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THE WATERFOWL FLYWAYS OF NORTH AMERICA

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CONTENTS

	Page		Page
Conservation significance of waterfowl flyways.....	1	The four important flyways—Continued.....	
Migration studied by the banding method.....	1	The Central flyway.....	8
Migration routes and flyways defined.....	2	The Pacific flyway.....	8
The four important flyways.....	3	Diversity of routes complicates administration.....	9
The Atlantic flyway.....	3	Waterfowl populations of the flyways.....	10
The Mississippi flyway.....	5	Summary and conclusions.....	11

CONSERVATION SIGNIFICANCE OF WATERFOWL FLYWAYS

There is today indisputable evidence that the waterfowl of North America have alarmingly decreased in numbers. There is also a growing conviction that special precautions must be taken to prevent the extermination of these valuable migratory species. Fortunately science has come to the aid of game-management agencies and points to facts developed by research on the migratory habits and migration routes of the various species through this country, East and West. Conservationists now know that the birds have a strong attachment for their ancestral flyways and they recognize the significance of this fact and its important bearing on the solution of their problems. It indicates that if the birds should be exterminated in any one of the four major flyways now definitely recognized, it would at best be a long time before that region could be repopulated, even though birds of the species affected should continue over other flyways to return to their great breeding grounds of the North. In the light of what has been learned about this attachment of birds for their ancestral flyways it is important that sportsmen throughout the country become acquainted with facts concerning each flyway if they are to aid their State and Federal conservation officials in preventing the extermination of the species that use any one of the four major waterfowl migration flyways.

MIGRATION STUDIED BY THE BANDING METHOD

From the time of its inception, the Bureau of Biological Survey has had as one of its major projects the study of bird migration. The father of these studies in North America, Wells W. Cooke, a biologist of the Bureau, had gathered together a great mass of information from contemporary bird students and from existing literature, and by examination of all available migration data was able

to work out the routes of travel of most species of North American migratory birds. The routes he delineated were necessarily of a more or less general nature, but in some cases he presented the data in remarkable detail.

At about the time of Professor Cooke's death, in 1916, which was the year the Migratory Bird Treaty with Great Britain was negotiated, the study of bird migration by banding was first undertaken by the Bureau. In that year, working in the Bear River Marshes of Great Salt Lake, Utah, Alexander Wetmore attached Biological Survey bands to several hundred ducks, herons, and other marsh and shore birds. Systematic bird banding in North America had been begun in 1909, when the American Bird Banding Association was formed, although 2 or 3 previous projects had been undertaken. The work of this association was taken over by the Biological Survey in 1920 and has continuously developed since that time. Tens of thousands of banded birds have been recovered, each record adding to our knowledge of the travels of migratory birds, and the aggregate permitting a much clearer exposition of the flight lines of the different species.

All kinds of native birds are banded, but because of their great importance as game, the migratory waterfowl have been given special attention. Many thousands of ducks and geese that were banded at points scattered over nearly the entire continent have been recovered, and the resulting data have aided materially in the elucidation of many complex problems of migration. Although the grouping of waterfowl-migration routes was suggested by some of the writings of Cooke, it remained for the banding work more clearly to portray this phase of migration, which forms the subject of this publication.

MIGRATION ROUTES AND FLYWAYS DEFINED

The terms "migration route" and "flyway" have in the past been used more or less indiscriminately, but for the purpose of this circular and in order that the full picture of migration may be better portrayed, it seems desirable to designate as migration routes the individual lanes of avian travel from breeding grounds to winter quarters, and as flyways those broader areas into which certain migration routes blend or come together in a definite geographic region. The individual migration routes may be likened to long trails, while the flyways resemble shorter arterial boulevards to which the routes are tributary. Except along the coasts, the boundaries of these flyways cannot always be sharply defined, particularly in the northern part of the interior, for the reason that—broadly speaking—all the country from Nebraska north to the Arctic coast is one great breeding ground that is used by many species of migratory waterfowl. From about latitude 45° southward to the Gulf coast, however, these flyways are fairly well marked, and it is within this region that most of the sport shooting takes place. The status of the ducks and geese in the different flyways, therefore, is of great interest not only to naturalists but also to sportsmen.

