EASTERN WYOMING			2.7		1.2	.5	.9
NEBRASKA	2.9				2.6	2.4	2.4
EASTERN COLORADO	67.1	73.7	70.3	92.3	73.3	71.3	72.5
KANSAS	1.4				.4	.3	.4
EASTERN NEW MEXICO	4.3		5.4		3.0	2.7	3.0
OKLAHOMA			2.7		.3		.2
TEXAS	2.9				1.0	1.1	1.1
CENTRAL FLYWAY	78.6	73.7	83.8	92.3	83.8	80.7	82.5
WASHINGTON					.3		.2
OREGON					.4		.2
IDAHO	2.9		2.7		1.5	1.1	1.5
WESTERN MONTANA	1.4		2.7		.6	.8	.8
WESTERN WYOMING					.4	.8	.5
CALIFORNIA						.5	.2
NEVADA					.1	.3	.2
UTAH	1.4	5.3	2.7		2.2	2.4	2.3
WESTERN COLORADO	2.9	5.3	2.7	7.7	2.1	3.5	2.6
ARIZONA	2.9	5.3			.1	.5	.5
WESTERN NEW MEXICO					.1	.3	.2
PACIFIC FLYWAY	11.4	15.8	10.8	7.7	7.9	10.2	8.9
BRITISH COLUMBIA					.3		.2
ALBERTA	5.7		2.7		4.8	5.1	4.7
SASKATCHEWAN	2.9	10.5	2.7		2.2	2.1	2.3
MANITOBA					.1		.1
ONTARIO						.3	.1
ALASKA AND CANADA	8.6	10.5	5.4		7.3	7.5	7.4
MEXICO					.1	.3	.2
MEXICO					.1	.3	.2
TOTAL (PERCENT)	100.0	100.0	100.0	100.0	100.0	100.0	100.0
TOTAL RECOVERIES	70	19	37	13	776	373	1288
<u>BANDED IN: W KANSAS</u>							
RECOVERED IN:							
MINNESOTA					.5	.9	.5
IOWA					.3	1.8	.5
ILLINOIS					.2	.9	.3
MISSOURI					.7		.5
KENTUCKY					.2		.1
ARKANSAS				100.0	2.9	2.7	3.0
TENNESSEE					.2		.1
LOUISIANA					1.5		1.2
MISSISSIPPI					.2	2.7	.5
MISSISSIPPI FLYWAY				100.0	6.5	8.9	7.0
EASTERN MONTANA					1.0		.8
NORTH DAKOTA					3.9	8.9	4.7
SOUTH DAKOTA					2.1	3.6	2.3
EASTERN WYOMING					1.0		.8
NEBRASKA					15.3	16.1	15.4
EASTERN COLORADO					8.2	1.8	7.1
KANSAS			50.0		24.8	21.4	24.3
EASTERN NEW MEXICO					.3		.3
OKLAHOMA					4.1	1.8	3.7
TEXAS			50.0		8.2	8.0	8.2
CENTRAL FLYWAY			100.0		68.8	61.6	67.7
OREGON					.5		.4
IDAHO					.5	.9	.5
WESTERN MONTANA					.8		.7
WESTERN WYOMING					.3	.9	.4
CALIFORNIA					.3		.3
UTAH					.3	.9	.4
PACIFIC FLYWAY					2.8	2.7	2.7
BRITISH COLUMBIA					.2		.1
ALBERTA					10.0	18.8	11.3
SASKATCHEWAN					10.8	7.1	10.2
MANITOBA					1.0	.9	1.0
ALASKA AND CANADA					21.9	26.8	22.5
TOTAL (PERCENT)			100.0	100.0	100.0	100.0	100.0
TOTAL RECOVERIES			2	1	613	112	728

TABLE A-1. DISTRIBUTION OF HUNTING SEASON BAND RECOVERIES (EXPRESSED AS PERCENT) FROM MALLARDS BANDED DURING WINTER, 1950-1977, IN MINOR REFERENCE AREAS--CONTINUED.

	ADULTS		SUBADULTS		UNKNOWN AGE		TOTAL
	MALES	FEMALES	MALES	FEMALES	MALES	FEMALES	BIRDS
BANDED IN: E NEW MEXICO							
RECOVERED IN:							
MINNESOTA		.8					.1
WISCONSIN					.2		.1
MICHIGAN				1.2			.1
IOWA	.3	.8					.1
MISSOURI		.8			.2	.8	.2
ARKANSAS	.5	.8		2.3			.4
TENNESSEE					.2		.1
LOUISIANA	.3				.2		.1
MISSISSIPPI FLYWAY	1.1	3.1		3.5	.9	.8	1.1
EASTERN MONTANA	1.1	1.6	.8		.7	.8	.9
NORTH DAKOTA	1.6	.8	1.6	1.2	2.1	.8	1.6
SOUTH DAKOTA	1.3				1.4		.8
EASTERN WYOMING	.8	3.9	.4	1.2	.9	1.7	1.1
NEBRASKA	3.7	4.7	2.7	4.7	3.4	3.4	3.6
EASTERN COLORADO	15.8	9.4	12.4	14.0	16.3	15.1	14.6
KANSAS	1.3	.8	1.2	1.2	1.4	.8	1.2
EASTERN NEW MEXICO	39.8	38.3	55.0	37.2	39.4	42.9	42.5
OKLAHOMA	.8						.2
TEXAS	5.9	.8	5.4	7.0	7.6	5.9	5.9
CENTRAL FLYWAY	72.2	60.2	79.5	66.3	73.2	71.4	72.3
WASHINGTON		.8					.1
OREGON					.2		.1
IDAHO	4.0	3.9	1.2	1.2	2.3		2.4
WESTERN MONTANA	.8	1.6	.8	1.2	.9		.9
WESTERN WYOMING	1.1	2.3	.4	1.2	.9		.9
CALIFORNIA	.5	1.6	.4		.2		.4
NEVADA					.2		.1
UTAH	5.3	6.3	4.3	4.7	4.6	2.5	4.7
WESTERN COLORADO	2.9	6.3	1.2	5.8	1.6	5.0	2.9
ARIZONA	1.1	.8		1.2	.9		.7
WESTERN NEW MEXICO	1.1	1.6	.4		.7	.8	.8
PACIFIC FLYWAY	16.8	25.0	8.5	15.1	12.6	8.4	13.9
BRITISH COLUMBIA				1.2	.2		.1
ALBERTA	4.8	6.3	7.0	7.0	6.2	11.8	6.5
SASKATCHEWAN	4.8	4.7	4.7	4.7	6.2	7.6	5.4
MANITOBA	.3	.8	.4	1.2	.2		.4
ALASKA AND CANADA	9.9	11.7	12.0	14.0	12.8	19.3	12.4
MEXICO				1.2	.5		.2
MEXICO				1.2	.5		.2
TOTAL (PERCENT)	100.0	100.0	100.0	100.0	100.0	100.0	100.0
TOTAL RECOVERIES	374	128	258	86	436	119	1401
BANDED IN: W OKLAHOMA-W TEXAS							
RECOVERED IN:							
DELAWARE						1.8	.3
ATLANTIC FLYWAY						1.8	.3
MINNESOTA				11.1	.5		.5
MICHIGAN						1.8	.3
IOWA				11.1	.5		.5
MISSOURI						1.8	.3
ARKANSAS	1.9				1.5	1.8	1.4
LOUISIANA	1.9		2.9		2.0	3.6	2.2
MISSISSIPPI					1.0	1.8	.8
ALABAMA					.5		.3
MISSISSIPPI FLYWAY	3.8		2.9	22.2	6.1	10.7	6.2
EASTERN MONTANA			5.7		2.5	1.8	2.2
NORTH DAKOTA	9.6	5.6	5.7		3.0	3.6	4.3
SOUTH DAKOTA	3.8		5.7		2.0		2.2
EASTERN WYOMING		5.6			.5		.5
NEBRASKA	13.5	11.1	17.1		11.6	7.1	11.7
EASTERN COLORADO	5.8	16.7	8.6	11.1	9.6	12.5	9.8
KANSAS	13.5		5.7		6.6	1.8	6.2
EASTERN NEW MEXICO					3.5	1.8	2.2
OKLAHOMA	3.8		2.9		2.5	5.4	3.0
TEXAS	21.2	33.3	31.4	33.3	28.3	17.9	26.3
CENTRAL FLYWAY	71.2	72.2	82.9	44.4	70.2	51.8	68.3
WASHINGTON		5.6			.5		.5
IDAHO	1.9		2.9				.5
WESTERN MONTANA			2.9		1.0		.8
WESTERN WYOMING						1.8	.3
NEVADA						1.8	.3
UTAH					1.5		.8
PACIFIC FLYWAY	1.9	5.6	5.7		3.0	3.6	3.3

TABLE A-1. DISTRIBUTION OF HUNTING SEASON BAND RECOVERIES (EXPRESSED AS PERCENT) FROM MALLARDS BANDED DURING WINTER, 1950-1977, IN MINOR REFERENCE AREAS--CONTINUED.

	ADULTS		SUBADULTS		UNKNOWN AGE		TOTAL
	MALES	FEMALES	MALES	FEMALES	MALES	FEMALES	BIRDS
BANDED IN: W OKLAHOMA-W TEXAS							
RECOVERED IN:							
ALBERTA	17.3	5.6	2.9	22.2	10.1	17.9	11.7
SASKATCHEWAN	5.8	16.7	5.7	11.1	10.6	12.5	10.0
MANITOBA						1.8	.3
ALASKA AND CANADA	23.1	22.2	8.6	33.3	20.7	32.1	22.0
TOTAL (PERCENT)	100.0	100.0	100.0	100.0	100.0	100.0	100.0
TOTAL RECOVERIES	52	18	35	9	198	56	369
BANDED IN: E SOUTH DAKOTA							
RECOVERED IN:							
MINNESOTA					2.0	4.8	2.7
WISCONSIN					.3	1.0	.5
MICHIGAN					.1		.1
IOWA	25.0				1.8	2.9	2.1
ILLINOIS					2.1	2.6	2.3
INDIANA						.2	.1
MISSOURI					4.0	6.3	4.5
KENTUCKY					.4		.3
ARKANSAS					7.5	7.9	7.6
TENNESSEE					.9	.7	.9
LOUISIANA					1.8	4.3	2.4
MISSISSIPPI					.6	1.2	.8
ALABAMA					.1	.2	.1
MISSISSIPPI FLYWAY	25.0				21.6	32.2	24.1
EASTERN MONTANA					.8	1.0	.9
NORTH DAKOTA					10.3	7.0	9.5
SOUTH DAKOTA	75.0				24.3	18.0	22.9
NEBRASKA					12.6	9.4	11.8
EASTERN COLORADO					.4	.2	.3
KANSAS					4.2	2.4	3.8
OKLAHOMA					1.8	1.9	1.8
TEXAS					1.7	3.6	2.1
CENTRAL FLYWAY	75.0				56.1	43.5	53.1
WASHINGTON					.4	.5	.4
OREGON					.2	.2	.2
IDAHO					.5	.2	.5
WESTERN MONTANA					.1	.5	.2
CALIFORNIA					.1	.2	.1
PACIFIC FLYWAY					1.2	1.7	1.3
DISTRICT OF MACKENZIE					.2	.2	.2
ALBERTA					6.2	7.2	6.4
SASKATCHEWAN					11.4	11.5	11.4
MANITOBA					3.4	3.1	3.3
ONTARIO					.1	.5	.2
ALASKA AND CANADA					21.2	22.6	21.5
TOTAL (PERCENT)	100.0				100.0	100.0	100.0
TOTAL RECOVERIES	4				1313	416	1733
BANDED IN: E NEBRASKA							
RECOVERED IN:							
MINNESOTA	.6	2.3	1.5		1.5	2.7	1.4
MICHIGAN					.1		.0
IOWA	2.7	2.3	1.5		2.9	2.4	2.6
ILLINOIS	.6	2.8	1.5	4.2	1.8	2.7	1.7
INDIANA	.1		.5		.5	.4	.4
KENTUCKY		.5			.1		.1
ARKANSAS	8.7	5.1	5.9	16.7	6.8	9.8	7.5
LOUISIANA	3.3	2.8	1.5		2.4	4.3	2.8
ALABAMA		.5			.1		.1
WISCONSIN	.1	.9			.2	.4	.2
MISSOURI	3.3	1.4	1.0		5.6	6.3	4.3
TENNESSEE	.4	.9			.8	.8	.6
MISSISSIPPI	1.3	2.3		4.2	.5	1.2	1.0
MISSISSIPPI FLYWAY	21.2	21.9	13.3	25.0	23.2	31.0	22.6
EASTERN MONTANA	.1	.5		4.2	.5	.8	.4
NORTH DAKOTA	4.6	7.0	3.0	4.2	7.1	8.2	6.2
SOUTH DAKOTA	5.1	4.2	3.4	4.2	8.1	7.5	6.5
NEBRASKA	33.5	24.7	51.2	33.3	35.0	21.6	33.6
EASTERN COLORADO	1.0	.9	1.0		.5	.4	.7
KANSAS	8.5	7.9	4.9	4.2	3.4	3.9	5.3
EASTERN NEW MEXICO			1.0		.1		.1
OKLAHOMA	4.2	4.2	3.4	4.2	1.8	5.9	3.2
TEXAS	4.2	6.5	1.0	4.2	1.6	1.6	2.7
CENTRAL FLYWAY	61.3	55.8	69.0	58.3	58.1	49.8	58.8
WASHINGTON	.3						.1

TABLE A-1. DISTRIBUTION OF HUNTING SEASON BAND RECOVERIES (EXPRESSED AS PERCENT) FROM MALLARDS BANDED DURING WINTER, 1950-1977, IN MINOR REFERENCE AREAS--CONTINUED.

	ADULTS		SUBADULTS		UNKNOWN AGE		TOTAL
	MALES	FEMALES	MALES	FEMALES	MALES	FEMALES	BIRDS
BANDED IN: E NEBRASKA							
RECOVERED IN:							
OREGON	.1	.5					.1
IDAHO		.9			.3		.2
WESTERN MONTANA	.1	.9					.1
CALIFORNIA	.3						.1
UTAH	.1	.5					.1
PACIFIC FLYWAY	1.0	2.8			.3		.7
BRITISH COLUMBIA		.5	.5			.4	.1
DISTRICT OF MACKENZIE					.1	.4	.1
ALBERTA	5.1	6.0	7.4		5.0	2.0	5.0
SASKATCHEWAN	10.3	9.3	8.9	12.5	10.7	12.9	10.6
MANITOBA	1.0	3.7	1.0	4.2	2.5	3.5	2.2
ALASKA AND CANADA	16.4	19.5	17.7	16.7	18.3	19.2	18.0
TOTAL (PERCENT)	100.0	100.0	100.0	100.0	100.0	100.0	100.0
TOTAL RECOVERIES	669	215	203	24	1150	255	2516
BANDED IN: E KANSAS							
RECOVERED IN:							
DELAWARE						.3	.0
SOUTH CAROLINA					.0		.0
ATLANTIC FLYWAY					.0	.3	.1
MINNESOTA					1.6	2.9	1.7
WISCONSIN					.1	.8	.2
MICHIGAN						.3	.0
IOWA					1.6	2.3	1.6
ILLINOIS					1.1	2.6	1.3
INDIANA					.0		.0
MISSOURI					4.6	4.9	4.5
KENTUCKY					.1		.1
ARKANSAS	5.7	5.0			7.4	5.5	7.1
TENNESSEE					.5		.4
LOUISIANA	5.7				2.8	3.4	2.9
MISSISSIPPI				33.3	1.1	.5	1.0
MISSISSIPPI FLYWAY	11.4	5.0		33.3	21.0	23.2	21.0
EASTERN MONTANA					.3		.3
NORTH DAKOTA	2.9				4.6	8.9	5.1
SOUTH DAKOTA	11.4	10.0		33.3	4.5	4.9	4.7
EASTERN WYOMING					.2		.2
NEBRASKA	17.1	10.0	20.0		9.8	8.9	9.8
EASTERN COLORADO	2.9				.7	.5	.7
KANSAS	22.9	50.0	60.0		27.7	24.5	27.4
EASTERN NEW MEXICO					.0		.0
OKLAHOMA	2.9			33.3	8.7	7.8	8.5
TEXAS	2.9	15.0			6.8	6.5	6.7
CENTRAL FLYWAY	62.9	85.0	80.0	66.7	63.4	62.0	63.4
WASHINGTON					.1		.1
OREGON					.1	.3	.1
IDAHO	2.9				.1		.1
WESTERN MONTANA					.2	.5	.2
WESTERN WYOMING					.1		.1
CALIFORNIA					.0		.0
NEVADA					.0		.0
UTAH					.1		.1
PACIFIC FLYWAY	2.9				.7	.8	.7
ALASKA					.0		.0
BRITISH COLUMBIA					.0	.3	.1
DISTRICT OF MACKENZIE					.0		.0
ALBERTA	8.6		20.0		4.5	4.7	4.6
SASKATCHEWAN	11.4	10.0			8.7	7.8	8.6
MANITOBA	2.9				1.4	1.0	1.3
ONTARIO					.1		.1
ALASKA AND CANADA	22.9	10.0	20.0		14.9	13.8	14.8
TOTAL (PERCENT)	100.0	100.0	100.0	100.0	100.0	100.0	100.0
TOTAL RECOVERIES	35	20	5	3	2316	384	2763
BANDED IN: E OKLAHOMA							
RECOVERED IN:							
GEORGIA					.0		.0
FLORIDA						.2	.0
ATLANTIC FLYWAY					.0	.2	.1
ALABAMA	.4						.0
MINNESOTA	1.3	3.6			.7	2.2	1.0
WISCONSIN		1.2			.1	.2	.1
MICHIGAN					.0		.0
IOWA		2.4	1.3	5.3	1.9	2.3	1.9

TABLE A-1. DISTRIBUTION OF HUNTING SEASON BAND RECOVERIES (EXPRESSED AS PERCENT) FROM MALLARDS BANDED DURING WINTER, 1950-1977, IN MINOR REFERENCE AREAS--CONTINUED.

	ADULTS		SUBADULTS		UNKNOWN AGE		TOTAL
	MALES	FEMALES	MALES	FEMALES	MALES	FEMALES	BIRDS
BANDED IN: E OKLAHOMA							
RECOVERED IN:							
ILLINOIS	.8	1.2			.6	.9	.7
INDIANA	.4						.0
OHIO					.0	.2	.1
MISSOURI	3.0		2.6		3.0	2.5	2.8
KENTUCKY					.0		.0
ARKANSAS	6.8	4.8	1.3		4.6	5.5	4.8
TENNESSEE					.1	.2	.1
LOUISIANA	2.5	2.4	1.3		2.8	3.6	2.9
MISSISSIPPI	.4		2.6		.4	.5	.4
MISSISSIPPI FLYWAY	15.7	15.5	9.0	5.3	14.3	17.9	15.0
EASTERN MONTANA	.8				.3	.5	.3
NORTH DAKOTA	6.4	8.3	1.3		5.3	5.8	5.4
SOUTH DAKOTA	3.4	4.8	2.6	5.3	4.6	4.2	4.4
EASTERN WYOMING					.1	.2	.1
NEBRASKA	5.9	8.3	19.2	5.3	8.7	6.4	8.3
EASTERN COLORADO	1.7	1.2	1.3		1.2	.5	1.1
KANSAS	14.0	8.3	15.4	21.1	11.2	8.3	10.9
EASTERN NEW MEXICO					.0		.0
OKLAHOMA	25.8	10.7	24.4	26.3	24.3	20.9	23.5
TEXAS	6.8	9.5	7.7	5.3	14.5	15.4	13.8
CENTRAL FLYWAY	64.8	51.2	71.8	63.2	70.3	62.1	67.9
WASHINGTON		1.2			.0	.2	.1
OREGON					.0		.0
IDAHO	.4				.2	.2	.2
WESTERN MONTANA	.8		1.3		.4	.2	.4
WESTERN WYOMING						.2	.0
CALIFORNIA					.0		.0
UTAH					.2		.1
WESTERN COLORADO	.4						.0
ARIZONA					.0		.0
PACIFIC FLYWAY	1.7	1.2	1.3		.9	.6	.9
ALASKA		1.2					.0
BRITISH COLUMBIA		2.4			.1	.2	.1
DISTRICT OF MACKENZIE					.0		.0
ALBERTA	6.8	8.3	7.7	10.5	4.0	6.2	4.9
SASKATCHEWAN	10.2	16.7	10.3	21.1	8.9	10.6	9.6
MANITOBA	.8	3.6			1.4	2.0	1.5
ONTARIO						.2	.0
ALASKA AND CANADA	17.8	32.1	17.9	31.6	14.5	19.2	16.2
TOTAL (PERCENT)	100.0	100.0	100.0	100.0	100.0	100.0	100.0
TOTAL RECOVERIES	236	84	78	19	2398	641	3458
BANDED IN: E TEXAS							
RECOVERED IN:							
MINNESOTA		6.3			.3	4.1	1.1
WISCONSIN	1.8						.2
IOWA					1.6	.8	1.1
ILLINOIS					.3	1.6	.5
MISSOURI					1.3	4.1	1.6
ARKANSAS	1.8	18.8	1.8		6.3	5.7	5.6
TENNESSEE					.3	.8	.3
LOUISIANA	3.5				7.1	11.5	6.7
MISSISSIPPI						.8	.2
MISSISSIPPI FLYWAY	7.0	25.0	1.8		17.2	29.5	17.2
EASTERN MONTANA			1.8		.5		.5
NORTH DAKOTA	7.0	6.3	5.4	16.7	4.2	2.5	4.5
SOUTH DAKOTA	10.5		5.4	16.7	2.9	4.9	4.4
EASTERN WYOMING						.8	.2
NEBRASKA	5.3	6.3	7.1		6.3	7.4	6.4
EASTERN COLORADO	5.3		3.6		.5		1.1
KANSAS	3.5	18.8	10.7	8.3	5.8	4.1	6.1
EASTERN NEW MEXICO					.3		.2
OKLAHOMA	1.8	6.3	8.9		5.3	3.3	4.8
TEXAS	28.1	25.0	46.4	58.3	42.1	31.1	39.0
CENTRAL FLYWAY	61.4	62.5	89.3	100.0	68.0	54.1	67.1
IDAHO					.3		.2
WESTERN MONTANA	1.8					.8	.3
WESTERN WYOMING						.8	.2
UTAH	3.5						.3
PACIFIC FLYWAY	5.3				.3	1.6	.9
BRITISH COLUMBIA					.3		.2
ALBERTA	10.5	12.5	3.6		4.5	9.8	6.1
SASKATCHEWAN	14.0		3.6		8.2	4.1	7.2
MANITOBA	1.8		1.8		1.6	.8	1.4
ALASKA AND CANADA	26.3	12.5	8.9		14.6	14.8	14.8

TABLE A-1. DISTRIBUTION OF HUNTING SEASON BAND RECOVERIES (EXPRESSED AS PERCENT) FROM MALLARDS BANDED DURING WINTER, 1950-1977, IN MINOR REFERENCE AREAS--CONTINUED.

