CANADA GOOSE MANAGEMENT

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ANADA GOOSE MANAGEMENT

Current Continental Problems and Programs

A Symposium Edited By

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Twenty centuries of "progress" have brought the average citizen a vote, a national anthem, a Ford, a bank account, and a high opinion of himself, but not the capacity to live in high density without befouling and denuding his environment, nor a conviction that such capacity, rather than such density, is the true test of whether he is civilized. The practice of game management may be one of the means of developing a culture which will meet this test.

—ALDO LEOPOLD

Foreword

THIS BOOK has grown out of the proceedings of a symposium on Canada geese sponsored by the North Central Section of The Wildlife Society and held in conjunction with the 29th Midwest Fish and Wildlife Conference at Madison, Wisconsin, on December 13, 1967. The goose symposium was the second in a biennial series. The first, on wood duck management and research, was held at Lansing, Michigan, in December, 1965. Transactions of that session also were published.

The Wildlife Society is a national professional group dedicated to the sound management of all wildlife. Society membership encompasses every conceivable specialty regarding wildlife and the broad fields of ecology and resource management. The North Central Section is a regional group within the national Society, drawing its members from 11 states.

The Canada goose was chosen as the subject of a symposium because of widespread interest in the bird on the part of waterfowl managers, hunters, resource administrators, and the wildlife-enjoying public. The geographic range of the species is nearly continent-wide, and the various subspecies have been the subjects of extended study by a great many individuals and organizations. This high level of concern pointed to a need for a forum where current information on Canada geese from all parts of North America could be assembled.

The symposium agenda was determined by a special program committee of the North Central Section. Time limitations put a one-day ceiling on the symposium, so papers were presented by invitation only. An effort was made to find those people who could best contribute significant information on the present problems, new research, and future prospects of Canada geese on a continental basis.

Serving with us on the special committee that organized the Canada goose symposium were C. Dennis Besadny, Wisconsin Department of Natural Resources, Madison; Arthur S. Hawkins, U.S. Fish and Wildlife Service, Minneapolis, Minn.; Harvey K. Nelson, U.S. Fish and Wildlife Service, Jamestown, North Dakota; Glen C. Sanderson, Illinois Natural History Survey, Urbana; and Richard W. Vaught, Missouri Department of Conservation, Columbia.

Special recognition is due the men who led the symposium sessions the day they were held: Eugene F. Bossenmaier, Manitoba Wildlife Branch, Winnipeg; and Calvin J. Barstow, Tennessee Game and Fish Commission, Nashville.

While the editors of Canada Goose Management have incorporated the constituent symposium papers in their original form, they have attempted throughout to add sections of insight, interpretation, and integration that hopefully lend to the volume a significant integrity. Included in these commentaries are remarks from the recorded floor discussions which followed the "live" presentation of each symposium paper.

The book has been published by Dembar Education Research Services, Inc., as a contribution to the resource management field, without financial support other than that to be engendered by sales. Royalties are assigned to the North Central Section of The Wildlife Society.—**JAMES B. HALE and ROBERT A. McCABE.**

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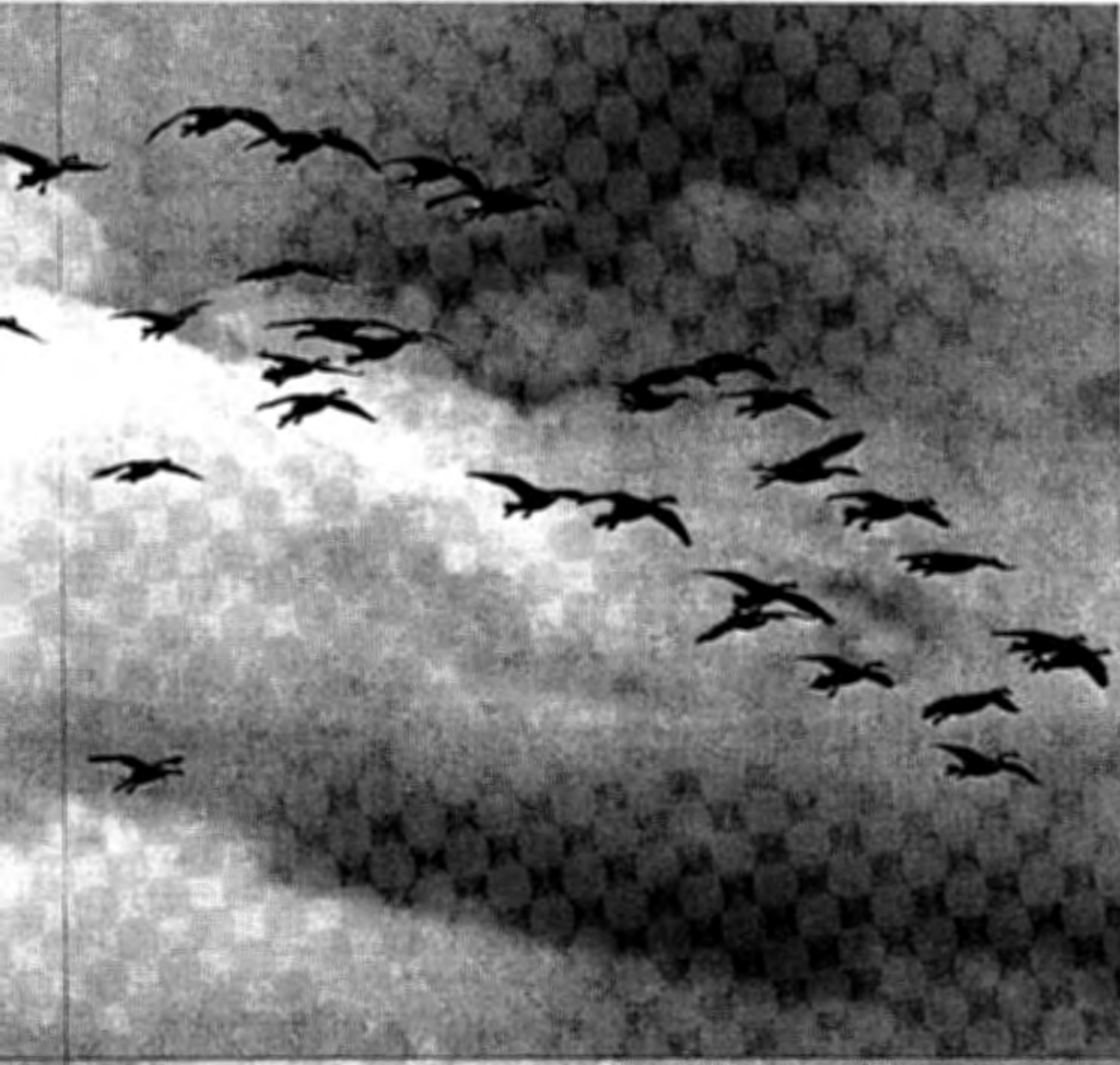


Introduction

THE CANADA, OR "COMMON," WILD GOOSE is seemingly a bird of striking contradictions.

In his classic reference on North American birds, Bent calls the Canada "the most generally well known of any of our wild fowl," and he indeed may be. Yet probably only avian afficionados know there are perhaps at least a dozen subspecies, or "races," of Canada geese, ranging in size from the 3-pound cackling Canada of the Pacific coast to the 18-pound giant Canada of the midwestern prairies.

The same authority characterizes the Canada as being "more persistently hunted, over a wider range of country and for a longer period, than any other American game bird." Yet today, in the face of a sharp decline in overall waterfowl numbers and an increase in gunning pressure, the Canada goose is generally doing quite well, thank you, and is even present in greater numbers in some places than in pre-historic times, although there are exceptions to this general situation.

As a matter of fact, strictly speaking the Canada goose is not what ornithologists call a true goose. That is, he does not belong to the genus Anser, as does the snow goose, for example. Technically the Canada goose is a brent, belonging to the genus Branta. But such distinctions concern few laymen. To the goose hunter a Canada goose is a goose, although he may go under many local nicknames like bustard, honker, oir a cravat, or wavy.

For generations the Canada goose has been the epitome of wildness, evoking with his semi-annual migrations a sure evidence of far-away places with strange-sounding names, and representing with his aerial strength and grace and acumen a contempt for the accouterments of civilization. Yet one of the papers in this book will call the Canada "the most easily managed and the most manipulated species of wildlife on this continent."

The traditional literature on the Canada goose, be it written by ornithologists or gunners, describes him as "so wary, so sagacious, so difficult to outwit." Yet as early as the 1920's one observer said that Canadas "are quick to lose their suspicions of man and his ways," and a more recent report indicates that some flocks actually develop a tradition of dependency: "Fear of man is lost; wildness is forfeited." One paper in this book even calls the Canada plain "stupid" at times.

One of the reasons the Canada goose appeals so strongly to people may well be the widely held understanding that geese mate for life. Yet adultery, divorce, and remarriage are not unknown among Canadas. As one observer has said, "We have seen some instances of mate-switching that would do Hollywood stars proud!"

Redwood trees, dams, and other natural resource issues may strain relations among western states and with Washington, yet one of the papers in this book highlights the level of cooperation the Canada goose has been able to engender.

The range of the Canada may still be said grossly to encompass the sweep of the continent "from the Atlantic to the Pacific and from the Gulf of Mexico to the Arctic coast," yet the evidence in this book strongly suggests that great numbers of birds are increasingly wintering well north of their traditional grounds—to the extent that in many latitudes the sight of a goose in March can no longer be looked upon as a sign of spring.

Some writers in this book say the Canada goose is so well understood that we can "rather accurately predict, even in chronological order, what a given goose population will do under specific circumstances." Other writers say that what we still do not know about Canada geese would fill volumes. Both groups may be right, depending on the problem at hand.

The titles of most of the papers in this book suggest the authors are talking about the management of geese. But the problems they pose and the solutions they suggest are really more frequently concerned with the management of goose hunters.

The comeback of the Canada goose during the past 20 years is perhaps the greatest success story in wildlife management, but the resulting situation around certain refuges represents one of the darkest hours in American sportsmanship.

Despite the contradictions inherent in any look at the Canada goose, however, on some points there is general agreement:

Regardless of size and color variations in the different races of Canada geese, the distinctive hallmark of the species is a black neck and head and a prominent white cheek patch. From manifold vantage points he is seen by uncounted millions at some season of the year—high in the air, pulsing onward over hill and valley, river and lake, forest and plain, country, town, and city, his wild clangor quickening pulses and cocking heads like no other outdoor phenomenon. So it is that more North Americans may well identify with the Canada than with any other bird. Certainly he is probably displayed on more tea towels, ash trays, weather vanes, letterheads, postage stamps, and airlines than any other species, not to mention on the national refuge signs of the U.S. Bureau of Sport Fisheries and Wildlife.

In recent years, economists and sociologists have tried to document this unique status of the Canada. They have found, for example, that at one refuge scores of persons come to watch the geese for every one who comes to shoot them, and that around another refuge the net annual benefits of the flock exceed 20 million dollars. But probably no one has ever better described the almost mystic value of the Canada than Arthur Cleveland Bent: "When once seen the grandeur of the Canada goose creates an impression on the mind which even the casual observer never forgets. As the clarion notes float downward on the still night air, who can resist the temptation to rush out of doors and peer into the darkness for a possible glimpse of the passing flock, as the shadowy forms glide over our roofs on their long journey? Or, even in daylight, what man is so busy that he will not pause and look upward at the serried ranks of our grandest wild fowl, as their well-known honking notes announce their coming and their going, he knows not whence or whither?"

In short, the Canada goose commands our well-nigh universal affection and respect. He is the big game of our wildfowl—"the king, the aristocrat, the trophy species"—whether he is pursued with gun, camera, or eye. Little wonder, then, that a species of waterfowl so ensconced in North American hearts and the North American way should be the subject of increasing attention by a growing battalion of biologists as they seek to conserve, maintain, and develop our wildlife resources. Where they have been on this quest, how they are doing, and where they are going is the subject of this book.

Canada goose management is a complex story with far-reaching dimensions in space and time. Three questions have perhaps been central to our concern for this species: Is there one continental goose population, or numerous populations? On what biological bases should we design goose conservation programs? And to what ends do we develop goose hunting regulations? In this symposium we attempt to answer these fundamental questions, drawing on the insights of 16 recognized experts in various facets of goose ecology and management. What emerges is a relatively clear-cut consensus that Canada geese in quantity and Canada goose hunting of quality are worthy, and attainable, goals in the 20th century on the continent of North America.

An Inventory of Continental Populations, Problems, and Prospects

THERE ARE, according to recent estimates, about a million and a quarter Canada geese in North America, give or take a hundred thousand or so. As Jahn says, this is "an interesting figure, but unmanageable." We can no more assess or manage Canada geese in a lump than we can poll or educate or govern people in the mass. Canada geese are not homogenous. There are significant ethnic and ecological distinctions that must be made among Canada geese before we can begin to understand them and provide for their continuing welfare.

One way to cut the Canada goose universe down to size is to think in terms of biological flyways, those pretty well-defined geographical regions to which avian life confines its migratory movements. Careful observations, based in large part upon the mass of data obtained by banding, have established waterfowl migration patterns that can roughly be divided into 4 zones, each encompassing a vast continental area. They have come to be known as the Atlantic, Mississippi, Central, and Pacific Flyways. The zones are not absolute. Although we may illustrate them on maps with bold lines and curves, their boundaries are fluid, responding to changes in water levels, weather, and bird behavior. But they are consistent enough to be invaluable in devising management guidelines and hunting regulations pertinent to each general region. To implement such guidelines and regulations, however, we have had to superimpose on each biological flyway an administrative flyway conforming to obvious boundaries like state lines. For example, waterfowl produced in Utah move into both the Pacific and the Central Flyways, but since the majority of them use the Pacific, the state of Utah is included in that flyway only. Both the biological flyway and the administrative flyway concepts are very important in Canada goose research and management, but it should not be forgotten that while biologists and hunters may recognize man-made boundaries, the geese do not. As a matter of fact, as Bellrose reports, more than any other species of waterfowl, Canada geese have radically altered their migration routes during the past decade as they have responded to newly created waterfowl refuges and feeding grounds. Nonetheless, since the flight corridors of Canada geese continue to be largely along a north-south axis, they fall within specific flying boundaries rather readily.

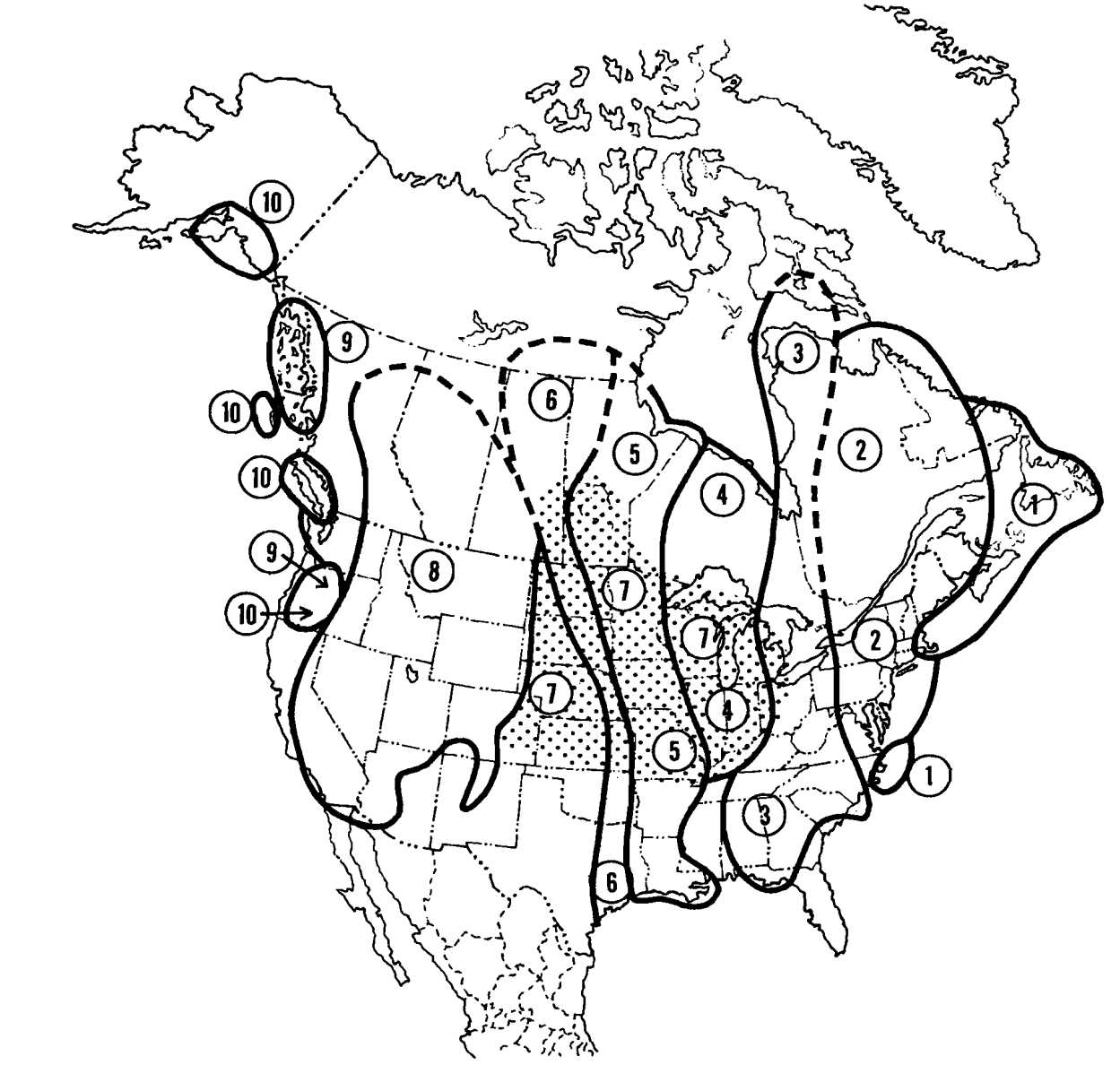
Another way to come to grips with the Canada goose situation is to pay attention to taxonomic variables. Few North American birds exhibit greater racial diversity than that found in Canada geese. Neither ornithologists nor hunters will agree on any set of names, scientific or common, and further subdivision or consolidation may emerge from current breeding ground investigations. As the international authority Delacour says, "Although the popular Canada geese have been perhaps more carefully watched, studied, and hunted than any others, we are yet far from fully understanding their variations. In the present still unsatisfactory state of our knowledge, we can only indicate some general tendencies." At the moment, perhaps the most accepted classification is that proposed by Delacour, who recognizes 11 living North American subspecies. Dr. Harold C. Hanson, on the other hand, will shortly postulate the existence of some 20 races, each of them with particular traits that may dictate particular management practices.