It is now a matter of common knowledge that migratory birds follow certain definite routes on their journeys to and from breeding

and winter quarters, but it is not generally understood that these routes are followed by the same groups of individual birds during successive years. Migration studies by the banding method have shown that by adhering more or less rigidly to any particular flyway the ducks and geese tend to perpetuate not only that ancestral route but also the groups of individuals that use it. The significance of this discovery to problems of administration is obvious.

THE FOUR IMPORTANT FLYWAYS

The four major waterfowl flyways of North America and their tributary migration routes are sketched in the following paragraphs. There is also briefly presented the status of their waterfowl populations.

THE ATLANTIC FLYWAY

The Atlantic flyway (fig. 1) may be described as extending from the Atlantic coast west to the Allegheny Mountains and curving northwestward across northern West Virginia and northeastern Ohio to the western end of Lake Erie. It has at least three primary migration routes and as many more that are also important as tributaries.

The extreme eastern route, which leads directly down the coast, has as its northern origin the eastern Arctic islands and the coast of Greenland. From these places come the greater snow geese (*Chen hyperborea*) and the Atlantic brant (*Branta bernicla hrota*), which follow the coast line to winter quarters in the great bays and sounds of Virginia and North Carolina. This also is the route used by large numbers of black ducks (*Anas rubripes*) and Canada geese (*B. canadensis*). These two species, however, occupy a curious part in the picture of this flyway. The Canada geese and the black ducks, so important to the sportsmen of New England, come chiefly from the New England area, the Maritime Provinces of Canada, the Labrador Peninsula, and Newfoundland. Few, if any, come from interior points that are far from the seacoast, and they *do not ordinarily travel very far south of Long Island Sound*. A few of the northeastern black ducks do drift south as far as the Carolinas, but the Canada geese rarely go south of New England.

Most of the black ducks of the south- and middle-Atlantic coast, and practically all the Canada geese, come from interior points. The ducks, which seem to come chiefly from western Quebec and Ontario, leave their breeding grounds in this region and at first travel southwestward through the peninsula of southern Ontario. This also is the course taken by the Canada geese from the breeding grounds around the eastern shores of Hudson Bay. Upon reaching the western end of Lake Erie, where it is augmented by birds bred in Michigan, the route divides, the majority of the birds turning abruptly to the east, some tarrying a while in the area along the south shore of the lake, but nearly all eventually making a cross-country flight over Pennsylvania and northern West Virginia to the Atlantic coast, which is reached in the vicinity of Chesapeake and Delaware Bays.

This route from the northwest is of great importance. In addition to being followed by the black ducks and Canada geese, it also is

the general course taken by the diving ducks and others that come from the great interior breeding grounds. No diving ducks breed in the eastern part of the continent, so practically every canvasback (*Nyroca valisineria*), redhead (*N. americana*), and scaup (*N. marila* and *N. affinis*) that is seen in winter in Chesapeake Bay, Back Bay, and other middle-Atlantic coastal waters, has pursued this route. Some moderate-sized flocks do travel eastward along Lake Erie to the Finger Lakes region of western New York, and occasionally these birds are noted in New England waters, but the main body reaches the coast south of New Jersey. With them are some pintails (*Dafila acuta tzitzihoo*), gadwalls (*Chaulelasmus streperus*), teals (*Nettion* and *Querquedula*), and other shoal-water species that also have bred in the interior.