	ADULTS		SUBADULTS		UNKNOWN AGE		TOTAL
	MALES	FEMALES	MALES	FEMALES	MALES	FEMALES	BIRDS
BANDED IN: E TEXAS							
RECOVERED IN:							
TOTAL (PERCENT)	100.0	100.0	100.0	100.0	100.0	100.0	100.0
TOTAL RECOVERIES	57	16	56	12	378	122	641
BANDED IN: S MINNESOTA-N IOWA							
RECOVERED IN:							
IOWA					3.1	1.7	2.8
ILLINOIS					6.6	5.1	6.3
INDIANA					.4		.3
ARKANSAS					8.3	10.2	8.7
MINNESOTA					50.7	52.5	51.0
WISCONSIN					4.4	5.1	4.5
MICHIGAN					.4		.3
MISSOURI					3.9		3.1
KENTUCKY					1.3		1.0
TENNESSEE					3.9	3.4	3.8
LOUISIANA					.9		.7
MISSISSIPPI					3.5		2.8
MISSISSIPPI FLYWAY					87.3	78.0	85.4
NORTH DAKOTA					4.8	5.1	4.9
SOUTH DAKOTA					.9	3.4	1.4
NEBRASKA					.4		.3
EASTERN COLORADO						1.7	.3
KANSAS					.4		.3
OKLAHOMA					.9	1.7	1.0
CENTRAL FLYWAY					7.4	11.9	8.3
ALBERTA					3.1		2.4
SASKATCHEWAN					1.3	3.4	1.7
MANITOBA					.9	5.1	1.7
ONTARIO						1.7	.3
ALASKA AND CANADA					5.2	10.2	6.3
TOTAL (PERCENT)					100.0	100.0	100.0
TOTAL RECOVERIES					229	59	288
BANDED IN: S IOWA-W MISSOURI							
RECOVERED IN:							
NEW YORK		.5					.0
PENNSYLVANIA	.1						.0
NORTH CAROLINA					.1		.0
SOUTH CAROLINA		.5			.1		.1
ATLANTIC FLYWAY	.1	.9			.2		.2
MINNESOTA	3.1	4.7	2.0	3.8	3.7	6.4	3.6
WISCONSIN	.1		.8	1.3	.3	.9	.4
IOWA	9.9	6.0	10.0	1.3	6.0	6.4	7.6
ILLINOIS	2.5	3.3	3.8		2.7	1.7	2.7
INDIANA	.1				.1	.4	.1
OHIO					.1		.0
MISSOURI	12.0	9.8	10.7	12.8	18.1	13.7	14.0
KENTUCKY	.3				.4	.4	.3
ARKANSAS	11.8	14.4	11.5	21.8	12.9	11.1	12.6
TENNESSEE	1.4	.5	.3	2.6	.9	1.3	1.0
LOUISIANA	3.2	6.0	2.6	2.6	5.1	6.4	4.3
MISSISSIPPI	2.7	1.9	2.8	3.8	1.5	1.3	2.1
ALABAMA	.1			1.3			.1
MISSISSIPPI FLYWAY	47.3	46.5	44.5	51.3	51.8	50.0	48.9
EASTERN MONTANA	.4	.5					.2
NORTH DAKOTA	7.0	5.1	6.9	10.3	7.6	4.3	6.9
SOUTH DAKOTA	5.8	6.5	4.6	10.3	6.8	5.6	6.2
EASTERN WYOMING	.1						.0
NEBRASKA	8.3	5.6	9.0	3.8	6.2	6.0	7.1
EASTERN COLORADO					.4		.2
KANSAS	5.1	2.3	7.2	6.4	1.9	1.7	3.7
EASTERN NEW MEXICO					.1		.0
OKLAHOMA	4.8	2.3	5.9	2.6	2.4	3.4	3.7
TEXAS	3.0	3.7	4.3	3.8	3.1	3.8	3.4
CENTRAL FLYWAY	34.5	26.0	37.9	37.2	28.6	24.8	31.3
WASHINGTON		.9			.2		.2
OREGON	.4	.5	.3			.4	.2
IDAHO	.4	.5			.1		.2
WESTERN MONTANA	.1	.9	.3		.1		.2
CALIFORNIA			.3		.1		.1
PACIFIC FLYWAY	1.0	2.8	.8		.5	.4	.9
ALASKA				1.3		.4	.1
BRITISH COLUMBIA	.1		.3				.1
ALBERTA	3.2	5.1	4.6	1.3	3.2	5.6	3.7

TABLE A-1. DISTRIBUTION OF HUNTING SEASON BAND RECOVERIES (EXPRESSED AS PERCENT) FROM MALLARDS BANDED DURING WINTER, 1950-1977, IN MINOR REFERENCE AREAS--CONTINUED.

	ADULTS		SUBADULTS		UNKNOWN AGE		TOTAL
	MALES	FEMALES	MALES	FEMALES	MALES	FEMALES	BIRDS
BANDED IN: S IOWA-W MISSOURI							
RECOVERED IN:							
SASKATCHEWAN	9.7	15.3	9.5	6.4	12.1	11.1	11.1
MANITOBA	3.8	3.3	2.6	1.3	3.5	7.3	3.7
ONTARIO	.1			1.3		.4	.1
QUEBEC					.1		.0
ALASKA AND CANADA	17.0	23.7	16.9	11.5	18.9	24.8	18.8
TOTAL (PERCENT)	100.0	100.0	100.0	100.0	100.0	100.0	100.0
TOTAL RECOVERIES	710	215	391	78	949	234	2577
BANDED IN: W ARKANSAS							
RECOVERED IN:							
MINNESOTA	20.0				2.9	8.8	3.9
WISCONSIN					.7		.6
IOWA	10.0				2.4	5.5	2.9
ILLINOIS	10.0				1.3		1.3
MISSOURI	20.0				3.6	4.4	3.9
ARKANSAS	30.0	100.0			42.4	33.0	41.1
TENNESSEE					1.1	2.2	1.3
LOUISIANA					4.7	8.8	5.2
MISSISSIPPI					1.3	1.1	1.3
MISSISSIPPI FLYWAY	90.0	100.0			60.5	63.7	61.4
EASTERN COLORADO					.7		.6
KANSAS					3.1	2.2	2.9
EASTERN MONTANA					.5		.4
NORTH DAKOTA					5.2	2.2	4.7
SOUTH DAKOTA					4.2	3.3	4.0
NEBRASKA					4.6	5.5	4.6
OKLAHOMA					2.3	2.2	2.2
TEXAS					2.3	1.1	2.1
CENTRAL FLYWAY					22.8	16.5	21.6
WASHINGTON					.2		.1
WESTERN MONTANA					.2		.1
PACIFIC FLYWAY					.3		.3
ALBERTA	10.0				4.1	5.5	4.3
SASKATCHEWAN					8.9	8.8	8.8
MANITOBA					3.3	4.4	3.3
ONTARIO					.2	1.1	.3
ALASKA AND CANADA	10.0				16.4	19.8	16.7
TOTAL (PERCENT)	100.0	100.0			100.0	100.0	100.0
TOTAL RECOVERIES	10	1			615	91	717
BANDED IN: E ARKANSAS-W TENNESSEE-NW MISSISSIPPI							
RECOVERED IN:							
VERMONT					.0		.0
NEW YORK					.1		.1
PENNSYLVANIA					.1	.1	.1
MARYLAND					.0	.1	.0
VIRGINIA			.2		.1		.1
NORTH CAROLINA		.3			.1		.1
SOUTH CAROLINA	.1		.2		.2		.1
GEORGIA					.1	.1	.1
ATLANTIC FLYWAY	.1	.3	.5		.8	.3	.6
MINNESOTA	3.7	11.4	3.9	6.7	5.8	13.2	7.0
WISCONSIN	2.4	2.6	1.7	4.8	2.6	4.7	2.9
MICHIGAN	.6	1.4	1.0	1.0	.5	1.5	.8
IOWA	4.6	4.8	5.9	6.7	4.1	2.6	4.2
ILLINOIS	6.7	5.4	7.4	4.8	7.8	9.8	7.8
INDIANA	.7	.3	.5	1.0	.6	.8	.6
OHIO	.3		.2		.2	.2	.2
MISSOURI	6.2	4.3	7.1	4.8	5.8	5.2	5.8
KENTUCKY	.9	1.4	.2	1.9	1.0	.9	.9
ARKANSAS	21.1	18.8	25.6	22.9	24.2	15.2	22.1
TENNESSEE	3.4	2.0	2.7		4.5	3.6	3.8
LOUISIANA	6.0	5.1	6.4	4.8	6.2	5.9	6.1
MISSISSIPPI	10.2	5.7	10.1	2.9	5.1	3.9	5.9
ALABAMA	.3		.5		.5	.5	.4
MISSISSIPPI FLYWAY	67.0	63.1	73.2	61.9	68.9	68.0	68.3
EASTERN MONTANA	.1				.1	.2	.1
NORTH DAKOTA	6.3	5.7	4.7	8.6	7.3	6.7	6.8
SOUTH DAKOTA	3.3	2.8	2.7	3.8	4.6	4.3	4.1
EASTERN WYOMING	.1						.0
NEBRASKA	2.3	2.0	2.0	1.9	2.0	1.8	2.0
EASTERN COLORADO	.1		.2		.1	.1	.1
KANSAS	1.6	1.7	2.0	1.9	1.0	.9	1.2
EASTERN NEW MEXICO					.0		.0
OKLAHOMA	1.3	.6	.7		.7	.3	.7

TABLE A-1. DISTRIBUTION OF HUNTING SEASON BAND RECOVERIES (EXPRESSED AS PERCENT) FROM MALLARDS BANDED DURING WINTER, 1950-1977, IN MINOR REFERENCE AREAS--CONTINUED.

	ADULTS		SUBADULTS		UNKNOWN AGE		TOTAL
	MALES	FEMALES	MALES	FEMALES	MALES	FEMALES	BIRDS
BANDED IN: E ARKANSAS-W TENNESSEE-NW MISSISSIPPI							
RECOVERED IN:							
TEXAS	.4	1.4	.5		.7	.9	.7
CENTRAL FLYWAY	15.6	14.2	12.8	16.2	16.5	15.3	15.7
WASHINGTON	.1				.0		.0
OREGON	.1	.3			.0		.1
IDAHO	.1				.1	.1	.1
WESTERN MONTANA		.3			.1		.1
PACIFIC FLYWAY	.4	.6			.2	.1	.2
ALASKA						.1	.0
BRITISH COLUMBIA	.1				.1		.1
DISTRICT OF MACKENZIE						.1	.0
ALBERTA	2.4	4.0	2.2	2.9	1.9	2.5	2.2
SASKATCHEWAN	8.9	9.7	8.1	12.4	8.1	6.0	8.1
MANITOBA	4.7	5.7	3.2	1.9	3.2	5.9	4.0
ONTARIO	.4	2.6		4.8	.4	1.6	.8
QUEBEC	.1						.0
ALASKA AND CANADA	16.8	21.9	13.5	21.9	13.6	16.2	15.1
TOTAL (PERCENT)	100.0	100.0	100.0	100.0	100.0	100.0	100.0
TOTAL RECOVERIES	698	352	407	105	3026	869	5457
BANDED IN: E TENNESSEE							
RECOVERED IN:							
VERMONT						.1	.0
NEW YORK	.4	.5	.6		.4	1.2	.6
PENNSYLVANIA	.6	1.4	.3	1.1	.4	.9	.6
WEST VIRGINIA					.1		.0
NEW JERSEY		.5			.1	.1	.1
DELAWARE	.2	.5			.1		.1
MARYLAND	.2				.3	.5	.3
VIRGINIA	.6				.6	.5	.5
NORTH CAROLINA	.4	.5	.6	1.1	.8	.5	.7
SOUTH CAROLINA	1.6		1.2	3.4	1.4	.9	1.3
GEORGIA	.8				.8	.7	.7
FLORIDA					.1	.1	.1
ATLANTIC FLYWAY	4.8	3.3	2.7	5.7	5.2	5.6	4.9
MINNESOTA	8.5	11.0	6.7	4.6	6.3	10.9	7.7
WISCONSIN	6.2	11.5	7.3	18.4	8.1	11.9	8.9
MICHIGAN	5.6	7.2	3.7	9.2	4.7	7.7	5.5
IOWA	2.0	2.9	4.3	2.3	4.1	3.0	3.6
ILLINOIS	10.5	7.7	11.3	4.6	10.3	6.9	9.5
INDIANA	2.6	1.9	1.8		2.2	1.9	2.1
OHIO	2.2	2.9	3.4	1.1	2.6	1.5	2.4
MISSOURI	3.6	1.9	.6	3.4	2.1	2.3	2.2
KENTUCKY	3.6	1.0	1.8	3.4	2.7	1.4	2.4
ARKANSAS	7.3	6.7	6.1	3.4	5.1	3.6	5.2
TENNESSEE	13.7	7.7	20.1	16.1	16.5	11.7	15.1
LOUISIANA	2.4	4.8	2.1		2.0	1.5	2.1
MISSISSIPPI	3.0	1.4	3.4	2.3	1.7	2.1	2.1
ALABAMA	1.2	1.0	1.8		2.6	2.4	2.2
MISSISSIPPI FLYWAY	72.2	69.4	74.4	69.0	71.1	68.8	70.9
EASTERN MONTANA					.0		.0
NORTH DAKOTA	4.8	5.7	5.2	3.4	4.9	3.0	4.5
SOUTH DAKOTA	1.2	2.4	.9	2.3	2.0	1.3	1.7
EASTERN WYOMING					.0		.0
NEBRASKA	.6	.5	.9	1.1	.3	.1	.4
EASTERN COLORADO					.0		.0
KANSAS	.2	.5			.3	.1	.2
OKLAHOMA	.2	.5	.3	1.1	.2	.4	.3
TEXAS	1.2	.5	.3		.3	.1	.4
CENTRAL FLYWAY	8.1	10.0	7.6	8.0	8.1	5.0	7.5
OREGON	.2						.0
WESTERN MONTANA					.0		.0
UTAH					.1		.0
PACIFIC FLYWAY	.2				.1		.1
BRITISH COLUMBIA					.0	.1	.0
ALBERTA	1.0	1.9	1.2		1.0	1.3	1.1
SASKATCHEWAN	4.8	3.3	5.8	1.1	4.1	3.6	4.1
MANITOBA	5.0	2.9	3.7	3.4	4.1	3.3	3.9
ONTARIO	4.0	9.1	4.6	11.5	6.2	12.1	7.2
QUEBEC					.1	.2	.1
NEWFOUNDLAND				1.1			.0
ALASKA AND CANADA	14.7	17.2	15.2	17.2	15.5	20.6	16.5
TOTAL (PERCENT)	100.0	100.0	100.0	100.0	100.0	100.0	100.0
TOTAL RECOVERIES	504	209	328	87	2300	843	4271

TABLE A-1. DISTRIBUTION OF HUNTING SEASON BAND RECOVERIES (EXPRESSED AS PERCENT) FROM MALLARDS BANDED DURING WINTER, 1950-1977, IN MINOR REFERENCE AREAS--CONTINUED.

	ADULTS		SUBADULTS		UNKNOWN AGE		
	MALES	FEMALES	MALES	FEMALES	MALES	FEMALES	TOTAL BIRDS
BANDED IN: W LOUISIANA							
RECOVERED IN:							
NEW YORK					.3		.2
VIRGINIA					.3	.6	.4
ATLANTIC FLYWAY					.6	.6	.6
MINNESOTA					2.7	4.9	3.2
WISCONSIN	6.7		11.1		.9	3.0	1.9
MICHIGAN						1.2	.4
IOWA		33.3			2.7	1.8	2.5
ILLINOIS					3.0	2.4	2.7
INDIANA						.6	.2
MISSOURI	6.7		11.1		3.9	4.9	4.4
KENTUCKY					.3	.6	.4
ARKANSAS	6.7		11.1		14.0	13.4	13.4
TENNESSEE					.3		.2
LOUISIANA	20.0	33.3	11.1		29.9	22.6	26.9
MISSISSIPPI	13.3				5.1	1.8	4.2
ALABAMA					.6		.4
MISSISSIPPI FLYWAY	53.3	66.7	44.4		63.3	57.3	60.6
EASTERN MONTANA					.6		.4
NORTH DAKOTA					5.7	4.9	5.1
SOUTH DAKOTA			11.1		3.9	3.7	3.8
NEBRASKA				50.0	4.8	1.2	3.6
EASTERN COLORADO					.3		.2
KANSAS			11.1		2.7	1.2	2.3
EASTERN NEW MEXICO						.6	.2
OKLAHOMA					.9	.6	.8
TEXAS					1.8	3.0	2.1
CENTRAL FLYWAY			22.2	50.0	20.6	15.2	18.4
WASHINGTON	6.7						.2
CALIFORNIA	6.7						.2
PACIFIC FLYWAY	13.3						.4
DISTRICT OF MACKENZIE	6.7				.3	.6	.6
ALBERTA	20.0				3.0	8.5	5.1
SASKATCHEWAN		33.3	33.3	50.0	9.3	9.8	9.8
MANITOBA	6.7				3.0	5.5	3.8
ONTARIO						2.4	.8
ALASKA AND CANADA	33.3	33.3	33.3	50.0	15.5	26.8	20.1
TOTAL (PERCENT)	100.0	100.0	100.0	100.0	100.0	100.0	100.0
TOTAL RECOVERIES	15	3	9	2	335	164	528

	ADULTS		SUBADULTS		UNKNOWN AGE		
	MALES	FEMALES	MALES	FEMALES	MALES	FEMALES	TOTAL BIRDS
BANDED IN: E LOUISIANA-SW MISSISSIPPI							
RECOVERED IN:							
VIRGINIA						.9	.2
SOUTH CAROLINA					.2		.2
GEORGIA					.2		.2
ATLANTIC FLYWAY					.5	.9	.5
MINNESOTA					3.3	3.6	3.3
WISCONSIN	10.0				.7	4.5	1.6
MICHIGAN					.7	.9	.7
IOWA					2.4	.9	2.0
ILLINOIS	10.0	25.0			4.7	3.6	4.7
INDIANA					.5		.4
MISSOURI					4.3	3.6	4.0
KENTUCKY					.7	.9	.7
ARKANSAS	10.0				19.7	9.8	17.3
TENNESSEE					2.8	.9	2.4
LOUISIANA	10.0	25.0			21.8	28.6	23.0
MISSISSIPPI	20.0				3.6	2.7	3.6
ALABAMA					.2		.2
MISSISSIPPI FLYWAY	60.0	50.0			65.4	59.8	64.1
EASTERN MONTANA					.2		.2
NORTH DAKOTA	20.0	25.0			3.3	4.5	4.0
SOUTH DAKOTA					5.0	3.6	4.6
NEBRASKA					2.6	2.7	2.6
EASTERN COLORADO					.5		.4
KANSAS	10.0				1.4	.9	1.5
OKLAHOMA					1.4	.9	1.3
TEXAS					1.9	3.6	2.2
CENTRAL FLYWAY	30.0	25.0			16.4	16.1	16.6
IDAHO					.2		.2
WESTERN MONTANA						.9	.2
PACIFIC FLYWAY					.2	.9	.4
ALBERTA					3.8	6.3	4.2

TABLE A-1. DISTRIBUTION OF HUNTING SEASON BAND RECOVERIES (EXPRESSED AS PERCENT) FROM MALLARDS BANDED DURING WINTER, 1950-1977, IN MINOR REFERENCE AREAS--CONTINUED.

	ADULTS		SUBADULTS		UNKNOWN AGE		TOTAL
	MALES	FEMALES	MALES	FEMALES	MALES	FEMALES	BIRDS
<u>BANDED IN: E LOUISIANA-SW MISSISSIPPI</u>							
RECOVERED IN:							
SASKATCHEWAN	10.0	25.0			10.9	8.9	10.6
MANITOBA					2.8	7.1	3.6
ALASKA AND CANADA	10.0	25.0			17.5	22.3	18.4
TOTAL (PERCENT)	100.0	100.0			100.0	100.0	100.0
TOTAL RECOVERIES	10	4			422	112	548
<u>BANDED IN: E MISSISSIPPI-ALABAMA</u>							
RECOVERED IN:							
NEW YORK		2.2	6.7		.1	.5	.3
PENNSYLVANIA					.2	.2	.2
WEST VIRGINIA					.1		.1
NEW JERSEY					.1		.1
MARYLAND						.2	.1
VIRGINIA	.8				.2	.5	.3
NORTH CAROLINA					.3	.2	.3
SOUTH CAROLINA					.8	1.4	.9
GEORGIA			6.7	11.1	2.5	1.4	2.0
FLORIDA	.8				.1	.2	.2
ATLANTIC FLYWAY	1.6	2.2	13.3	11.1	4.5	4.7	4.3
MINNESOTA	7.1	4.3	13.3	11.1	7.9	11.3	8.7
WISCONSIN	4.0	4.3	6.7	22.2	4.1	7.8	5.2
MICHIGAN	2.4	8.7	6.7		1.5	4.2	2.5
IOWA	4.0	2.2		11.1	4.2	4.0	4.0
ILLINOIS	7.1	8.7	13.3		9.4	7.3	8.6
INDIANA	.8	4.3			1.1	1.2	1.2
OHIO	1.6			11.1	1.5	.7	1.3
MISSOURI	4.0				4.4	1.9	3.5
KENTUCKY		2.2			.7	.5	.6
ARKANSAS	9.5	8.7	6.7		6.0	7.1	6.7
TENNESSEE	4.0	4.3	13.3		4.0	3.8	4.0
LOUISIANA	5.6	4.3			3.6	3.3	3.7
MISSISSIPPI	17.5	21.7	6.7	11.1	12.3	7.5	11.6
ALABAMA	2.4	2.2	13.3		10.5	9.2	9.2
MISSISSIPPI FLYWAY	69.8	76.1	80.0	66.7	71.1	69.6	70.8
EASTERN MONTANA					.1		.1
NORTH DAKOTA	7.9	4.3			4.2	5.4	4.7
SOUTH DAKOTA	2.4	2.2			2.1	1.6	2.0
NEBRASKA	.8	2.2			1.2	.5	1.0
KANSAS	.8				.7	.2	.6
OKLAHOMA					.3	.5	.3
TEXAS					.4	.2	.3
CENTRAL FLYWAY	11.9	8.7			9.1	8.5	8.9
WASHINGTON					.1		.1
WESTERN MONTANA					.1		.1
CALIFORNIA					.1		.1
PACIFIC FLYWAY					.3		.2
BRITISH COLUMBIA						.5	.1
ALBERTA	.8	4.3	6.7	11.1	1.5	.5	1.3
SASKATCHEWAN	6.3	6.5			7.7	7.8	7.5
MANITOBA	7.9			11.1	4.2	4.9	4.5
ONTARIO	1.6	2.2			1.8	3.5	2.2
ALASKA AND CANADA	16.7	13.0	6.7	22.2	15.1	17.2	15.7
TOTAL (PERCENT)	100.0	100.0	100.0	100.0	100.0	100.0	100.0
TOTAL RECOVERIES	126	46	15	9	961	425	1587
<u>BANDED IN: N ILLINOIS-N INDIANA-SW MICHIGAN</u>							
RECOVERED IN:							
NEW YORK					.2	.5	.3
PENNSYLVANIA						.2	.0
WEST VIRGINIA			50.0		.1	.2	.1
MARYLAND					.1		.0
VIRGINIA					.3	.7	.4
NORTH CAROLINA					.3	.5	.4
SOUTH CAROLINA					1.0	1.2	1.0
GEORGIA					.3	.5	.4
FLORIDA					.2		.2
ATLANTIC FLYWAY			50.0		2.4	3.6	2.7
MINNESOTA	6.3				6.3	9.4	7.0
WISCONSIN	2.1				9.1	18.0	11.1
MICHIGAN	4.2	100.0			22.9	24.5	22.9
IOWA	6.3				3.6	3.3	3.5
ILLINOIS	31.3				11.9	7.8	11.3
INDIANA	2.1				9.0	7.6	8.5
OHIO					.8	.7	.8
MISSOURI	8.3				2.1	.8	1.9

TABLE A-1. DISTRIBUTION OF HUNTING SEASON BAND RECOVERIES (EXPRESSED AS PERCENT) FROM MALLARDS BANDED DURING WINTER, 1950-1977, IN MINOR REFERENCE AREAS--CONTINUED.

	ADULTS		SUBADULTS		UNKNOWN AGE		TOTAL
	MALES	FEMALES	MALES	FEMALES	MALES	FEMALES	BIRDS
BANDED IN: N ILLINOIS-N INDIANA-SW MICHIGAN							
RECOVERED IN:							
KENTUCKY	2.1		50.0		1.4	1.7	1.5
ARKANSAS	8.3				3.7	2.3	3.5
TENNESSEE	8.3				3.9	2.6	3.7
LOUISIANA					1.8	.7	1.5
MISSISSIPPI					1.5	.7	1.3
ALABAMA					1.1	.5	.9
MISSISSIPPI FLYWAY	79.2	100.0	50.0		79.0	80.6	79.3
NORTH DAKOTA	4.2				4.5	2.2	3.9
SOUTH DAKOTA	2.1				1.5	1.0	1.4
NEBRASKA					.4		.3
KANSAS					.3	.2	.2
TEXAS	4.2				.3		.3
CENTRAL FLYWAY	10.4				6.9	3.3	6.1
IDAHO					.1		.1
PACIFIC FLYWAY					.1		.1
DISTRICT OF MACKENZIE					.1		.0
ALBERTA					1.0	.3	.8
SASKATCHEWAN	2.1				4.4	2.6	3.9
MANITOBA	8.3				4.4	3.0	4.1
ONTARIO					1.9	6.1	2.8
QUEBEC						.2	.0
ALASKA AND CANADA	10.4				11.7	12.3	11.8
MEXICO						.2	.0
MEXICO						.2	.0
TOTAL (PERCENT)	100.0	100.0	100.0		100.0	100.0	100.0
TOTAL RECOVERIES	48	2	2		1886	604	2542
BANDED IN: SE GREAT LAKES REGION							
RECOVERED IN:							
VERMONT					.4		.3
CONNECTICUT					.1		.1
NEW YORK	10.0	33.3	75.0	25.0	10.2	17.1	12.3
PENNSYLVANIA		11.1			11.4	12.7	11.5
WEST VIRGINIA					.4	.4	.4
NEW JERSEY					.1	.4	.2
DELAWARE					.8		.6
MARYLAND	10.0				.6	.4	.7
VIRGINIA					2.7	.4	2.1
NORTH CAROLINA	10.0				2.1	.8	1.9
SOUTH CAROLINA					2.7	2.8	2.6
GEORGIA					.6	.4	.6
FLORIDA					.1		.1
ATLANTIC FLYWAY	30.0	44.4	75.0	25.0	32.2	35.5	33.2
MINNESOTA					4.7	5.6	4.8
WISCONSIN					5.2	4.4	4.9
MICHIGAN	10.0	11.1			8.6	10.8	9.1
IOWA					1.1		.8
ILLINOIS			25.0		2.3	.8	2.0
INDIANA					1.3	1.6	1.3
OHIO	10.0				9.5	7.6	8.9
MISSOURI					.9		.7
KENTUCKY					1.0	.8	.9
ARKANSAS					1.4	.4	1.1
TENNESSEE					2.9	1.2	2.4
LOUISIANA					.3	1.2	.5
MISSISSIPPI					1.4	.4	1.1
ALABAMA					.9	.4	.7
MISSISSIPPI FLYWAY	20.0	11.1	25.0		41.3	35.1	39.2
NORTH DAKOTA					3.2	1.2	2.6
SOUTH DAKOTA					1.5	.8	1.3
KANSAS					.1		.1
CENTRAL FLYWAY					4.8	2.0	4.0
ALBERTA					.1	.4	.2
SASKATCHEWAN					2.8	1.6	2.4
MANITOBA	10.0				2.8	2.8	2.8
ONTARIO	40.0	44.4		75.0	15.3	21.9	17.5
QUEBEC					.8	.8	.7
ALASKA AND CANADA	50.0	44.4		75.0	21.7	27.5	23.6
TOTAL (PERCENT)	100.0	100.0	100.0	100.0	100.0	100.0	100.0
TOTAL RECOVERIES	10	9	4	4	792	251	1070

TABLE A-1. DISTRIBUTION OF HUNTING SEASON BAND RECOVERIES (EXPRESSED AS PERCENT) FROM MALLARDS BANDED DURING WINTER, 1950-1977, IN MINOR REFERENCE AREAS--CONTINUED.