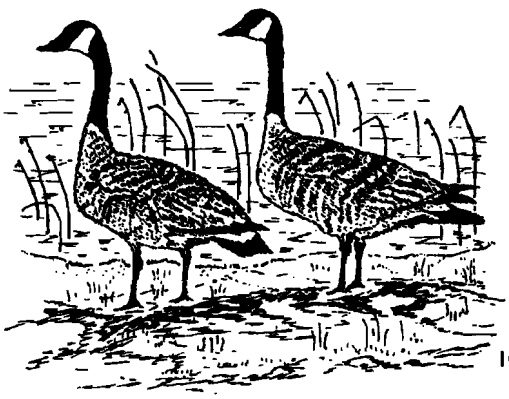
From a management perspective, at least as useful as the drawing of taxonomic distinctions among the various subspecies of Canada geese is the growing tendency to divide the birds into ecological units known as populations. This term is used to designate all components of a large group of birds typically utilizing fairly well-known breeding grounds, migration routes, and wintering grounds. A population commonly includes only one subspecies. Where our knowledge permits, populations are further broken down into flocks or flights associated with specific concentration areas, usually at or just north of the primary wintering grounds.

Thus we can speak, for example, of the Mississippi Flyway, having within it a Mississippi Valley Population of Canadas, made up in part of the Horicon Flock, composed principally of the subspecies interior but probably with other subspecies sometimes intermixed on migration and wintering areas.

Just as it is useful to catagorize the Canada goose, so is it useful to catagorize goose management. There are four broad avenues to goose

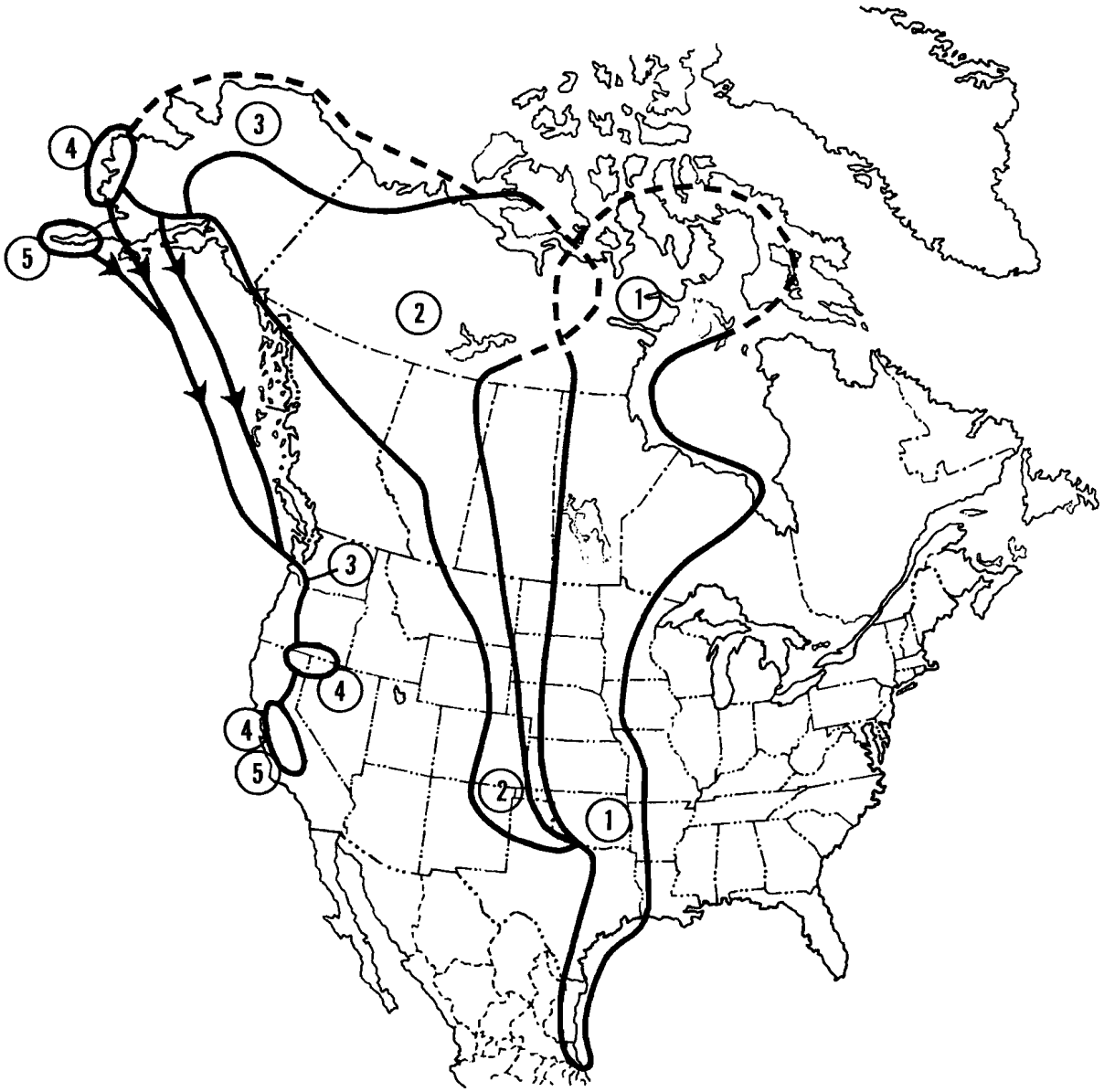
PRINCIPAL RANGES OF LARGE CANADA GEESE *(Branta canadensis)*



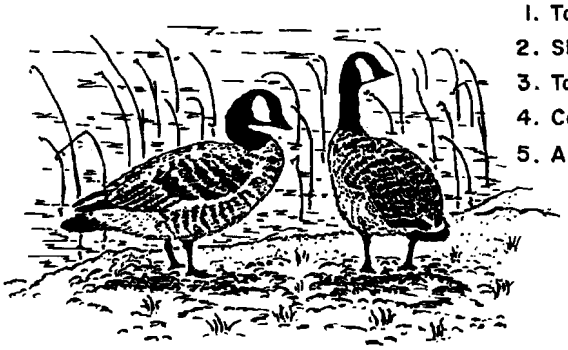


Population	*Subspecies*
1. North Atlantic	*canadensis*
2. South Atlantic	*canadensis and interior*
3. Southeast	*interior*
4. Mississippi Valley	*Interior*
5. Eastern Prairie	*interior*
6. Western Prairie	*interior, maxima and moffitti*
7. Giant Canada Goose	*maxima*
8. Great Basin	*moffitti*
9. Vancouver Canada Goose	*fulva*
10. Dusky Canada Goose	*occidentalis*

PRINCIPAL RANGES OF SMALL CANADA GEESE *(Branta canadensis)*

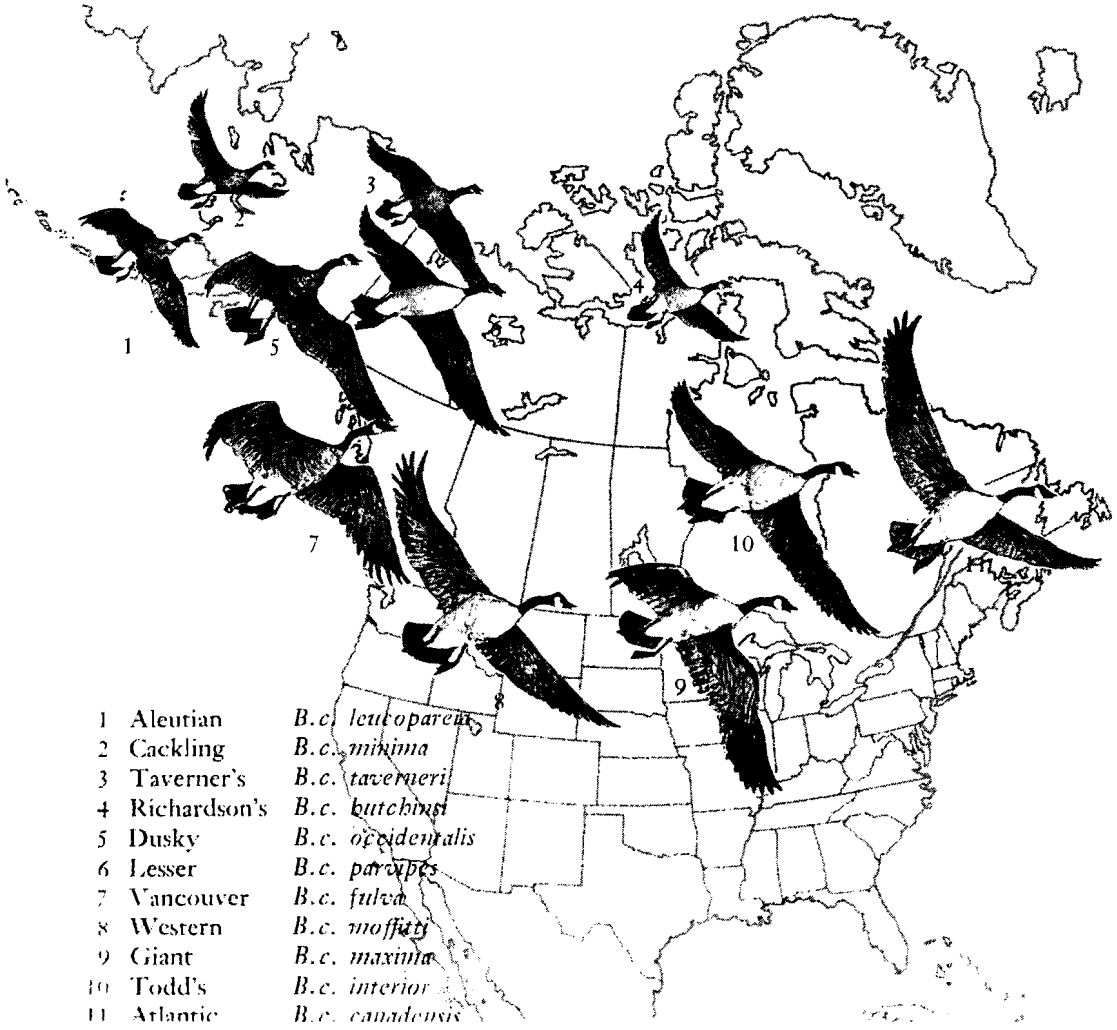


Population	*Subspecies*
1. Tall Grass Prairie	*parvipes* and *hutchinsii*
2. Short Grass Prairie	*parvipes* and *taverneri*
3. Taverner's Canada Goose	*taverneri*
4. Cackling Canada Goose	*minima*
5. Aleutian Canada Goose	*leucopareia*



management—biological research, population management, habitat management, and biopolitics. The whole complex might be called ecological engineering. Research includes those deep-digging investigations that seek to uncover wholly new insights into the ways and wise use of the wild, and those applied studies focused on better recreational engineering devices and techniques. Population management involves group and flight manipulation, hunting regulations, enforcement, waste abatement, and artificial introductions. Habitat management includes the acquisition, development, and maintenance of production habitat, migration habitat, wintering habitat, and hunting habitat. Biopolitics involves meriting and winning public support for sound management practices —the "engineering of consent."

In this chapter on an inventory of continental Canada goose populations, problems, and prospects, the primary approach is by flyway. Within each flyway we take a look at particular subspecies, population, and flock problems and their associated management practices or proposals. What emerges overall may be summarized as follows: (1) Over the past 20 years Canada goose numbers have increased; (2) The increase seems to be due to the conscious allocation of travel-route and wintering-ground refuges, and to the inadvertent jump in food supply in the wake of mechanical cornpickers; (3) But the goose increase is not shared equally by the states in each flyway, significant numbers of birds being "short-stopped" at or above the Mason-Dixon line; (4) The concentrations of birds in certain areas have produced hunter concentrations, with the threat of over-shooting; (5) Because most Canadas breed far above the reach of men and machines, drought and predators, the prospects for maintenance and even increase of goose numbers is very good; (6) But flock distribution in fall is faulty; (7) And the ability and willingness of hunters to abide by selective shooting regulations is uncultivated. Within this overall picture are numerous local or regional divergences which must be woven into our understanding of the total pattern of Canada goose ecology and management.



ABOUT FORTY PER CENT of the Canada geese are associated with about one-fourth of the continent—the Atlantic Flyway. They are produced primarily on the vast tundra areas of northeastern Canada in one of the few environments not yet dominated by man. They rally in early fall on tidal flats from James Bay to Newfoundland, and then proceed rather directly to their wintering grounds. Formerly these wintering grounds were south of Washington from North Carolina to Florida. Today Maryland alone holds more than half of the total flyway population, and there are wintering flocks of significant size in Delaware and New Jersey. Why the shift? The mid-eastern shore, by accident and by design, has become prime goose habitat—large, open cornfields where mechanical pickers leave a residue of grain, in juxtaposition with an abundance of aquatic sanctuaries both natural and planned. As Addy and Heyland say, "With a setup like this, why would the birds go elsewhere?"

Thus, while the overall Canada goose population in the Atlantic Flyway has approximately doubled in the past 20 years, the distribution of the resource has become skewed, and with it the harvest. The upper states, with half the hunters, take only about a fifth of the birds, the lower states less than 10 percent, the middle states the balance. Furthermore, as more and more birds funnel into an ever more truncated area, the stage is set for the decline in the quality of the sport that has harassed the Mississippi Flyway.

Atlantic Flyway management goals, then, become those of not only maintaining and increasing gross numbers of birds, but of so distributing their concentrations and their use that the maximum number of people can share in conserving and enjoying the resource. To accomplish this dual mission will require more biological knowledge than we now possess and more biopolitical muscle than we have been willing to exert. In short, as Addy has said, "Controlling the kill is our big problem."

1

CANADA GOOSE MANAGEMENT IN EASTERN CANADA AND THE ATLANTIC FLYWAY

C. E. Addy and J. D. Heyland

THE CANADA GOOSE has long been an important contributor to waterfowl hunting in the Atlantic Flyway and eastern Canada. In addition, Eskimos and Indians, particularly in the coastal areas of Quebec and Labrador, utilize these birds for subsistence and derive some income by guiding hunting parties.

With duck populations at markedly reduced levels during much of the past decade, considerable interest has developed in the possibility that the Canada goose could take up some of the slack in waterfowl hunting lost to the ducks. The species is rather easily managed compared to many species of game birds. Geese react favorably to situations where adequate food, water, and sanctuary are provided. During the fall and winter they will feed exclusively on upland agricultural lands and do not require wetlands other than a limited amount of open water, such as a pond, where the birds can rest, drink and wash. The species has strong homing instincts and can be counted on to utilize specific breeding, migration and wintering areas each year. It appears, too, that the breeding grounds can accommodate more birds than has occurred in the past. In other words, the evidence indicates that if we provide the proper migration and wintering habitat and control the kill, we can have more geese and hopefully have them widely dispersed throughout the flyway.

As with many seemingly simple and straightforward solutions to waterfowl management problems, however, Canada goose management in the Atlantic Flyway has many inherent complications. Most of the complications concern human activity as it affects the distribution of birds, hunting opportunity and kill.

In order to develop a research and management program and encourage the various management agencies and individuals involved to direct their efforts toward common goals, the Atlantic Waterfowl Council established a Canada Goose Committee. The job of this committee is to develop flyway-wide programs in which all parties can participate and assist in the coordination of effort toward common objectives.