A most interesting tributary of this northwestern route has its starting point in the Bear River Marshes of Great Salt Lake, Utah, and is apparently used exclusively by redheads. As conclusively shown by banding records, many redheads banded as ducklings in these marshes start their fall journey by first flying north across southeastern Idaho and northwestern Wyoming, turn eastward across Montana, the Dakotas, Minnesota, Wisconsin, and Michigan, and, joining others of their species en route out of the Prairie Provinces of Canada, continue to the Finger Lakes region of western New York, or to the coasts of Maryland and Virginia. This is probably one of the most remarkable migration routes of all North American waterfowl, and it is interesting to observe that in crossing from west to east through the Dakotas, Minnesota, and Wisconsin, many of these birds are actually flying at right angles to others of their own kind that are following routes from the north to the Mississippi or the Central flyways.

The greater scaup, or big bluebill (*Nyroca marila*), which in winter is sometimes present in large rafts in waters adjacent to Long Island, and the scoters, or "sea coots" (*Melanitta* and *Oidemia*) of the New England coast, also come chiefly from interior points. Their routes across Canadian territory, however, are not yet well understood, although, as stated by Cooke, in the case of the white-winged scoter (*M. deglandi*) it appears that the birds leave their summer home west of Hudson Bay and travel nearly due east to coastal Labrador. Thence, traveling across the Gulf of St. Lawrence and along the coast, they reach their winter home, which extends from northeastern Maine to Chesapeake Bay.

Another tributary route to the Atlantic flyway is really a branch from the Mississippi flyway that apparently leaves the parent stream in the general vicinity of St. Louis, Mo., and, striking across the mountains, reaches the coast of South Carolina. This route is followed by blue-winged teals (*Querquedula discors*), and probably by some gadwalls, shovelers (*Spatula clypeata*), and possibly by some ringnecks (*Nyroca collaris*). The last-named species, however, is a Mississippi-flyway bird and, while in winter it is often plentiful in southern Georgia and northern Florida, it is significant that of several hundred banded in Georgia, not one has been recovered from a point on the Atlantic coast, their route of migration being through the Mississippi Valley.

It will thus be seen that the Atlantic flyway is a complicated system of migration routes, which helps to explain why hunters of the Atlantic coastal region enjoy so much more favorable gunning conditions than do the sportsmen of the West. Because of these facts there is great danger in attempts to influence legislation or regulation in favor of the Atlantic-coast sportsmen, which would result in a greater slaughter and soon reduce the birds of this flyway to the deplorably low numbers now existing in the Central and Pacific flyways.

THE MISSISSIPPI FLYWAY

In some respects the Mississippi flyway (fig. 2) is relatively simple, although it has at least one complicating feature. Its eastern boundary runs through southern Ontario to western Lake Erie, thence across Ohio and Indiana to the Mississippi Valley, where it closely follows the river to its mouth. This line is clearly defined. The western boundary, however, does not permit such precise definition, for the reason that in eastern Nebraska and western Missouri and Arkansas, it merges imperceptibly into the Central flyway. Nevertheless, a boundary line may be drawn with reasonable accuracy from southern Saskatchewan, across northeastern Montana, thence southward along the Missouri River to western Missouri and across western Arkansas and northwestern Louisiana to southeastern Texas.

Easily the most important migration route of this flyway is the long lane of travel that starts on the Yukon Flats in Alaska, traverses the valley of the Mackenzie River, and the great lake and prairie region of central Canada, receiving many accretions on the way, and in turn contributing to other flyways. Running generally from northwest to southeast, it enters the United States on a broad front from Montana to Wisconsin but tends to constriction as it proceeds southward, so that in central Arkansas it results in heavy concentration. This might be termed the "mallard route" (*Anas platyrhynchos*), although it is used also by large numbers of pintails and Canada geese and by lesser numbers of several other shoal-water species. The ring-necked duck likewise concentrates on this route, as do some of the lesser scaups (*Nyroca affinis*) and a few other deep-water ducks. Coming in from their breeding grounds in western Ontario and Michigan and from Wisconsin and Minnesota, a considerable body of black ducks proceeds across Illinois by way of the Illinois River. Another contingent of this species, together with a good representation of Canada geese, comes in from the northeast. These latter birds, from breeding grounds in western Quebec and Ontario and from Michigan, leave their companions bound for the Atlantic coast in the general vicinity of western Lake Erie, and, proceeding across northwestern Ohio and through Indiana, reach the Mississippi Valley near the mouth of the Ohio River.