	ADULTS		SUBADULTS		UNKNOWN AGE		TOTAL
	MALES	FEMALES	MALES	FEMALES	MALES	FEMALES	BIRDS
BANDED IN: SE MISSOURI-S ILLINOIS-SW INDIANA-W KENTUCKY							
RECOVERED IN:							
NEW YORK	.1	1.0				.1	.1
PENNSYLVANIA	.2		.3		.0		.1
WEST VIRGINIA		.5					.0
NEW JERSEY						.1	.0
DELAWARE	.1		.3				.0
MARYLAND	.1					.1	.0
VIRGINIA	.2		.3		.0	.1	.1
NORTH CAROLINA	.1				.1	.3	.1
SOUTH CAROLINA	.2				.2	.2	.2
GEORGIA					.1	.3	.1
FLORIDA	.1				.0		.0
ATLANTIC FLYWAY	.9	1.5	1.0		.5	1.1	.7
MINNESOTA	6.2	14.4	4.3	19.3	7.3	14.8	8.6
WISCONSIN	3.7	10.4	2.3	1.8	3.5	6.9	4.3
MICHIGAN	.4	3.5	1.3		.5	1.8	.8
IOWA	5.3	7.5	7.3	1.8	4.4	4.5	4.8
ILLINOIS	14.4	11.4	14.3	19.3	17.7	14.1	16.1
INDIANA	.8	1.0	1.3	1.8	1.1	.9	1.0
OHIO	.2	.5	1.0	1.8	.2	.3	.2
MISSOURI	6.1	5.0	5.3	5.3	8.0	5.5	7.0
KENTUCKY	1.9	1.5	3.0		2.8	2.0	2.4
ARKANSAS	15.1	5.0	17.6	8.8	13.5	11.0	13.3
TENNESSEE	5.5	4.5	5.6	10.5	5.8	4.8	5.5
LOUISIANA	5.7	3.0	6.0		3.7	4.1	4.2
MISSISSIPPI	6.1	5.5	5.0	3.5	3.2	2.6	3.8
ALABAMA	.7		.7		.5	.7	.6
MISSISSIPPI FLYWAY	72.0	73.1	75.1	73.7	72.4	73.9	72.8
EASTERN MONTANA	.1				.1	.3	.1
NORTH DAKOTA	6.9	5.5	5.3	7.0	6.1	4.2	5.9
SOUTH DAKOTA	2.4	2.5	2.3		2.6	2.6	2.5
NEBRASKA	1.1	1.5	1.3		1.2	.8	1.1
EASTERN COLORADO	.1						.0
KANSAS	.9	1.5			.7	.6	.7
EASTERN NEW MEXICO					.0		.0
OKLAHOMA	.5		.3		.2		.2
TEXAS	.9				.4	.2	.5
CENTRAL FLYWAY	12.8	10.9	9.3	7.0	11.3	8.6	11.0
WASHINGTON	.1	.5			.1	.1	.1
OREGON	.2				.1		.1
IDAHO	.1				.1	.1	.1
WESTERN MONTANA					.0	.1	.0
WESTERN WYOMING	.1						.0
CALIFORNIA					.0		.0
UTAH					.0		.0
WESTERN COLORADO					.0		.0
PACIFIC FLYWAY	.4	.5			.3	.2	.3
ALASKA	.1						.0
BRITISH COLUMBIA	.2				.0		.1
DISTRICT OF MACKENZIE						.1	.0
ALBERTA	1.8	1.5	1.7	3.5	1.4	1.9	1.6
SASKATCHEWAN	6.9	4.5	9.0	7.0	7.8	7.3	7.5
MANITOBA	4.1	5.0	3.7	3.5	5.3	5.5	5.0
ONTARIO	.8	2.5		5.3	.8	1.4	1.0
QUEBEC		.5			.0		.0
ALASKA AND CANADA	13.9	13.9	14.3	19.3	15.4	16.2	15.2
MEXICO			.3		.0		.0
MEXICO			.3		.0		.0
TOTAL (PERCENT)	100.0	100.0	100.0	100.0	100.0	100.0	100.0
TOTAL RECOVERIES	1692	201	301	57	4744	1590	8592
BANDED IN: SE INDIANA-S OHIO-E KENTUCKY							
RECOVERED IN:							
VERMONT						.5	.1
MASSACHUSETTS					.2		.1
NEW YORK					1.4	2.6	1.7
PENNSYLVANIA					.7	1.5	.9
WEST VIRGINIA					.5		.4
NEW JERSEY					.4		.3
DELAWARE					.4	.5	.4
MARYLAND					.5	.5	.5
VIRGINIA					1.6	1.0	1.4
NORTH CAROLINA					2.3	1.0	2.0
SOUTH CAROLINA					3.2	3.6	3.3
GEORGIA					.4	1.5	.7
FLORIDA					.2		.1
ATLANTIC FLYWAY					11.7	12.8	12.0

TABLE A-1. DISTRIBUTION OF HUNTING SEASON BAND RECOVERIES (EXPRESSED AS PERCENT) FROM MALLARDS BANDED DURING WINTER, 1950-1977, IN MINOR REFERENCE AREAS--CONTINUED.

	ADULTS		SUBADULTS		UNKNOWN AGE		TOTAL
	MALES	FEMALES	MALES	FEMALES	MALES	FEMALES	BIRDS
BANDED IN: SE INDIANA-S OHIO-E KENTUCKY							
RECOVERED IN:							
MICHIGAN					8.4	11.2	9.1
IOWA					2.7	.5	2.1
ILLINOIS	50.0				3.9	3.6	3.9
INDIANA					2.0	.5	1.6
KENTUCKY					2.7	2.6	2.6
ARKANSAS	50.0	100.0			3.9	1.5	3.5
LOUISIANA					2.1	2.0	2.1
ALABAMA					2.5	3.1	2.6
MINNESOTA					4.6	4.1	4.5
WISCONSIN					7.8	4.1	6.8
OHIO					16.2	17.3	16.4
MISSOURI					.7		.5
TENNESSEE					5.2	4.6	5.0
MISSISSIPPI					2.7	1.5	2.4
MISSISSIPPI FLYWAY	100.0	100.0			65.3	56.6	63.2
NORTH DAKOTA					3.9	2.6	3.5
SOUTH DAKOTA					.5	.5	.5
NEBRASKA					.7		.5
KANSAS					.5		.4
TEXAS					.2		.1
CENTRAL FLYWAY					5.9	3.1	5.1
ALBERTA					.4		.3
SASKATCHEWAN					2.1		1.6
MANITOBA					2.7	1.5	2.4
ONTARIO					11.7	24.5	15.0
QUEBEC					.2	1.5	.5
ALASKA AND CANADA					17.1	27.6	19.7
TOTAL (PERCENT)	100.0	100.0			100.0	100.0	100.0
TOTAL RECOVERIES	2	1			562	196	761
BANDED IN: NORTH-ATLANTIC STATES							
RECOVERED IN:							
MAINE	6.5				2.7	4.5	3.3
VERMONT	2.2				.8	.8	.9
NEW HAMPSHIRE					1.3	2.5	1.5
MASSACHUSETTS				9.1	27.7	25.9	24.2
CONNECTICUT	6.5			9.1	5.5	4.5	5.1
RHODE ISLAND	2.2				1.5	1.6	1.5
NEW YORK	60.9	60.0	77.8	72.7	33.1	36.2	37.7
PENNSYLVANIA	2.2				1.3	.4	1.0
NEW JERSEY	4.3	13.3	11.1		3.1	3.3	3.6
DELAWARE					.2	1.2	.5
MARYLAND	2.2	6.7	5.6		.6		.7
VIRGINIA					.4		.2
NORTH CAROLINA					.2	.4	.2
ATLANTIC FLYWAY	87.0	80.0	94.4	90.9	78.4	81.5	80.4
MINNESOTA					1.5		.9
WISCONSIN	2.2				1.0		.7
MICHIGAN		6.7			1.3	.4	1.0
IOWA	2.2				.6		.5
ILLINOIS					1.0		.6
INDIANA					.2		.1
OHIO					.6		.4
KENTUCKY					.2		.1
ARKANSAS					.4		.2
TENNESSEE					.4		.2
LOUISIANA						.4	.1
ALABAMA					.2		.1
MISSISSIPPI FLYWAY	4.3	6.7			7.5	.8	5.1
NORTH DAKOTA					.4	.4	.4
CENTRAL FLYWAY					.4	.4	.4
WASHINGTON						.4	.1
PACIFIC FLYWAY						.4	.1
SASKATCHEWAN					.2		.1
MANITOBA			5.6		.6		.5
ONTARIO		13.3			5.0	7.8	5.6
QUEBEC	6.5			9.1	7.3	7.8	7.2
NEW BRUNSWICK					.4	.4	.4
PRINCE EDWARD ISLAND						.8	.2
NOVA SCOTIA	2.2						.1
ALASKA AND CANADA	8.7	13.3	5.6	9.1	13.6	16.9	14.1
TOTAL (PERCENT)	100.0	100.0	100.0	100.0	100.0	100.0	100.0
TOTAL RECOVERIES	46	15	18	11	477	243	810

TABLE A-1. DISTRIBUTION OF HUNTING SEASON BAND RECOVERIES (EXPRESSED AS PERCENT) FROM MALLARDS BANDED DURING WINTER, 1950-1977, IN MINOR REFERENCE AREAS--CONTINUED.

	ADULTS		SUBADULTS		UNKNOWN AGE		TOTAL
	MALES	FEMALES	MALES	FEMALES	MALES	FEMALES	BIRDS
BANDED IN: CENTRAL APPALACHIAN REGION							
RECOVERED IN:							
PENNSYLVANIA					2.5		1.6
WEST VIRGINIA					20.0	23.5	19.4
MARYLAND	20.0				7.5		6.5
VIRGINIA					10.0	5.9	8.1
NORTH CAROLINA					2.5		1.6
SOUTH CAROLINA					2.5		1.6
ATLANTIC FLYWAY	20.0				45.0	29.4	38.7
MINNESOTA					2.5	5.9	3.2
WISCONSIN					7.5	11.8	8.1
MICHIGAN					5.0	5.9	4.8
IOWA	20.0						1.6
ILLINOIS	20.0				5.0		4.8
OHIO					12.5	5.9	9.7
KENTUCKY						5.9	1.6
TENNESSEE					2.5		1.6
MISSISSIPPI FLYWAY	40.0				35.0	35.3	35.5
NORTH DAKOTA	20.0					5.9	3.2
CENTRAL FLYWAY	20.0					5.9	3.2
SASKATCHEWAN					2.5		1.6
MANITOBA					5.0		3.2
ONTARIO	20.0				12.5	29.4	17.7
ALASKA AND CANADA	20.0				20.0	29.4	22.6
TOTAL (PERCENT)	100.0				100.0	100.0	100.0
TOTAL RECOVERIES	5				40	17	62
BANDED IN: MID-ATLANTIC STATES							
RECOVERED IN:							
MAINE					.1	.1	.1
VERMONT					.4	.3	.3
NEW HAMPSHIRE					.0	.3	.1
MASSACHUSETTS		1.2			.4	.4	.4
CONNECTICUT		1.2			.3	.7	.4
RHODE ISLAND					.1		.0
NEW YORK	5.8	11.0	3.1	3.4	4.6	8.4	5.9
PENNSYLVANIA	15.1	9.8	6.3	6.9	8.8	9.6	9.1
WEST VIRGINIA			3.1		.1	.1	.1
NEW JERSEY	3.5	6.1	6.3	6.9	7.6	10.2	8.3
DELAWARE	2.3	9.8	9.4	20.7	7.6	6.7	7.4
MARYLAND	22.1	22.0	3.1	27.6	19.6	16.0	18.6
VIRGINIA	14.0	2.4	31.3	13.8	10.8	8.4	10.1
NORTH CAROLINA	3.5	1.2	6.3		3.7	2.0	3.2
SOUTH CAROLINA	1.2				1.4	.9	1.2
GEORGIA					.3	.1	.2
FLORIDA					.1		.0
ATLANTIC FLYWAY	67.4	64.6	68.8	79.3	65.7	64.1	65.3
MINNESOTA	3.5				3.2	3.0	3.1
WISCONSIN	1.2	4.9			3.3	3.3	3.2
MICHIGAN	4.7	1.2	3.1	3.4	3.0	2.9	3.0
IOWA	2.3		6.3		.8	.4	.7
ILLINOIS		1.2			1.7	.7	1.3
INDIANA					.5	.5	.4
OHIO	2.3	2.4	3.1		1.3	1.1	1.3
MISSOURI	1.2				.2	.1	.2
KENTUCKY	2.3	1.2		3.4	.2	.1	.3
ARKANSAS		1.2			.6	.4	.5
TENNESSEE					.8	.3	.6
LOUISIANA	1.2	1.2			.3		.2
MISSISSIPPI					.5	.1	.4
ALABAMA					.2	.1	.2
MISSISSIPPI FLYWAY	18.6	13.4	12.5	6.9	16.7	12.9	15.4
EASTERN MONTANA					.0		.0
NORTH DAKOTA	1.2	2.4	3.1		1.6	.3	1.2
SOUTH DAKOTA	2.3		3.1		.5	.2	.4
EASTERN WYOMING					.0		.0
NEBRASKA					.1		.0
EASTERN COLORADO					.1		.0
KANSAS					.1		.0
CENTRAL FLYWAY	3.5	2.4	6.3		2.3	.5	1.8
CALIFORNIA					.0		.0
UTAH					.0		.0
PACIFIC FLYWAY					.1		.0
ALBERTA		1.2			.3	.1	.2
SASKATCHEWAN	1.2			3.4	1.0	1.0	1.0

TABLE A-1. DISTRIBUTION OF HUNTING SEASON BAND RECOVERIES (EXPRESSED AS PERCENT) FROM MALLARDS BANDED DURING WINTER, 1950-1977, IN MINOR REFERENCE AREAS--CONTINUED.

	ADULTS		SUBADULTS		UNKNOWN AGE		TOTAL BIRDS
	MALES	FEMALES	MALES	FEMALES	MALES	FEMALES	
BANDED IN: MID-ATLANTIC STATES							
RECOVERED IN:							
MANITOBA		1.2	3.1	3.4	2.2	1.4	1.9
ONTARIO	5.8	13.4	9.4	6.9	9.9	17.3	12.1
QUEBEC	3.5	3.7			1.7	2.7	2.1
NEW BRUNSWICK					.0		.0
PRINCE EDWARD ISLAND					.0		.0
NOVA SCOTIA					.1		.0
NEWFOUNDLAND					.0		.0
ALASKA AND CANADA	10.5	19.5	12.5	13.8	15.2	22.5	17.4
TOTAL (PERCENT)	100.0	100.0	100.0	100.0	100.0	100.0	100.0
TOTAL RECOVERIES	86	82	32	29	3258	1504	4991
BANDED IN: NORTH CAROLINA							
RECOVERED IN:							
MAINE					.2		.1
VERMONT					.4	.7	.5
MASSACHUSETTS				16.7	.6	.7	.7
CONNECTICUT					.7	.7	.7
RHODE ISLAND					.2		.1
NEW YORK		37.5	25.0		4.7	9.2	6.7
PENNSYLVANIA			8.3		4.5	4.6	4.4
WEST VIRGINIA					.2		.1
NEW JERSEY					2.1	4.6	2.8
DELAWARE	18.2			16.7	3.2	2.8	3.3
MARYLAND	9.1			16.7	5.2	4.9	5.1
VIRGINIA	9.1				6.4	3.9	5.4
NORTH CAROLINA	27.3	12.5	16.7	33.3	24.5	21.8	23.5
SOUTH CAROLINA					2.2	2.1	2.1
GEORGIA	9.1				.2		.2
FLORIDA					.2		.1
ATLANTIC FLYWAY	72.7	50.0	50.0	83.3	55.4	56.0	55.9
ILLINOIS	18.2		8.3		3.6	2.1	3.3
INDIANA					.6		.4
ARKANSAS					.9	.4	.7
ALABAMA					.2	.4	.2
MINNESOTA					3.4	2.8	3.0
WISCONSIN			8.3		3.2	3.2	3.2
MICHIGAN					3.6	5.3	4.0
IOWA					1.7	.4	1.2
OHIO			8.3		1.3	1.8	1.5
MISSOURI					.4	.7	.5
KENTUCKY					.4		.2
TENNESSEE					1.1	.4	.8
MISSISSIPPI					.9	.4	.7
MISSISSIPPI FLYWAY	18.2		25.0		21.2	17.6	19.6
NORTH DAKOTA			8.3		1.1	.4	.9
SOUTH DAKOTA					1.1		.7
KANSAS					.2	.4	.2
OKLAHOMA					.4		.2
CENTRAL FLYWAY			8.3		2.8	.7	2.1
ALBERTA					.4		.2
SASKATCHEWAN	9.1		8.3		1.1	.7	1.2
MANITOBA		12.5			4.5		2.9
ONTARIO		37.5	8.3	16.7	12.4	19.0	14.6
QUEBEC					2.2	6.0	3.4
ALASKA AND CANADA	9.1	50.0	16.7	16.7	20.6	25.7	22.3
TOTAL (PERCENT)	100.0	100.0	100.0	100.0	100.0	100.0	100.0
TOTAL RECOVERIES	11	8	12	6	534	284	855
BANDED IN: GEORGIA-SOUTH CAROLINA							
RECOVERED IN:							
VERMONT	.2			.6	.1		.1
MASSACHUSETTS					.1		.0
CONNECTICUT	.2			.6		.1	.1
NEW YORK	1.5	2.3	2.7	3.6	.7	3.6	1.9
PENNSYLVANIA	.7	.4	.9	5.4	1.1	1.8	1.3
WEST VIRGINIA		.8				.2	.1
NEW JERSEY	.4		.3		.4	.4	.3
DELAWARE	.4	.4	.6		.1	.8	.4
MARYLAND	1.1	1.5	.6	1.2	.9	1.2	1.0
VIRGINIA	2.0	.4	1.8		1.1	1.2	1.2
NORTH CAROLINA	1.8	1.9	1.5	.6	2.1	2.4	2.0
SOUTH CAROLINA	33.6	32.0	36.0	34.3	28.6	24.9	29.5
GEORGIA	1.8	1.1	1.2	.6	2.5	1.5	1.9
FLORIDA	.2				.2		.1
ATLANTIC FLYWAY	44.0	40.6	45.6	47.0	37.9	38.1	40.0
MINNESOTA	3.5	2.6	2.1	1.8	6.4	7.5	5.4

TABLE A-1. DISTRIBUTION OF HUNTING SEASON BAND RECOVERIES (EXPRESSED AS PERCENT) FROM MALLARDS BANDED DURING WINTER, 1950-1977, IN MINOR REFERENCE AREAS--CONTINUED.

	ADULTS		SUBADULTS		UNKNOWN AGE		TOTAL
	MALES	FEMALES	MALES	FEMALES	MALES	FEMALES	BIRDS
BANDED IN: GEORGIA-SOUTH CAROLINA							
RECOVERED IN:							
WISCONSIN	4.4	6.4	3.9	6.0	5.4	7.7	5.8
MICHIGAN	5.5	8.3	6.6	10.8	5.2	9.1	6.7
IOWA	2.9	1.5	2.4	.6	2.8	1.7	2.3
ILLINOIS	3.1	.8	2.4	.6	4.7	3.6	3.6
INDIANA	.9	1.5	1.5	.6	1.6	.8	1.3
OHIO	3.3	4.5	3.0	3.0	3.1	3.6	3.3
MISSOURI	.4	.4	.6	1.2	1.3	.8	1.0
KENTUCKY	.9	.4	1.5	1.2	1.2	1.0	1.1
ARKANSAS	1.5	.8	1.8		2.3	1.3	1.7
TENNESSEE	2.7	.8	3.0	1.2	3.0	2.1	2.5
LOUISIANA	1.5	.4	.6	.6	.9	.4	.8
MISSISSIPPI	1.8	.4	2.1	.6	1.4	.4	1.2
ALABAMA	1.5	.4	1.2	.6	1.3	.1	1.0
MISSISSIPPI FLYWAY	34.1	28.9	32.9	28.9	40.6	40.0	37.7
EASTERN MONTANA	.2						.0
NORTH DAKOTA	3.3		3.6	1.2	3.7	1.4	2.8
SOUTH DAKOTA	.7	.4	.3		1.2	1.0	.9
EASTERN WYOMING					.1		.0
NEBRASKA	.4		.3		.2	.1	.2
KANSAS					.1		.0
OKLAHOMA			.3				.0
TEXAS		.4			.2	.1	.1
CENTRAL FLYWAY	4.6	.8	4.5	1.2	5.5	2.6	4.1
WASHINGTON					.1		.0
WESTERN MONTANA					.1	.1	.1
CALIFORNIA	.2						.0
PACIFIC FLYWAY	.2				.1	.1	.1
YUKON						.1	.0
BRITISH COLUMBIA					.1		.0
ALBERTA	.4	.8			.4	.8	.5
SASKATCHEWAN	2.0	1.1	1.2		2.8	2.3	2.2
MANITOBA	3.5	.8	1.8	1.2	3.4	1.5	2.6
ONTARIO	10.8	25.6	13.0	19.3	9.0	14.1	12.4
QUEBEC	.2	1.5	.9	2.4	.2	.2	.5
ALASKA AND CANADA	17.0	29.7	16.9	22.9	15.9	19.1	18.2
TOTAL (PERCENT)	100.0	100.0	100.0	100.0	100.0	100.0	100.0
TOTAL RECOVERIES	452	266	331	166	1669	842	3726
BANDED IN: FLORIDA							
RECOVERED IN:							
VIRGINIA					2.0		1.0
GEORGIA					2.0		1.0
FLORIDA					8.2	3.3	5.2
ATLANTIC FLYWAY					12.2	3.3	7.3
ALABAMA					2.0		1.0
MINNESOTA	11.1	25.0			6.1	3.3	7.3
WISCONSIN	11.1				6.1	20.0	10.4
MICHIGAN						3.3	1.0
IOWA	11.1				2.0		2.1
ILLINOIS	11.1				10.2		6.3
OHIO		12.5				3.3	2.1
MISSOURI					4.1	13.3	6.3
KENTUCKY		12.5			4.1		3.1
ARKANSAS	22.2	12.5			8.2	10.0	10.4
TENNESSEE	11.1	12.5			6.1	3.3	6.3
LOUISIANA					12.2	3.3	7.3
MISSISSIPPI		12.5					1.0
MISSISSIPPI FLYWAY	77.8	87.5			61.2	60.0	64.6
NORTH DAKOTA					2.0	3.3	2.1
SOUTH DAKOTA	11.1				6.1		4.2
NEBRASKA					2.0		1.0
KANSAS					2.0		1.0
CENTRAL FLYWAY	11.1				12.2	3.3	8.3
DISTRICT OF MACKENZIE						3.3	1.0
ALBERTA					2.0		1.0
SASKATCHEWAN	11.1				2.0		2.1
MANITOBA		12.5			2.0	6.7	4.2
ONTARIO					8.2	23.3	11.5
ALASKA AND CANADA	11.1	12.5			14.3	33.3	19.8
TOTAL (PERCENT)	100.0	100.0			100.0	100.0	100.0
TOTAL RECOVERIES	9	8			49	30	96

Appendix B.

Survival and Recovery Rate Estimates from Winter Banding Data

Annual estimates of survival rate, recovery rate, and their standard errors are presented by minor reference area in this Appendix. Additionally, arithmetic means and their standard errors, as well as estimates of mean life span (MLS) and its standard error, are presented. In all data sets but one, the estimates are based on Model 1 of Brownie et al. (1978). The only exception occurred with male mallards banded in reference area 253 during 1949–51, for which Model 1 was conclusively rejected in favor of Model 0. Model goodness-of-fit statistics and associated probability levels are presented for each data set for which they could be computed. Total bandings and recoveries are also presented for each data set.