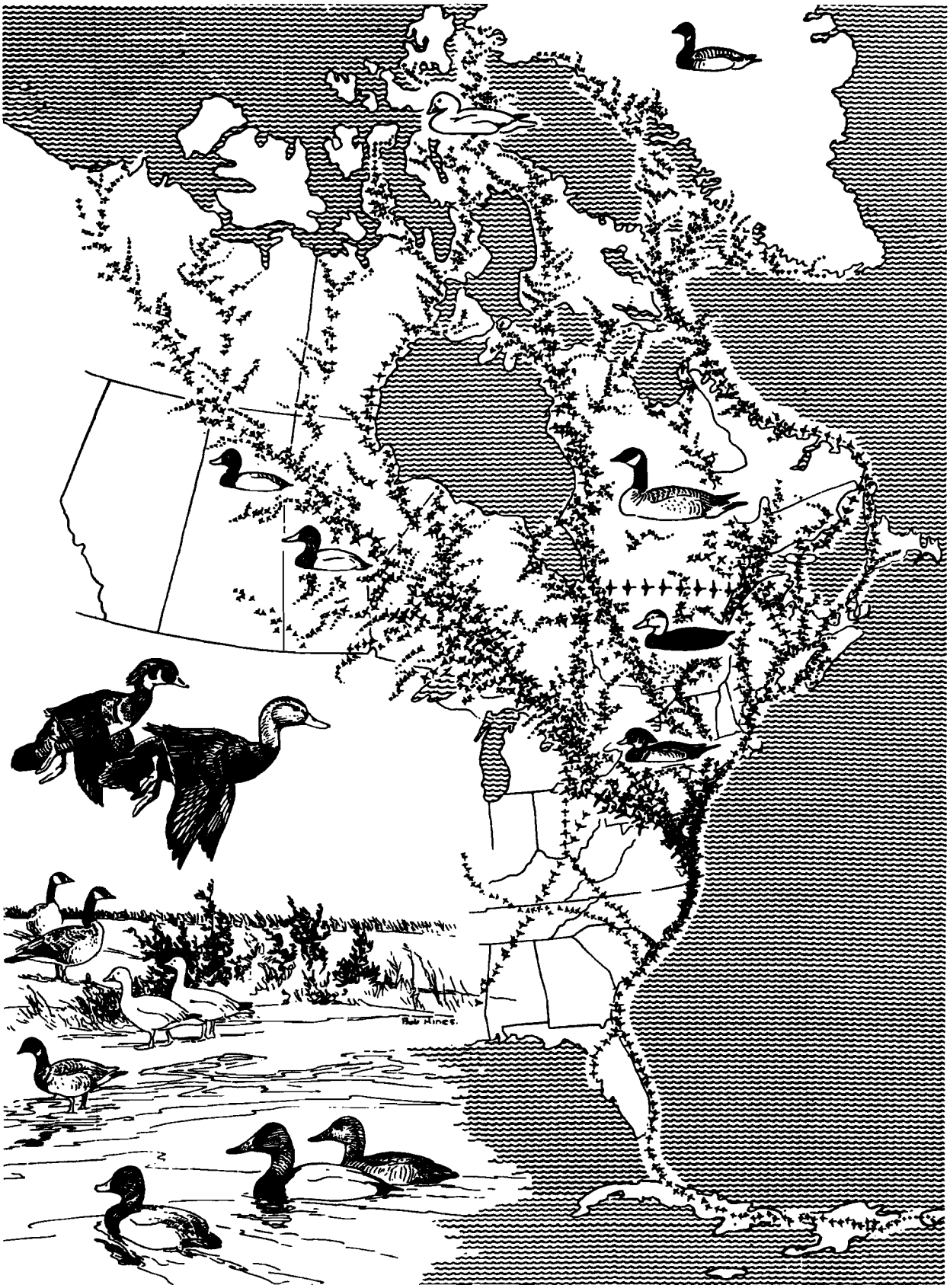
The management program, developed by this committee, has the following objectives:

- An increased flyway population, with a goal of a wintering population of 750,000 to 1,000,000 birds
- Maximum fall/winter distribution of geese within the flyway.
- Improvement in the recreational quality of the sport.
- A more equitable distribution of kill and hunting opportunity.
- Reduction in the waste of birds.

In the discussions which follow, we delve into the various population characteristics and management considerations with which we must cope in our management program and which to some extent delineate the scope of actions needed.

Taxonomic Classifications

The Atlantic Flyway has three subspecies of Branta canadensis, according to the 1957 A. O. U Check-list of North American Birds and Delacour


Bob Hines

(1954). They are the Atlantic, B. c. canadensis; Todd's, B. c. interior; and Richardson's B. c. hutchinsii. The nominate canadensis reportedly breeds in southern Baffin Island, northern and eastern Quebec, Labrador and Newfoundland and winters south from Nova Scotia through the eastern part of the flyway to coastal South Carolina and Georgia.

Most of the birds wintering in Florida, Georgia, interior South Carolina, western North Carolina and western Pennsylvania and some of the birds wintering in the mid-Atlantic coastal area are believed to be interior, which reportedly breeds from southern Baffin Island and the east coast area of Hudson and James Bays west to Manitoba and Minnesota. What the relative numbers are between the two forms, interior and canadensis, wintering in the flyway is unknown because supposedly both forms occur in the primary concentration areas of Maryland, Virginia, and North Carolina.

Based on recoveries from winter bandings, bandings in the Ungava area of the breeding grounds and at intermediate points, there is considerable overlap and mixing of birds within the ranges described for these two subspecies.

Richardson's goose, which breeds in the Arctic Island region of eastern Canada, is believed to occur in limited numbers in the flyway, but little concrete evidence is available as to actual numbers and distribution. Although the Check-list (1957) indicates the species as occurring in the Atlantic Flyway, Delacour (1954) mentions only Texas and Mexico as wintering areas for hutchinsii.

Population Units

Adequate coordinated banding, population inventories, kill surveys and other investigations have not progressed to the extent that practical population management units can be accurately defined in the Atlantic Flyway at the present time. However, the flocks, concentrations, or subpopulations wintering in the following areas warrant continued special attention and investigation. Our judgment here is based on publications by Hanson and Smith (1950), Hankla and Rudolph (1967), Williams (1967) and field data from banding, kill surveys and various population surveys.

a. Outer coastal areas, particularly the Outer Banks of North Carolina, the ocean shore of the Delmarva Peninsula, eastern end of Long Island, Cape Cod and the southeastern coast of Nova Scotia: Some or most of the birds wintering in these areas seem to be strongly associated with salt water habitats. Newfoundland appears to be an important breeding ground for these birds. Coastal habitats from Maryland south may also accommodate birds originating from more westerly breeding habitats. Number of wintering birds in this maritime population is believed to be about 30,000. The numbers haven't fluctuated much over the years.

b. Midflyway tidewater area in Delaware, Maryland, Virginia, and North Carolina: This region has wintered close to 90 percent of the flyway population in recent years. However, whereas 15 to 20 years ago the primary concentration was in eastern North Carolina, the Maryland-Delaware area now winters the bulk of the birds. Maryland alone now holds more than half the total flyway population. Delaware winters between 50,000 to 100,000 birds where 15 years ago only a few hundred occurred. North Carolina now winters about a third of what formerly occurred there.

At the moment, the geese are widely distributed throughout this extensive tidewater area where grain fields are a primary attraction. The birds involved appear to operate as a single population unit. However, with a breeding range extending from the coast of Labrador to the eastern shores of Hudson and James Bays, and with several diverse migration routes employed, there are undoubtedly differences in kill and mortality characteristics of management significance between various components of birds which make up the total concentration. In time, the results of banding and other surveys may indicate segments within this population needing special management attention. For example, banding may show that geese using the James and other rivers of the mainland shore of Virginia exhibit characteristics quite different from those birds occurring on the eastern shore of Maryland or those in eastern North Carolina.

c. New Jersey: In recent years, an increasing number of Canada geese have been wintering in southeastern New Jersey. The population now totals between 4,000 and 6,000 birds.

Some of these birds may be the result of "short-stopping". However, indications are that at the moment the birds are mostly nonmigrants resulting from a breeding population which has become established primarily on Brigantine National Wildlife Refuge. It is not likely that this group of birds is closely associated with the midflyway population at the present time.

d. Florida: During the past 20 years, this flock, located in the St. Marks-Tallahassee area, has declined from an estimated 30,000 birds to approximately 6,000. The breeding area for this flock appears to extend at least as far north as Baffin Island.

Limited winter bandings during the period of high population levels indicated migration south through both the Atlantic Flyway and the eastern portion of the Mississippi Flyway. In recent years, however, recoveries from bandings in Florida have largely disappeared from the Mississippi Flyway. Only the Atlantic segment continues. Although recoveries occur in most of the goose concentration areas of New York State, Pennsylvania, and the middle and southern Atlantic Flyway states, the major portion is accounted for by Maryland, Florida, and Pennsylvania. In Canada, Quebec is apparently the major harvester.

Crider (1967) discusses and documents interceptions in the North of birds bound for their wintering area in Florida. With a migration route extending from Hudson Strait to the Gulf of Mexico these birds would encounter many lush and attractive habitats enroute which not only must tend to hold or delay the birds, but subject them to considerable hunting pressure before they reach their Florida destination.

e. South Carolina: Since 1949, the population associated with the Santee National Wildlife Refuge has increased from a few hundred birds to in excess of 40,000 birds reported in the 1964 January survey. Since 1964, however, the winter count has dropped to about 25,000. This decline may not be a temporary phenomenon since most wintering flocks from North Carolina south have been declining significantly in spite of the fact that the overall flyway population has been increasing.

Although recoveries occur over a wide area from Michigan and Illinois to the outer banks of North Carolina, the Santee flock appears to be most strongly associated with concentration areas to the north in Virginia, Maryland, Delaware and western Pennsylvania.

f. North Carolina (Anson County and vicinity): This local wintering flock of the Piedmont Plateau, which ten years ago was reported to number about 10,000 birds, has steadily declined in recent years. The number now present is approximately 3,000.

The Pee Dee National Wildlife Refuge has been established with the hope that under proper habitat management this flock can be encouraged to expand. Just when the refuge acquisition program will be completed and the necessary management undertaken is uncertain at the present time.

This flock is believed to be closely associated with the Pymatuning, Pennsylvania birds and those occurring in eastern Tennessee.

g. Northwestern Pennsylvania: Approximately 5,000 geese winter in the Pymatuning area of Pennsylvania. Many of these are probably nonmigrants. The local spring population of breeders and nonbreeders totals about 3,000 birds.

Migrants through the Pymatuning area appear to be most closely associated with flocks located in eastern Tennessee, Alabama, western North Carolina, and South Carolina, as well as the adjacent Mosquito Creek area in Ohio.

h. Other wintering flocks: In addition to those areas and flocks discussed above there are scattered small groups in Georgia, South Carolina, Virginia, Maryland, Pennsylvania, New York State and New England. Some of the New England and New York State groups are composed in part of nonmigrants resulting from local breeding populations. Home-grown flocks in the northern states of the flyway have increased considerably in recent years and now total about 10,000 breeding birds. Although perhaps of secondary importance to the principal concentrations listed above, these minor wintering groups or fringe flocks, particularly in the southern states, warrant serious study and attention. They may be the nuclei for new substantial flocks and contribute measurably to increasing the overall flyway population and improved hunting opportunity.

Breeding Grounds

Results from Canada goose banding on the wintering grounds and the Canadian breeding grounds are not dealt with here in any detail. An analysis of these data will be published by the junior author and perhaps others at a later date. Suffice to say that the results of banding to date indicate that the primary breeding range of Atlantic Flyway Canada geese extends from the James Bay lowlands and the east coast of Hudson Bay east to Newfoundland.

Within this extensive area of eastern Canada, Canada geese nest in two broadly different types of habitat; the forest-muskeg type of the James Bay lowlands and the Arctic tundra. The latter is found in the upper Ungava Peninsula above the tree line, at Cape Henrietta Maria in Ontario and on the Belcher Islands and other islands in Hudson Bay.

Hanson and Smith (1950) have described the muskeg in the area of the James Bay lowlands west and south of James and Hudson Bays in Ontario. They divided the general classification into five types depending on the amount of forest and/or open water available. They are: (1) well-timbered muskeg, (2) open muskeg, (3) lakeland muskeg, (4) pothole muskeg, and (5) "smallpox" muskeg. Within the general classification, in areas where geese nest, birds select nest sites on small islands in lakes or ponds. If such select sites are unavailable the birds will nest on any dry portions of land near water. The same situation prevails in the lowland area east of James Bay. Throughout the whole territory nesting is generally scattered.

Gillespie (pers. comm.) estimates that 10,000 breeding birds (5,000 breeding pairs) nest in the interior of the island. The nesting habitat which they generally occupy is in the interior of the southern half of the island--the so-called "Caribou Barrens". This area is mostly the nonforested or thinly forested portion of the province and involves about 19,000 square miles of territory. The habitat is characterized by thin, acidic soils, numerous small bogs and shallow ponds, scattered black spruce (Picea mariana) and typical bog shrubs (Vaccinium spp., Rhododendron sp., etc). All water areas are acidic and are generally nutrient poor. Nest sites are usually on small islands in shallow ponds, but may also be found on the shores of lakes, beaver houses or on the banks of rivers.

Canada goose nesting areas in the Ungava tundra are generally restricted to the east shore of Hudson Bay between Port Harrison and Kovic Bay, and on the west shore of Ungava Bay between the Payne River and the George River. These two regions correspond to the recently emerged portions of the coasts. In both these regions the nesting grounds are confined to a strip only 15 to 30 miles deep. Preferred nesting sites in these areas are small islands in lakes and ponds. The island may be as small as 3 feet across in a pond of much less than an acre. In the absence of these nest sites, geese will nest on high points near water courses or ponds. In addition to muskeg and tundra nesting areas, Canada geese nest generally throughout central Quebec and Labrador. Relative population densities throughout the Quebec-Labrador area are shown in Figure 1. This has been taken directly from the report of Kaczynski and Chamberlain (1966). The stratification was determined from the analysis of aerial reconnaissance data obtained during five summers.

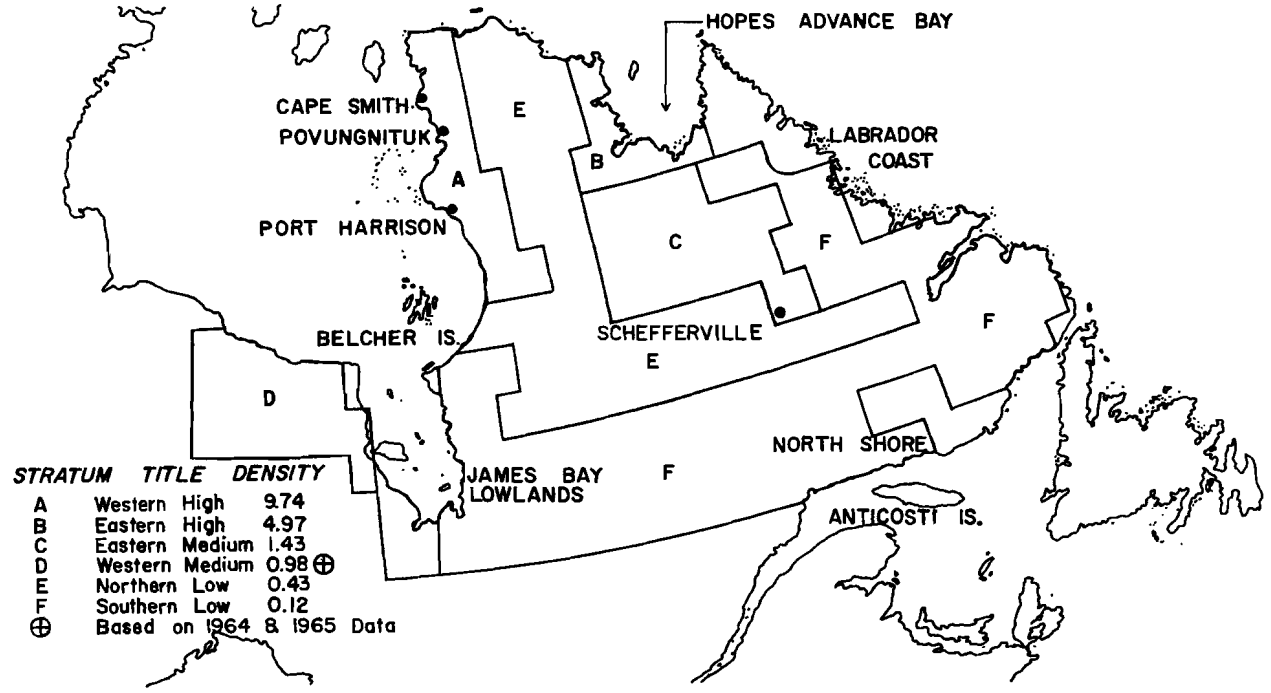


FIGURE 1. Canada Goose Density Strata in Eastern Canada (Based on 5-Year Average Density per Square Mile; after Kaczynski and Chamberlain, 1966).

Waterfowl habitat in the northern portion of the breeding range is not subject to radical changes such as that of the prairie region. It does not undergo long periods of severe flooding and probably never experiences drought, although water levels do drop somewhat during July and August. Thus, it is safe to say that the habitat is secure from extreme alteration from one year to the next. The factor which most severely affects nesting habitat and nesting success is the weather. Adverse weather conditions in the spring can retard the nesting season of arctic and subarctic nesting species, and can be so severe that the season may be considered a "bust". Cold, snowy conditions late in the spring may kill already established clutches. Although flooding does not affect the tundra portion of the breeding range, the muskeg areas may be subject to periodic flooding which may not be excessive, but some nests on low hummocks in ponds and lakes may be flooded out under such conditions. It is highly unlikely that renesting occurs in any portion of the arctic or subarctic breeding range. Thus, if a goose does not succeed with her first nest she does not succeed at all.

It is not likely that the arctic and subarctic breeding grounds of Canada geese will be altered to any significant extent in the foreseeable future. Industrial and urban sprawl will not affect these areas save for a few isolated cases where mining developments may make small inroads into the breeding range. In all probability it will not be possible to improve the breeding habitat in the arctic and subarctic. However, we should not dismiss this possibility altogether, perhaps, until we know more of the energy and habitat requirements of breeding geese.

The number of Canada geese wintering in the Atlantic Flyway states has increased over the past few years to an estimated 600,000 birds in 1967. This suggests that the breeding grounds are not limiting populations at the present time. To the human eye the nesting habitat in Quebec, Ontario and Labrador is unlimited. It is apparent that more and more geese each year are finding suitable breeding habitat. Very probably we will be able to go on for some years to come packing more geese into the breeding grounds. Ultimately it will be sport hunting and/or winter habitat, if anything, which will limit the growth of goose populations.

Migration and Wintering Habitat

The bulk of the Canada geese migrating through and wintering in the Atlantic Flyway are produced in eastern Canada west as far as the eastern shores of Hudson and James Bays and adjacent islands. Prior to migration into the United States portion of the flyway, the nonbreeders and family groups move to coastal areas where concentrations rapidly build during late August and September. There is no known traditional concentration or staging area anywhere in the vast interior of the Quebec-Labrador-Newfoundland region where the bulk of our geese are produced. Undoubtedly, the reason for this is that the extensive tidal marshes and shallow aquatic areas of the coast are much more productive of food than the relatively sterile habitats of the interior. During early September the bulk of the Atlantic Flyway's population is concentrated on tidal areas of Newfoundland, Labrador, Ungava Bay, the east coast of Hudson Bay and the east and south coast of James Bay.

The primary movement out of Canada is during October and early November. Upon leaving James

Bay and other concentration areas in southern Canada, many Canadas fly directly to their wintering grounds. However, in recent years, due in part to special management efforts, more and more birds have been stopping enroute in northern states and southeastern Ontario. Geese have traditionally stopped in numbers at Merrymeeting Bay in Maine, but, for the most part, the large flights coming out of eastern Canada overflew southern New England, Long Island, and New Jersey. However, management at Parker River National Wildlife Refuge in Massachusetts demonstrated that several thousand geese can be stopped for a period of weeks where formerly scarcely a dozen would be found.