The features of particular significance in this flyway are the vast areas of breeding territory that are tributary to it and the greatly restricted winter quarters. These factors result in a heavy concentration during winter, and are conducive to erroneous conclusions relative to abundance and to excessive slaughter.

FIGURE 2.—The Mississippi flyway, with tributary migration routes.

FIGURE 1.—The Atlantic flyway, with tributary migration routes.

FIGURE 4.—The Pacific flyway, with tributary migration routes.

FIGURE 3.—The Central flyway, with tributary migration routes.

THE CENTRAL FLYWAY

As previously stated, the eastern boundary of the Central flyway (fig. 3) merges imperceptibly with the western boundary of the Mississippi flyway, but in general it is bounded in this direction by the Missouri River and by the western parts of Arkansas and Missouri. The western boundary appears to start on the north at Great Salt Lake, Utah, and runs southeastward across Utah and western New Mexico.

Along this flyway sweep flocks of ducks that in the north country share a common breeding ground with others of the same species that follow in migration all the other flyways. Lying across the northern terminus of the western boundary is the most important single breeding ground for waterfowl that now remains in the United States—the Bear River Marshes at the northern end of Great Salt Lake, Utah. This is still an important breeding area for pintails, redheads, cinnamon teal (*Querquedula cyanoptera*), and others. A large percentage of the birds raised here follow lanes of travel westward to the Pacific flyway, but it is noteworthy that there are at least three routes that leave this area in an easterly or northeasterly direction. One of these, tributary to the Atlantic flyway, has been described (p. 4). A second easterly route from these breeding grounds extends across southern Wyoming, turns southward across the Laramie plains and eastern Colorado, and by way of the Panhandle of Texas ends on the Gulf coast. The third route turns southward in northwestern Colorado, crosses the Uncompahgre Plateau, passes through the San Luis Valley, and extends southward into Mexico.

It is significant that while the Bear River Marshes are an important waterfowl concentration point, where large numbers of ducks are killed each season, it has furnished almost no recovery records of birds banded in Canada.

With the exception of the tributary routes from the Bear River Marshes, this also is a relatively simple flyway, as the majority of the ducks that use it make direct north and south journeys from breeding grounds in central Canada and other northern regions to their winter quarters, which are chiefly in Texas.

THE PACIFIC FLYWAY

The Pacific flyway (fig. 4) presents some interesting peculiarities. While the map shows a route that follows the coast of British Columbia, it should be pointed out that this is not an important lane of travel for many of our game ducks, but it is followed chiefly by the diminutive cackling goose (*Branta canadensis minima*), the black brant (*B. nigricans*), and some of the sea ducks. The cackling geese that breed in the region of the delta of the Yukon River in Alaska follow this route across the Alaska Peninsula and the Gulf of Alaska and along the coast of British Columbia, and turn into the interior near the mouth of the Columbia River. Proceeding eastward only a short distance they again turn south to their winter quarters at the Tule Lake Wildlife Refuge, on the Oregon-California line, and in the Sacramento Valley of California. A few continue southward as far as the northern part of the San Joaquin Valley.

Most of the other geese, including the greatly reduced Ross's goose (*Chen rossii*), and the ducks, however, that use the United States part of this route, come from eastern Alaska, the Mackenzie Valley, and other interior points. Again, the great breeding grounds of central and northwestern Canada and eastern Alaska produce most of the birds killed by California and Oregon sportsmen. Starting in Alaska, Yukon, and Mackenzie, this route—which also is used in common with many birds that are to follow other flyways—runs southward through the Prairie Provinces. The Pacific flyway contingent probably parallels closely the eastern foothills of the Rocky Mountains. The route branches somewhere near the international border, and while some birds continue southeastward into the Central and Mississippi flyways, others turn southwestward across northwestern Montana and the Panhandle of Idaho, follow along the Snake and Columbia River Valleys, and turn southward across central Oregon to the great interior valleys of California. This is the route followed by the pintails and the widgeons, or baldpates (*Mareca americana*), which are of such importance to California sportsmen.