Table B-1. *Estimates of survival and recovery rates for male mallards banded during winter in S British Columbia-W Washington (201).*

Year (i)	$\hat{S}_i$	$\hat{SE}(\hat{S}_i)$	$\hat{f}_i$	$\hat{SE}(\hat{f}_i)$
1970	0.702	0.243	0.107	0.018
1971	0.663	0.259	0.037	0.015
Means[a]	**0.682**[b]	**0.098**	**0.072**	**0.012**

[a]Based on 430 bandings and 89 recoveries. Model 1 goodness-of-fit $\chi^2 = 2.3$, 6 *df*, $P = 0.89$.
[b]$\hat{MLS} = 2.6$, $\hat{SE}(\hat{MLS}) = 1.0$.

Table B-2. *Estimates of survival and recovery rates for female mallards banded during winter in S British Columbia-W Washington (201).*

Year (i)	$\hat{S}_i$	$\hat{SE}(\hat{S}_i)$	$\hat{f}_i$	$\hat{SE}(\hat{f}_i)$
1933	0.643	0.239	0.093	0.028
1934	0.580	0.227	0.073	0.014
1935	0.627	0.330	0.026	0.010
Means[a]	**0.616**[b]	**0.121**	**0.064**	**0.011**
1960	0.506	0.199	0.037	0.015
1961	0.495	0.195	0.066	0.018
Means[c]	**0.501**[d]	**0.115**	**0.052**	**0.012**

[a]Based on 717 bandings and 73 recoveries. Model 1 goodness-of-fit $\chi^2 = 5.4$, 2 *df*, $P = 0.07$.
[b]$\hat{MLS} = 2.1$, $\hat{SE}(\hat{MLS}) = 0.8$.
[c]Based on 623 bandings and 55 recoveries. Model 1 goodness-f-fit $\chi^2 = 8.8$, 4 *df*, $P = 0.07$.
[d]$\hat{MLS} = 1.4$, $\hat{SE}(\hat{MLS}) = 0.5$.

Table B-3. *Estimates of survival and recovery rates for male mallards banded during winter in E Washington-NE Oregon (202).*

Year (i)	$\hat{S}_i$	$\hat{SE}(\hat{S}_i)$	$\hat{f}_i$	$\hat{SE}(\hat{f}_i)$
1948	0.523	0.206	0.068	0.033
1949	0.644	0.073	0.083	0.010
1950	0.485	0.041	0.074	0.006
1951	0.589	0.046	0.086	0.006
1952	0.825	0.104	0.049	0.004
1953	0.509	0.081	0.086	0.010
1954	0.603	0.086	0.057	0.007
1955	0.510	0.067	0.088	0.009
1956	0.701	0.078	0.051	0.006
Means[a]	**0.599**[b]	**0.025**	**0.071**	**0.004**
1958	0.591	0.133	0.050	0.015
1959	0.726	0.074	0.042	0.006
1960	0.697	0.072	0.046	0.004
1961	0.582	0.057	0.050	0.005
1962	0.678	0.056	0.060	0.004
1963	0.657	0.061	0.057	0.005
1964	0.441	0.056	0.084	0.006
1965	0.703	0.086	0.071	0.009
1966	0.600	0.052	0.080	0.006
1967	0.586	0.051	0.060	0.005
1968	0.512	0.062	0.084	0.006
1969	0.646	0.083	0.074	0.009
1970	0.755	0.080	0.096	0.009
1971	0.677	0.071	0.054	0.005
1972	0.576	0.068	0.088	0.008
1973	0.520	0.067	0.093	0.009
1974	0.719	0.088	0.068	0.007
1975	0.649	0.076	0.054	0.005
1976	0.711	0.104	0.050	0.004
Means[c]	**0.633**[d]	**0.010**	**0.066**	**0.002**

[a]Based on 9,453 bandings and 1,708 recoveries. Model 1 goodness-of-fit $\chi^2 = 70.1$, 60 *df*, $P = 0.18$.
[b]$\hat{MLS} = 2.0$, $\hat{SE}(\hat{MLS}) = 0.2$.
[c]Based on 23,013 bandings and 3,498 recoveries. Model 1 goodness-of-fit $\chi^2 = 141.6$, 107 *df*, $P = 0.01$.
[d]$\hat{MLS} = 2.2$, $\hat{SE}(\hat{MLS}) = 0.1$.

Table B-4. *Estimates of survival and recovery rates for female mallards banded during winter in E Washington–NE Oregon (202).*

Year (i)	$\hat{S}_i$	$\hat{SE}(\hat{S}_i)$	$\hat{f}_i$	$\hat{SE}(\hat{f}_i)$
1949	0.646	0.130	0.056	0.011
1950	0.475	0.066	0.045	0.006
1951	0.496	0.070	0.068	0.007
1952	0.512	0.102	0.039	0.005
1953	0.582	0.150	0.072	0.013
1954	0.550	0.157	0.057	0.011
1955	0.529	0.163	0.050	0.011
1956	0.404	0.105	0.028	0.007
Means[a]	**0.524[b]**	**0.023**	**0.052**	**0.003**
1958	0.801	0.306	0.038	0.015
1959	0.593	0.132	0.016	0.005
1960	0.519	0.113	0.027	0.005
1961	0.528	0.109	0.038	0.008
1962	0.678	0.111	0.038	0.005
1963	0.600	0.109	0.035	0.006
1964	0.408	0.096	0.045	0.006
1965	0.658	0.147	0.038	0.009
1966	0.670	0.088	0.052	0.006
1967	0.665	0.093	0.028	0.003
1968	0.452	0.085	0.040	0.005
1969	0.589	0.109	0.038	0.007
1970	0.871	0.159	0.055	0.007
1971	0.557	0.123	0.040	0.007
1972	0.564	0.149	0.053	0.009
1973	0.494	0.164	0.040	0.009
1974	0.743	0.240	0.033	0.009
1975	0.435	0.104	0.022	0.004
1976	0.929	0.237	0.028	0.005
Means[c]	**0.619[d]**	**0.022**	**0.037**	**0.002**

[a]Based on 5,317 bandings and 576 recoveries. Model 1 goodness-of-fit $\chi^2 = 39.2$, 28 *df*, $P = 0.08$.
[b]$\hat{MLS} = 1.6$, $\hat{SE}(\hat{MLS}) = 0.1$.
[c]Based on 13,905 bandings and 1,149 recoveries. Model 1 goodness-of-fit $\chi^2 = 102.8$, 72 *df*, $P = 0.01$.
[d]$\hat{MLS} = 2.2$, $\hat{SE}(\hat{MLS}) = 0.2$.

Table B-5. *Estimates of survival and recovery rates for male mallards banded during winter in W Oregon–NW California (203).*

Year (i)	$\hat{S}_i$	$\hat{SE}(\hat{S}_i)$	$\hat{f}_i$	$\hat{SE}(\hat{f}_i)$
1951	0.365	0.113	0.137	0.028
1952	0.746	0.162	0.050	0.020
1953	0.607	0.071	0.114	0.013
1954	0.534	0.055	0.140	0.012
1955	0.556	0.075	0.098	0.007
1956	0.575	0.083	0.101	0.014
1957	0.736	0.085	0.113	0.011
1958	0.632	0.077	0.078	0.008
1959	0.469	0.062	0.065	0.008
1960	0.853	0.117	0.106	0.013
1961	0.597	0.075	0.084	0.009
1962	0.595	0.069	0.067	0.007
1963	0.598	0.073	0.094	0.009
1964	0.428	0.055	0.100	0.010
1965	0.699	0.091	0.098	0.011
1966	0.592	0.098	0.082	0.009
1967	0.772	0.163	0.071	0.011
1968	0.639	0.325	0.069	0.012
1969	0.385	0.202	0.048	0.024
Means[a]	**0.599[b]**	**0.013**	**0.090**	**0.003**

[a]Based on 9,369 bandings and 2,053 recoveries. Model 1 goodness-of-fit $\chi^2 = 103.7$, 89 *df*, $P = 0.14$.
[b]$\hat{MLS} = 2.0$, $\hat{SE}(\hat{MLS}) = 0.1$.

Table B-6. *Estimates of survival and recovery rates for female mallards banded during winter in W Oregon–NW California (203).*

Year (i)	$\hat{S}_i$	$\hat{SE}(\hat{S}_i)$	$\hat{f}_i$	$\hat{SE}(\hat{f}_i)$
1951	0.344	0.137	0.107	0.024
1952	0.462	0.177	0.097	0.032
1953	0.428	0.098	0.101	0.018
1954	0.502	0.077	0.086	0.011
1955	0.437	0.080	0.073	0.008
1956	0.514	0.109	0.090	0.016
1957	0.888	0.174	0.078	0.012
1958	0.426	0.087	0.054	0.009
1959	0.482	0.110	0.055	0.009
1960	0.467	0.108	0.054	0.011
1961	0.718	0.143	0.066	0.011
1962	0.552	0.110	0.042	0.007
1963	0.491	0.097	0.056	0.009
1964	0.498	0.092	0.068	0.010
1965	0.652	0.129	0.064	0.009
1966	0.501	0.125	0.047	0.008
1967	0.861	0.288	0.050	0.011
1968	0.222	0.137	0.035	0.010
1969	1.008	0.694	0.060	0.034
Means[a]	**0.550**[b]	**0.036**	**0.068**	**0.004**

[a]Based on 7,164 bandings and 952 recoveries. Model 1 goodness-of-fit $\chi^2 = 61.0$, 58 *df*, $P = 0.37$.
[b]$\hat{MLS} = 1.7$, $\hat{SE}(\hat{MLS}) = 0.2$.

Table B-7. *Estimates of survival and recovery rates for male mallards banded during winter in SE Oregon–NE California–NW Nevada (204).*

Year (i)	$\hat{S}_i$	$\hat{SE}(\hat{S}_i)$	$\hat{f}_i$	$\hat{SE}(\hat{f}_i)$
1949	0.403	0.226	0.135	0.056
1950	0.763	0.167	0.063	0.012
1951	0.608	0.308	0.072	0.016
Means[a]	**0.591**[b]	**0.124**	**0.090**	**0.020**
1957	0.508	0.105	0.103	0.016
1958	0.614	0.124	0.091	0.018
1959	0.756	0.150	0.106	0.015
1960	0.693	0.161	0.038	0.008
1961	0.663	0.144	0.063	0.013
1962	0.592	0.087	0.035	0.006
1963	0.921	0.141	0.050	0.007
Means[c]	**0.678**[d]	**0.026**	**0.069**	**0.005**
1966	0.344	0.060	0.043	0.006
1967	1.038	0.211	0.090	0.018
1968	0.681	0.135	0.073	0.012
Means[e]	**0.688**[f]	**0.055**	**0.069**	**0.007**

[a]Based on 626 bandings and 120 recoveries. Model 1 goodness-of-fit $\chi^2 = 4.1$, 6 *df*, $P = 0.67$.
[b]$\hat{MLS} = 1.9$, $\hat{SE}(\hat{MLS}) = 0.8$.
[c]Based on 3,169, bandings and 505 recoveries. Model 1 goodness-of-fit $\chi^2 = 56.1$, 46 *df*, $P = 0.15$.
[d]$\hat{MLS} = 2.6$, $\hat{SE}(\hat{MLS}) = 0.3$.
[e]Based on 1,624 bandings and 273 recoveries. Model 1 goodness-of-fit $\chi^2 = 18.1$, 17 *df*, $P = 0.39$.
[f]$\hat{MLS} = 2.7$, $\hat{SE}(\hat{MLS}) = 0.6$.

Table B-8. *Estimates of survival and recovery rates for female mallards banded during winter in SE Oregon–NE California–NW Nevada (204).*

Year (i)	$\hat{S}_i$	$\hat{SE}(\hat{S}_i)$	$\hat{f}_i$	$\hat{SE}(\hat{f}_i)$
1950	0.609	0.240	0.049	0.013
1951	0.233	0.155	0.055	0.020
Means[a]	**0.421[b]**	**0.115**	**0.052**	**0.012**
1957	0.391	0.172	0.063	0.021
1958	0.657	0.264	0.070	0.026
1959	0.419	0.165	0.074	0.017
1960	0.598	0.260	0.021	0.009
1961	1.111	0.523	0.056	0.021
1962	0.419	0.165	0.014	0.005
1963	0.487	0.193	0.029	0.009
Means[c]	**0.583[d]**	**0.064**	**0.047**	**0.007**
1966	0.151	0.062	0.029	0.007
1967	0.485	0.242	0.089	0.031
1968	1.040	0.461	0.043	0.018
Means[e]	**0.559[f]**	**0.138**	**0.053**	**0.012**

[a]Based on 381 bandings and 42 recoveries. Model 1 goodness-of-fit $\chi^2 = 3.8$, 1 *df*, $P = 0.05$.
[b]$\hat{MLS} = 1.2$, $\hat{SE}(\hat{MLS}) = 0.4$.
[c]Based on 1,447 bandings and 116 recoveries. Model 1 goodness-of-fit $\chi^2 = 10.8$, 9 *df*, $P = 0.29$.
[d]$\hat{MLS} = 1.9$, $\hat{SE}(\hat{MLS}) = 0.4$.
[e]Based on 853 bandings and 59 recoveries. Model 1 goodness-of-fit $\chi^2 = 6.6$, 5 *df*, $P = 0.25$.
[f]$\hat{MLS} = 1.7$, $\hat{SE}(\hat{MLS}) = 0.7$.

Table B-9. *Estimates of survival and recovery rates for male mallards banded during winter in Central California–W Nevada (211).*

Year (i)	$\hat{S}_i$	$\hat{SE}(\hat{S}_i)$	$\hat{f}_i$	$\hat{SE}(\hat{f}_i)$
1949	0.467	0.126	0.065	0.015
1950	0.642	0.202	0.057	0.015
Means[a]	**0.554[b]**	**0.099**	**0.061**	**0.011**
1953	0.595	0.115	0.090	0.016
1954	0.657	0.081	0.052	0.006
1955	0.628	0.091	0.046	0.006
1956	0.739	0.105	0.044	0.007
1957	0.530	0.078	0.061	0.007
1958	1.024	0.193	0.069	0.009
1959	0.520	0.099	0.030	0.005
1960	0.567	0.083	0.055	0.008
1961	0.582	0.075	0.061	0.006
1962	0.656	0.085	0.043	0.006
1963	0.606	0.085	0.066	0.007
1964	0.480	0.071	0.064	0.008
1965	0.808	0.125	0.054	0.007
1966	0.569	0.086	0.066	0.010
1967	0.663	0.092	0.084	0.009
Means[c]	**0.642[d]**	**0.013**	**0.059**	**0.002**
1971	0.593	0.080	0.121	0.013
1972	0.291	0.129	0.106	0.011
1973	0.885	0.394	0.100	0.045
1974	0.515	0.080	0.087	0.011
1975	0.857	0.135	0.095	0.012
1976	0.559	0.133	0.080	0.008
Means[e]	**0.617[f]**	**0.053**	**0.098**	**0.009**

[a]Based on 520 bandings and 81 recoveries. Model 1 goodness-of-fit $\chi^2 = 5.6$, 7 *df*, $P = 0.59$.
[b]$\hat{MLS} = 1.7$, $\hat{SE}(\hat{MLS}) = 0.5$.
[c]Based on 9,593 bandings and 1,527 recoveries. Model 1 goodness-of-fit $\chi^2 = 94.9$, 99 *df*, $P = 0.60$.
[d]$\hat{MLS} = 2.25$, $\hat{SE}(\hat{MLS}) = 0.1$.
[e]Based on 3,766 bandings and 597 recoveries. Model 1 goodness-of-fit $\chi^2 = 11.1$, 11 *df*, $P = 0.43$.
[f]$\hat{MLS} = 2.1$, $\hat{SE}(\hat{MLS}) = 0.4$.

Table B-10. *Estimates of survival and recovery rates for female mallards banded during winter in Central California-W Nevada (211).*

Year (i)	$\hat{S}_i$	$\hat{SE}(\hat{S}_i)$	$\hat{f}_i$	$\hat{SE}(\hat{f}_i)$
1949	0.572	0.256	0.014	0.008
1950	0.473	0.236	0.021	0.009
Means[a]	**0.522[b]**	**0.133**	**0.017**	**0.006**
1953	0.638	0.181	0.050	0.015
1954	0.630	0.142	0.048	0.008
1955	0.536	0.127	0.026	0.006
1956	0.737	0.201	0.042	0.008
1957	0.457	0.147	0.034	0.008
1958	0.549	0.171	0.025	0.007
1959	0.579	0.183	0.044	0.010
1960	0.796	0.226	0.029	0.008
1961	0.352	0.085	0.024	0.005
1962	0.439	0.104	0.044	0.008
1963	0.949	0.272	0.038	0.008
1964	0.436	0.141	0.033	0.009
1965	0.402	0.113	0.025	0.007
1966	0.625	0.162	0.051	0.012
1967	0.785	0.213	0.053	0.010
Means[c]	**0.594[d]**	**0.025**	**0.038**	**0.002**
1971	0.425	0.112	0.050	0.011
1972	0.385	0.268	0.053	0.009
1973	0.494	0.344	0.027	0.019
1974	0.403	0.106	0.079	0.013
1975	1.045	0.245	0.045	0.010
1976	0.507	0.207	0.053	0.008
Means[e]	**0.543[f]**	**0.050**	**0.051**	**0.005**

[a]Based on 454 bandings and 29 recoveries. Model 1 goodness-of-fit $\chi^2 = 3.6$, 3 *df*, $P = 0.31$.
[b]$\hat{MLS} = 1.5$, $\hat{SE}(\hat{MLS}) = 0.6$.
[c]Based on 5,948 bandings and 508 recoveries. Model 1 goodness-of-fit $\chi^2 = 48.5$, 49 *df*, $P = 0.50$.
[d]$\hat{MLS} = 1.9$, $\hat{SE}(\hat{MLS}) = 0.2$.
[e]Based on 2,725 bandings and 234 recoveries. Model 1 goodness-of-fit $\chi^2 = 131.1$, 5 *df*, $P = 0.02$.
[f]$\hat{MLS} = 1.6$, $\hat{SE}(\hat{MLS}) = 0.3$.

Table B-11. *Estimates of survival and recovery rates for male mallards banded during winter in W Idaho (221).*

Year (i)	$\hat{S}_i$	$\hat{SE}(\hat{S}_i)$	$\hat{f}_i$	$\hat{SE}(\hat{f}_i)$
1950	0.679	0.068	0.055	0.006
1951	0.624	0.073	0.054	0.005
1952	0.992	0.213	0.053	0.006
1953	0.512	0.296	0.040	0.008
Means[a]	**0.702[b]**	**0.076**	**0.051**	**0.003**
1958	0.810	0.125	0.048	0.009
1959	1.144	0.209	0.043	0.007
1960	0.418	0.077	0.024	0.005
1961	0.766	0.152	0.041	0.006
Means[c]	**0.784[d]**	**0.052**	**0.039**	**0.003**
1964	0.513	0.232	0.035	0.009
1965	0.395	0.166	0.012	0.007
1966	0.551	0.092	0.067	0.012
1967	0.717	0.091	0.059	0.006
1968	0.683	0.118	0.052	0.007
1969	0.631	0.126	0.038	0.007
1970	0.583	0.152	0.052	0.009
1971	0.680	0.165	0.077	0.018
1972	0.757	0.114	0.053	0.007
1973	0.614	0.111	0.052	0.007
1974	0.579	0.124	0.063	0.009
1975	0.453	0.112	0.047	0.008
1976	0.736	0.230	0.043	0.009
Means[e]	**0.607[f]**	**0.021**	**0.050**	**0.003**

[a]Based on 3,461 bandings and 556 recoveries. Model 1 goodness-of-fit $\chi^2 = 21.0$, 21 *df*, $P = 0.46$.
[b]$\hat{MLS} = 2.8$, $\hat{SE}(\hat{MLS}) = 0.9$.
[c]Based on 2,612 bandings and 335 recoveries. Model 1 goodness-of-fit $\chi^2 = 26.8$, 18 *df*, $P = 0.08$.
[d]$\hat{MLS} = 4.1$, $\hat{SE}(\hat{MLS}) = 1.1$.
[e]Based on 6,433 bandings and 819 recoveries. Model 1 goodness-of-fit $\chi^2 = 52.1$, 46 *df*, $P = 0.25$.
[f]$\hat{MLS} = 2.0$, $\hat{SE}(\hat{MLS}) = 0.1$.

Table B-12. *Estimates of survival and recovery rates for female mallards banded during winter in W Idaho (221).*

Year (i)	$\hat{S}_i$	$\hat{SE}(\hat{S}_i)$	$\hat{f}_i$	$\hat{SE}(\hat{f}_i)$
1950	0.461	0.084	0.042	0.007
1951	0.647	0.153	0.053	0.008
1952	0.657	0.211	0.027	0.007
Means[a]	**0.588[b]**	**0.064**	**0.040**	**0.004**
1958	0.636	0.338	0.037	0.013
1959	0.479	0.267	0.017	0.008
1960	0.328	0.160	0.017	0.008
Means[c]	**0.481[d]**	**0.103**	**0.024**	**0.006**
1966	0.439	0.154	0.052	0.014
1967	1.089	0.263	0.028	0.006
1968	0.344	0.114	0.020	0.005
1969	0.532	0.189	0.041	0.012
1970	0.341	0.155	0.036	0.010
1971	0.681	0.311	0.059	0.025
1972	0.777	0.218	0.028	0.008
1973	1.023	0.372	0.031	0.008
1974	0.243	0.104	0.027	0.008
1975	0.448	0.186	0.032	0.009
1976	1.028	0.701	0.026	0.008
Means[e]	**0.631[f]**	**0.072**	**0.035**	**0.003**

[a]Based on 1,745 bandings and 188 recoveries. Model 1 goodness-of-fit $\chi^2 = 12.5$, 8 *df*, $P = 0.13$.
[b]$\hat{MLS} = 1.9$, $\hat{SE}(\hat{MLS}) = 0.4$.
[c]Based on 809 bandings and 45 recoveries.
[d]$\hat{MLS} = 1.4$, $\hat{SE}(\hat{MLS}) = 0.4$.
[e]Based on 3,686 bandings and 244 recoveries. Model 1 goodness-of-fit $\chi^2 = 18.9$, 22 *df*, $P = 0.65$.
[f]$\hat{MLS} = 2.2$, $\hat{SE}(\hat{MLS}) = 0.5$.

Table B-13. *Estimates of survival and recovery rates for male mallards banded during winter in W Montana (222).*

Year (i)	$\hat{S}_i$	$\hat{SE}(\hat{S}_i)$	$\hat{f}_i$	$\hat{SE}(\hat{f}_i)$
1964	0.548	0.075	0.025	0.005
1965	0.798	0.087	0.040	0.006
1966	0.816	0.082	0.054	0.004
1967	0.547	0.059	0.038	0.004
1968	0.855	0.100	0.045	0.004
1969	0.469	0.056	0.026	0.003
Means[a]	**0.672[b]**	**0.017**	**0.038**	**0.002**

[a]Based on 9,415 bandings and 1,215 recoveries. Model 1 goodness-of-fit $\chi^2 = 55.8$, 41 *df*, $P = 0.06$.
[b]$\hat{MLS} = 2.5$, $\hat{SE}(\hat{MLS}) = 0.2$.

Table B-14. *Estimates of survival and recovery rates for female mallards banded during winter in W Montana (222).*

Year (i)	$\hat{S}_i$	$\hat{SE}(\hat{S}_i)$	$\hat{f}_i$	$\hat{SE}(\hat{f}_i)$
1949	0.721	0.137	0.039	0.007
1950	0.444	0.098	0.043	0.008
1951	0.567	0.321	0.034	0.008
Means[a]	**0.577[b]**	**0.109**	**0.039**	**0.004**
1964	1.021	0.326	0.039	0.011
1965	0.432	0.122	0.019	0.006
1966	0.627	0.183	0.038	0.006
1967	0.474	0.145	0.026	0.008
1968	0.913	0.242	0.028	0.006
1969	0.388	0.118	0.019	0.005
Means[c]	**0.642[d]**	**0.055**	**0.028**	**0.003**

[a]Based on 1,531 bandings and 170 recoveries. Model 1 goodness-of-fit $\chi^2 = 12.9$, 8 *df*, $P = 0.12$.
[b]$\hat{MLS} = 1.8$, $\hat{SE}(\hat{MLS}) = 0.6$.
[c]Based on 3,229 bandings and 228 recoveries. Model 1 goodness-of-fit $\chi^2 = 14.8$, 16 *df*, $P = 0.54$.
[d]$\hat{MLS} = 2.3$, $\hat{SE}(\hat{MLS}) = 0.4$.

Table B-15. *Estimates of survival and recovery rates for male mallards banded during winter in E Idaho–SW Wyoming (223).*

Year (i)	$\hat{S}_i$	$\hat{SE}(\hat{S}_i)$	$\hat{f}_i$	$\hat{SE}(\hat{f}_i)$
1963	0.848	0.181	0.059	0.013
1964	0.496	0.095	0.038	0.007
1965	1.090	0.207	0.038	0.008
1966	0.469	0.091	0.039	0.007
1967	0.719	0.147	0.041	0.007
1968	0.611	0.134	0.031	0.007
1969	0.822	0.144	0.024	0.006
1970	0.705	0.093	0.040	0.005
1971	0.564	0.081	0.041	0.005
1972	0.780	0.111	0.053	0.007
1973	0.465	0.091	0.059	0.006
1974	0.872	0.232	0.061	0.011
1975	0.931	0.255	0.039	0.008
1976	0.919	0.248	0.022	0.004
Means[a]	**0.735[b]**	**0.023**	**0.042**	**0.002**

[a]Based on 8,894 bandings and 899 recoveries. Model 1 goodness-of-fit $\chi^2 = 65.7$, 65 *df*, $P = 0.45$.
[b]$\hat{MLS} = 3.3$, $\hat{SE}(\hat{MLS}) = 0.3$.