The same has been true for much of northern and central New York State and Pennsylvania where relatively few of the many thousands of southbound migrants have ever stopped. However, this situation is changing rapidly. Bureau and state management areas, such as Wilson Hill, Oak Orchard, Howlands Island Game Management Areas and Montezuma and Iroquois National Wildlife Refuges are beginning to stop thousands of birds in upstate New York. In Pennsylvania, the Pymatuning Management Area has been in existence for many years and has been accommodating a concentration of at least 10,000 birds during the fall period. In addition, however, the newly established Erie National Wildlife Refuge nearby and a new state management area being acquired in the midst of lush farmlands of southeastern Pennsylvania undoubtedly will, when brought to full management potential, considerably augment the fall goose population in the state.

Likewise, in Ontario, management for Canada geese is beginning to pay off. Miner's concentration at Kingsville has long been well known. However, southeastern Ontario has many possibilities for attracting geese. At the present time, management of habitats associated with the St. Lawrence Seaway is attracting ever-increasing numbers of geese.

A factor that may be influencing the attractiveness of a northern area to migrants is the presence of locally produced birds which act as decoys. Although most areas managed for geese start out with a penned decoy flock, most established management areas in the northern states and Ontario now have thriving local breeding populations.

Throughout most of eastern Canada, man has had relatively little influence on the distribution and habits of Canada geese. On the other hand, in the states of the flyway the distribution of geese is markedly influenced by the type and location of areas managed specifically for geese.

In the past, federal management areas accommodated the major portion of the flyway population. State management areas were scarcely involved at all. This ratio is rapidly changing, with both state and private management assuming an ever-increasing share of the management job. At the present time, Bureau management areas probably accommodate at one time or another during the fall and winter period about 40 percent of the population.

The role of federal, state, private and unmanaged open areas in providing for the needs of Canada geese in the flyway varies from state to state. It is difficult, except in a few instances, to evaluate the contribution of a particular state, federal, or private management area because, more often than not, the daily activities of the birds will encompass two or more areas.

Some examples of situations encountered are as follows. Usually goose concentrations have been established or preserved through the management of a strategically located Bureau refuge. This occurred in the prime wintering concentration area of Maryland and Delaware. Bombay Hook Refuge in Delaware provided the beginnings of a goose population which now exceeds 50,000 birds. Blackwater Refuge provided sanctuary and food for a major portion of Maryland's Canada geese 20-30 years ago. Both these management areas were instrumental in starting or maintaining goose flocks. However, within a relatively few years the influence of these areas declined as state and private management took over. From a winter population of 60,000 to 70,000 in the early 1940's, Maryland's population has increased to over 350,000. Blackwater Refuge has relatively little influence today on most of Maryland's fall and winter goose population. The bulk of the food and living space for this sizeable population is provided by private managed and unmanaged areas. To date, state management areas in Maryland have not been involved to any significant extent with goose management.

In Delaware, much the same thing is happening, but it has not progressed as far. Bombay Hook Refuge still accommodates about half the population, but state and private areas are attracting an ever-increasing number of birds.

When one considers that the Delaware-Maryland area now accommodates close to two-thirds of the flyway's winter population, the contribution of the private landowner is considerable in providing the bulk of the food and habitat for these birds. For example, at a conservative estimate of one-half pound of food/day/bird, the Maryland population alone from November through February would consume approximately 10,500 tons of food. Since it is doubtful that the birds obtain over 5 percent of their food from the federal and state areas, one begins to realize the importance of the contribution of private lands and waters to the welfare of the population.

By contrast, the Santee National Wildlife Refuge in South Carolina continues to provide the bulk of the food and habitat for the flock which has developed there. At the present time, the size of the flock is about 25,000 birds, but has been up to 40,000 in the past. An adjacent state management area on the reservoir and limited surrounding private lands provide some hunting opportunity and some limited feeding habitat. However, the primary needs of the birds are supplied on the refuge.

Some Bureau and state management areas in the northern end of the flyway provide for most of the needs of the birds present during the fall period. This is true, for example, with the Pymatuning area in Pennsylvania and Parker River Refuge in Massachusetts. On the other hand, Montezuma Refuge birds in New York State feed extensively on surrounding lands. There is considerable variation

between management areas in the extent to which they provide for the needs of the birds present. Undoubtedly, as these areas attract more and more birds, the surrounding private landowners, who have the necessary agricultural land, will begin to manage for goose hunting.

To summarize the role of public agencies and private landowners in the management of geese in the Atlantic Flyway, we make the following observations:

1. Bureau refuges have been of primary significance in establishing goose flocks or maintaining flocks in local situations and fringe areas. All prime concentration areas in the flyway have Bureau refuges involved.

2. Only in Delaware, Virginia, Pennsylvania and New York have state management areas made significant contributions toward the establishment and maintenance of goose flocks.

3. During the fall and winter period a major portion of the flyway's Canada geese are dependent on managed and unmanaged private lands and unmanaged shallow tidal waters for their living requirements.

Habitat and Populations

From a flyway wintering population of 200,000 to 300,000 in the late 1940's, the number has grown to 600,000 birds. The 600,000 figure is the highest ever recorded and was attained in 1966 and 1967.

While in the intervening 20 years the flyway population has about doubled, there have been many areas which have not shared in this increase. In fact, the overall distribution within the flyway has changed markedly. Generally speaking, there has been a shift from south to north in numbers and proportion of birds.

During the late 1940's and early 1950's, North Carolina was the center of wintering distribution and accommodated more geese than any other state. Then in the mid-1950's as the flyway population increased, the increment went primarily to Maryland with limited increases to Delaware. At the same time, the Santee flock in South Carolina was building. Then during the 1960's populations in the Maryland-Delaware area exceeded North Carolina's by a considerable margin most years. During the period of early buildup in Maryland the North Carolina population remained substantially unchanged. However, in recent years the North Carolina population has declined to a level less than half of what it used to be.

Since the early 1950's, the Florida population also declined from an average of about 25,000 to 6,000.

The winter distribution as it occurs at the present time is portrayed in Figure 2.

An account of the Winter Survey for key states is given in Table 1 and illustrates in a rough sort of way the marked changes in distribution which have occurred over the past 20 years. Note that figures for some states in some years appear to be considerably out of line. Due to the nature of the survey

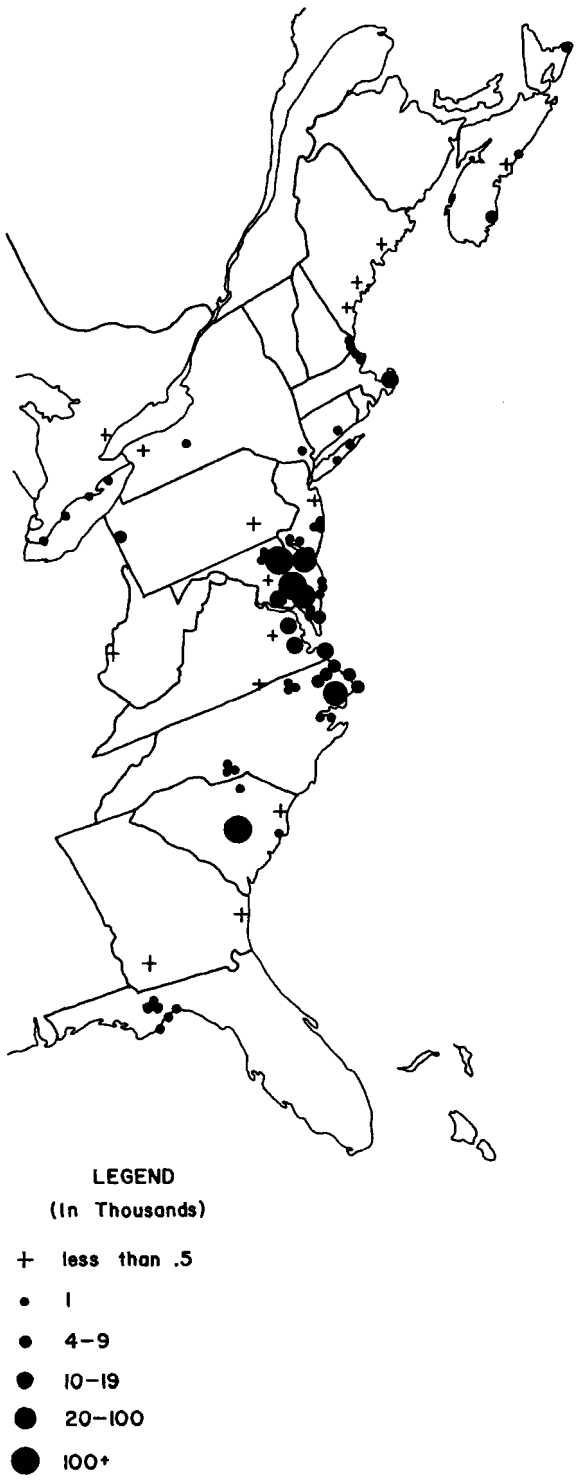


FIGURE 2. Current Winter Distribution of Canada Geese in the Atlantic Flyway and Eastern Canada.

TABLE 1. Estimates of Canada Goose Numbers, January Survey

	Delaware	Maryland	Virginia	North Carolina	South Carolina	Florida
1948	200	42,100	20,000	106,400	300	10,000
1949	200	101,800	34,200	139,000	700	18,000
1950	800	87,700	44,800	120,400	1,700	16,700
1951	800	57,000	30,100	148,300	1,000	21,900
1952	2,500	53,500	40,000	154,900	1,500	27,800
1953	7,300	220,500	40,000	151,400	3,100	47,000
1954	3,000	148,200	34,700	107,700	3,600	25,600
1955	2,800	260,000	55,200	155,700	3,200	19,100
1956	4,700	223,800	50,700	185,900	6,100	26,800
1957	6,800	180,800	30,600	103,100	7,600	18,600
1958	2,800	95,500	27,800	146,900	11,300	17,800
1959	11,900	69,200	27,000	152,000	11,800	13,000
1960	14,100	137,700	31,500	148,200	19,400	11,100
1961	22,200	241,300	49,900	189,100	15,800	8,200
1962	24,400	192,900	26,200	128,100	16,400	8,300
1963	23,900	196,600	49,700	149,500	33,600	7,000
1964	39,200	221,900	31,300	162,200	44,400	4,400
1965	48,500	242,000	36,600	99,500	26,800	7,000
1966	52,000	352,700	44,000	91,500	29,900	6,000
1967	83,500	356,900	35,600	65,900	25,300	6,300

and the manner in which it was conducted, the accuracy undoubtedly varied a lot from state to state between years. However, although specific figures may be suspect, we feel that the Winter Survey does portray the trend in distribution reasonably well.

The explanation for the changes which have occurred in goose distribution encompasses several factors. Lacking specific concrete data, the interpretation of the situation naturally will vary among individuals. However, we feel that the changes in habitat and habits of the birds which have developed over the years have been important contributing factors. Also, differences in kill and other mortality factors undoubtedly have contributed to the decline of one flock and permitted increases in others. Probably excessive mortality has occurred in some flocks where substantial harvest is taken during migration as well as on the terminal wintering area. Such may be the situation with the Florida group of birds. Assuming good breeding ground conditions, the status of the overall flyway population is determined by the interaction of all these factors. Without the habitat, the marked changes in population abundance and distribution would not have occurred, at least to the extent that it has. On the other hand, the best habitat in the world will not maintain a population if the kill exceeds production.

Canada geese have forsaken their traditional aquatic habitats and have become primarily upland feeders while in the Atlantic Flyway. It is the abundance, quality and availability of agricultural foods which determine the location of primary goose concentrations, not the extent and abundance of aquatic foods.

Without knowledge as to crop location in relation to goose concentrations and how fields are managed, statistics on the acreage of corn and other grains are of little value as an indicator of actual or potential goose habitat. There are over 6 million acres of corn harvested for grain in the Atlantic Flyway, but only a small fraction of these acres are actually used to any extent by Canada geese. To be attractive to and utilized by Canada geese, grain fields should be large and open, quantities of waste grain should be left in the field and not plowed under, and there must be a nearby sanctuary encompassing a body of water which is large enough that the birds would be undisturbed and have a feeling of security.

The advent of the mechanical corn picker set the stage for the creation of hundreds of thousands of acres of prime goose feeding grounds. Under mechanization, large fields, "clean" farming and better yields resulted, in addition to the fact that much spilled or shattered grain was left in the field. This agricultural development has been widespread and where it occurred within the primary wintering range of Canada geese, the response by the birds has been substantial. However, utilization of grain fields by geese has not been uniform in all parts of the flyway. Failure of geese to utilize an extensive area of grain fields may be due to one or all of several factors. There may be no tradition for geese on the area, the fields may be plowed in the fall, or there may be no adequate nearby sanctuary where the birds would not be disturbed.

The eastern shore of Maryland has become what one might call one big area of ideal Canada goose habitat. Consider these features:

a. The primary goose area extends from Elkton south to Cedar Island at the Virginia line, a distance of about 120 miles. The width would average about 25 miles.

b. Throughout this area corn fields are scattered. They total about 325,000 acres. In fact, the whole Delmarva Peninsula contains about 546,000 acres of corn. Some fields are plowed in early fall and planted to a cover crop. But many of the corn fields are left in stubble until late fall or over winter. Many landowners purposely manage their fields for geese and goose shooting. In addition to the corn acreage, the Peninsula contains about 136,000 acres of small grain, mostly wheat and barley.

c. The eastern shore is interlaced with dozens of shallow bays and tidal creeks and rivers, many of which have an abundance of aquatics. Chesapeake Bay lies adjacent on the west. Most open water constitutes a sanctuary for Canada geese since Maryland law prohibits shooting from a boat. In addition, there is a scattering of federal, state and private sanctuaries within the upland area itself. There is an abundance of sanctuaries both natural and planned.

d. Most of the land is in private ownership and the number of hunters is restricted pretty much to landowners, guests or on a fee basis. There is no free hunting of any consequence.

e. Geese are scattered from one end of the area to the other and the birds aren't concentrated in one or two limited areas. About 300,000 geese now winter in this area.

With a setup like this, one would wonder why birds would go elsewhere in the flyway.

Management in Delaware is developing in much the same manner although Bureau and state lands assume a greater role. In Virginia, the Bureau and state have contributed significantly to maintaining geese in the Back Bay area, Hog Island, and Presquile, and have plans for goose management at Buggs Island reservoir and elsewhere. However, it appears that private management, while significant, has not contributed to the same degree as in Maryland and Delaware.

In North Carolina, the principal effort on goose management is by the Bureau in the Pungo-Mattamuskeet area and on the outer Banks at Pea Island. Upland habitats, even in the Mattamuskeet area, have deteriorated to some extent. Apparently, a high proportion of the grain fields are now harvested early, plowed and planted to a cover crop or left unplanted. This practice limits the amount of waste grain available for geese. It is believed that the uplands aren't as attractive to geese as formerly, but steps are being taken by the state to encourage landowners to manage for geese. North Carolina certainly has tremendous potential, but it would take a considerable effort to compete successfully with states to the north. For example, the 13-county area, from Currituck Sound to the Pamlico River, where the primary goose concentrations occur, has only 187,000 acres of corn. This acreage is just a little over half that present on the eastern shore of Maryland alone. And when one considers that, due in part to early harvest and plowing, much of the acreage is unattractive to geese, one realizes the problem North Carolina has in trying to maintain or increase its wintering population.

The shift in distribution from southern areas to the north is a continuing phenomenon. As mentioned previously, new state and federal goose management areas are being established farther north, particularly in Pennsylvania, New York and Ontario. Most of these areas lie across the principal flight lanes of a major segment of the geese bound for mid-Atlantic wintering areas. When completed, all of these northern management areas undoubtedly will stop geese long enough to provide shooting for hunters in the vicinity. This will represent a kill at least partly additive to that which the population has been experiencing to date. If "hot foods" are grown on the management areas and also available on surrounding private lands, the potential is there for stopping sizeable numbers of birds for an extended period in the fall. Major flights to coastal wintering areas could be delayed until December, depending in part on weather conditions.

The aim of management, as proposed by the Canada Goose Committee of the Atlantic Waterfowl Council, is to permit the normal flow of birds to traditional wintering areas in the south. To be in keeping with this objective, it would seem that proper management of northern areas would call for the growing of aquatics and green crops, not corn and other grains. Although the lack of "hot foods" on Bureau and state management areas would not cause undesirable concentrations and an extended delay in migration, there are other factors to be considered. Unfortunately or fortunately, depending on whose axe is being ground, many of the existing and proposed northern management areas are located in the midst of fertile agricultural situations. In other words, the management of private lands in the vicinity could, and probably would, in time dominate the situation. Once goose hunting became established, there would be no compunction on the part of the private landowner to provide all the "hot foods" needed to keep the birds around as long as possible or at least throughout the hunting season. Management agencies, in their effort to provide limited additional hunting opportunity, find themselves in the dilemma of starting something they may lose control over within a relatively few years time.

Hunting Mortality

Canada

Canada goose hunting in eastern Canada falls into two categories: (1) subsistence hunting by Indians and Eskimos, and (2) sport hunting by white sportsmen. Both of these aspects must be given consideration when we talk about harvest management of the species within the flyway.

Harvest by Indians and Eskimos. The native populations to be considered are those of the coasts of James Bay, Hudson Bay, Hudson Strait, Ungava Bay, Labrador and the Belcher Islands.

The greatest number of Canada geese killed by native peoples occurs in James Bay, and takes place mainly during the spring migration. Depending on weather conditions at the time of the northward migration, the kill of geese may be larger or smaller; the slower the spring, the slower the migration and, therefore, greater hunting opportunities for the Indians.

Hanson and Currie (1957) have published estimates of the goose harvest by natives. Since these figures were made available, new data have been compiled by the Ontario Department of Lands and Forests. The statistics for the period 1960 to 1966 indicate that the Indians in the three settlements of Moosonee, Fort Albany and Attawapiskat annually kill about 1,900, 3,200 and 3,700, respectively (Fig. 3).