The Bear River marshes of Utah probably furnish the majority of the redheads that are killed for sport in California. Banding records have indicated two routes that are roughly parallel. The northernmost leaves the breeding grounds in a northwesterly direction and, describing an arc across southwestern Idaho and southeastern Oregon, enters California near the California-Nevada line. The second route runs through central Nevada and reaches the California valleys near the confluence of the Sacramento and San Joaquin Rivers.

The breeding grounds of interior British Columbia have been little affected either by agricultural or drought conditions and continue to produce a fairly good supply of waterfowl, but banding records have shown that these birds have comparatively little importance to the sportsmen of the United States other than to those of northwestern Washington. The reason apparently is found in the relatively mild climate of the Puget Sound section, which is the wintering ground for most of the British Columbia ducks. Very few birds banded in that Province have been recovered from points south of Washington.

DIVERSITY OF ROUTES COMPLICATES ADMINISTRATION

It is of interest in this brief resume of the four major flyways and their tributary migration routes to visualize the separate route systems in relation to each other when considered for the country as a whole. (Figs. 1-4.) The result will indicate the complexity of the problem of equalizing the shooting privileges of gunners in the different parts of the country, among whom there is some sentiment that the hunting regulations should favor the sportsmen of one section even though discriminating against those of another. The administrative problems raised by such a complex system of flyways as is here mapped makes it necessary to take into consideration the status of the birds not only on the flyway of any one State but on the several other flyways, as regards decreasing abundance and other factors of far-reaching importance to the conservation of the species involved.

WATERFOWL POPULATIONS OF THE FLYWAYS.

As stated above, there appears to be a readily demonstrable natural law to the effect that, although groups of birds of the same species may share a common breeding ground, they are so strongly influenced by their ancestral lanes of migration that they will continue to follow them even though conditions en route or on the wintering grounds may become distinctly adverse to their welfare. As a working hypothesis, this was pointed out to ornithologists by the writer 6 or 7 years ago at a time when a severe outbreak of botulism was decimating the ducks of western areas. At that time it was predicted that, because of the great attachment of migratory birds for their ancestral flyways, it would be possible practically to exterminate the ducks of the West without seriously interfering with the supply of birds of the same species in the Atlantic and Mississippi flyways, and that the birds of these species using the eastern flyways would be slow to overflow and repopulate the devastated areas of the West, even though environmental conditions might be so altered as to be entirely favorable.

The banding work has furnished abundant proof that ducks adhere to their ancestral flyways. For example: At the waterfowl-banding station at Lake Merritt, in Oakland, Calif., several hundred ducks (chiefly pintails and baldpates, or widgeons) have been banded every year since 1926. More than 550 return records have been received, of which nearly 97 percent represent ducks that were taken within the territory of the Pacific flyway. During the season 1933-34, more than half the birds trapped at the station were already carrying bands attached there in previous years.

Of 243 return records of ducks banded in Saskatchewan, only 5 or 6 of these birds were killed at points outside the Central and Mississippi flyways. Only two went to California and none to any other Pacific coast State.

Data from other stations show similar conditions. The nearest approach to an exception is shown by records of ducks banded in Kansas. The distribution of returns from these ducks covers a greater scope of country than from any other group, as the birds have been recovered at points scattered from the Atlantic to the Pacific and from the sub-Arctic regions of Alaska and northwestern Canada south through Mexico to Honduras and Colombia. Nevertheless, the gross total of all ducks banded in Kansas and recovered at points outside the Central flyway is only about 15 percent of the total number of return records received.