Table B-16. *Estimates of survival and recovery rates for female mallards banded during winter in E Idaho-SW Wyoming (223).*

Year (i)	$\hat{S}_i$	$\hat{SE}(\hat{S}_i)$	$\hat{f}_i$	$\hat{SE}(\hat{f}_i)$
1963	0.431	0.213	0.057	0.017
1964	0.694	0.327	0.029	0.009
1965	0.333	0.149	0.017	0.008
1966	0.773	0.251	0.041	0.009
1967	0.339	0.109	0.017	0.005
1968	0.955	0.339	0.017	0.006
1969	0.538	0.206	0.022	0.007
1970	0.519	0.162	0.011	0.004
1971	0.601	0.225	0.039	0.009
1972	0.558	0.202	0.028	0.009
1973	0.400	0.182	0.036	0.007
1974	0.185	0.100	0.043	0.018
1975	3.670	1.828	0.036	0.012
1976	0.330	0.188	0.009	0.004
Means[a]	**0.738**[b]	**0.125**	**0.029**	**0.003**

[a]Based on 5,368 bandings and 255 recoveries. Model 1 goodness-of-fit $\chi^2 = 21.6$, 23 *df*, $P = 0.54$.
[b]$\hat{MLS} = 3.3$, $\hat{SE}(\hat{MLS}) = 1.8$.

Table B-17. *Estimates of survival and recovery rates for male mallards banded during winter in NE Nevada-W Utah (224).*

Year (i)	$\hat{S}_i$	$\hat{SE}(\hat{S}_i)$	FP1$\hat{f}_i$	$\hat{SE}(\hat{f}_i)$
1966	0.603	0.099	0.053	0.010
1967	0.550	0.076	0.061	0.008
1968	0.618	0.096	0.074	0.009
1969	0.745	0.243	0.066	0.010
Means[a]	**0.629**[b]	**0.062**	**0.064**	**0.005**

[a]Based on 2,361 bandings and 372 recoveries. Model 1 goodness-of-fit $\chi^2 = 19.6$, 14 *df*, $P = 0.14$.
[b]$\hat{MLS} = 2.2$, $\hat{SE}(\hat{MLS}) = 0.5$.

Table B-18. *Estimates of survival and recovery rates for female mallards banded during winter in NE Nevada-W Utah (224).*

Year (i)	$\hat{S}_i$	$\hat{SE}(\hat{S}_i)$	$\hat{f}_i$	$\hat{SE}(\hat{f}_i)$
1966	0.340	0.137	0.045	0.014
1967	0.475	0.115	0.038	0.009
1968	0.796	0.238	0.057	0.010
1969	0.451	0.276	0.022	0.007
Means[a]	**0.516**[b]	**0.080**	**0.041**	**0.005**

[a]Based on 1,359 bandings and 121 recoveries. Model 1 goodness-of-fit $\chi^2 = 11.7$, 8 *df*, $P = 0.17$.
[b]$\hat{MLS} = 1.5$, $\hat{SE}(\hat{MLS}) = 0.4$.

Table B-19. *Estimates of survival and recovery rates for male mallards banded during winter in E Utah-W Colorado (225).*

Year (i)	$\hat{S}_i$	$\hat{SE}(\hat{S}_i)$	$\hat{f}_i$	$\hat{SE}(\hat{f}_i)$
1974	0.531	0.106	0.030	0.007
1975	0.761	0.133	0.039	0.006
1976	0.809	0.189	0.044	0.006
Means[a]	**0.700**[b]	**0.065**	**0.038**	**0.004**

[a]Based on 3,273 bandings and 239 recoveries. Model 1 goodness-of-fit $\chi^2 = 6.1$, 3 *df*, $P = 0.11$.
[b]$\hat{MLS} = 2.8$, $\hat{SE}(\hat{MLS}) = 0.7$.

Table B-20. *Estimates of survival and recovery rates for female mallards banded during winter in E Utah-W Colorado (225).*

Year (i)	$\hat{S}_i$	$\hat{SE}(\hat{S}_i)$	$\hat{f}_i$	$\hat{SE}(\hat{f}_i)$
1974	0.513	0.159	0.023	0.007
1975	0.616	0.155	0.020	0.004
Means[a]	**0.551**[b]	**0.073**	**0.023**	**0.003**

[a]Based on 2,853 bandings and 120 recoveries. Model 1 goodness-of-fit $\chi^2 = 3.7$, 3 *df*, $P = 0.29$.
[b]$\hat{MLS} = 1.7$, $\hat{SE}(\hat{MLS}) = 0.4$.

Table B-21. *Estimates of survival and recovery rates for male mallards banded during winter in S Nevada-S California-W Arizona (231).*

Year (i)	$\hat{S}_i$	$\hat{SE}(\hat{S}_i)$	$\hat{f}_i$	$\hat{SE}(\hat{f}_i)$
1963	0.881	0.274	0.078	0.021
1964	0.490	0.153	0.054	0.017
1965	0.504	0.117	0.077	0.017
1966	0.697	0.154	0.066	0.013
1967	0.718	0.285	0.069	0.015
Means[a]	**0.658**[b]	**0.069**	**0.069**	**0.007**

[a]Based on 954 bandings and 172 recoveries. Model 1 goodness-of-fit $\chi^2 = 22.2$, 14 *df*, $P = 0.07$.
[b]$\hat{MLS} = 2.4$, $\hat{SE}(\hat{MLS}) = 0.6$.

Table B-22. *Estimates of survival and recovery rates for female mallards banded during winter in S Nevada-S California-W Arizona (231).*

Year (i)	$\hat{S}_i$	$\hat{SE}(\hat{S}_i)$	$\hat{f}_i$	$\hat{SE}(\hat{f}_i)$
1963	1.111	0.502	0.062	0.024
1964	0.670	0.301	0.023	0.012
1965	0.320	0.120	0.044	0.014
1966	0.541	0.177	0.068	0.016
1967	0.847	0.440	0.007	0.004
Means[a]	**0.698**[b]	**0.116**	**0.041**	**0.007**

[a]Based on 845 bandings and 90 recoveries. Model 1 goodness-of-fit $\chi^2 = 15.8$, 6 *df*, $P = 0.01$.
[b]$\hat{MLS} = 2.8$, $\hat{SE}(\hat{MLS}) = 1.3$.

Table B-23. *Estimates of survival and recovery rates for male mallards banded during winter in E Montana (241).*

Year (i)	$\hat{S}_i$	$\hat{SE}(\hat{S}_i)$	$\hat{f}_i$	$\hat{SE}(\hat{f}_i)$
1959	0.783	0.419	0.065	0.036
1960	1.512	0.924	0.049	0.027
1961	0.423	0.241	0.013	0.008
Means[a]	**0.906**[b]	**0.238**	**0.042**	**0.015**
1964	0.507	0.139	0.025	0.010
1965	0.738	0.083	0.017	0.004
1966	0.737	0.082	0.040	0.004
Means[c]	**0.660**[d]	**0.051**	**0.027**	**0.004**
1970	0.618	0.157	0.067	0.011
1971	0.583	0.148	0.053	0.013
1972	0.604	0.119	0.053	0.008
Means[e]	**0.602**[f]	**0.051**	**0.058**	**0.006**

[a]Based on 269 bandings and 28 recoveries. Model 1 goodness-of-fit $\chi^2 = 1.1$, 2 *df*, $P = 0.57$.
[b]$\hat{MLS} = 10.1$, $\hat{SE}(\hat{MLS}) = 26.8$.
[c]Based on 4,192 bandings and 518 recoveries. Model 1 goodness-of-fit $\chi^2 = 19.7$, 14 *df*, $P = 0.14$.
[d]$\hat{MLS} = 2.4$, $\hat{SE}(\hat{MLS}) = 0.5$.
[e]Based on 1,815 bandings and 224 recoveries. Model 1 goodness-of-fit $\chi^2 = 7.4$, 10 *df*, $P = 0.69$.
[f]$\hat{MLS} = 2.0$, $\hat{SE}(\hat{MLS}) = 0.3$.

Table B-24. *Estimates of survival and recovery rates for female mallards banded during winter in E Montana (241).*

Year (i)	$\hat{S}_i$	$\hat{SE}(\hat{S}_i)$	$\hat{f}_i$	$\hat{SE}(\hat{f}_i)$
1964	0.462	0.357	0.025	0.014
1965	0.562	0.229	0.009	0.005
1966	0.431	0.151	0.019	0.004
Means[a]	**0.485**[b]	**0.123**[b]	**0.018**	**0.005**

[a]Based on 1,598 bandings and 65 recoveries. Model 1 goodness-of-fit $\chi^2 = 4.3$, 1 *df*, $P = 0.04$.
[b]$\hat{MLS} = 1.4$, $\hat{SE}(\hat{MLS}) = 0.5$.

Table B-25. *Estimates of survival and recovery rates for male mallards banded during winter in W North Dakota-W South Dakota (242).*

Year (i)	$\hat{S}_i$	$\hat{SE}(\hat{S}_i)$	$\hat{f}_i$	$\hat{SE}(\hat{f}_i)$
1940	1.004	0.615	0.065	0.022
1941	0.472	0.295	0.025	0.017
1942	0.488	0.177	0.054	0.017
Means[a]	**0.655**[b]	**0.142**	**0.048**	**0.011**
1965	0.614	0.208	0.026	0.011
1966	0.439	0.067	0.029	0.005
1967	0.759	0.178	0.025	0.004
1968	0.496	0.116	0.020	0.005
1969	0.760	0.100	0.057	0.007
1970	0.627	0.078	0.050	0.006
1971	0.745	0.085	0.047	0.005
1972	0.570	0.073	0.049	0.005
1973	0.642	0.088	0.042	0.005
1974	0.852	0.130	0.027	0.003
1975	0.635	0.115	0.038	0.005
1976	0.677	0.155	0.032	0.004
Means[c]	**0.651**[d]	**0.023**	**0.037**	**0.002**

[a]Based on 487 bandings and 61 recoveries. Model 1 goodness-of-fit $\chi^2 = 9.4$, 4 *df*, $P = 0.05$.
[b]$\hat{MLS} = 2.4$, $\hat{SE}(\hat{MLS}) = 1.2$.
[c]Based on 12,390 bandings and 1,178 recoveries. Model 1 goodness-of-fit $\chi^2 = 62.8$, 49 *df*, $P = 0.09$.
[d]$\hat{MLS} = 2.3$, $\hat{SE}(\hat{MLS}) = 0.2$.

Table B-26. *Estimates of survival and recovery rates for female mallards banded during winter in W North Dakota–W South Dakota (242).*

Year (i)	$\hat{S}_i$	$\hat{SE}(\hat{S}_i)$	$\hat{f}_i$	$\hat{SE}(\hat{f}_i)$
1969	0.529	0.193	0.034	0.010
1970	0.705	0.243	0.030	0.009
1971	0.535	0.158	0.020	0.005
1972	0.424	0.135	0.021	0.005
1973	0.447	0.150	0.021	0.005
1974	0.798	0.305	0.017	0.005
1975	0.406	0.177	0.017	0.006
1976	0.533	0.240	0.018	0.006
Means[a]	**0.547**[b]	**0.045**	**0.022**	**0.002**

[a]Based on 4,406 bandings and 179 recoveries. Model 1 goodness-of-fit $\chi^2 = 9.2$, 14 *df*, $P = 0.82$.
[b]$\hat{MLS} = 1.7$, $\hat{SE}(\hat{MLS}) = 0.2$.

Table B-27. *Estimates of survival and recovery rates for female mallards banded during winter in N Wyoming (243).*

Year (i)	$\hat{S}_i$	$\hat{SE}(\hat{S}_i)$	$\hat{f}_i$	$\hat{SE}(\hat{f}_i)$
1964	0.276	0.282	0.010	0.010
1965	0.583	0.203	0.004	0.003
1966	0.338	0.107	0.019	0.006
Means[a]	**0.399**[b]	**0.101**	**0.011**	**0.004**

[a]Based on 1,357 bandings and 68 recoveries. Model 1 goodness-of-fit $\chi^2 = 9.4$, 4 *df*, $P = 0.05$.
[b]$\hat{MLS} = 1.1$, $\hat{SE}(\hat{MLS}) = 0.3$.

Table B-28. *Estimates of survival and recovery rates for male mallards banded during winter in SE Wyoming–W Nebraska (251).*

Year (i)	$\hat{S}_i$	$\hat{SE}(\hat{S}_i)$	$\hat{f}_i$	$\hat{SE}(\hat{f}_i)$
1964	0.233	0.117	0.043	0.016
1965	0.599	0.073	0.020	0.004
1966	0.831	0.077	0.034	0.004
1967	0.695	0.065	0.030	0.003
1968	0.677	0.065	0.032	0.003
1969	0.810	0.092	0.058	0.005
1970	0.597	0.090	0.047	0.005
1971	0.707	0.112	0.040	0.005
1972	0.541	0.082	0.052	0.006
1973	0.703	0.127	0.050	0.006
1974	0.959	0.232	0.022	0.004
1975	0.425	0.103	0.031	0.006
1976	1.064	0.631	0.035	0.005
Means[a]	**0.680**[b]	**0.500**	**0.038**	**0.002**

[a]Based on 12,937 bandings and 1,471 recoveries. Model 1 goodness-of-fit $\chi^2 = 57.9$, 59 *df*, $P = 0.52$.
[b]$\hat{MLS} = 2.6$, $\hat{SE}(\hat{MLS}) = 0.5$.

Table B-29. *Estimates of survival and recovery rates for female mallards banded during winter in SE Wyoming–W Nebraska (251).*

Year (i)	$\hat{S}_i$	$\hat{SE}(\hat{S}_i)$	$\hat{f}_i$	$\hat{SE}(\hat{f}_i)$
1965	0.625	0.175	0.013	0.005
1966	0.896	0.204	0.016	0.004
1967	0.585	0.141	0.014	0.003
1968	0.672	0.166	0.017	0.004
1969	0.805	0.234	0.016	0.004
1970	0.387	0.130	0.021	0.005
1971	0.674	0.216	0.020	0.005
1972	0.583	0.215	0.021	0.005
1973	0.551	0.247	0.014	0.004
1974	0.642	0.437	0.014	0.005
1975	0.363	0.233	0.006	0.004
Means[a]	**0.617**[b]	**0.032**	**0.016**	**0.001**

[a]Based on 6,310 bandings and 277 recoveries. Model 1 goodness-of-fit $\chi^2 = 19.2$, 29 *df*, $P = 0.92$.
[b]$\hat{MLS} = 2.1$, $\hat{SE}(\hat{MLS}) = 0.2$.

Table B-30. *Estimates of survival and recovery rates for male mallards banded during winter in NE Colorado (252).*

Year (i)	$\hat{S}_i$	$\hat{SE}(\hat{S}_i)$	$\hat{f}_i$	$\hat{SE}(\hat{f}_i)$
1945	0.699	0.092	0.073	0.011
1946	0.629	0.059	0.070	0.006
1947	0.729	0.050	0.035	0.003
1948	0.687	0.035	0.032	0.002
1949	0.722	0.032	0.048	0.002
1950	0.682	0.050	0.048	0.002
1951	0.614	0.091	0.064	0.005
1952	1.680	1.179	0.053	0.007
Means[a]	**0.805**[b]	**0.146**	**0.053**	**0.002**
1964	0.820	0.061	0.033	0.004
1965	0.717	0.044	0.022	0.002
1966	0.720	0.044	0.030	0.002
1967	0.681	0.043	0.042	0.003
1968	0.782	0.055	0.045	0.003
1969	0.867	0.080	0.041	0.003
1970	0.586	0.054	0.048	0.004
1971	0.716	0.053	0.047	0.003
1972	0.663	0.053	0.060	0.004
1973	0.603	0.054	0.048	0.003
1974	0.819	0.074	0.028	0.002
1975	0.709	0.072	0.038	0.003
1976	0.811	0.114	0.032	0.003
Means[c]	**0.730**[d]	**0.010**	**0.040**	**0.001**

[a]Based on 21,525 bandings and 3,449 recoveries. Model 1 goodness-of-fit $\chi^2 = 77.4$, 48 *df*, $P = 0.00$.
[b]$\hat{MLS} = 4.6$, $\hat{SE}(\hat{MLS}) = 3.9$.
[c]Based on 38,436 bandings and 4,428 recoveries. Model 1 goodness-of-fit $\chi^2 = 106.7$, 77 *df*, $P = 0.01$.
[d]$\hat{MLS} = 3.2$, $\hat{SE}(\hat{MLS}) = 0.1$.

Table B-31. *Estimates of survival and recovery rates for female mallards banded during winter in NE Colorado (252).*

Year (i)	$\hat{S}_i$	$\hat{SE}(\hat{S}_i)$	$\hat{f}_i$	$\hat{SE}(\hat{f}_i)$
1945	0.747	0.156	0.041	0.011
1946	0.741	0.111	0.042	0.006
1947	0.598	0.078	0.026	0.004
1948	0.565	0.058	0.035	0.003
1949	0.577	0.049	0.036	0.003
1950	0.647	0.095	0.033	0.002
1951	0.558	0.159	0.045	0.007
Means[a]	**0.633**[b]	**0.030**	**0.037**	**0.002**
1964	0.573	0.133	0.031	0.006
1965	0.658	0.113	0.017	0.003
1966	0.500	0.067	0.016	0.002
1967	0.695	0.088	0.026	0.003
1968	0.716	0.092	0.017	0.002
1969	0.731	0.115	0.021	0.003
1970	0.545	0.085	0.022	0.003
1971	0.645	0.085	0.024	0.003
1972	0.586	0.080	0.025	0.003
1973	0.734	0.112	0.021	0.002
1974	0.637	0.101	0.013	0.002
1975	0.593	0.107	0.020	0.002
1976	0.449	0.109	0.017	0.002
Means[c]	**0.620**[d]	**0.015**	**0.021**	**0.001**

[a]Based on 12,205 bandings and 1,145 recoveries. Model 1 goodness-of-fit $\chi^2 = 58.0$, 38 *df*, $P = 0.02$.
[b]$\hat{MLS} = 2.2$, $\hat{SE}(\hat{MLS}) = 0.2$.
[c]Based on 27,383 bandings and 1,306 recoveries. Model 1 goodness-of-fit $\chi^2 = 57.5$, 55 *df*, $P = 0.38$.
[d]$\hat{MLS} = 2.1$, $\hat{SE}(\hat{MLS}) = 0.1$.

Table B-32. *Estimates of survival and recovery rates for male mallards banded during winter in SE Colorado (253).*

Year (i)	$\hat{S}_i$	$\hat{SE}(\hat{S}_i)$	$\hat{f}_i$	$\hat{SE}(\hat{f}_i)$
1949	0.743	0.085	0.049	0.004
1950	0.584	0.086	0.042	0.006
1951	0.682	0.128	0.040	0.008
Means[a]	**0.669[b]**	**0.040**	**0.044**	**0.004**
1966	0.892	0.140	0.017	0.005
1967	0.822	0.136	0.025	0.005
1968	0.628	0.102	0.025	0.005
1969	1.103	0.197	0.036	0.006
1970	0.703	0.143	0.031	0.005
1971	0.643	0.123	0.034	0.006
1972	0.534	0.095	0.039	0.006
1973	0.611	0.124	0.039	0.006
1974	1.376	0.347	0.030	0.006
1975	0.714	0.210	0.020	0.004
1976	0.606	0.232	0.021	0.005
Means[c]	**0.785[d]**	**0.029**	**0.029**	**0.002**

[a]Based on 4,552 bandings and 698 recoveries. Model 0 goodness-of-fit $\chi^2 = 33.2$, 17 *df*, $P = 0.01$.
[b]$\hat{MLS} = 2.5$, $\hat{SE}(\hat{MLS}) = 0.4$.
[c]Based on 6,620 bandings and 616 recoveries. Model 1 goodness-of-fit $\chi^2 = 81.0$, 49 *df*, $P = 0.00$.
[d]$\hat{MLS} = 4.1$, $\hat{SE}(\hat{MLS}) = 0.6$.

Table B-33. *Estimates of survival and recovery rates for female mallards banded during winter in SE Colorado (253).*

Year (i)	$\hat{S}_i$	$\hat{SE}(\hat{S}_i)$	$\hat{f}_i$	$\hat{SE}(\hat{f}_i)$
1949	0.841	0.113	0.036	0.004
1950	0.524	0.113	0.027	0.004
1951	0.450	0.120	0.032	0.007
Means[a]	**0.605[b]**	**0.042**	**0.032**	**0.003**
1966	0.750	0.245	0.019	0.008
1967	0.469	0.133	0.022	0.006
1968	1.535	0.591	0.021	0.006
1969	0.522	0.231	0.010	0.004
1970	0.822	0.340	0.007	0.003
1971	0.390	0.147	0.009	0.003
1972	0.613	0.238	0.020	0.005
1973	0.331	0.147	0.015	0.005
1974	0.585	0.268	0.018	0.006
1975	0.635	0.348	0.011	0.004
1976	0.138	0.128	0.014	0.006
Means[c]	**0.617[d]**	**0.055**	**0.015**	**0.002**

[a]Based on 3,738 bandings and 325 recoveries. Model 1 goodness-of-fit $\chi^2 = 12.7$, 14 *df*, $P = 0.55$.
[b]$\hat{MLS} = 2.0$, $\hat{SE}(\hat{MLS}) = 0.3$.
[c]Based on 5,210 bandings and 180 recoveries. Model 1 goodness-of-fit $\chi^2 = 28.7$, 20 *df*, $P = 0.09$.
[d]$\hat{MLS} = 2.1$, $\hat{SE}(\hat{MLS}) = 0.4$.

Table B-34. *Estimates of survival and recovery rates for female mallards banded during winter in S Central Colorado (254).*

Year (i)	$\hat{S}_i$	$\hat{SE}(\hat{S}_i)$	$\hat{f}_i$	$\hat{SE}(\hat{f}_i)$
1950	0.398	0.113	0.050	0.013
1951	0.595	0.128	0.074	0.013
Means[a]	**0.496[b]**	**0.072**	**0.062**	**0.009**
1961	0.124	0.124	0.024	0.017
1962	0.894	0.148	0.009	0.004
1963	0.693	0.150	0.037	0.006
Means[c]	**0.570[d]**	**0.069**	**0.023**	**0.006**

[a]Based on 1,792 bandings and 187 recoveries. Model 1 goodness-of-fit $\chi^2 = 5.8$, 7 *df*, $P = 0.57$.
[b]$\hat{MLS} = 1.4$, $\hat{SE}(\hat{MLS}) = 0.3$.
[c]Based on 1,953 bandings and 175 recoveries. Model 1 goodness-of-fit $\chi^2 = 10.1$, 6 *df*, $P = 0.12$.
[d]$\hat{MLS} = 1.8$, $\hat{SE}(\hat{MLS}) = 0.4$.

Table B-35. *Estimates of survival and recovery rates for male mallards banded during winter in W Kansas (255).*

Year (i)	$\hat{S}_i$	$\hat{SE}(\hat{S}_i)$	$\hat{f}_i$	$\hat{SE}(\hat{f}_i)$
1972	0.832	0.153	0.037	0.007
1973	0.795	0.162	0.043	0.007
1974	0.589	0.137	0.021	0.004
Means[a]	**0.739[b]**	**0.058**	**0.034**	**0.004**

[a]Based on 2,540 bandings and 215 recoveries. Model 1 goodness-of-fit $\chi^2 = 13.8$, 9 *df*, $P = 0.13$.
[b]$\hat{MLS} = 3.3$, $\hat{SE}(\hat{MLS}) = 0.9$.

Table B-36. *Estimates of survival and recovery rates for female mallards banded during winter in W Kansas (255).*

Year (i)	$\hat{S}_i$	$\hat{SE}(\hat{S}_i)$	$\hat{f}_i$	$\hat{SE}(\hat{f}_i)$
1936	0.435	0.102	0.033	0.009
1937	1.689	0.657	0.037	0.006
Means[a]	**1.062**	**0.327**	**0.035**	**0.005**
1966	0.756	0.238	0.019	0.005
1967	0.487	0.159	0.022	0.006
Means[b]	**0.621[c]**	**0.098**	**0.020**	**0.004**
1972	0.323	0.234	0.021	0.008
1973	0.397	0.271	0.009	0.005
1974	0.352	0.288	0.018	0.009
Means[d]	**0.357[e]**	**0.109**	**0.016**	**0.004**

[a]Based on 1,368 bandings and 130 recoveries. Model 1 goodness-of-fit $\chi^2 = 10.0$, 4 *df*, $P = 0.04$.
[b]Based on 1,643 bandings and 88 recoveries. Model 1 goodness-of-fit $\chi^2 = 4.7$, 6 *df*, $P = 0.58$.
[c]$\hat{MLS} = 2.1$, $\hat{SE}(\hat{MLS}) = 0.7$.
[d]Based on 842 bandings and 23 recoveries.
[e]$\hat{MLS} = 1.0$, $\hat{SE}(\hat{MLS}) = 0.3$.