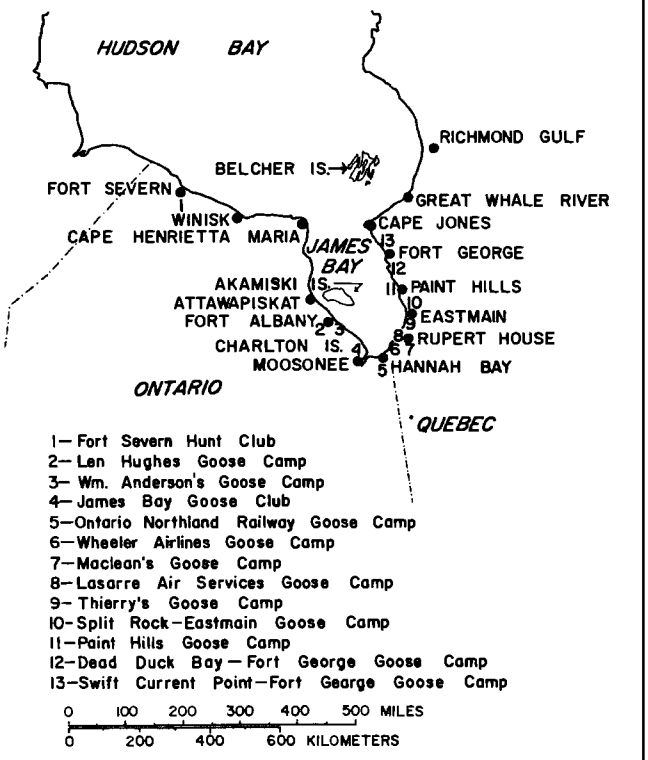


FIGURE 3. Commercial Goose-Hunting Camps, James Bay.

Spring shooting accounts for 80 to 90 percent of these geese. The annual kill by Indians at Winisk and Fort Severn, on the Ontario coast of Hudson Bay is 500 to 900 for each settlement. These are probably Mississippi Flyway geese (A. Gagnon and B. Dawson, pers. comm.). Indian bands south and west of James and Hudson Bays may account for 1,000 birds, but again these are probably Mississippi Flyway geese (B. Dawson, pers. comm.). Considering all the possible maximum figures, the annual harvest by Ontario Indians is approximately 11,600 Canada geese.

Unfortunately, accurate data on the goose kill do not exist for the four settlements of Rupert House, Eastmain, Paint Hills and Fort George on the east coast of James Bay (Fig. 3). Based on extremely limited data, we estimate that these villages take 12,000 to 15,000 Canada geese annually with probably 80 percent killed in the spring.

In review, if we take the maximum kill figures for all settlements, we feel it is safe to say that the Indians in James and Hudson Bays annually kill and retrieve about 26,600 Canada geese.

There are several communities of Eskimos on the east coast of Hudson Bay, the Belcher Islands, Hudson Strait, Ungava Bay and the Labrador Coast some of which annually kill numbers of Canada geese (Table 2).

TABLE 2 Eskimo and Indian Communities in Eastern Canada

Community	Population	
	Eskimos	Indians
Great Whale River	504	260
Port Harrison	411 (89 families)	0
Povungnituk	562 (119 families)	0
Sugluk	337 (60 families)	0
Wakeham Bay	167	0
Payne Bay	150 (30 families)	0
Fort Chimo	550	0
George River	158	0
Port Burwell	100	0
Belcher Islands	100	0

The Indians and Eskimos of Great Whale River annually travel south to Cape Jones for the fall goose migration. They may, depending on the migration pattern, kill up to 4,000 birds. They do not hunt north of the settlement because the geese generally overfly this area and only come to ground toward Cape Jones.

Belcher Island Eskimos do some wing shooting but most of the kill is of molting geese during the summer. Exact figures are unknown, but the take probably amounts to about 1,000 birds.

The largest harvest of Canada geese on the east coast of Hudson Bay is made by the Eskimos from Port Harrison and Povungnituk (Fig. 4). These hunters kill some birds during the spring and fall migration but by far the greatest take is during the summer molting period. Between the two, 2,500 to 3,000 flightless geese are killed each summer.

The Sugluk and Wakeham Bay Eskimos, on the south side of Hudson Strait, kill some geese during the fall migration but the total is small and probably does not exceed 600.

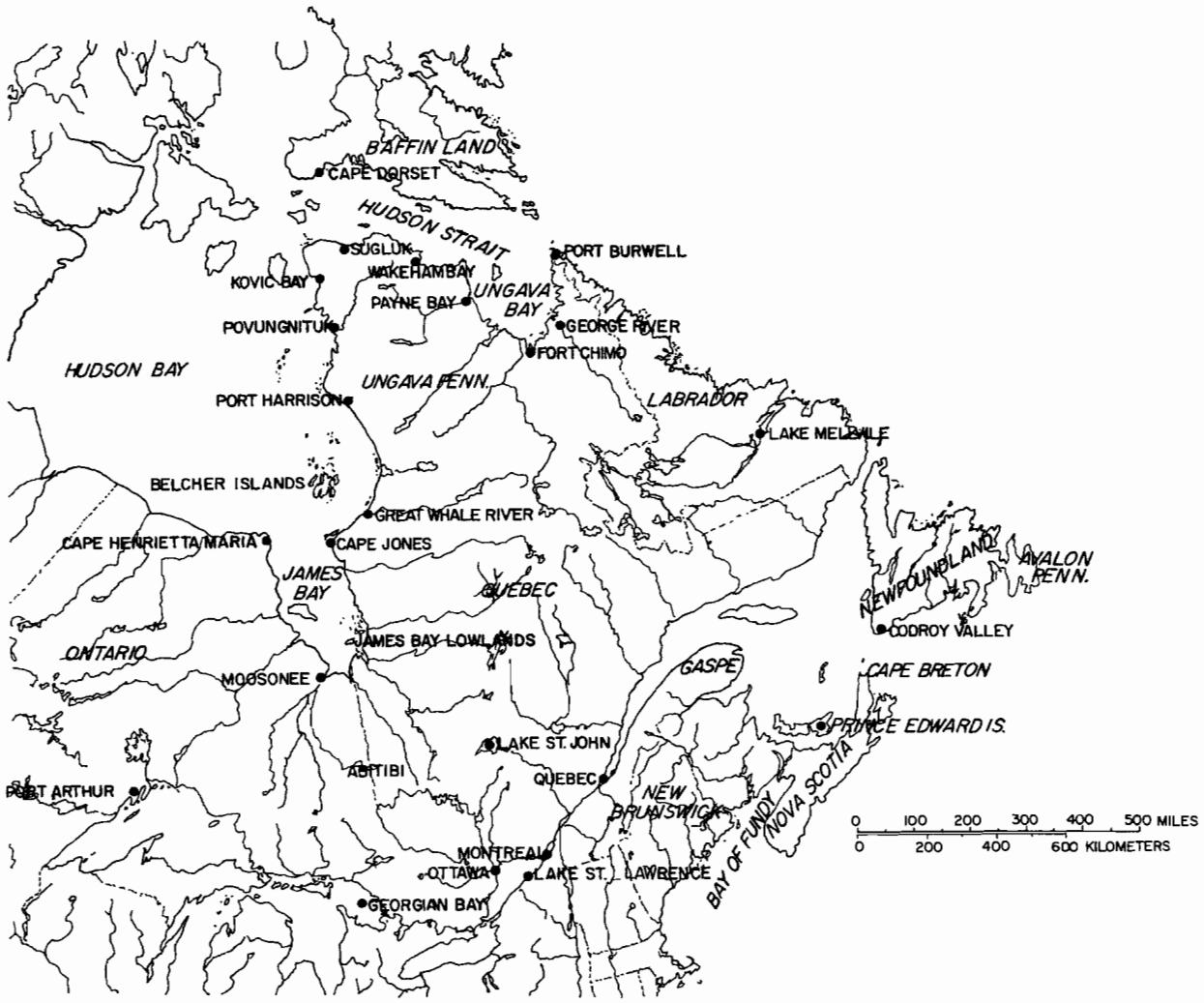


FIGURE 4. Names of Places in Eastern Canada Referred to in the Text.

In former times, natives from Payne Bay used to raid the molting grounds to the south of their settlement. However, this practice is not extensive now and probably very few geese are killed there. Eskimos at Fort Chimo kill only a few geese each year while those at George River and Port Burwell almost none.

The goose harvest on the Labrador coast is an unknown quantity, but probably is not large. Eskimos from Cape Dorset, Baffin Island, may kill up to 100 geese per year. They are prevented from getting more because the migrants overfly them and the nesting grounds are too remote.

In total, and here we add in 2,000 birds to cover the unknown kill, the annual harvest of Canada geese by Eskimos and Indians from Great Whale River around the coast to the Strait of Belle Isle may add up to 10,700 geese. This figure, coupled with the kill by Indians around James Bay and the Ontario coast of Hudson Bay, gives an approximate total of 37,300 Canada geese harvested annually by natives for subsistence in Ontario, Quebec, the Belcher Islands and Labrador.

White Sport-Kill – James Bay. For some years commercial goose-hunting camps have been operated in James Bay. Their locations are shown in Figure 3 and the capacity for hunters per day is indicated in Table 3.

In 1965 the Indian bands at Eastmain, Paint Hills and Fort George, Quebec, under the sponsorship and supervision of the Department of Indian Affairs and Northern Development, opened commercial goose-hunting camps. The locations of these camps are also indicated in Figure 3, and their capacity per day is shown in Table 3.

The number of Canada geese killed at these and the longer established camps indicate that we may expect approximately 400 geese to be killed on the west side of James Bay and 150 on the east coast by sport hunters. Approximately 250 of the 400 from the west side are taken at the Fort Severn Hunt

TABLE 3. Hunter Capacity of Commercial Goose-Hunting Camps in James Bay

Name of Camp	Location	Number of Hunters per Day
Len Hughes' Goose Camp	Ft. Albany, Ontario	20
William Anderson's Goose Camp	Ft. Albany, Ontario	20
James Bay Goose Club	North Bluff, Ontario	18
Ontario Northland Railway Goose Camp	Hannah Bay, Ontario	20
Wheeler Airline's Goose Camp	Cabbage Willows, Quebec	16
MacLean's Goose Camp	Ile Lemoine, Quebec	20
La Sarre Air Services' Goose Camp	Pontax River, Quebec	10
Thierry's Goose Camp	Jack River, Quebec	8
Name of Sponsoring Village		
Eastmain	Split Rock	12
Paint Hills	Paint Hills Bay	12
Fort George	Swift Current Point	12
Fort George	Dead Duck Bay	12

Club, and are probably Mississippi Valley geese. If we allow an additional 500 birds to compensate for the untallied kill, and for those birds brought into Moosonee by itinerant sport hunters operating out of the mouth of the Moose River from the town of Moosonee, we find that approximately 1,050 Canada geese are killed each year by sport hunters during the legal hunting season.

Taking all estimates, white and native, into consideration, the annual harvest of Canada geese in James and Hudson Bays is probably about 27,650 birds. In the whole region from James Bay to the Ungava Peninsula and the Labrador coast, the annual kill is approximately 38,350. Bear in mind that this is a calculated estimate and is subject to correction. In addition, weather conditions during the spring and fall migration periods may cause large increases or decreases in the harvest, especially in James Bay. It is well to point out also, that the kill of 38,350 does not concern the Atlantic Flyway entirely because a significant but unknown portion is involved with the Mississippi Flyway.

Three factors which may cause increases in the future in the sport kill in James Bay must be considered. (1) Because Canada geese traditionally migrate through the area in the early part of September, the date for the opening of the season in Quebec was advanced from the former dates of September 10 to 15 to September 1 in 1967 in order to allow sport hunters a greater opportunity to hunt these geese. (2) The commercial camps recently opened at Eastmain, Paint Hills and Fort George have as yet not become well known and, therefore, have not operated at capacity. However, in a few years we may expect that they will. At that time we may expect white sportsmen to frequent that portion of the shooting range more readily and more often. In addition, Canada geese are more common at the upper end of James Bay than at the lower. Therefore, once these camps become well established, more geese will be killed because of the greater availability of birds. (3) It is anticipated that within a few years a road will be built to Rupert House from one of the northern communities in Quebec. If this comes to pass, we can expect a greatly increased number of sport hunters in the southeastern sector of James Bay. Where now sport hunting in the area is restricted to a relatively few individuals, because of the high cost involved, the area will then be open to all who can afford to drive a car to Rupert House.

Taking these three items into consideration we anticipate the annual take of Canada geese in James Bay will show an increase over the next several years. However, we feel that it will be some time, unless drastic changes take place in hunting conditions or methods, before the sport kill becomes excessive.

White Sport-Kill – Southern Regions. Canada goose hunting areas in Quebec, south of James Bay, are scattered. The Abitibi area (Fig. 4) supports some hunting, but the numbers of hunters involved is not known nor is the number of birds shot. However, the kill is probably not large. Some hunting is done in Lake St. John (Fig. 4), but once again the extent is unknown. The area south and east of Montreal, and points east along the St. Lawrence River account for the largest kill in the southern portion of the province. The former area involves the immediate Montreal area and that extending south from Montreal to the Canada - U. S. border. The St. Lawrence River does not boast any particular "hot spots", but rather the hunting opportunity is scattered along the river to Gaspe. Surveys by the Canadian Wildlife Service indicated that the total kill of Canada geese in southern Quebec approximates 11,000 (Munro, 1962, 1963).

Hunting opportunity in southern Ontario is very sparse. Dawson (pers. comm.) states that the Lake St. Claire area and the extreme eastern end of the province are the only areas in the province

AS ONE COMMENTATOR has said, "The Mississippi Flyway and all of its problems overwhelm a lot of us. . . . If you don't get anything else out of this, try to grasp the complexity of this problem and the fact that it's going to become even more complex in the years ahead."

The Mississippi Flyway problem starts with the configuration of the flyway itself. Day has called it "a big funnel." More than any other flyway it is that—vast stretch of central and west-central Canada narrowing to the region of the western Great Lakes, its orifice a relatively constricted channel from the confluence of the Ohio and Mississippi Rivers southward. In this funnel less than a third of North America's Canada geese collide with over 40 percent of North America's goose hunters. What is more, the principal collision takes place in only a few areas where man, nature, and geese have conspired to produce concentrations of waterfowl and waterfowl hunters that have set modern records for high quantity and low quality in both birds and people.

Several lessons would seem to be quite clear from the Mississippi Flyway experience. First, the proper development of migration and wintering habitat will produce more geese. Second, more geese produce more goose shooters and goose watchers. Third, the heightened goose demand requires, on the one hand, elaborate inter-state compacts and intra-state controls to ration the take, and more travel-lane refuges and feeding grounds to increase and distribute the bird population.

Whether we can respond quickly and broadly enough to Vaught's cry for "more land" for geese and hunters becomes more a problem in socioeconomics than in ecology. A growing school of economists, led by John Krutilla, thinks we can afford it, if we can come up with a mechanism to correct the operation of the so-called "free market" so that "all natural areas peculiarly suited for specialized recreation uses receive consideration for such uses."

The Vaught paper summarizes the Mississippi Flyway situation, with emphasis on the growing economic and esthetic dimensions of goose management in a region of urban sprawl. Later in this book three other writers offer a detailed case history of the travails of husbanding and harvesting the Mississippi Valley Population.

2

PROBLEMS AND ECONOMICS OF CANADA GOOSE MANAGEMENT IN THE MISSISSIPPI FLYWAY

Richard W. Vaught

IT APPEARS THAT Canada geese have reached the point of being a predictable resource. Our talents as biologists and managers have been so successful in recording past events associated with Canada goose management that we can rather accurately predict, even in chronological order, what a given goose population will do under specific circumstances.

We can predict with near certainty, for example, when Canada geese will arrive at migration and wintering areas. We can predict much of their behavior following arrival, their reaction to food availability, the amount of food and preferred types that will provide a sustenance for a known population for a specific period, the changes occurring in distribution patterns, and of course problems associated with harvest.

With all our knowledge of Canada geese, however, we sometimes fail to direct it towards the culmination of some of our present and predicted management problems. It matters little in which flyway a problem exists. Canada geese react very much the same wherever they are located. Whether they be separated into populations such as Tennessee Valley, Tall Grass Prairie, Mississippi Valley or Eastern Prairie, problems dealing with each of these populations, during migration or on wintering areas, will be relatively the same. These include distribution, harvest, depredation and waste.

Although we have learned much about Canada geese on migration and wintering areas, we stand in the realm of mysticism concerning important factors that control annual production on the nesting grounds. Events occurring between the time of arrival on and departure from the nesting grounds still remain somewhat a riddle. If presently planned Canadian studies can be carried out and expanded, we may someday be able to predict what the fall flights will be and name the factors influencing them.

To more clearly understand one of the basic problems facing Canadian goose managers in the Mississippi Flyway, it is necessary to compare Canada goose populations and hunter numbers in each of the four flyways (Table 5). The average number of Canada geese in the January midwinter inventory during the past four years was 1,366,000. Less than 1/3 (31 %) of this number was located in the Mississippi Flyway. The average number of hunters in the United States for the three-year period from 1964 through 1966 was 1,575,000. About 42 percent of these were located in the Mississippi Flyway. The average total harvest for the same period was 549,000 geese. Hunters in the Mississippi Flyway took only 26 percent of this total. Such figures clearly indicate where flyway hunting pressures exist.