In order to test the strength of the homing instinct and the attachment of ducks to ancestral flyways, several shipments of banded birds, chiefly pintails, were made from Avery Island, La., to prearranged points, where in spring they were liberated in favorable areas. During the season 1933-34 there were retrapped at Avery Island banded pintails that in previous seasons had been trapped there, shipped by express, and liberated at Washington, D. C.; Blackwater Migratory Bird Refuge, Cambridge, Md.; the O. L. Austin Ornithological Research Station, at North Eastham, Cape Cod, Mass.; Berkeley, Calif.; Lake Malheur Migratory Bird Refuge, Voltage, Oreg.; and the National Bison Range, Moiese, Mont. Here

were groups of birds indigenous to the Mississippi flyway, forcibly removed, and liberated in the Atlantic and the Pacific flyways where others of their own kind were relatively common, but which refused to follow these flyways, as indicated by the fact that a succeeding season finds them back in their original winter quarters.

Surely, no further proof is necessary to show that the waterfowl conditions in any one limited area cannot be applied as a criterion to the entire continent. Such being the case, it becomes of more than passing interest to examine the data collected by the Biological Survey from all sources during the spring and summer of 1934, and apply these data to the various flyways on which they were obtained. In table 1 the comparison is with the same season in 1933. Since that season was generally admitted to be far below normal, the reports of "no change" might, with justification, be added to the heading "decrease."

TABLE 1.—*Status of game waterfowl in the four major flyways in 1934, compared with 1933*

Flyway	Observers reporting—		
	Increase	No change	Decrease
Atlantic.....	86	117	120
Mississippi.....	74	123	114
Central.....	43	88	171
Pacific.....	41	65	122

The figures indicate that the birds of the Atlantic and Mississippi flyways were relatively more abundant in the 2 years than were those of the Central and Pacific flyways. The reason is not difficult to find. On the Atlantic coast the black duck and the Canada goose have held their own fairly well, chiefly because little if any of their breeding grounds have been adversely affected by agriculture, drainage, drought, or other factors¹; while the principal game ducks of the Mississippi flyway are the mallard and the pintail, both of which have extensive breeding ranges, large parts of which are north of the affected regions. Moreover, in both the Atlantic and the Mississippi flyways the shotgun has been almost the only destructive factor on the migration routes and in the winter quarters. Though drainage has been a disturbing factor on these two flyways, there has not been the devastation due to disease, drought, and drainage that has contributed to decimate the flocks of the Central and the Pacific flyways.

SUMMARY AND CONCLUSIONS

Four definitely recognizable flyways are followed by waterfowl on their spring and fall migrations in the United States. Covering practically the whole country and extending northward into Canada and southward into Mexico, these flyways are readily definable by

¹ Many reports on the black duck were received while this circular was in process of publication, showing that this species also suffered a serious reduction in number during the year, due in part to the severity of the winter of 1933-34 on the Atlantic coast. According to well-qualified observers, the fall flight of 1934 was not more than 25 percent as great as that of 1933.

the terms Atlantic, Mississippi, Central, and Pacific. The strong attachment that these birds have for their ancestral migration routes may mean an abundance in one flyway. It does not, however, mean an increase in other flyways in succeeding seasons. Heavy over-shooting throughout the country and drainage, agricultural activities, and drought in the western parts have reduced the numbers of migratory waterfowl over the entire continent, but the decrease has been much more rapid in the Central and Pacific coast areas. This fact is significant in the solution of problems in the conservation and management of the waterfowl resource. It makes it appear inevitable that, if the depletion of the birds of the Central and Pacific flyways and of certain species in the Mississippi and Atlantic flyways continues as it has in the last few years, a complete suspension of shooting privileges for a time may become imperative over all the flyways, in order to enable the remaining remnants of the waterfowl to increase. The results of the 1934-35 shooting season may be decisive.