Table B-37. *Estimates of survival and recovery rates for male mallards banded during winter in E New Mexico (261).*

Year (i)	$\hat{S}_i$	$\hat{SE}(\hat{S}_i)$	$\hat{f}_i$	$\hat{SE}(\hat{f}_i)$
1966	0.759	0.088	0.033	0.005
1967	0.621	0.067	0.031	0.004
1968	0.775	0.135	0.029	0.004
1969	0.894	0.165	0.049	0.008
1970	0.506	0.082	0.039	0.004
1971	0.646	0.129	0.043	0.007
1972	0.509	0.147	0.047	0.008
1973	0.754	0.213	0.053	0.014
1974	0.607	0.128	0.030	0.005
1975	0.701	0.171	0.038	0.007
1976	0.751	0.215	0.031	0.006
Means[a]	**0.684[b]**	**0.022**	**0.039**	**0.002**

[a]Based on 8,892 bandings and 913 recoveries. Model 1 goodness-of-fit $\chi^2 = 42.1$, 44 *df*, $P = 0.56$.
[b]$\hat{MLS} = 2.6$, $\hat{SE}(\hat{MLS}) = 0.2$.

Table B-38. *Estimates of survival and recovery rates for female mallards banded during winter in E New Mexico (261).*

Year (i)	$\hat{S}_i$	$\hat{SE}(\hat{S}_i)$	$\hat{f}_i$	$\hat{SE}(\hat{f}_i)$
1966	0.613	0.141	0.020	0.005
1967	0.733	0.154	0.019	0.004
1968	0.815	0.379	0.014	0.003
1969	0.308	0.147	0.017	0.008
1970	0.507	0.147	0.028	0.006
1971	0.749	0.269	0.026	0.007
1972	0.263	0.140	0.026	0.008
1973	0.842	0.460	0.038	0.018
1974	0.222	0.096	0.018	0.005
1975	0.717	0.295	0.022	0.008
1976	0.377	0.182	0.026	0.007
Means[a]	**0.559[b]**	**0.049**	**0.023**	**0.002**

[a]Based on 6,226 bandings and 288 recoveries. Model 1 goodness-of-fit $\chi^2 = 21.3$, 19 *df*, $P = 0.32$.
[b]$\hat{MLS} = 1.7$, $\hat{SE}(\hat{MLS}) = 0.3$.

Table B-39. *Estimates of survival and recovery rates for male mallards banded during winter in W Oklahoma-W Texas (262).*

Year (i)	$\hat{S}_i$	$\hat{SE}(\hat{S}_i)$	$\hat{f}_i$	$\hat{SE}(\hat{f}_i)$
1971	0.616	0.251	0.015	0.010
1972	0.938	0.228	0.018	0.006
1973	0.893	0.290	0.028	0.006
1974	0.518	0.201	0.008	0.003
1975	0.672	0.225	0.022	0.007
1976	0.968	0.482	0.031	0.006
Means[a]	**0.768[b]**	**0.091**	**0.020**	**0.003**

[a]Based on 2,636 bandings and 147 recoveries. Model 1 goodness-of-fit $\chi^2 = 11.4$, 13 *df*, $P = 0.58$.
[b]$\hat{MLS} = 3.8$, $\hat{SE}(\hat{MLS}) = 1.7$.

Table B-40. *Estimates of survival and recovery rates for female mallards banded during winter in W Oklahoma-W Texas (262).*

Year (i)	$\hat{S}_i$	$\hat{SE}(\hat{S}_i)$	$\hat{f}_i$	$\hat{SE}(\hat{f}_i)$
1972	0.556	0.304	0.020	0.011
1973	0.579	0.287	0.017	0.006
1974	1.182	0.983	0.018	0.009
1975	0.262	0.223	0.007	0.006
1976	0.542	0.472	0.013	0.006
Means[a]	**0.624[b]**	**0.180**	**0.015**	**0.004**

[a]Based on 1,337 bandings and 41 recoveries.
[b]$\hat{MLS} = 2.1$, $\hat{SE}(\hat{MLS}) = 1.3$.

Table B-41. *Estimates of survival and recovery rates for male mallards banded during winter in E South Dakota (271).*

Year (i)	$\hat{S}_i$	$\hat{SE}(\hat{S}_i)$	$\hat{f}_i$	$\hat{SE}(\hat{f}_i)$
1951	0.536	0.122	0.059	0.007
1952	0.558	0.138	0.066	0.016
1953	0.778	0.150	0.079	0.012
1954	0.619	0.118	0.046	0.009
Means[a]	**0.623[b]**	**0.030**	**0.062**	**0.006**
1960	0.721	0.127	0.028	0.005
1961	0.550	0.090	0.018	0.003
1962	0.856	0.117	0.020	0.003
1963	0.544	0.074	0.023	0.003
1964	0.772	0.104	0.035	0.004
1965	0.863	0.106	0.019	0.003
1966	0.495	0.060	0.025	0.003
Means[c]	**0.686[d]**	**0.019**	**0.024**	**0.001**

[a]Based on 2,217 bandings and 361 recoveries. Model 1 goodness-of-fit $\chi^2 = 25.4$, 18 *df*, $P = 0.11$.
[b]$\hat{MLS} = 2.1$, $\hat{SE}(\hat{MLS}) = 0.2$.
[c]Based on 9,744 bandings and 857 recoveries. Model 1 goodness-of-fit $\chi^2 = 49.3$, 54 *df*, $P = 0.65$.
[d]$\hat{MLS} = 2.7$, $\hat{SE}(\hat{MLS}) = 0.2$.

Table B-42. *Estimates of survival and recovery rates for female mallards banded during winter in E South Dakota (271).*

Year (i)	$\hat{S}_i$	$\hat{SE}(\hat{S}_i)$	$\hat{f}_i$	$\hat{SE}(\hat{f}_i)$
1951	0.500	0.200	0.062	0.010
1952	0.476	0.218	0.051	0.020
1953	0.606	0.384	0.046	0.012
1954	0.207	0.126	0.015	0.010
Means[a]	**0.447[b]**	**0.071**	**0.043**	**0.007**
1960	0.416	0.141	0.022	0.006
1961	0.561	0.153	0.019	0.004
1962	0.697	0.276	0.011	0.003
1963	0.388	0.147	0.009	0.004
1964	0.792	0.196	0.028	0.005
1965	0.593	0.193	0.015	0.004
1966	0.321	0.106	0.020	0.006
Means[c]	**0.538[d]**	**0.035**	**0.018**	**0.002**

[a]Based on 1,177 bandings and 128 recoveries. Model 1 goodness-of-fit $\chi^2 = 1.9$, 4 *df*, $P = 0.76$.
[b]$\hat{MLS} = 1.2$, $\hat{SE}(\hat{MLS}) = 0.3$.
[c]Based on 5,263 bandings and 236 recoveries. Model 1 goodness-of-fit $\chi^2 = 23.3$, 21 *df*, $P = 0.33$.
[d]$\hat{MLS} = 1.6$, $\hat{SE}(\hat{MLS}) = 0.2$.

Table B-43. *Estimates of survival and recovery rates for male mallards banded during winter in E Nebraska (272).*

Year (i)	$\hat{S}_i$	$\hat{SE}(\hat{S}_i)$	$\hat{f}_i$	$\hat{SE}(\hat{f}_i)$
1952	0.653	0.071	0.082	0.009
1953	0.583	0.064	0.081	0.008
1954	0.618	0.067	0.085	0.008
1955	0.706	0.080	0.072	0.007
1956	0.626	0.090	0.063	0.007
Means[a]	**0.637[b]**	**0.021**	**0.077**	**0.004**
1966	0.713	0.073	0.034	0.005
1967	0.697	0.067	0.048	0.005
1968	0.740	0.083	0.038	0.004
1969	0.858	0.126	0.040	0.005
1970	0.635	0.104	0.046	0.006
1971	0.721	0.133	0.057	0.007
1972	0.338	0.074	0.049	0.008
1973	0.954	0.200	0.072	0.013
Means[c]	**0.707[d]**	**0.024**	**0.048**	**0.003**

[a]Based on 4,411 bandings and 887 recoveries. Model 1 goodness-of-fit $\chi^2 = 32.2$, 29 *df*, $P = 0.31$.
[b]$\hat{MLS} = 2.2$, $\hat{SE}(\hat{MLS}) = 0.2$.
[c]Based on 6,653 bandings and 979 recoveries. Model 1 goodness-of-fit $\chi^2 = 45.1$, 45 *df*, $P = 0.47$.
[d]$\hat{MLS} = 2.9$, $\hat{SE}(\hat{MLS}) = 0.3$.

Table B-44. *Estimates of survival and recovery rates for female mallards banded during winter in E Nebraska (272).*

Year (i)	$\hat{S}_i$	$\hat{SE}(\hat{S}_i)$	$\hat{f}_i$	$\hat{SE}(\hat{f}_i)$
1952	0.516	0.127	0.096	0.016
1953	0.409	0.107	0.085	0.016
1954	0.622	0.149	0.053	0.011
1955	0.553	0.142	0.065	0.013
1956	0.528	0.149	0.050	0.011
Means[a]	**0.525[b]**	**0.039**	**0.070**	**0.006**
1966	0.695	0.178	0.024	0.008
1967	0.773	0.169	0.024	0.005
1968	0.703	0.201	0.024	0.005
1969	0.687	0.229	0.017	0.005
1970	0.409	0.127	0.021	0.006
1971	0.607	0.166	0.030	0.007
1972	0.802	0.362	0.032	0.007
1973	0.516	0.256	0.015	0.007
Means[c]	**0.649[d]**	**0.037**	**0.023**	**0.002**

[a]Based on 1,581 bandings and 221 recoveries. Model 1 goodness-of-fit $\chi^2 = 17.7$, 14 *df*, $P = 0.22$.
[b]$\hat{MLS} = 1.6$, $\hat{SE}(\hat{MLS}) = 0.2$.
[c]Based on 3,600 bandings and 233 recoveries. Model 1 goodness-of-fit $\chi^2 = 28.6$, 26 *df*, $P = 0.33$.
[d]$\hat{MLS} = 2.3$, $\hat{SE}(\hat{MLS}) = 0.3$.

Table B-45. *Estimates of survival and recovery rates for male mallards banded during winter in E Kansas (273).*

Year (i)	$\hat{S}_i$	$\hat{SE}(\hat{S}_i)$	$\hat{f}_i$	$\hat{SE}(\hat{f}_i)$
1930	0.697	0.279	0.204	0.058
1931	0.625	0.196	0.040	0.021
Means[a]	**0.661[b]**	**0.130**	**0.122**	**0.031**
1965	0.654	0.168	0.013	0.009
1966	0.693	0.068	0.043	0.006
1967	0.756	0.054	0.039	0.003
1968	0.699	0.072	0.035	0.003
1969	0.654	0.069	0.037	0.004
Means[c]	**0.691[d]**	**0.034**	**0.033**	**0.002**

[a]Based on 190 bandings and 54 recoveries. Model 1 goodness-of-fit $\chi^2 = 5.1$, 2 *df*, $P = 0.08$.
[b]$\hat{MLS} = 2.4$, $\hat{SE}(\hat{MLS}) = 1.2$.
[c]Based on 9,365 bandings and 1,361 recoveries. Model 1 goodness-of-fit $\chi^2 = 42.7$, 36 *df*, $P = 0.21$.
[d]$\hat{MLS} = 2.7$, $\hat{SE}(\hat{MLS}) = 0.4$.

Table B-46. *Estimates of survival and recovery rates for female mallards banded during winter in E Kansas (273).*

Year (i)	$\hat{S}_i$	$\hat{SE}(\hat{S}_i)$	$\hat{f}_i$	$\hat{SE}(\hat{f}_i)$
1930	0.764	0.334	0.167	0.058
1931	1.063	0.479	0.057	0.026
1932	0.202	0.120	0.065	0.026
Means[a]	**0.676[b]**	**0.146**	**0.096**	**0.023**
1963	0.524	0.389	0.020	0.010
1964	0.795	0.800	0.033	0.025
1965	0.332	0.238	0.004	0.004
1966	0.742	0.147	0.034	0.007
1967	0.617	0.111	0.030	0.004
1968	0.562	0.153	0.018	0.003
1969	0.864	0.254	0.022	0.006
Means[c]	**0.634[d]**	**0.071**	**0.023**	**0.004**

[a]Based on 176 bandings and 37 recoveries. Model 1 goodness-of-fit $\chi^2 = 0.2$, 1 *df*, $P = 0.69$.
[b]$\hat{MLS} = 2.6$, $\hat{SE}(\hat{MLS}) = 1.4$.
[c]Based on 3,969 bandings and 272 recoveries. Model 1 goodness-of-fit $\chi^2 = 16.9$, 10 *df*, $P = 0.08$.
[d]$\hat{MLS} = 2.2$, $\hat{SE}(\hat{MLS}) = 0.5$.

Table B-47. *Estimates of survival and recovery rates for male mallards banded during winter in E Oklahoma (281).*

Year (i)	$\hat{S}_i$	$\hat{SE}(\hat{S}_i)$	$\hat{f}_i$	$\hat{SE}(\hat{f}_i)$
1939	0.551	0.081	0.070	0.010
1940	0.466	0.072	0.096	0.010
1941	0.683	0.220	0.081	0.011
1942	0.472	0.155	0.053	0.017
1943	0.554	0.093	0.064	0.011
1944	0.484	0.127	0.076	0.010
Means[a]	**0.535**[b]	**0.029**	**0.073**	**0.005**
1947	0.427	0.118	0.087	0.020
1948	0.606	0.108	0.058	0.012
1949	0.587	0.114	0.072	0.010
1950	0.508	0.132	0.065	0.013
1951	0.703	0.167	0.069	0.017
1952	0.599	0.087	0.084	0.013
1953	0.522	0.052	0.091	0.008
1954	0.741	0.065	0.101	0.009
1955	0.583	0.053	0.074	0.005
1956	0.564	0.088	0.074	0.006
Means[c]	**0.584**[d]	**0.018**	**0.077**	**0.004**
1966	0.639	0.074	0.046	0.007
1967	0.779	0.083	0.050	0.005
1968	0.716	0.089	0.037	0.004
1969	0.676	0.081	0.035	0.004
1970	0.731	0.084	0.052	0.005
1971	0.757	0.125	0.040	0.004
1972	0.626	0.115	0.041	0.007
1973	0.769	0.116	0.043	0.006
1974	1.263	0.235	0.035	0.004
1975	0.380	0.073	0.019	0.003
1976	0.700	0.161	0.042	0.005
Means[e]	**0.730**[f]	**0.022**	**0.040**	**0.002**

[a]Based on 2,766 bandings and 484 recoveries. Model 1 goodness-of-fit $\chi^2 = 33.0$, 23 *df*, $P = 0.08$.
[b]$\hat{MLS} = 1.6$, $\hat{SE}(\hat{MLS}) = 0.1$.
[c]Based on 7,130 bandings and 1,344 recoveries. Model 1 goodness-of-fit $\chi^2 = 44.0$, 47 *df*, $P = 0.60$.
[d]$\hat{MLS} = 1.9$, $\hat{SE}(\hat{MLS}) = 0.1$.
[e]Based on 11,575 bandings and 1,300 recoveries. Model 1 goodness-of-fit $\chi^2 = 44.7$, 53 *df*, $P = 0.78$.
[f]$\hat{MLS} = 3.2$, $\hat{SE}(\hat{MLS}) = 0.3$.

Table B-48. *Estimates of survival and recovery rates for female mallards banded during winter in E Oklahoma (281).*

Year (i)	$\hat{S}_i$	$\hat{SE}(\hat{S}_i)$	$\hat{f}_i$	$\hat{SE}(\hat{f}_i)$
1939	0.355	0.100	0.070	0.014
1940	0.568	0.145	0.062	0.011
1941	0.364	0.171	0.056	0.013
1942	0.776	0.369	0.064	0.029
1943	0.350	0.095	0.049	0.012
1944	0.504	0.187	0.069	0.014
Means[a]	**0.486**[b]	**0.052**	**0.062**	**0.007**
1947	1.250	0.438	0.043	0.021
1948	0.436	0.130	0.036	0.012
1949	0.548	0.177	0.060	0.012
1950	0.536	0.219	0.057	0.018
1951	0.567	0.228	0.063	0.021
1952	0.624	0.189	0.047	0.015
1953	0.466	0.092	0.055	0.009
1954	0.454	0.080	0.062	0.009
1955	0.433	0.070	0.070	0.007
1956	0.472	0.125	0.067	0.009
Means[c]	**0.579**[d]	**0.044**	**0.056**	**0.004**
1964	0.556	0.451	0.010	0.010
1965	0.761	0.570	0.017	0.016
1966	0.434	0.113	0.019	0.006
1967	0.804	0.214	0.030	0.006
1968	1.052	0.347	0.022	0.006
1969	0.495	0.149	0.011	0.003
1970	0.631	0.167	0.021	0.005
1971	0.395	0.127	0.019	0.004
1972	0.462	0.175	0.032	0.009
1973	0.678	0.234	0.022	0.007
1974	0.523	0.170	0.017	0.004
1975	0.437	0.145	0.022	0.005
1976	0.809	0.433	0.023	0.005
Means[e]	**0.618**[f]	**0.047**	**0.020**	**0.002**

[a]Based on 1,540 bandings and 197 recoveries. Model 1 goodness-of-fit $\chi^2 = 11.1$, 11 *df*, $P = 0.43$.
[b]$\hat{MLS} = 1.4$, $\hat{SE}(\hat{MLS}) = 0.2$.
[c]Based on 3,876 bandings and 468 recoveries. Model 1 goodness-of-fit $\chi^2 = 37.8$, 27 *df*, $P = 0.08$.
[d]$\hat{MLS} = 1.8$, $\hat{SE}(\hat{MLS}) = 0.3$.
[e]Based on 6,961 bandings and 305 recoveries. Model 1 goodness-of-fit $\chi^2 = 20.4$, 23 *df*, $P = 0.62$.
[b]$\hat{MLS} = 2.1$, $\hat{SE}(\hat{MLS}) = 0.3$.

Table B-49. *Estimates of survival and recovery rates for male mallards banded during winter in E Texas (282).*

Year (i)	$\hat{S}_i$	$\hat{SE}(\hat{S}_i)$	$\hat{f}_i$	$\hat{SE}(\hat{f}_i)$
1964	0.430	0.180	0.075	0.032
1965	0.827	0.317	0.079	0.020
1966	0.446	0.175	0.049	0.020
1967	0.526	0.171	0.054	0.015
Means[a]	**0.557[b]**	**0.072**	**0.064**	**0.011**
1972	0.472	0.216	0.047	0.023
1973	0.761	0.335	0.056	0.012
1974	0.582	0.254	0.028	0.013
1975	0.631	0.121	0.037	0.006
1976	0.710	0.168	0.037	0.004
Means[c]	**0.631[d]**	**0.062**	**0.041**	**0.006**

[a]Based on 493 bandings and 93 recoveries. Model 1 goodness-of-fit $\chi^2 = 16.9$, 13 *df*, $P = 0.21$.
[b]$\hat{MLS} = 1.7$, $\hat{SE}(\hat{MLS}) = 0.4$.
[c]Based on 3,829 bandings and 247 recoveries. Model 1 goodness-of-fit $\chi^2 = 8.8$, 5 *df*, $P = 0.12$.
[d]$\hat{MLS} = 2.2$, $\hat{SE}(\hat{MLS}) = 0.5$.

Table B-50. *Estimates of survival and recovery rates for female mallards banded during winter in E Texas (282).*

Year (i)	$\hat{S}_i$	$\hat{SE}(\hat{S}_i)$	$\hat{f}_i$	$\hat{SE}(\hat{f}_i)$
1973	0.137	0.117	0.047	0.016
1974	0.891	0.740	0.046	0.026
1975	0.307	0.152	0.011	0.005
1976	0.703	0.248	0.020	0.004
Means[a]	**0.510[b]**	**0.179**	**0.031**	**0.008**

[a]Based on 2,246 bandings and 75 recoveries.
[b]$\hat{MLS} = 1.5$, $\hat{SE}(\hat{MLS}) = 0.8$.

Table B-51. *Estimates of survival and recovery rates for male mallards banded during winter in S Minnesota–N Iowa (291).*

Year (i)	$\hat{S}_i$	$\hat{SE}(\hat{S}_i)$	$\hat{f}_i$	$\hat{SE}(\hat{f}_i)$
1971	0.565	0.185	0.101	0.021
1972	0.582	0.154	0.039	0.010
1973	0.860	0.212	0.036	0.009
1974	0.537	0.126	0.038	0.008
1975	0.765	0.294	0.039	0.007
1976	0.694	0.331	0.026	0.010
Means[a]	**0.667[b]**	**0.054**	**0.046**	**0.005**

[a]Based on 2,374 bandings and 201 recoveries. Model 1 goodness-of-fit $\chi^2 = 7.4$, 12 *df*, $P = 0.83$.
[b]$\hat{MLS} = 2.5$, $\hat{SE}(\hat{MLS}) = 0.5$.

Table B-52. *Estimates of survival and recovery rates for female mallards banded during winter in S Minnesota–N Iowa (291).*

Year (i)	$\hat{S}_i$	$\hat{SE}(\hat{S}_i)$	$\hat{f}_i$	$\hat{SE}(\hat{f}_i)$
1971	0.591	0.423	0.034	0.019
1972	0.421	0.277	0.024	0.014
1973	0.769	0.421	0.022	0.010
1974	0.254	0.127	0.019	0.008
1975	0.471	0.248	0.029	0.009
1976	0.538	0.426	0.044	0.020
Means[a]	**0.507[b]**	**0.101**	**0.029**	**0.006**

[a]Based on 1,170 bandings and 54 recoveries. Model 1 goodness-of-fit $\chi^2 = 6.2$, 1 *df*, $P = 0.01$.
[b]$\hat{MLS} = 1.5$, $\hat{SE}(\hat{MLS}) = 0.4$.

Table B-53. *Estimates of survival and recovery rates for male mallards banded during winter in S Iowa–W Missouri (292).*

Year (i)	$\hat{S}_i$	$\hat{SE}(\hat{S}_i)$	$\hat{f}_i$	$\hat{SE}(\hat{f}_i)$
1952	0.507	0.087	0.072	0.012
1953	0.466	0.097	0.095	0.015
1954	1.191	0.286	0.104	0.020
1955	0.474	0.110	0.046	0.010
1956	0.773	0.185	0.062	0.012
1957	0.926	0.349	0.060	0.013
Means[a]	**0.723[b]**	**0.063**	**0.073**	**0.006**
1963	0.772	0.100	0.030	0.005
1964	0.532	0.073	0.036	0.005
1965	0.726	0.096	0.025	0.004
1966	0.544	0.079	0.043	0.005
1967	0.960	0.131	0.045	0.006
1968	0.606	0.068	0.031	0.004
1969	0.662	0.065	0.035	0.004
1970	0.668	0.067	0.057	0.005
1971	0.579	0.099	0.051	0.005
1972	0.781	0.162	0.069	0.011
Means[c]	**0.683[d]**	**0.016**	**0.042**	**0.002**

[a]Based on 1,625 bandings and 289 recoveries. Model 1 goodness-of-fit $\chi^2 = 23.4$, 23 *df*, $P = 0.44$.
[b]$\hat{MLS} = 3.1$, $\hat{SE}(\hat{MLS}) = 0.8$.
[c]Based on 9,944 bandings and 1,322 recoveries. Model 1 goodness-of-fit $\chi^2 = 90.2$, 71 *df*, $P = 0.06$.
[d]$\hat{MLS} = 2.6$, $\hat{SE}(\hat{MLS}) = 0.2$.

Table B-54. *Estimates of survival and recovery rates for female mallards banded during winter in S Iowa–W Missouri (292).*

Year (i)	$\hat{S}_i$	$\hat{SE}(\hat{S}_i)$	$\hat{f}_i$	$\hat{SE}(\hat{f}_i)$
1952	0.701	0.338	0.054	0.013
1953	0.367	0.229	0.034	0.017
1954	0.597	0.346	0.041	0.021
1955	0.330	0.153	0.060	0.025
1956	0.806	0.314	0.040	0.016
Means[a]	**0.555[b]**	**0.081**	**0.046**	**0.008**
1963	0.787	0.207	0.022	0.006
1964	0.466	0.145	0.031	0.007
1965	0.695	0.239	0.024	0.006
1966	0.350	0.117	0.019	0.006
1967	0.801	0.231	0.032	0.008
1968	0.494	0.129	0.019	0.005
1969	0.497	0.109	0.030	0.006
1970	0.892	0.224	0.030	0.005
1971	0.489	0.223	0.023	0.005
1972	0.385	0.248	0.022	0.009
Means[c]	**0.586[d]**	**0.036**	**0.025**	**0.002**

[a]Based on 667 bandings and 78 recoveries. Model 1 goodness-of-fit $\chi^2 = 5.5$, 2 *df*, $P = 0.06$.
[b]$M\hat{L}S = 1.7$, $\hat{SE}(M\hat{L}S) = 0.4$.
[c]Based on 4,716 bandings and 292 recoveries. Model 1 goodness-of-fit $\chi^2 = 40.4$, 25 *df*, $P = 0.03$.
[d]$M\hat{L}S = 1.9$, $\hat{SE}(M\hat{L}S) = 0.2$.