We certainly do not have a hunter shortage. The basic problem involves the age-old principle of supply and demand and there is little doubt about the dramatic increase of the latter. As a matter of fact, demand has become the directing factor of management. With present demand levels, most of our efforts are being exerted on harvest controls. The Bureau and state involvement in carrying out current surveys from nesting grounds to wintering areas, concerted efforts to establish new nesting flocks, increased expenditures for expanding goose research projects, and many other projects of equal importance

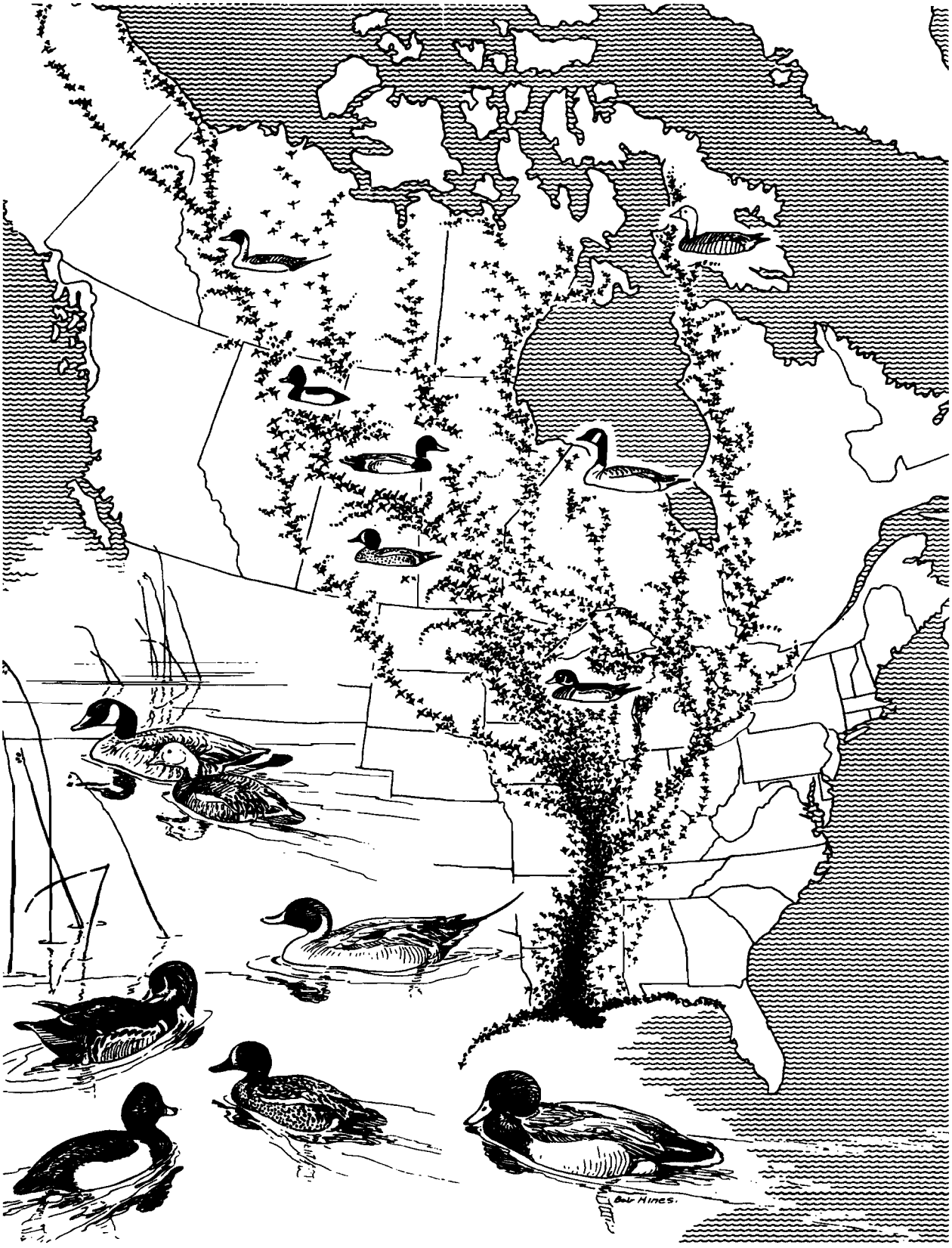

Bob Hines.

TABLE 5. Canada Goose Statistics by Flyway (1964-66)

	Canada Goose Population January Inventory*					Duck Stamp Sales Active Hunters*					Harvest No. Geese Bagged*				
Year	Atl.	Miss.	Cent.	Pac.	Total	Atl.	Miss.	Cent.	Pac.	Total	Atl.	Miss.	Cent.	Pac.	Total
1964	528	429	246	218	1,421	280	660	280	321	1,541	125	148	128	162	563
% of Total	37.2	30.2	17.3	15.3		18.17	42.82	18.17	20.83		22.20	26.3	22.7	28.8	
1965	482	443	244	138	1,307	279	615	250	332	1,476	77	139	81	122	419
% of Total	36.9	33.9	18.7	10.6		18.90	41.66	16.93	22.49		18.4	33.2	19.3	29.11	
1966	600	381	202	184	1,367	309	730	301	369	1,709	140	147	190	186	663
% of Total	43.9	27.9	14.8	13.5		18.1	42.7	17.6	21.6		21.1	22.2	28.7	28.1	
1967	604	481	226	220	1,531										
% of Total	39.5	31.4	14.8	14.4											
Average 1964-66	537	418	231	180	1,366	289	668	277	341	1,575	114	145	133	157	549
% of Total	39.3	30.6	16.9	13.2		18.3	42.4	17.6	21.7		20.8	26.4	24.2	28.6	

* In thousands

are further evidence of this great demand by the hunter for Canada geese. Even though present hunting pressures are considered high, these pressures will grow progressively higher as opportunities for hunting geese became more dispersed. Whether or not additional goose hunting opportunities are provided in the Mississippi Flyway depends to a great extent on our future management philosophy.

How many geese do we want? What are the limitations? Can we have too many? What are the criteria for quality goose hunting? Who decides quality – the hunter or the manager? What is our primary objective?

An answer to the last question is simple: the resource base is our primary obligation and this takes first priority. Much of our present-day thinking, however, is formulated under the guidance of past history. For example, when a Canada goose was killed twenty years ago it was a proud day for the hunter. The goose was paraded up and down the main street of the town, with the kill often publicized on the front page of the local press. Now we hear that applied goose management has destroyed the hunter prestige resulting from the bagging of a majestic Canada goose, or that the quality of the hunt has deteriorated because of the increased ease of harvest.

But have we tempered the image of deer hunting during the past fifteen years? Does the wild turkey carry the image it possessed five to ten years ago? As a wildlife resource builds through successful management, with resulting increased hunter enthusiasm, does this inevitably mean a decreasing prestige in the stalk or hunt necessary to bag an animal? With such pronounced interest being shown by hunters to take game, I seriously doubt there has been any loss of prestige. I hope we never return to the days when the killing of a Canada goose, turkey, or a deer is a rarity, if this be the base for quality. They now are plentiful, with most states harvesting more than ever before.

There has been talk of directing management to decrease Canada goose populations in some areas of the flyway. Would it not be reasonable to assume that with such management hunter interest would decline as it did with ducks when restrictive regulations were necessary? There is a well-known restrictive level, below which the hunt is no longer worthy of the time, effort, and cost involved. When this point is reached the hunters' desire and enthusiasm are suppressed. Restrictive regulations on ducks probably played an influencing role in diverting the interest of Missouri waterfowl hunters to geese. The availability of geese was, of course, also important.

Hunter numbers and harvest data collected from the Fountain Grove Public Hunting Area is an excellent example of what has happened in Missouri (Table 6). This area is located only a few miles from Swan Lake and is considered by many hunters as one of the best duck hunting areas of the state. In 1967, the Missouri goose season opened on October 20, while the duck season opened on November 1. For the first 12-day period 1,697 hunters directed their efforts to goose harvest only. Both duck and goose seasons were open for the next 12-days, and 2,465 hunters used the area. On November 12, the goose season

TABLE 6. Fountain Grove Harvest Data, 1967-68

Time (12-Day Period)	Hunters Present			Harvest During Type of Season					
					Geese and Ducks			Kill/Hunter	
	No.	Percent	Percent Change From Prior Period	Geese Only	Geese	Ducks	Ducks Only	Geese	Ducks
Oct. 20-31	1,697	36.2		1,394				.82	
Nov. 1-12	2,465	52.6	+45.3		1,661	1,835		.67	.74
Nov. 13-24	526	11.2	-78.6				803		1.53
Goose Season Total	4,162							.73	
Duck Season Total	2,991								.88
Combined Totals	4,688				3,055		2,638		

closed in the Swan Lake Zone which includes the Fountain Grove Area. The duck season remained open, but hunter numbers dropped to 526 during the following 12 days of "ducks only" hunting. This was a 79 percent decrease from the previous 12-day dual species period. It is not known whether similar situations are occurring at other comparable goose management areas in the flyway, or whether more lenient duck regulations will draw hunters back to ducks after experiencing goose hunting. We do know that restrictive regulations on ducks are immediately reflected in Duck Stamp Sales (Table 7). How restrictive we can be in regulating harvest of Canada geese without seriously reducing hunter interest in pursuing this sport is of utmost importance.

Harvest figures show a terrific demand for Canada geese in the Mississippi Flyway and in other flyways. Canada goose populations must be increased if we are to provide even a token of what is needed to satisfy present and future demands.

How can we increase populations in view of the problems we now face with present numbers? I do not believe our problems are a matter of "too many geese", but rather of "too little land". Most state and federal refuge lands in the Mississippi Flyway were originally acquired for purposes other than Canada goose management and consequently they are not large enough. The space required to provide for the needs of present and future populations is, to me, the No. 1 Canada goose problem in the Mississippi Flyway.

It does sound rather simple for it has been repeated over, and over again, "We need more land". Not just any land, but productive soil that will produce enough food to support double or even triple the population, if such is demanded. We can successfully manage Canada geese if we have the basic ingredient – food. Without it, the job is impossible.

Admittedly, productive land needed for Canada goose management is difficult to acquire, for it is not cheap. On the other hand, neither is the economic value of the resource we are attempting to manage. In a recent economic study in Missouri, Henderson (1964) reported some important facts concerning the value of the Canada goose resource at Swan Lake. Based on statistical calculations, he found the net benefits from the Eastern Prairie population while at Swan Lake exceeded 20 million dollars. The present value of approximately 120,000 Canada geese was determined by capitalization of the assets at 2.5 percent to be $120,497,500. Using a 6 percent rate, the value of future returns would be $341,873,908.

TABLE 7. National Duck Stamp Sales

Year	Mallards (Daily Bag-Possession)	Season Length	Number Sold
1946	7-14	45	2,016,841
1947	4- 8	30	1,722,677
1948	4- 8	30	2,127,603
1949	4- 8	40	1,954,734
1950	4- 8	35	1,903,644
1951	4- 8	45	2,167,767
1952	4- 8	55	2,296,628
1953	4- 8	55	2,268,446
1954	4- 8	55	2,184,550
1955	4- 8	70	2,369,940
1956	4- 8	70	2,332,014
1957	4- 8	70	2,355,353
1958	4- 8	70	2,165,562
1959	3- 6	50	1,628,365
1960	3- 6	50	1,727,534
1961	2- 4	30	1,346,003
1962	1- 2	25	1,147,553
1963	2- 4	25	1,451,605
1964	2- 4	40	1,565,860
1965	1- 2	40	1,558,755
1966	2- 2	45	1,805,341

TABLE 8. A Comparison of Total Local Expenditures of Hunters in Southern Illinois and the Swan Lake Area in Missouri, 1958 and 1964

Category	Southern Illinois Hunters, 1958	Swan Lake Hunters, 1964
Transportation	$ 37,000	$ 25,098
Food	206,000	77,756
Lodging	127,000	28,306
Blinds	365,000	156,798
Processing	30,000	26,379
Ammunition	48,000	24,866
Miscellaneous Expenditures (Including entertainment)	270,000	15,424
Total	$1,083,000	$354,627

A report of local expenditures by waterfowl hunters in southern Illinois (Joselyn, 1958) serves to show economic differences between areas. In 1958, hunters using a two-county area around the Horseshoe Lake Refuge spent approximately three times the amount expended in the Swan Lake area in 1964 (Table 8). If a statistical expansion of economic values were calculated for this population of Canada geese, the final results would be more astounding than those at Swan Lake. Another economic study compiled in an area associated with Horicon Marsh, Wisconsin, indicated local farmers and merchants took in approximately $560,000 annually (Keith, 1964).

Speaking in general terms, if these figures could be expanded to include all Canada geese in the Mississippi Flyway, the economic values would soar to more than a half billion dollars. It must be understood that such studies primarily incorporate net benefits from consumptive uses under a specific set of circumstances on a particular area. Other consumptive values accrue during migration north and south of these concentration points.

All these figures fail to take into account the aesthetic or nonconsumptive values. Admittedly it is difficult or nearly impossible to place an economic value on these items, but they may be as great or greater than the consumptive values.

The Honorable John D. Dingell of Michigan told members of the House of Representatives that hunters benefit many facets of the nation's economy, although the public is often unaware of it (Dingell, 1967). He reported that millions of American hunters contribute to the general well-being and welfare of the nation out of all proportion to their numbers. They pour about 1.5 billion dollars a year into the general economy. According to Henderson, Joselyn and Keith, a significant portion of this amount is related to the ultilization of the Canada goose resource.

Is not this value criterion enough for expending funds for acquisition of Canada goose lands?

If land is the No. 1 need in the Mississippi Flyway, the next question is where is the money to acquire it? At the present time "Duck Stamp" funds are being expended for duck production habitat in northern flyway states as rapidly as it is being appropriated. There is presently a backlog of acquisition contracts awaiting funds for processing. This program is a very worthy one and I support it whole-heartedly, but who is representing the goose hunters' interests? Is there a land acquisition program being directed to solve some of the goose problems? I have used the name "Duck Stamp" rather loosely and the designation is really a misnomer. It is a Migratory Bird Hunting Stamp, implying that funds from such be invested in areas of need including all migratory species hunted. Is it possible for migratory bird stamp funds to be allocated for land acquisition based on the division of hunter interest? If all the migratory bird stamp funds are to be diverted into duck resource needs, then it is time to look to other sources of income to protect the goose resource. Several of the more important existing goose management problems could be greatly alleviated by acquisition of food-producing acres.

Except for factors beyond our control that influence annual productivity on the nesting grounds, the future of this great resource still rests in our hands.

THE CENTRAL FLYWAY is a grab-bag of subspecies and situations.

The various "small" Canada geese constitute the least understood, the least managed, and the most numerous birds. The Tall Grass Prairie Population, composed principally of Richardson's Canada geese, follows one of the longest migration routes—from the eastern Arctic, down the eastern portion of the Flyway, to the Texas gulf coast. While its numbers seem to be down somewhat from the early 1960's, it should respond to reductions in daily bag limits recently imposed. In the western Central Flyway is the Short Grass Prairie Population, composed mainly of lesser Canadas. It breeds in the far north generally west of the 100th Meridian, stages in Alberta and Saskatchewan, and moves late in the season to Nebraska, Colorado, New Mexico, and Texas. This population is distinctly on the increase.

The "large" Canada geese in the Central Flyway likewise occur in two distinct populations. The western Prairie Population, composed mostly of Todd's Canadas, breeds in southern Canada and winters along the Missouri River. Its numbers are trending downward to the point where a specific management program will probably be called for. The Highline Population, composed of western Canadas, breeds on the prairies of Saskatchewan and Manitoba and is beginning to pioneer stock ponds in Montana; it winters in Wyoming, Colorado, and New Mexico. Its inventory trend is upward.

In general, in the eastern portion of the flyway, where birds are feeling human pressures, the Canada situation warrants some concern, while in the western portion the birds are increasing at a satisfying rate under current harvesting conditions. In only two places has the flyway experienced "over-population" problems. On the large Wagner Ranch in Texas a build-up of some 50,000 geese is sometimes responsible for depredation on green wheat, but the flock disperses under continuous harassment by aircraft. In the vicinity of Fort Collins, Colorado, the creation of a refuge shortstops some 10,000 birds which will probably have to be hurried along south to New Mexico by some device, in what Jahn calls "a fine example of good-neighbor policy."

3

CANADA GOOSE POPULATIONS OF THE CENTRAL FLYWAY—THEIR STATUS AND FUTURE

Jack R. Grieb

THE CENTRAL FLYWAY has been aware of the vagaries of Canada goose management for some time. It has taken steps, generally through committee action, to assemble all available information on populations of geese in the flyway and has instituted cooperative programs where necessary to provide information for management. These have generally been cooperative studies in the true sense of the word, with concerned provinces, states, Canadian Wildlife Service and the Bureau of Sport Fisheries and Wildlife contributing manpower, equipment, and in some cases, money. The result has been a strong improvement in our understanding and management of Canada goose populations in this flyway. Hopefully, this attitude and progress will continue in the future.

Central Flyway Canada geese can be divided into two general categories: (1) small white-cheeked species which nest in the Arctic; and (2) larger species which nest in the sub-Arctic regions mainly in the prairie provinces and northern states. In addition to these wild populations, many states have had excellent success with the establishment of local breeding populations which are beginning to flourish throughout the northern states of the flyway. These resident and semidomestic flocks will not be considered in this report.

Small White-Cheeked Canada Geese

This pint-sized member of Branta canadensis is the most numerous Canada goose in the Central Flyway. In addition it is probably the least understood and most unmanaged. Consider that the hunting season is set mainly on the basis of post-hunting season (January Inventory) counts and does not consider the production results of the current year. There is no other species of waterfowl which is managed quite so grossly!

Despite this, these birds are very much on the scene, and it is a tribute to their ability to maintain their status despite our feeble management efforts.

Tall Grass Prairie Population

This population originates in the eastern Arctic and migrates down through the eastern Central Flyway to its terminal wintering area along the Texas gulf coast (Fig. 5). It has one of the longest migrations of any of the distinct Canada goose populations. This population was named by Marquardt (1962) because its migration path follows the tall grass prairies of the great plains.

Marquardt (1962) spent considerable effort attempting to determine the variation of species in the Central Flyway. In general, he felt that birds he observed at Salt Plains National Wildlife Refuge were mainly variations of B. c. hutchinsii with smaller numbers of B. c. leucopareia, and B. c. parvipes. On the other hand, MacInnes (1963) believed that all geese in the Tall Grass Prairie Population were size variations of B. c. hutchinsii. I would doubt the existence of B. c. leucopareia in this population and would deduce that the majority if not all birds would be B. c. hutchinsii.