Table B-55. *Estimates of survival and recovery rates for male mallards banded during winter in W Arkansas (301).*

Year (i)	$\hat{S}_i$	$\hat{SE}(\hat{S}_i)$	$\hat{f}_i$	$\hat{SE}(\hat{f}_i)$
1963	0.586	0.116	0.020	0.008
1964	0.712	0.403	0.070	0.009
1965	0.376	0.211	0.016	0.010
1966	0.777	0.091	0.067	0.008
Means[a]	**0.613[b]**	**0.058**	**0.043**	**0.004**

[a]Based on 3,380 bandings and 492 recoveries. Model 1 goodness-of-fit $\chi^2 = 18.5$, 18 *df*, $P = 0.43$.
[b]$M\hat{L}S = 2.0$, $\hat{SE}(M\hat{L}S) = 0.4$.

Table B-56. *Estimates of survival and recovery rates for male mallards banded during winter in E Arkansas–W Tennessee–NW Mississippi (302).*

Year (i)	$\hat{S}_i$	$\hat{SE}(\hat{S}_i)$	$\hat{f}_i$	$\hat{SE}(\hat{f}_i)$
1950	0.778	0.271	0.076	0.033
1951	0.389	0.095	0.085	0.019
1952	0.741	0.105	0.077	0.013
1953	0.595	0.063	0.073	0.007
1954	0.893	0.164	0.058	0.007
1955	0.531	0.110	0.047	0.009
1956	1.251	0.557	0.056	0.009
1957	0.318	0.182	0.034	0.015
Means[a]	**0.687[b]**	**0.064**	**0.063**	**0.006**
1959	0.453	0.220	0.065	0.017
1960	0.669	0.441	0.050	0.023
1961	0.420	0.292	0.031	0.018
1962	0.463	0.210	0.012	0.010
1963	0.608	0.046	0.039	0.004
1964	0.715	0.045	0.062	0.003
1965	0.717	0.049	0.030	0.002
1966	0.608	0.042	0.048	0.003
1967	0.642	0.063	0.042	0.003
1968	0.740	0.082	0.037	0.004
1969	0.657	0.080	0.039	0.003
1970	0.821	0.102	0.064	0.007
1971	0.709	0.076	0.054	0.005
1972	0.840	0.140	0.047	0.004
1973	0.588	0.129	0.035	0.005
1974	0.587	0.137	0.033	0.006
1975	0.551	0.114	0.050	0.009
1976	0.825	0.150	0.052	0.006
Means[c]	**0.645[d]**	**0.018**	**0.044**	**0.002**

[a]Based on 3,222 bandings and 603 recoveries. Model 1 goodness-of-fit $\chi^2 = 34.3$, 30 *df*, $P = 0.27$.
[b]$M\hat{L}S = 2.7$, $\hat{SE}(M\hat{L}S) = 0.7$.
[c]Based on 25,974 bandings and 3,333 recoveries. Model 1 goodness-of-fit $\chi^2 = 81.6$, 88 *df*, $P = 0.67$.
[d]$M\hat{L}S = 2.3$, $\hat{SE}(M\hat{L}S) = 0.1$.

Table B-57. *Estimates of survival and recovery rates for female mallards banded during winter in E Arkansas–W Tennessee–NW Mississippi (302).*

Year (i)	$\hat{S}_i$	$\hat{SE}(\hat{S}_i)$	$\hat{f}_i$	$\hat{SE}(\hat{f}_i)$
1963	0.522	0.089	0.030	0.006
1964	0.594	0.076	0.043	0.004
1965	0.459	0.056	0.024	0.003
1966	0.640	0.077	0.041	0.004
1967	0.544	0.098	0.033	0.003
1968	0.608	0.114	0.018	0.003
1969	0.695	0.118	0.033	0.004
1970	0.716	0.137	0.035	0.005
1971	0.371	0.090	0.036	0.005
1972	0.496	0.152	0.045	0.009
1973	0.792	0.279	0.018	0.005
1974	0.416	0.154	0.024	0.007
1975	0.942	0.317	0.033	0.008
1976	0.484	0.164	0.019	0.004
Means[a]	**0.591**[b]	**0.023**	**0.031**	**0.001**

[a]Based on 15,905 bandings and 1,085 recoveries. Model 1 goodness-of-fit $\chi^2 = 56.1$, 52 *df*, $P = 0.32$.
[b]$\hat{MLS} = 1.9$, $\hat{SE}(\hat{MLS}) = 0.1$.

Table B-58. *Estimates of survival and recovery rates for male mallards banded during winter in E Tennessee (303).*

Year (i)	$\hat{S}_i$	$\hat{SE}(\hat{S}_i)$	$\hat{f}_i$	$\hat{SE}(\hat{f}_i)$
1959	0.228	0.052	0.047	0.008
1960	0.521	0.104	0.085	0.013
1961	0.634	0.171	0.062	0.011
1962	0.672	0.158	0.032	0.010
1963	0.670	0.066	0.051	0.005
1964	0.734	0.071	0.057	0.005
1965	0.698	0.051	0.036	0.003
1966	0.744	0.055	0.051	0.003
1967	0.622	0.056	0.046	0.004
1968	0.611	0.054	0.034	0.003
1969	0.713	0.065	0.046	0.004
1970	0.716	0.064	0.074	0.006
1971	0.607	0.081	0.057	0.004
1972	0.594	0.137	0.068	0.009
Means[a]	**0.626**[b]	**0.012**	**0.053**	**0.002**
1975	1.003	0.258	0.033	0.010
1976	0.445	0.126	0.047	0.008
Means[c]	**0.724**[d]	**0.126**	**0.040**	**0.006**

[a]Based on 18,405 bandings and 2,834 recoveries. Model 1 goodness-of-fit $\chi^2 = 123.3$, 98 *df*, $P = 0.04$.
[b]$\hat{MLS} = 2.1$, $\hat{SE}(\hat{MLS}) = 0.1$.
[c]Based on 1,948 bandings and 118 recoveries. Model 1 goodness-of-fit $\chi^2 = 0.5$, 1 *df*, $P = 0.47$.
[d]$\hat{MLS} = 3.1$, $\hat{SE}(\hat{MLS}) = 1.7$.

Table B-59. *Estimates of survival and recovery rates for female mallards banded during winter in E Tennessee (303).*

Year (i)	$\hat{S}_i$	$\hat{SE}(\hat{S}_i)$	$\hat{f}_i$	$\hat{SE}(\hat{f}_i)$
1959	0.342	0.148	0.027	0.011
1960	0.692	0.266	0.041	0.013
1961	0.301	0.130	0.026	0.009
1962	0.707	0.262	0.051	0.020
1963	0.690	0.125	0.039	0.006
1964	0.483	0.088	0.041	0.006
1965	0.643	0.084	0.029	0.004
1966	0.524	0.058	0.036	0.003
1967	0.631	0.086	0.043	0.004
1968	0.590	0.093	0.025	0.003
1969	0.553	0.096	0.030	0.004
1970	0.693	0.123	0.048	0.007
1971	0.674	0.199	0.039	0.005
1972	0.219	0.095	0.027	0.007
Means[a]	**0.553**[b]	**0.024**	**0.036**	**0.002**
1975	0.526	0.266	0.034	0.012
1976	0.196	0.125	0.033	0.009
Means[c]	**0.361**[d]	**0.136**	**0.034**	**0.007**

[a]Based on 12,083 bandings and 1,029 recoveries. Model 1 goodness-of-fit $\chi^2 = 66.7$, 55 *df*, $P = 0.13$.
[b]$\hat{MLS} = 1.7$, $\hat{SE}(\hat{MLS}) = 0.1$.
[c]Based on 1,291 bandings and 46 recoveries.
[d]$\hat{MLS} = 1.0$, $\hat{SE}(\hat{MLS}) = 0.4$.

Table B-60. *Estimates of survival and recovery rates for male mallards banded during winter in W Louisiana (304).*

Year (i)	$\hat{S}_i$	$\hat{SE}(\hat{S}_i)$	$\hat{f}_i$	$\hat{SE}(\hat{f}_i)$
1976[a]	0.555[b]	0.117	0.032	0.005

[a]Based on 2,846 bandings and 141 recoveries.
[b]$\hat{MLS} = 1.7$, $\hat{SE}(\hat{MLS}) = 0.6$.

Table B-61. *Estimates of survival and recovery rates for female mallards banded during winter in W Louisiana (304).*

Year (i)	$\hat{S}_i$	$\hat{SE}(\hat{S}_i)$	$\hat{f}_i$	$\hat{SE}(\hat{f}_i)$
1934	0.437	0.456	0.056	0.054
1935	0.488	0.393	0.063	0.032
Means[a]	**0.462**[b]	**0.274**	**0.060**	**0.031**
1976[c]	0.177[d]	0.095	0.024	0.005

[a]Based on 112 bandings and 11 recoveries.
[b]$\hat{MLS} = 1.3$, $\hat{SE}(\hat{MLS}) = 1.0$.
[c]Based on 2,349 bandings and 56 recoveries.
[d]$\hat{MLS} = 0.6$, $\hat{SE}(\hat{MLS}) = 0.2$.

Table B-62. *Estimates of survival and recovery rates for male mallards banded during winter in E Louisiana-SW Mississippi (305).*

Year (i)	$\hat{S}_i$	$\widehat{SE}(\hat{S}_i)$	$\hat{f}_i$	$\widehat{SE}(\hat{f}_i)$
1938	1.746	0.851	0.021	0.021
1939	0.320	0.096	0.019	0.008
1940	0.593	0.165	0.051	0.007
Means[a]	**0.887**[b]	**0.277**	**0.030**	**0.008**
1954	0.571	0.160	0.064	0.018
1955	0.481	0.109	0.055	0.013
1956	0.874	0.156	0.065	0.013
Means[c]	**0.642**[d]	**0.062**	**0.061**	**0.009**
1976[e]	0.628[f]	0.148	0.044	0.005

[a]Based on 1,397 bandings and 148 recoveries. Model 1 goodness-of-fit χ^2 = 2.1, 4 *df*, *P* = 0.71.
[b]$\widehat{MLS}$ = 8.3, $\widehat{SE}$($\widehat{MLS}$) = 21.6.
[c]Based on 1,149 bandings and 192 recoveries. Model 1 goodness-of-fit χ^2 = 13.9, 12 *df*, *P* = 0.31.
[d]$\widehat{MLS}$ = 2.3, $\widehat{SE}$($\widehat{MLS}$) = 0.5.
[e]Based on 1,948 bandings and 141 recoveries.
[f]$\widehat{MLS}$ = 2.2, $\widehat{SE}$($\widehat{MLS}$) = 1.1.

Table B-63. *Estimates of survival and recovery rates for female mallards banded during winter in E Louisiana-SW Mississippi (305).*

Year (i)	$\hat{S}_i$	$\widehat{SE}(\hat{S}_i)$	$\hat{f}_i$	$\widehat{SE}(\hat{f}_i)$
1939	0.211	0.095	0.016	0.009
1940	0.876	0.342	0.060	0.008
Means[a]	**0.543**[b]	**0.175**	**0.038**	**0.006**
1954	0.352	0.220	0.032	0.022
1955	0.397	0.167	0.059	0.023
1956	0.944	0.374	0.094	0.026
Means[c]	**0.564**[d]	**0.134**	**0.061**	**0.014**
1976[e]	0.468[f]	0.225	0.029	0.007

[a]Based on 1,059 bandings and 109 recoveries. Model 1 goodness-of-fit χ^2 = 1.6, 2 *df*, *P* = 0.46.
[b]$\widehat{MLS}$ = 1.6, $\widehat{SE}$($\widehat{MLS}$) = 0.9.
[c]Based on 502 bandings and 51 recoveries. Model 1 goodness-of-fit χ^2 = 2.2, 2 *df*, *P* = 0.33.
[d]$\widehat{MLS}$ = 1.8, $\widehat{SE}$($\widehat{MLS}$) = 0.7.
[e]Based on 947 bandings and 36 recoveries.
[f]$\widehat{MLS}$ = 1.3, $\widehat{SE}$($\widehat{MLS}$) = 0.8.

Table B-64. *Estimates of survival and recovery rates for male mallards banded during winter in E Mississippi-Alabama (306).*

Year (i)	$\hat{S}_i$	$\widehat{SE}(\hat{S}_i)$	$\hat{f}_i$	$\widehat{SE}(\hat{f}_i)$
1955	1.104	0.280	0.046	0.018
1956	0.634	0.164	0.055	0.013
1957	0.564	0.159	0.066	0.014
1958	0.803	0.234	0.055	0.013
1959	0.708	0.219	0.032	0.008
1960	0.261	0.095	0.039	0.010
Means[a]	**0.679**[b]	**0.050**	**0.049**	**0.005**
1963	0.803	0.179	0.042	0.014
1964	0.463	0.065	0.056	0.007
1965	0.734	0.083	0.040	0.006
1966	0.681	0.090	0.051	0.004
1967	0.587	0.141	0.040	0.006
1968	0.550	0.141	0.038	0.009
1969	0.638	0.153	0.034	0.007
1970	0.713	0.185	0.090	0.019
1971	0.635	0.177	0.056	0.011
Means[c]	**0.645**[d]	**0.026**	**0.050**	**0.003**
1975	0.210	0.157	0.057	0.022
1976	0.521	0.225	0.053	0.017
Means[e]	**0.366**[f]	**0.123**	**0.055**	**0.014**

[a]Based on 1,302 bandings and 169 recoveries. Model 1 goodness-of-fit χ^2 = 25.3, 21 *df*, *P* = 0.24.
[b]$\widehat{MLS}$ = 2.6, $\widehat{SE}$($\widehat{MLS}$) = 0.5.
[c]Based on 5,368 bandings and 734 recoveries. Model 1 goodness-of-fit χ^2 = 60.0, 52 *df*, *P* = 0.21.
[d]$\widehat{MLS}$ = 2.3, $\widehat{SE}$($\widehat{MLS}$) = 0.2.
[e]Based on 1,210 bandings and 78 recoveries.
[f]$\widehat{MLS}$ = 1.0, $\widehat{SE}$($\widehat{MLS}$) = 0.3.

Table B-65. *Estimates of survival and recovery rates for female mallards banded during winter in E Mississippi–Alabama (306).*

Year (i)	$\hat{S}_i$	$\hat{SE}(\hat{S}_i)$	$\hat{f}_i$	$\hat{SE}(\hat{f}_i)$
1955	0.882	0.476	0.059	0.033
1956	0.326	0.128	0.040	0.014
1957	0.412	0.168	0.080	0.021
1958	0.503	0.214	0.067	0.020
1959	0.542	0.218	0.036	0.012
1960	0.294	0.164	0.049	0.016
Means[a]	**0.493**[b]	**0.085**	**0.055**	**0.008**
1963	0.412	0.189	0.037	0.015
1964	0.867	0.237	0.032	0.006
1965	0.339	0.084	0.015	0.004
1966	0.663	0.131	0.044	0.005
1967	1.234	0.739	0.032	0.006
1968	0.167	0.102	0.005	0.003
1969	0.424	0.135	0.039	0.010
1970	1.300	0.532	0.058	0.016
1971	0.268	0.146	0.041	0.014
Means[c]	**0.630**[d]	**0.089**	**0.033**	**0.003**

[a]Based on 887 bandings and 88 recoveries. Model 1 goodness-of-fit $\chi^2 = 7.1$, 3 *df*, $P = 0.07$.
[b]$\hat{MLS} = 1.4$, $\hat{SE}(\hat{MLS}) = 0.4$.
[c]Based on 3,950 bandings and 306 recoveries. Model 1 goodness-of-fit $\chi^2 = 33.1$, 21 *df*, $P = 0.04$.
[d]$\hat{MLS} = 2.2$, $\hat{SE}(\hat{MLS}) = 0.7$.

Table B-66. *Estimates of survival and recovery rates for male mallards banded during winter in N Illinois–N Indiana–SW Michigan (311).*

Year (i)	$\hat{S}_i$	$\hat{SE}(\hat{S}_i)$	$\hat{f}_i$	$\hat{SE}(\hat{f}_i)$
1956	0.866	0.099	0.071	0.007
1957	0.528	0.182	0.082	0.009
1958	0.522	0.185	0.063	0.021
1959	0.541	0.116	0.060	0.010
1960	0.906	0.195	0.076	0.015
Means[a]	**0.673**[b]	**0.033**	**0.071**	**0.006**
1963	0.515	0.133	0.075	0.021
1964	0.574	0.076	0.086	0.010
1965	0.646	0.073	0.054	0.007
1966	0.737	0.077	0.064	0.007
1967	0.810	0.103	0.048	0.005
1968	0.720	0.122	0.032	0.004
1969	0.530	0.086	0.029	0.005
1970	1.492	0.503	0.068	0.008
1971	0.336	0.114	0.025	0.008
1972	0.579	0.087	0.045	0.006
1973	0.707	0.100	0.051	0.007
Means[c]	**0.695**[d]	**0.038**	**0.052**	**0.003**

[a]Based on 3,040 bandings and 545 recoveries. Model 1 goodness-of-fit $\chi^2 = 39.8$, 25 *df*, $P = 0.03$.
[b]$\hat{MLS} = 2.5$, $\hat{SE}(\hat{MLS}) = 0.3$.
[c]Based on 8,154 bandings and 1,224 recoveries. Model 1 goodness-of-fit $\chi^2 = 67.5$, 65 *df*, $P = 0.39$.
[d]$\hat{MLS} = 2.8$, $\hat{SE}(\hat{MLS}) = 0.4$.

Table B-67. *Estimates of survival and recovery rates for female mallards banded during winter in N Illinois–N Indiana–SW Michigan (311).*

Year (i)	$\hat{S}_i$	$\hat{SE}(\hat{S}_i)$	$\hat{f}_i$	$\hat{SE}(\hat{f}_i)$
1958	0.370	0.270	0.063	0.035
1959	0.476	0.193	0.051	0.017
1960	0.601	0.217	0.056	0.018
Means[a]	**0.483**[b]	**0.107**	**0.056**	**0.014**
1963	0.572	0.241	0.047	0.020
1964	0.641	0.151	0.042	0.009
1965	0.605	0.123	0.027	0.006
1966	0.411	0.077	0.048	0.007
1967	0.770	0.183	0.050	0.006
1968	0.493	0.140	0.025	0.006
1969	0.403	0.104	0.027	0.006
Means[c]	**0.556**[d]	**0.040**	**0.038**	**0.004**
1972	0.634	0.238	0.041	0.010
1973	0.472	0.169	0.025	0.009
Means[e]	**0.553**[f]	**0.102**	**0.035**	**0.007**

[a]Based on 732 bandings and 72 recoveries.
[b]$\hat{MLS} = 1.4$, $\hat{SE}(\hat{MLS}) = 0.4$.
[c]Based on 3,806 bandings and 344 recoveries. Model 1 goodness-of-fit $\chi^2 = 23.8$, 28 *df*, $P = 0.69$.
[d]$\hat{MLS} = 1.7$, $\hat{SE}(\hat{MLS}) = 0.2$.
[e]Based on 1,154 bandings and 78 recoveries. Model 1 goodness-of-fit $\chi^2 = 4.0$, 3 *df*, $P = 0.26$.
[f]$\hat{MLS} = 1.7$, $\hat{SE}(\hat{MLS}) = 0.5$.

Table B-68. *Estimates of survival and recovery rates for male mallards banded during winter in SE Great Lakes Region (312).*

Year (i)	$\hat{S}_i$	$\hat{SE}(\hat{S}_i)$	$\hat{f}_i$	$\hat{SE}(\hat{f}_i)$
1961	0.453	0.356	0.047	0.026
1962	0.358	0.156	0.014	0.010
1963	0.830	0.214	0.030	0.010
1964	0.428	0.123	0.046	0.011
1965	0.568	0.156	0.053	0.014
1966	0.457	0.178	0.063	0.015
1967	1.143	0.421	0.083	0.032
1968	0.643	0.123	0.038	0.007
1969	0.651	0.114	0.034	0.007
1970	0.865	0.127	0.048	0.007
1971	0.515	0.079	0.043	0.006
1972	0.652	0.133	0.058	0.008
1973	0.769	0.222	0.049	0.009
1974	0.187	0.077	0.035	0.009
1975	1.148	0.455	0.126	0.044
1976	0.737	0.339	0.050	0.009
Means[a]	**0.650**[b]	**0.043**	**0.051**	**0.004**

[a]Based on 5,129 bandings and 610 recoveries. Model 1 goodness-of-fit $\chi^2 = 53.2$, 51 *df*, $P = 0.39$.
[b]$\hat{MLS} = 2.3$, $\hat{SE}(\hat{MLS}) = 0.4$.

Table B-69. *Estimates of survival and recovery rates for female mallards banded during winter in SE Great Lakes Region (312).*

Year (i)	$\hat{S}_i$	$\hat{SE}(\hat{S}_i)$	$\hat{f}_i$	$\hat{SE}(\hat{f}_i)$
1961	0.830	0.742	0.043	0.029
1962	0.435	0.334	0.016	0.012
1963	0.231	0.129	0.024	0.011
1964	0.373	0.200	0.056	0.019
1965	0.480	0.254	0.033	0.017
1966	0.577	0.457	0.053	0.022
1967	0.559	0.442	0.039	0.029
1968	0.429	0.162	0.022	0.007
1969	0.526	0.184	0.033	0.011
1970	0.614	0.184	0.034	0.008
1971	0.551	0.162	0.025	0.007
1972	1.008	0.462	0.030	0.007
1973	0.558	0.462	0.019	0.008
1974	0.067	0.061	0.009	0.006
1975	0.441	0.346	0.085	0.048
1976	0.010	0.086	0.049	0.013
Means[a]	**0.486**[b]	**0.056**	**0.035**	**0.005**

[a]Based on 2,910 bandings and 185 recoveries.
[b]$\hat{MLS} = 1.4$, $\hat{SE}(\hat{MLS}) = 0.2$.

Table B-70. *Estimates of survival and recovery rates for male mallards banded during winter in SE Missouri–S Illinois–SW Indiana–W Kentucky (313).*

Year (i)	$\hat{S}_i$	$\widehat{SE}(\hat{S}_i)$	$\hat{f}_i$	$\widehat{SE}(\hat{f}_i)$
1922	0.244	0.121	0.154	0.045
1923	0.725	0.143	0.105	0.017
Means[a]	**0.485[b]**	**0.089**	**0.129**	**0.024**
1955	0.619	0.052	0.056	0.007
1956	0.491	0.131	0.080	0.004
1957	0.811	0.265	0.103	0.028
1958	0.624	0.164	0.075	0.015
1959	0.617	0.121	0.063	0.012
1960	0.732	0.270	0.058	0.005
1961	0.332	0.195	0.030	0.011
1962	0.871	0.404	0.034	0.017
1963	0.598	0.037	0.045	0.003
1964	0.639	0.055	0.066	0.003
1965	0.645	0.054	0.034	0.003
1966	0.766	0.040	0.052	0.003
1967	0.721	0.046	0.045	0.002
1968	0.753	0.055	0.031	0.002
1969	0.692	0.045	0.039	0.003
1970	0.643	0.048	0.055	0.003
1971	0.635	0.053	0.061	0.004
Means[c]	**0.658[d]**	**0.019**	**0.055**	**0.002**
1975	0.589	0.103	0.050	0.006
1976	0.723	0.145	0.056	0.008
Means[e]	**0.656[f]**	**0.066**	**0.053**	**0.005**

[a]Based on 577 bandings and 131 recoveries. Model 1 goodness-of-fit $\chi^2 = 11.8$, 4 *df*, $P = 0.02$.
[b]$M\hat{L}S = 1.4$, $\widehat{SE}(M\hat{L}S) = 0.4$.
[c]Based on 39,023 bandings and 5,768 recoveries. Model 1 goodness-of-fit $\chi^2 = 111.9$, 97 *df*, $P = 0.14$.
[d]$M\hat{L}S = 2.4$, $\widehat{SE}(M\hat{L}S) = 0.2$.
[e]Based on 3,952 bandings and 281 recoveries. Model 1 goodness-of-fit $\chi^2 = 8.4$, 1 *df*, $P = 0.00$.
[b]$M\hat{L}S = 2.4$, $\widehat{SE}(M\hat{L}S) = 0.6$.

Table B-71. *Estimates of survival and recovery rates for female mallards banded during winter in SE Missouri–S Illinois–SW Indiana–W Kentucky (313).*

Year (i)	$\hat{S}_i$	$\widehat{SE}(\hat{S}_i)$	$\hat{f}_i$	$\widehat{SE}(\hat{f}_i)$
1922	0.320	0.184	0.122	0.051
1923	0.538	0.142	0.096	0.022
Means[a]	**0.429[b]**	**0.109**	**0.109**	**0.028**
1963	0.497	0.060	0.031	0.004
1964	0.485	0.103	0.050	0.005
1965	0.697	0.148	0.029	0.006
1966	0.447	0.053	0.038	0.004
1967	0.533	0.075	0.036	0.003
1968	0.759	0.121	0.027	0.004
1969	0.536	0.077	0.026	0.003
1970	0.511	0.085	0.038	0.004
1971	0.586	0.105	0.036	0.005
Means[c]	**0.561[d]**	**0.015**	**0.035**	**0.001**
1975	0.940	0.284	0.041	0.007
1976	0.257	0.118	0.032	0.008
Means[e]	**0.598[f]**	**0.130**	**0.036**	**0.005**

[a]Based on 319 bandings and 71 recoveries. Model 1 goodness-of-fit $\chi^2 = 9.4$, 3 *df*, $P = 0.02$.
[b]$M\hat{L}S = 1.2$, $\widehat{SE}(M\hat{L}S) = 0.4$.
[c]Based on 15,729 bandings and 1,184 recoveries. Model 1 goodness-of-fit $\chi^2 = 46.3$, 38 *df*, $P = 0.17$.
[d]$M\hat{L}S = 1.7$, $\widehat{SE}(M\hat{L}S) = 0.1$.
[e]Based on 2,435 bandings and 103 recoveries. Model 1 goodness-of-fit $\chi^2 = 0.1$, 1 *df*, $P = 0.76$.
[f]$M\hat{L}S = 2.0$, $\widehat{SE}(M\hat{L}S) = 0.8$.

Table B-72. *Estimates of survival and recovery rates for male mallards banded during winter in SE Indiana–S Ohio–E Kentucky (314).*

Year (i)	$\hat{S}_i$	$\widehat{SE}(\hat{S}_i)$	$\hat{f}_i$	$\widehat{SE}(\hat{f}_i)$
1967	0.952	0.213	0.059	0.009
1968	0.453	0.100	0.029	0.008
1969	0.655	0.116	0.058	0.008
1970	0.617	0.110	0.078	0.014
1971	0.678	0.187	0.071	0.009
1972	0.640	0.215	0.082	0.023
1973	0.636	0.151	0.065	0.015
Means[a]	**0.662[b]**	**0.026**	**0.063**	**0.005**

[a]Based on 3,016 bandings and 536 recoveries. Model 1 goodness-of-fit $\chi^2 = 47.7$, 31 *df*, $P = 0.03$.
[b]$M\hat{L}S = 2.4$, $\widehat{SE}(M\hat{L}S) = 0.2$.

Table B-73. *Estimates of survival and recovery rates for female mallards banded during winter in SE Indiana–S Ohio–E Kentucky (314).*

Year (i)	$\hat{S}_i$	$\hat{SE}(\hat{S}_i)$	$\hat{f}_i$	$\hat{SE}(\hat{f}_i)$
1967	0.408	0.130	0.062	0.011
1968	0.797	0.246	0.035	0.013
1969	0.408	0.110	0.047	0.009
1970	0.994	0.286	0.061	0.015
1971	0.327	0.194	0.041	0.009
1972	0.606	0.421	0.036	0.021
1973	0.578	0.269	0.028	0.013
Means[a]	**0.588**[b]	**0.050**	**0.044**	**0.005**

[a]Based on 2,001 bandings and 195 recoveries. Model 1 goodness-of-fit $\chi^2 = 23.7$, 14 *df*, $P = 0.05$.
[b]$M\hat{L}S = 1.9$, $\hat{SE}(M\hat{L}S) = 0.3$.

Table B-74. *Estimates of survival and recovery rates for male mallards banded during winter in North-Atlantic States (321).*

Year (i)	$\hat{S}_i$	$\hat{SE}(\hat{S}_i)$	$\hat{f}_i$	$\hat{SE}(\hat{f}_i)$
1962	0.696	0.323	0.053	0.030
1963	0.628	0.202	0.046	0.013
1964	0.306	0.109	0.063	0.017
1965	0.693	0.201	0.077	0.021
1966	0.752	0.160	0.040	0.009
1967	0.426	0.090	0.037	0.008
1968	0.827	0.189	0.071	0.013
1969	0.525	0.153	0.055	0.011
1970	1.233	0.394	0.058	0.015
1971	0.529	0.145	0.014	0.004
1972	0.709	0.217	0.028	0.006
1973	0.600	0.168	0.017	0.005
1974	0.659	0.154	0.036	0.006
1975	0.616	0.178	0.029	0.006
1976	0.247	0.154	0.027	0.006
Means[a]	**0.630**[b]	**0.033**	**0.043**	**0.003**

[a]Based on 4,939 bandings and 439 recoveries. Model 1 goodness-of-fit $\chi^2 = 37.7$, 44 *df*, $P = 0.74$.
[b]$M\hat{L}S = 2.2$, $\hat{SE}(M\hat{L}S) = 0.3$.

Table B-75. *Estimates of survival and recovery rates for female mallards banded during winter in North-Atlantic States (321).*

Year (i)	$\hat{S}_i$	$\hat{SE}(\hat{S}_i)$	$\hat{f}_i$	$\hat{SE}(\hat{f}_i)$
1963	0.492	0.212	0.042	0.017
1964	0.339	0.179	0.071	0.022
1965	0.734	0.324	0.031	0.016
1966	0.458	0.153	0.039	0.012
1967	0.612	0.237	0.037	0.009
1968	0.447	0.183	0.036	0.013
1969	0.413	0.158	0.045	0.012
1970	0.923	0.362	0.049	0.017
1971	0.763	0.334	0.029	0.008
1972	0.758	0.441	0.013	0.005
1973	0.370	0.187	0.007	0.004
1974	0.509	0.165	0.017	0.005
1975	0.784	0.355	0.028	0.007
Means[a]	**0.585**[b]	**0.043**	**0.034**	**0.003**

[a]Based on 3,582 bandings and 211 recoveries. Model 1 goodness-of-fit $\chi^2 = 32.4$, 21 *df*, $P = 0.05$.
[b]$M\hat{L}S = 1.9$, $\hat{SE}(M\hat{L}S) = 0.3$.

Table B-76. *Estimates of survival and recovery rates for male mallards banded during winter in Mid-Atlantic States (332).*

Year (i)	$\hat{S}_i$	$\hat{SE}(\hat{S}_i)$	$\hat{f}_i$	$\hat{SE}(\hat{f}_i)$
1954	0.698	0.230	0.023	0.013
1955	0.447	0.110	0.052	0.015
1956	0.574	0.070	0.086	0.009
Means[a]	**0.573**[b]	**0.069**	**0.054**	**0.007**
1958	0.649	0.095	0.059	0.008
1959	0.783	0.107	0.051	0.007
1960	0.568	0.062	0.048	0.005
1961	0.619	0.050	0.045	0.004
1962	0.673	0.053	0.044	0.003
1963	0.698	0.068	0.044	0.003
1964	0.609	0.061	0.046	0.004
1965	0.627	0.066	0.042	0.004
1966	0.858	0.097	0.060	0.006
1967	0.597	0.059	0.038	0.004
1968	0.652	0.065	0.047	0.004
1969	0.573	0.062	0.058	0.005
1970	0.732	0.091	0.063	0.006
1971	0.591	0.083	0.050	0.006
1972	0.680	0.124	0.053	0.006
1973	0.629	0.125	0.040	0.007
1974	0.514	0.095	0.049	0.007
1975	0.631	0.139	0.070	0.010
1976	0.937	0.323	0.049	0.008
Means[c]	**0.664**[d]	**0.017**	**0.050**	**0.001**

[a]Based on 1,860 bandings and 343 recoveries. Model 1 goodness-of-fit $\chi^2 = 18.9$, 11 *df*, $P = 0.06$.
[b]$\hat{MLS} = 1.8$, $\hat{SE}(\hat{MLS}) = 0.4$.
[c]Based on 21,785 bandings and 2,897 recoveries. Model 1 goodness-of-fit $\chi^2 = 135.0$, 117 *df*, $P = 0.13$.
[d]$\hat{MLS} = 2.4$, $\hat{SE}(\hat{MLS}) = 0.2$.

Table B-77. *Estimates of survival and recovery rates for female mallards banded during winter in Mid-Atlantic States (332).*

Year (i)	$\hat{S}_i$	$\hat{SE}(\hat{S}_i)$	$\hat{f}_i$	$\hat{SE}(\hat{f}_i)$
1954	0.461	0.184	0.059	0.022
1955	0.675	0.181	0.050	0.016
1956	0.554	0.102	0.073	0.009
Means[a]	**0.563**[b]	**0.070**	**0.061**	**0.010**
1958	0.565	0.126	0.056	0.009
1959	0.568	0.120	0.044	0.008
1960	0.547	0.091	0.041	0.006
1961	0.544	0.073	0.031	0.004
1962	0.598	0.085	0.039	0.004
1963	0.488	0.079	0.030	0.004
1964	0.733	0.116	0.038	0.005
1965	0.376	0.062	0.032	0.004
1966	0.596	0.102	0.056	0.008
1967	0.615	0.091	0.033	0.005
1968	0.558	0.084	0.038	0.005
1969	0.517	0.088	0.044	0.005
1970	0.565	0.100	0.035	0.005
1971	0.680	0.139	0.043	0.006
1972	0.629	0.174	0.032	0.006
1973	0.459	0.134	0.026	0.006
1974	0.428	0.117	0.037	0.007
1975	0.624	0.185	0.034	0.007
1976	0.402	0.154	0.037	0.008
Means[c]	**0.552**[d]	**0.014**	**0.038**	**0.001**

[a]Based on 1,597 bandings and 196 recoveries. Model 1 goodness-of-fit $\chi^2 = 1.7$, 7 *df*, $P = 0.97$.
[b]$\hat{MLS} = 1.7$, $\hat{SE}(\hat{MLS}) = 0.4$.
[c]Based on 16,355 bandings and 1,350 recoveries. Model 1 goodness-of-fit $\chi^2 = 103.8$, 74 *df*, $P = 0.01$.
[d]$\hat{MLS} = 1.7$, $\hat{SE}(\hat{MLS}) = 0.1$.

Table B-78. *Estimates of survival and recovery rates for male mallards banded during winter in North Carolina (333).*

Year (i)	$\hat{S}_i$	$\hat{SE}(\hat{S}_i)$	$\hat{f}_i$	$\hat{SE}(\hat{f}_i)$
1955	0.339	0.121	0.067	0.026
1956	0.904	0.264	0.079	0.030
1957	0.468	0.179	0.090	0.025
Means[a]	**0.570**[b]	**0.084**	**0.079**	**0.016**
1961	0.915	0.493	0.065	0.024
1962	0.490	0.280	0.038	0.022
1963	0.678	0.255	0.046	0.018
1964	0.509	0.173	0.061	0.017
1965	1.044	0.445	0.030	0.010
1966	0.472	0.190	0.022	0.010
1967	0.452	0.090	0.033	0.007
1968	0.614	0.109	0.050	0.010
1969	0.995	0.296	0.064	0.009
1970	0.436	0.136	0.037	0.011
1971	0.715	0.174	0.064	0.011
1972	0.562	0.195	0.052	0.011
Means[c]	**0.657**[d]	**0.042**	**0.047**	**0.004**
1975	1.020	0.498	0.016	0.011
1976	0.204	0.115	0.034	0.011
Means[e]	**0.612**[f]	**0.239**	**0.025**	**0.008**

[a] Based on 252 bandings and 62 recoveries. Model 1 goodness-of-fit $\chi^2 = 5.0$, 6 *df*, $P = 0.54$.
[b] $\hat{MLS} = 1.8$, $\hat{SE}(\hat{MLS}) = 0.5$.
[c] Based on 2,799 bandings and 370 recoveries. Model 1 goodness-of-fit $\chi^2 = 51.3$, 39 *df*, $P = 0.09$.
[d] $\hat{MLS} = 2.4$, $\hat{SE}(\hat{MLS}) = 0.4$.
[e] Based on 897 bandings and 43 recoveries.
[f] $\hat{MLS} = 2.0$, $\hat{SE}(\hat{MLS}) = 1.6$.

Table B-79. *Estimates of survival and recovery rates for female mallards banded during winter in North Carolina (333).*

Year (i)	$\hat{S}_i$	$\hat{SE}(\hat{S}_i)$	$\hat{f}_i$	$\hat{SE}(\hat{f}_i)$
1955	0.534	0.288	0.082	0.035
1956	0.467	0.235	0.068	0.034
Means[a]	**0.501**[b]	**0.131**	**0.075**	**0.025**
1961	0.565	0.503	0.029	0.020
1962	0.253	0.212	0.021	0.019
1963	0.837	0.496	0.066	0.026
1964	0.397	0.200	0.017	0.009
1965	0.520	0.297	0.043	0.015
1966	0.248	0.146	0.037	0.017
1967	0.438	0.119	0.031	0.008
1968	1.030	0.255	0.026	0.008
Means[c]	**0.536**[d]	**0.078**	**0.034**	**0.006**
1975	0.532	0.299	0.022	0.012
1976	0.489	0.247	0.033	0.011
Means[e]	**0.511**[f]	**0.168**	**0.027**	**0.008**

[a] Based on 176 bandings and 32 recoveries. Model 1 goodness-of-fit $\chi^2 = 3.9$, 1 *df*, $P = 0.05$.
[b] $\hat{MLS} = 1.4$, $\hat{SE}(\hat{MLS}) = 0.5$.
[c] Based on 1,729 bandings and 139 recoveries. Model 1 goodness-of-fit $\chi^2 = 12.5$, 5 *df*, $P = 0.03$.
[d] $\hat{MLS} = 1.6$, $\hat{SE}(\hat{MLS}) = 0.4$.
[e] Based on 781 bandings and 33 recoveries.
[b] $\hat{MLS} = 1.5$, $\hat{SE}(\hat{MLS}) = 0.7$.

Table B-80. *Estimates of survival and recovery rates for male mallards banded during winter in Georgia–South Carolina (341).*

Year (i)	$\hat{S}_i$	$\hat{SE}(\hat{S}_i)$	$\hat{f}_i$	$\hat{SE}(\hat{f}_i)$
1955	0.350	0.197	0.081	0.045
1956	0.880	0.191	0.067	0.014
1957	0.590	0.340	0.081	0.017
1958	0.670	0.455	0.063	0.035
Means[a]	**0.622**[b]	**0.090**	**0.073**	**0.015**
1961	0.397	0.118	0.079	0.014
1962	0.864	0.225	0.038	0.014
1963	0.643	0.077	0.052	0.007
1964	0.532	0.091	0.053	0.006
1965	0.874	0.141	0.058	0.011
1966	0.678	0.059	0.068	0.004
1967	0.640	0.069	0.054	0.005
1968	0.657	0.069	0.044	0.004
1969	0.706	0.069	0.047	0.005
1970	0.567	0.062	0.065	0.005
1971	0.673	0.074	0.056	0.006
1972	0.826	0.091	0.064	0.006
1973	0.620	0.077	0.061	0.006
1974	0.649	0.132	0.047	0.005
1975	0.729	0.181	0.055	0.010
1976	0.590	0.165	0.045	0.008
Means[c]	**0.665**[d]	**0.015**	**0.055**	**0.002**

[a]Based on 604 bandings and 117 recoveries. Model 1 goodness-of-fit $\chi^2 = 8.8$, 3 *df*, $P = 0.03$.
[b]$\hat{MLS} = 2.1$, $\hat{SE}(\hat{MLS}) = 0.6$.
[c]Based on 14,486 bandings and 2,243 recoveries. Model 1 goodness-of-fit $\chi^2 = 131.9$, 87 *df*, $P = 0.00$.
[d]$\hat{MLS} = 2.5$, $\hat{SE}(\hat{MLS}) = 0.1$.

Table B-81. *Estimates of survival and recovery rates for female mallards banded during winter in Georgia–South Carolina (341).*

Year (i)	$\hat{S}_i$	$\hat{SE}(\hat{S}_i)$	$\hat{f}_i$	$\hat{SE}(\hat{f}_i)$
1963	0.558	0.120	0.054	0.009
1964	0.419	0.098	0.032	0.005
1965	0.641	0.139	0.047	0.011
1966	0.652	0.083	0.050	0.004
1967	0.629	0.099	0.037	0.004
1968	0.478	0.076	0.027	0.004
1969	0.622	0.088	0.034	0.005
1970	0.614	0.102	0.047	0.005
1971	0.471	0.084	0.035	0.005
1972	0.502	0.082	0.041	0.005
1973	0.524	0.091	0.045	0.006
1974	0.422	0.099	0.029	0.004
1975	0.779	0.262	0.057	0.012
1976	0.238	0.105	0.032	0.008
Means[a]	**0.539**[b]	**0.019**	**0.041**	**0.002**

[a]Based on 13,581 bandings and 1,155 recoveries. Model 1 goodness-of-fit $\chi^2 = 52.4$, 46 *df*, $P = 0.24$.
[b]$\hat{MLS} = 1.6$, $\hat{SE}(\hat{MLS}) = 0.1$.

Appendix C

Persons and Agencies That Have Banded More Than 1,000 Normal, Wild Mallards During the Winter Banding Period, 1922–1982

Table C-1. *Individuals and agencies that have banded more than 1,000 normal, wild mallards during the winter banding period, 1922–1982.*

Permittee	Current address	Number banded
Illinois Dep. Conserv.	Springfield, IL	67,583
Colorado Div. Wildl.	Fort Collins, CO	55,874
Nebraska Game & Parks Comm.	Lincoln, NE	52,742
Oregon Dep. Fish & Wildl.	Portland, OR	37,531
Kansas Fish & Game Comm.	Pratt, KS	35,047
White River NWR	Dewitt, AR	32,315
Idaho Fish & Game Dep.	Boise, ID	28,045
Santee NWR	Summerton, SC	25,988
Columbia NWR	Othello, WA	22,094
Iowa Conserv. Comm.	Clear Lake, IA	22,063
California Dep. Fish & Game	Sacramento, CA	21,508
Wyoming Game & Fish Dep.	Lander, WY	20,948
Blackwater NWR	Cambridge, MD	20,655
Lake Andes NWR	Lake Andes, SD	19,960
Montana Fish & Game Dep.	Fairfield, MT	19,948
South Dakota Dep. Game, Fish & Parks	Aberdeen, SD	18,051
Oklahoma Dep. Wildl. Conserv.	Porter, OK	17,097
Cross Creeks NWR	Dover, TN	16,944
Michigan Dep. Nat. Resour.	Lansing, MI	16,790
Tennessee Wildl. Resour. Agency	Nashville, TN	16,020
Washington Dep. Game	Ephrata, WA	14,618
McNary NWR	Burbank, WA	14,090
C. M. Russell NWR	Lewistown, MT	12,063
C. G. Vendel	Great Bend, KS	11,744
Camas NWR	Hamer, ID	11,417
Holla Bend NWR	Russellville, AR	10,888
Lacassine NWR	Lake Arthur, LA	10,164
Arkansas Game & Fish Dep.	Little Rock, AR	9,713

Table C-1. *Continued.*

Permittee	Current address	Number banded
Louisiana Dep. Wildl. & Fisheries	Baton Rouge, LA	9,692
New Mexico Dep. Game	Placitas, NM	9,213
Pennsylvania Game Comm.	Harrisburg, PA	9,045
Indiana Dep. Nat. Resour.	Medaryville, IN	8,972
Tennessee NWR	Paris, TN	8,909
Washita NWR	Butler, OK	8,869
Ohio Div. Wildl.	Columbus, OH	8,652
Squaw Creek NWR	Mound City, MO	8,220
Texas Waterfowl Survey (Texas Parks & Wildl. Dep.)	Austin, TX	7,802
Missouri Dep. Conserv.	Columbia, MO	7,688
Sacramento NWR	Willows, CA	7,651
Wheeler NWR	Decatur, AL	7,521
Bitter Lake NWR	Roswell, NM	7,059
Mingo NWR	Puxico, MO	6,786
Bombay/Prime Hook NWRS	Smyrna, DE	6,497
Mississippi Game & Fish Comm.	Jackson, MS	6,310
Deer Flat NWR	Nampa, ID	6,239
North Carolina Wildl. Resour. Comm.	Aurora, NC	5,937
Alamosa/Monte Vista NWR Complex	Alamosa, CO	5,567
Texas Parks & Wildl. Dep.	Austin, TX	5,476
La Creek NWR	Martin, SD	5,351
Massachusetts Div. Fish & Game	Westboro, MA	5,286
Kentucky Dep. Fish & Wildl. Resour.	Murray, KY	4,928
New York Dep. Environ. Conserv.	Delmar, NY	4,878
H. S. Davis		4,865
Savannah NWR	Savannah, GA	4,852
Salt Plains NWR	Jet, OK	4,703
Noxubee NWR	Brooksville, MS	4,596
Utah Div. Wildl. Resour.	Salt Lake City, UT	4,578
Minnesota Div. Fish & Wildl.	Bemidji, MN	4,545
Buffalo Lake NWR	Umbarger, TX	4,525
M. J. Turner	Little Rock, AR	4,514
Lee Metcalf NWR	Stevensville, MT	4,423
Maryland Wildl. Adm.-Game	Wye Mills, MD	4,304
J. A. Neff		4,281
Bosque Del Apache NWR	Socorro, NM	4,229
Eufaula NWR	Eufaula, AL	4,185
Hatchie NWR	Brownsville, TN	4,151
Flint Hills NWR	Hartford, KS	4,030
Yazoo NWR	Hollandale, MS	3,777
R. M. Imler		3,616
Malheur NWR	Burns, OR	3,584
Umatilla NWR	Umatilla, OR	3,517
Tishomingo NWR	Tishomingo, OK	3,407

Table C-1. *Continued.*

Permittee	Current address	Number banded
Big Lake NWR	Manila, AR	3,179
Quivira NWR	Stafford, KS	3,157
Nevada Dep. Wildl.	Reno, NV	3,092
Presquile NWR	Hopewell, VA	2,741
P. F. Osborn		2,701
Sand Lake NWR	Columbia, SD	2,649
Benton Lake NWR	Black Eagle, MT	2,647
E. A. McIlhenny		2,641
North Dakota Game & Fish Dep.	Bismarck, ND	2,527
F. W. Robl	Great Bend, KS	2,524
Virginia Comm. Game & Inland Fish. (Staunton Fld. Off.)	Staunton, VA	2,524
New Jersey Dep. Environ. Prot.	Trenton, NJ	2,131
Wapanocca NWR	Turrell, AR	2,111
Mattamuskeet NWR	Swanquarter, NC	2,061
National Bison Range NWR	Moiese, MT	2,021
South Carolina Wildl. & Marine Resour.	McClellanville, SC	1,988
H. E. Greenwald		1,859
Colorado Coop. Wildl. Re. Unit	Fort Collins, CO	1,686
Eastern Neck NWR	Rock Hall, MD	1,661
Choctaw NWR	Jackson, AL	1,570
L. G. Sugden	Saskatoon, SK	1,480
Reelfoot NWR	Samburg, TN	1,470
Ridgefield NWR	Ridgefield, WA	1,439
W. L. Finley NWR	Corvallis, OR	1,425
L. Walton		1,381
D. H. Welsh		1,257
Toppenish & Conboy Lake NWRS	Burbank, WA	1,221
Catahoula NWR	Jena, LA	1,111
Kirwin NWR	Kirwin, KS	1,080
A. J. Butler		1,056
Chincoteague NWR	Chincoteague, VA	1,013

Nichols, James D., and James E. Hines. 1987. **Population ecology of the mallard. VIII. Winter distribution patterns and survival rates of winter-banded mallards.** U.S. Fish Wildl. Serv., Resour. Publ. 162. 154 pp.

This report contains descriptions of wintering ground reference areas and provides descriptive data on mallard band recovery distribution patterns. Sources of variation in winter distribution patterns of mallards and in survival rates estimated from winter bandings are investigated. Mallard survival rate estimates based on preseason and winter bandings are compared.

Key words: Mallards (*Anas platyrhynchos*), population ecology, winter distribution patterns, survival rates, band recovery data, band recovery models, migratory birds.

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☆ U.S. Government Printing Office: 1987—773-205/60004

A list of current *Resource Publications* follows.

153. Handbook of Toxicity of Pesticides to Wildlife, by Rick H. Hudson, Richard K. Tucker, and M. A. Haegele. 1984. 97 pp.
154. Nonconsumptive Use of Wildlife in the United States, by William W. Shaw and William R. Mangun. 1984. 20 pp.
155. Ecology and Management of the Bullfrog, by R. Bruce Bury and Jill A. Whelan. 1984. 23 pp.
156. Statistical Inference from Band Recovery Data—A Handbook, by Cavell Brownie, David R. Anderson, Kenneth P. Burnham, and Douglas S. Robson. 1985. 305 pp.
157. The Breeding Bird Survey: Its First Fifteen Years, 1965–1979, by Chandler S. Robbins, Danny Bystrak, and Paul H. Geissler. 1986. 196 pp.
158. Techniques for Studying Nest Success of Ducks in Upland Habitats in the Prairie Pothole Region, by Albert T. Klett, Harold F. Duebbert, Craig A. Faanes, and Kenneth F. Higgins. 1986. 24 pp.
159. Research and Development Series: An Annotated Bibliography, 1889–1985, by Thomas J. Cortese and Barbara J. Grosheck. 1987. In press.
160. Manual of Acute Toxicity: Interpretation and Data Base for 410 Chemicals and 66 Species of Freshwater Animals, by Foster L. Mayer and Mark R. Ellersieck, 1986. 579 pp.
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