Breeding range of the Tall Grass Prairie birds in the eastern Arctic is generally east of the 100th

Meridian and north of about 60° N lat. Geese are not distributed evenly over this area but seem to prefer low coastal habitat such as the tidewater flats of the McConnell River which MacInnes (1963) used as a study area in his investigation of a portion of this population. This habitat preference makes transect sampling of the population difficult and probably impossible with any degree of reliability. As a consequence, fall flight forecasts are unreliable and only general inferences relating to population status can be made based on limited nesting surveys conducted by such persons as Charles MacInnes of the University of Western Ontario.

Nesting densities vary. In high quality habitat at McConnell River MacInnes (1962) found an average density of 6.5 nests per square mile, but on Southampton Island a 3.25-square-mile study area in the best habitat contained 14 nests. These probably represent some of the best breeding habitat in the Arctic, and nesting pair numbers exceeding this would not likely be found for any substantial area.

Migration begins early in the fall with a movement of geese into staging areas. MacInnes (1963) indicated that geese will reach peak numbers on sub-Arctic staging areas which include parts of Manitoba and Ontario about September 20 each year. Peak numbers will be present on staging areas mainly in North and South Dakota in mid-October. Kansas and Oklahoma concentrations reach peak numbers in mid-November, and the largest concentrations occur on wintering areas by mid-December.

MacInnes (1963) further points out that this is not a gradual sweep of geese into each of these areas from the area above, since it is obvious that fragments of this population over-fly some of the concentration areas and contribute to the buildup of populations to the south at the same time northern concentrations are increasing.

According to Marquardt (1962) the gulf coast of Texas from Galveston southward serves as the major wintering area for this population. Depending upon weather conditions, some birds will winter as far north as Salt Plains National Wildlife Refuge in Oklahoma. Furthermore, most geese are concentrated on Federal Refuges or private ranches which do not permit hunting. After the hunting season, geese disperse over a large area and utilize agricultural fields of the previous harvest season.

As a result of concern by some persons in the Central Flyway, a cooperative goose census was begun in 1960. Each year this effort has become more refined, and considerable confidence is now being placed in the results of this census. Generally, the survey is conducted by states and provinces, Canadian Wildlife Service and the Bureau of Sport Fisheries and Wildlife in mid-October of each year. It is an intense effort on a broad front from Canada to Texas, and undoubtedly offers the best possible estimate of the size of this population.

Results of past years' counts indicate that the population has fluctuated from almost 100,000 in 1961 and 1963 to about 70,000 the remaining years (Table 9). Brazda and Pospichal (1966) infer in their report that the 1962 inventory may have been in error and that there probably was a decrease in the total population from 1963 to 1964 when it dropped from almost 100,000 to 70,000 geese. They conclude that this population is no more than holding its own and may be decreasing slightly. In addition, they feel that there is an urgent need to continue all possible studies to determine the annual status of the population. They recommended that the objective be to increase the size of this population to 100,000 birds at the time of the early fall inventory.

To accomplish an increase in population size, Brazda and Pospichal (1966) recommended a decrease in total harvest by reduction in daily bag and possession limits. In addition they felt there was a need to reduce the length of season, establish a season bag limit on Canada geese, and expand the fall-winter banding program to provide better mortality estimates of this population.

Schoonover (1966) indicated that 74 percent of the second-year band recoveries in the 1963-65 period of birds banded (in-season) at Sand Lake National Wildlife Refuge occurred in "key harvest areas", which included parts of Manitoba, North Dakota, South Dakota, Oklahoma, and Texas (Table 10). He also indicated that the time and place of this occurrence within these states and provinces was conducive to species managment. Therefore, restrictions could be placed on this Canada goose population which would not influence the harvest of other goose populations.

Banding during the hunting season, such as that done at Sand Lake will describe harvest areas, but will not provide accurate estimates of mortality. MacInnes (1963) estimated annual survival of adults from second-year Sand Lake recoveries of birds banded 1956-62 at 75 percent. He further estimated immature survival rates from birds banded on his study area in the Arctic at 25 percent. Additional information is obviously needed along this line

The Tall Grass Prairie Subcommittee of the Central Flyway Technical Committee agreed with the interpretation of data previously presented. As a consequence, management objectives were set during the 1967 spring Technical Committee meeting which would reduce the harvest and attempt to increase the population by 20 percent as measured by the October coordinated survey. As a result of these proposals, the Central Flyway Waterfowl Council at the August, 1967, meeting in Omaha recommended a reduction in daily bag limit from 2 to 1 in "key areas" of North Dakota, South Dakota, Oklahoma and Texas with possession limits remaining at 2 birds. These recommendations were accepted by the Bureau of Sport Fisheries and Wildlife and became a part of the official hunting regulations for the 1967-68 waterfowl hunting season (USDI, 1967).

With the foregoing knowledge, we must conclude that this population, while down in numbers from the early 1960's, is not in serious shape. Now what about the future? Presently, there are a lot of people thinking about the Tall Grass Prairie Population. The Central Flyway has an active technical subcommittee working on it. Meetings have been held for the purpose of discussing research programs, both current and proposed. Charles MacInnes has

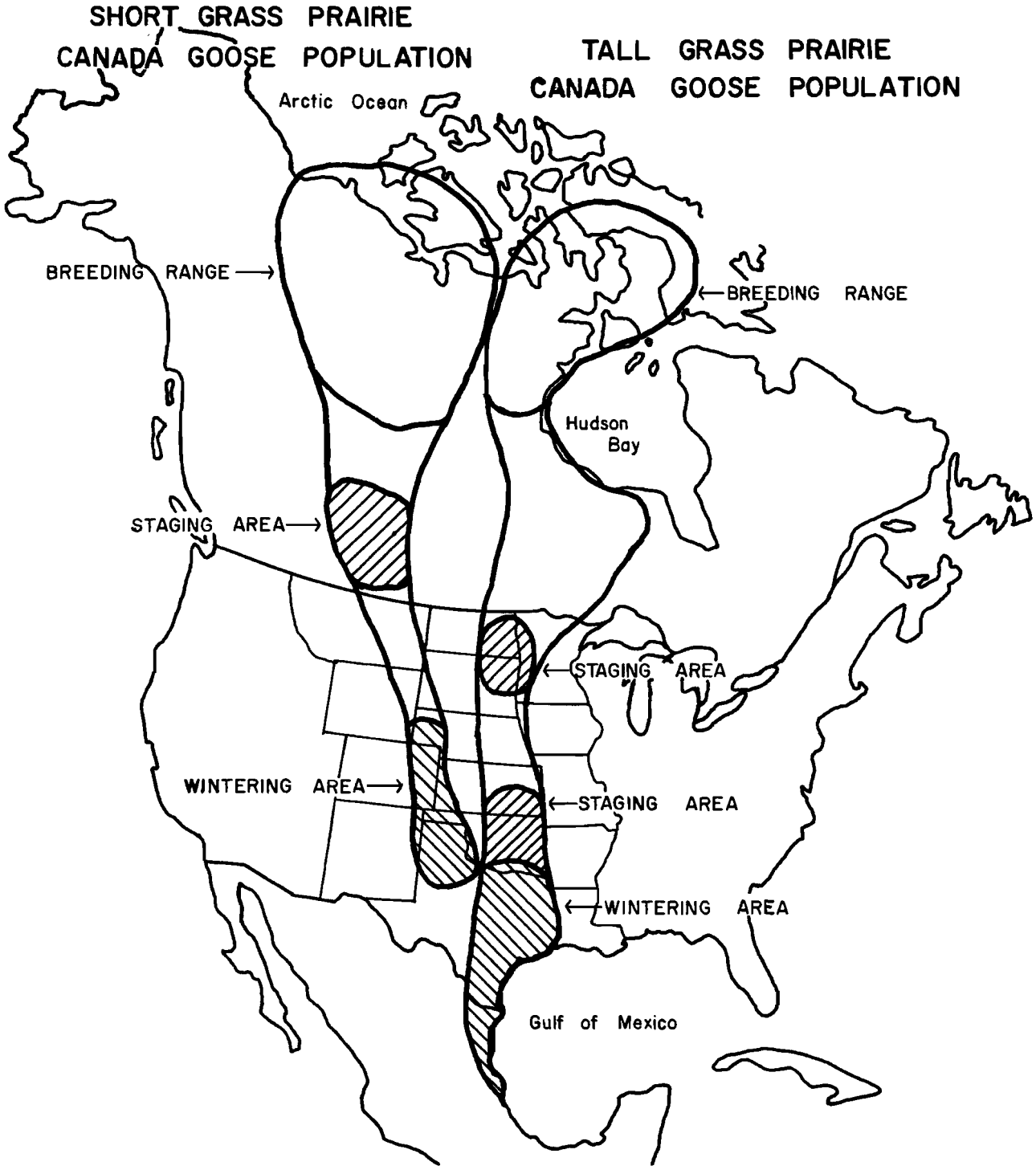


FIGURE 5. Ranges of Small White-cheeked Canada Geese of the Central Flyway.

TABLE 9. Results of Coordinated Tall Grass Prairie Canada Goose Population Census, Mid-October, 1961-66*

Area	Year					
	1961	1962	1963	1964	1965	1966
Canada						
Manitoba	No Count	5,000**	6,400**	675	1,109	154
Saskatchewan	No Count	No Count	8,900[1]	3,470	1,012	2,385
Total		5,000	15,300	4,045	2,121	2,539
Region III						
North Dakota	26,600	24,100	37,520	26,790	17,442	24,511
South Dakota	24,400	14,900	14,730	11,125	3,304	11,013
Minnesota	No Count	100	200	-	200	No Count
Nebraska	1,300	1,100	205	525	618	1,561
Missouri	1,000	1,200	No Count	1,350	3,575	4,320
Total	53,300	41,400	52,655	39,790	25,139	41,405
Region II						
Kansas	2,050	3,100	1,320	995	4,199	1,262
Oklahoma	23,550	8,400	14,360	16,685	19,881	12,667
Texas	18,850	10,750	15,295	13,315	19,336	11,353
Total	44,450	22,240	30,975	30,995	43,416	25,282
Grand Total	97,750	68,650	98,930	74,825	70,676	69,226

* From Brazda and Winship (1962) and Brazda and Pospichal (1966).
**Data not based on actual census, but on birds observed on a few areas at time of survey.
[1] Incomplete coverage.

continued his intensive research programs in the Arctic, which will permit more thorough knowledge of the biology of this breeding goose population. Plans have been made to improve the banding of this population. States have contributed money for Arctic banding efforts, and there are plans for cooperative banding on the lower Texas gulf coast which will include manpower and equipment from the Canadian Wildlife Service, states and the Bureau of Sport Fisheries and Wildlife.

Considering all of the interest and proposed surveys, we can be optimistic about the future of this population. Thus, it is believed that it will only be a matter of time before adequate management programs will be instituted with the result that the full recreation potential of this population will be realized.

Short Grass Prairie Population

This inhabitant of the western Central Flyway nests in the far north, generally west of the 100th Meridian and north of about 58° N lat, occupies staging areas in Alberta and Saskatchewan for several months during the fall, and winters in the western Nebraska panhandle, southwest Colorado, northeast New Mexico, and the Texas panhandle. It is generally considered a small white-cheeked goose and is composed mainly of Branta canadensis parvipes, with some B. c. hutchinsii and a small number of B. c. moffitti (Fig. 6).

Marquardt aptly named this population, as he did Tall Grass birds, after their affinity for the short grass portion of the great plains. However, analysis of band recoveries from wintering flocks and particularly those at Two Buttes Reservoir in southeast Colorado, the Waggoner Ranch flock in eastern Texas panhandle, and the Buffalo Lake flock in the central Texas panhandle, indicated that there were essentially two segments of this population. These have been named the eastern and western segment, with the eastern segment composed of birds wintering in the eastern Texas panhandle, and the western in the rest of the wintering area described.

The eastern segment of this population occupies the eastern portion of the generally described breeding area mainly in the vicinity of Coronation Gulf, Queen Maud Gulf, Bathurst Inlet, Sherman Inlet and Chantry Inlet and appear to be mostly coastal nesters (Tom Barry, 1966 pers. comm.). Dr. David F. Parmelee, Professor of Biology, Kansas State Teachers College (1966, pers. comm.) indicated that pairs of Canada geese were scattered throughout southeastern Victoria Island from the coast to at least 60 miles inland. He further concluded that this population was composed of Branta canadensis hutchinsii which was distinct from another group

TABLE 10. Distribution of Second-Year Band Recoveries of the Tall Grass Prairie Population Banded at Sand Lake National Wildlife Refuge*

Area	Year (Percent of Total Second-Year Recoveries)						
	1951-56	1957-61	1962	1963	1964	1965	1966
Saskatchewan							1.7
Ontario	2.4	.4	0	.7	.4	.6	.4
Manitoba	4.0	4.7	10.0	8.0	8.1	8.2	3.0
North Dakota	11.0	20.3	24.3	32.2	35.1	45.3	33.4
South Dakota	29.1	24.0	13.8	12.6	14.3	15.9	11.1
Nebraska	3.1	3.0	2.5	3.0	2.3	2.4	3.9
Kansas	4.7	4.1	5.4	3.3	3.1	2.9	3.0
Oklahoma	6.3	8.8	6.3	13.3	6.2	7.1	9.9
Texas	31.5	28.7	28.0	19.3	19.7	14.1	23.6
Minnesota	0	2.0	0	0	4.6	1.8	3.0
Missouri	1.6	1.1	1.7	.7	.8	1.2	.4
Mexico	.8	.9	4.6	0	3.5	.6	6.0
Iowa	.8	.6	1.3	1.0	.8	0	.9
Louisiana	0	.1	0	.3	.4	0	0
Wisconsin	0	.3	0	0	.8	0	0

*From Schoonover (1966).

of birds that occupied the Perry River area and the west coast of Baffin Island.

From all available information, eastern segment birds nest between 101° and 110° W long. MacInnes (1963) feels that there is a zone of possible interspersion of this population with the Tall Grass, roughly between the Simpson (101° W) and Ellice (104° W) Rivers and the Queen Maud Gulf region. This inference seems logical from the results of this study.

Robert Smith, Flyway Biologist, Bureau of Sport Fisheries and Wildlife (1966, pers. comm.) and Alexander Dzubin, Wildlife Scientist, Canadian Wildlife Service (1966, pers. comm.) have indicated that band recoveries in northern Alberta and the Northwest Territories are closely related to areas of human habitation. Smith, however, points out from these data that, while the Waggoner Ranch or eastern segment birds are barren land breeders, it seems clear that the western segment (southeast Colorado – Buffalo Lake) are predominately birds of the forest. Barry (1966, pers. comm.) also felt that Two Buttes birds are mostly occupants of the MacKenzie drainage. Thus, it appears that this western segment nests in an area west of 110° W long, west to the Yukon Territory, north of about 58° N lat to the Arctic Ocean.

Distinction between eastern and western segments of this population carry down to the staging area in east central Alberta and west central Saskatchewan. Analysis of band recoveries indicate that larger percentages of Waggoner Ranch bandings are recovered in Saskatchewan, and the same is true for Two Buttes bandings in Alberta. Admittedly, the provincial border is not the reason for separation of this goose population since geese are distributed by habitat rather than an administrative line. Actually, there are good migration areas close to the line between Alberta and Saskatchewan such as Grassy Island Lake, or Eyre Lake, which attract birds from both segments of this population.

Geese will remain on the staging area until forced southward by weather. Usually this will occur by mid-November, but birds have arrived as early as November 5 and as late as December 10 in the Arkansas Valley (western segment), and November 4 to December 5 at Waggoner Ranch (eastern segment) (Table 11). This behavior is decidedly different from that exhibited by the Tall Grass Prairie Population which, as previously indicated, moves into United States areas in early October. The reason for this difference is that prairie areas extend into Canada in western Saskatchewan and eastern Alberta. This is the grain-growing habitat used for staging areas by both goose populations.

Because Short Grass Prairie birds remain so long in Canada, a large portion of the total harvest is taken there. While only about 10 percent of the second-year Sand Lake band recoveries are taken in Canada, more than 50, and in some years as high as high as 55, percent of the total band recoveries from birds banded at Two Buttes Reservoir in southeast Colorado are taken in Canada (Table 12). These data do not reflect that immature birds are taken at a greater rate and, consequently, because of juvenile vulnerability, a larger proportion of young would be bagged in Canada. This would mean that even a larger percentage of the total population

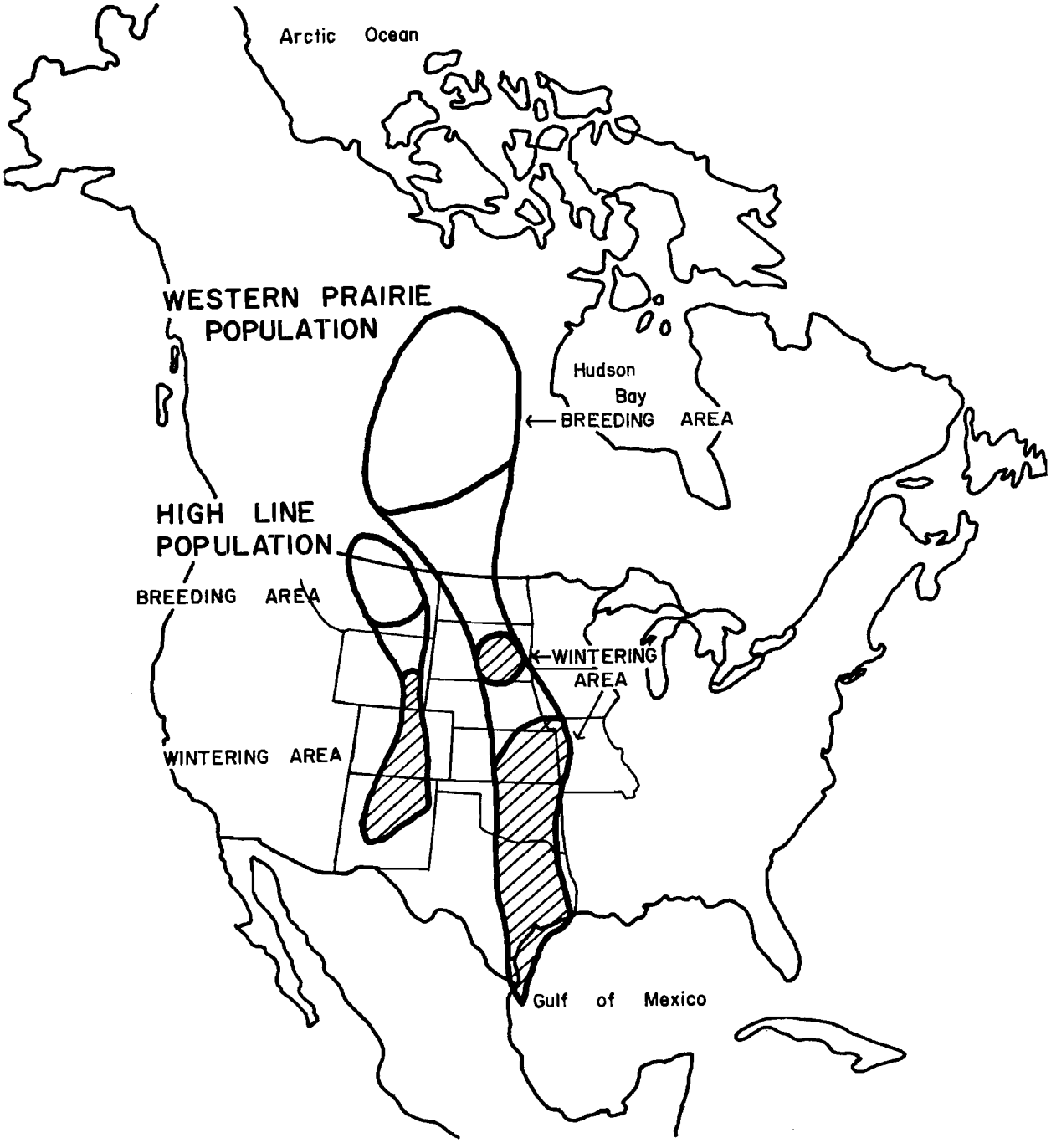


FIGURE 6. Ranges of Large White-cheeked Canada Geese of the Central Flyway.

TABLE 11. Arrival Dates of Short Grass Prairie Canada Goose Population on Their Wintering Grounds

Area	Year						
	1959-60	1960-61	1961-62	1962-63	1963-64	1964-65	1965-66
Colorado							
Arkansas Valley	Nov. 7	Nov. 8	Nov. 5	Dec. 10	Nov. 22	Nov. 20	Nov. 12
Nebraska							
Panhandle				Dec. 9			Nov. 12
Texas							
Waggoner Ranch	Nov. 5	Nov. 5	Nov. 4	Dec. 4		Nov. 20	Nov. 13
Buffalo Lake							Nov. 14

harvest than indicated by band recoveries occurs in Canada.

Several inventories of this population have been attempted in the past. One of these was a staging area census which was subsequently abandoned because test results indicated that counts on the staging area in Canada were not indicative of the number of birds which finally arrived on wintering areas. This technique breaks down simply because the same percentage of birds are not present on the staging area at the time of the count (second week in October) each year.

The objective of this inventory was to provide a look at this population as it moved from inaccessible breeding areas in the Arctic to the accessible reaches of the northern great plains. Population status inferences could then be drawn, and harvest

TABLE 12. Percentage Distribution of First-Year Recoveries by Banding Year, Southeast Colorado Bandings

Area of Recovery	Banding Year												
	1950-51	1951-52	1952-53	1955-56	1956-57	1957-58	1958-59	1959-60	1960-61	1961-62	1962-63	1963-64	All
Far North*	2.7	3.1	3.7		2.3	3.4	4.3		6.8	2.7	3.9		3.1
Alberta**	37.0	27.3	32.7	17.4	45.5	33.9	39.1	42.8	31.7	46.0	28.9	33.4	34.0
Saskatchewan**	20.0	21.0	29.0	13.0	11.4	8.5	6.5	16.7	11.4	21.6	17.3	14.8	18.4
Manitoba**	1.4												0.1
British Columbia**											1.9		0.1
Canada Totals	61.6	51.4	65.4	30.4	59.2	45.8	49.9	59.5	49.9	70.3	52.0	48.2	55.7
Montana	1.4	1.6											0.4
North Dakota									2.3				0.1
South Dakota	1.4	0.8				1.7	2.2	2.4		2.7	1.9		1.1
Wyoming	1.4	0.8											0.3
Nebraska	8.2	3.9	5.9	13.0	6.8	3.4	6.5	4.8	2.3	2.7	3.9	11.1	5.5
Colorado	20.5	22.6	17.0	47.8	20.4	38.9	32.6	30.9	25.0	21.6	21.1	18.5	24.5
Kansas											1.9		0.1
Oklahoma		0.8											0.1
New Mexico		1.6	0.7		2.3						1.9		0.7
Texas													
Buffalo Lake		10.2	4.4	4.4	4.5	3.4	2.2		6.8	2.7	7.7	11.1	5.1
Waggoner Ranch		3.1	4.4	4.4	6.8		2.2		11.4		1.9	7.4	3.3
Gulf Coast			1.5				2.2				1.9	3.7	0.7
Other Flyways	5.5	2.4	0.7			6.8	2.2	2.4	2.3		5.8		2.4
U. S. TOTALS	38.4	47.8	34.6	69.6	40.8	54.2	50.1	40.5	50.1	29.7	48.0	51.8	44.2
GRAND TOTALS	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Number Recoveries	75	128	135	23	44	59	46	42	44	37	52	27	712

* All Canadian recoveries above 53° N lat.
**Below 53° N lat.

manipulated by restrictions in the hunting regulations if a reduction was warranted.

The second count was also designed as a safety valve. It is conducted during the first week of December over all wintering areas. The actual date of the count is announced by the Assistant Regional Supervisor of Management and Enforcement, Region II, and results from each state or federal cooperator are returned to this individual. These data are then compiled and sent to all interested persons in the Central Flyway and Canada.

Essentially, this is a good count, and confidence can be placed in the results. Furthermore, it is made in sufficient time that, if warranted, states could take appropriate action to restrict the harvest of this population.

The best and most accurate inventory of this population is made in January during the very tail-end of the hunting season, concurrently with the regular January waterfowl inventory. The birds are still concentrated on refuge-type areas by hunting and results will indicate the number of geese remaining in the population after harvest. Inventory totals can be compared with the December count and if numbers do not reach expected levels the entire inventory can be repeated. This was done in 1966 when birds were obviously missed in both Colorado and Texas during the regularly scheduled inventory period.

Results of past January inventories are depicted for the eastern segment in Figure 7 and the western in Figure 8. These reveal that both segments have been increasing in a strong and regular fashion from 1948 through 1966. Obviously, inventories during earlier years are probably not as accurate as later counts, although poor inventories could have been responsible for fluctuation in counts during some of the more recent years. A more

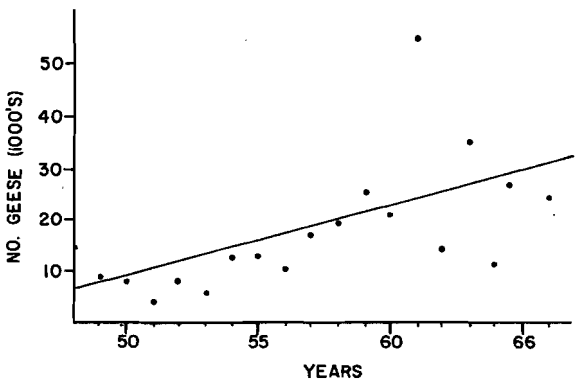


FIGURE 7. January Inventory Results of the Eastern Segment (Waggoner Ranch-Knox Co.) Short Grass Prairie Population (1948-1966).

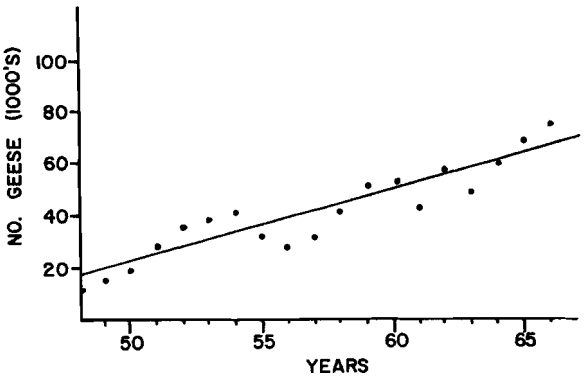


FIGURE 8. January Inventory Results of the Western Segment (S. E. Colorado-Buffalo Lake-N. W. R.) Short Grass Prairie Population (1948-1966)

reasonable idea of growth rate for the eastern segment can probably be obtained from the calculated regression line indicated in Figure 7. This line would tend to average together actual population changes and poor inventories and depict the growth rate of the population. From this we estimate that the eastern segment increased from about 6,000 birds in 1948 to almost 30,000 in 1966, an average annual increase of more than 21 percent.

The only obvious discrepancy in data plotted in Figure 7 is one count of 55,000 geese made on the Waggoner Ranch in 1961. This occurred prior to annual aerial harassment of this population on this area, and it is possible that a portion of the Tall Grass Prairie Population could have been present during the inventory period.

The growth rate of the western segment is likewise depicted by a regression line in Figure 8. This indicates an increase from about 15,000 in 1948 to 66,000 in 1966 which is an average annual growth of 19 percent over this time interval. It is interesting that both of these segments have increased in a similar manner over this span of years. This may indicate that habitat and mortality factors were similar between the two segments during these years of growth.

Annual mortality rates calculated from Two Buttes and Waggoner Ranch bandings indicate annual adult mortality of .280 for Two Buttes and .238 for Waggoner Ranch. These were calculated by the composite dynamic method as discussed by Geis and Taber (1963). Reasons for a lower annual mortality rate at Waggoner were that data were gathered mainly during the time geese were completely protected on Waggoner Ranch, and before aerial harassment drove these birds out to other areas each fall. It

is believed that the mortality rate of .280 is a good estimate of the total mortality received by this population, and that this has permitted a steady and continued growth over the years.

Mortality rates of immature birds are difficult to estimate since most banding was done during the winter after the hunting season. Limited banding on the staging area in Canada prior to and during the early part of the hunting season indicates a first-year mortality rate of .389 for adults and .548 for birds-of-the-year. These rates are undoubtedly high since band recoveries were not complete for any cohort at time of analysis. However, they do reaffirm that juvenile mortality during the first year is greater than that sustained by adults.

In consideration of this information, the status of this population is excellent and losses due to all mortality causes do not exceed the productive capacity of the population. This does not mean that this balance cannot be upset either by poor production rates or overharvest in some areas. For this reason it has been proposed that an annual meeting be held in conjunction with the spring Central Flyway Technical Committee, with representatives of appropriate provinces, states, the Canadian Wildlife Service and the Bureau of Sport Fisheries and Wildlife, to discuss the current status of and make recommendations for the future of this population. Hopefully, the future status of this population can be manipulated through the use of season length and bag size regulations without resorting to some form of quota system.

Large Canada Geese

The large subspecies of Branta canadensis generally breed farther south and winter farther north than their smaller counterparts. Because of their accessibility during the year it would not be surprising if more and better information had been developed than for small Canada populations. This, however, has not been the case, and generally speaking we know far less about the large birds.

Banding programs of large Canada populations have been somewhat sporadic. Inventories have not been coordinated, and are not particularly reliable. As a consequence, we do not fully understand the extent of breeding range, migration routes and wintering areas. In addition, mortality rates are not known and estimates of population status and trends are vague. We are not even sure that all populations have been isolated and identified.

At least two specific populations of large Canada geese do exist in the Central Flyway. These will be examined in the remainder of this discussion.

Western Prairie Canada Goose Population

This population appears to be composed mainly of Branta canadensis interior with some B. c. moffitti and remnants of B. c. maxima which may have existed as independent populations in past years (Vaught and Kirsh, 1966; Rutherford, 1965). However, Nelson (1962) assumes that most of the birds wintering in South Dakota are B. c. moffitti. Regardless of the taxonomy, it is one of the largest populations of Canada geese in the Central Flyway where the least management information is gathered annually.

Fortunately, this situation is recognized and will soon be corrected. According to information received from Rod Drewien, South Dakota waterfowl biologist (1967, pers. comm.) all available information relating to this population will soon be analyzed by himself and Leo M. Kirsh, Bureau of Sport Fisheries and Wildlife, in an effort to learn more about the current status and make recommendations for the future of this population.

Location of the nesting range, based on recoveries of birds banded at Lake Andes National Wildlife Refuge, Fort Randall Reservoir, and Red Lake in South Dakota, extends from the area around Portage la Prairie, Manitoba, westward to eastern Alberta. The southern boundary extends to about 49° 30' N lat, with the northern boundary extending possibly to the treeline (Fig. 6) (Drewien, 1967 pers. comm.; Rutherford, 1965; Vaught and Kirsh, 1966; Williams, 1967).

Drewien indicated few band recoveries from the northern portion of the breeding range, but limited recovery data did reveal that nonbreeders and possible unsuccessful nesters apparently move north into the Beverly Lake area, Keewatin District (64° 30' N lat, 100° 30' W long) N.W.T. for the summer molt.

Timing of migration for this population seems to be later than the Tall Grass Prairie birds, and probably is similar to the Short Grass Prairie Population. Peak counts of geese in South Dakota have been recorded as early as November 1 and as late as the first week in December. Usually, the major movement occurs between November 10 and 20 (Drewien, 1967, pers. comm.).

All information indicates that the major wintering area occurs along the Mississippi River including the Fort Randall Reservoir area and Lake Andes National Wildlife Refuge in southeast South Dakota. An unknown but probably smaller number of birds winter south of this area as evidenced by small but consistent numbers of recoveries mainly from Missouri, Oklahoma and Texas (Drewien, 1967, pers. comm.). Rutherford (1965) indicates that a few birds winter as far south as the Texas gulf coast (Fig. 6).

Harvest areas, as judged by band recoveries, indicate that about 75 percent of South Dakota banded birds are recovered in South Dakota, Saskatchewan and Manitoba. The other 25 percent come mainly from harvest areas in Missouri, Oklahoma and Texas, with a minor portion from Nebraska and Kansas (Drewien, 1967, pers. comm.).

Size of this population has been quoted as high as 60,000 to 100,000 geese with concentrations up to 40,000 on such places as Fort Randall Reservoir in South Dakota (Buller, 1967, pers. comm.). The results of weekly aerial counts along the Missouri River since 1953 reveal that the largest number counted were 48,000 birds in 1954 and the smallest

peak was 23,500 in 1967. Peak counts for the three previous years were 36,400 in 1964; 25,500 in 1965; and 28,100 in 1966 (Drewien, 1967, pers. comm. and Nelson, 1962). This information shows somewhat of a downward trend in this population; however, the degree is difficult to assess.

The Western Prairie Population has reached a position where careful consideration should be given to the annual determination of its status. Certainly, the compilation of available data by Drewien and Kirsh will do much to indicate areas where additional study is needed, and to pinpoint the range of this bird, so that an adequate management program can be formulated

Highline Canada Goose Population

This population of the Great Basin Canada goose, Branta canadensis moffitti, breeds in the prairie portions of southwestern Saskatchewan and southern Alberta, and eastern Montana. The population migrates down the front range of the Rocky Mountains to its wintering areas on the North Platte River in eastern Wyoming and adjacent lakes, north central Colorado and to its terminal wintering area on the Bosque del Apache National Wildlife Refuge south of Alburquerque, New Mexico (Fig. 6) (Rutherford, 1965).

The estimated posthunting season population as of January, 1967, was about 19,000 geese of which approximately 2,000 wintered in Wyoming, 12,000 in Colorado, and 5,000 in New Mexico. According to Dale Witt, waterfowl biologist in Montana, (1967, pers. comm.), annual mortality rates from past bandings average 37 percent for adults and 50 percent for juveniles. It is further estimated that the average fall flight in recent years prior to the hunting season was at least 22,000 birds.

The general trend of this population is upward judging from a steady increase in numbers of wintering birds. This appears to be a result of goose breeding pairs pioneering into the stock pond area of eastern Montana (Witt, 1967, pers. comm.). This spreading out has increased the production potential of the population and generally provides it with a larger, more stable breeding base with which to safeguard its annual status.

The general objective is to increase the size of this population by about 10 percent each year. This objective can apparently be met with current hunting regulations barring a series of poor production years, and a continuance of current harvest levels in all harvest areas. During the present year (1967), a late April snowstorm and extremely cold weather (below zero continuously for a week in northern Montana) hampered nesting attempts and hatching. It has been predicted that the fall flight of this population may be as much as 20 percent below that of last year (Witt, 1967, pers. comm.).

One interesting problem which has occurred in the management of this population is that inadvertently Colorado has begun holding larger than normal numbers of wintering geese in the area north of Denver. This came about when a large area was closed to goose hunting to protect a resident flock being established in the Fort Collins vicinity. From 1948 through 1959, January inventories in this area had encountered geese during only two years, and these numbered no more than 70 birds. With the first year of the closure in 1960, 660 geese wintered in the closed area, and this number has increased steadily each year until 1967 when almost 10,000 Canada geese were counted on the inventory.

Although about 800 of the 10,000 birds were residents, it is still obvious that the closed area attracted many migrant birds. With this in mind it has been agreed with New Mexico that no new areas will be closed to goose hunting in this northern portion of Colorado. Furthermore, if low numbers continue in New Mexico wintering areas, some additional relief will be given by opening closed areas in an effort to push birds south with hunting pressure. States of the Central Flyway are aware of the needs of their neighbors and do not propose to interfere with their wintering waterfowl populations to the extent that they will loose access to their resource.

Conclusion

Canada goose populations of the Central Flyway are generally in good condition. Perhaps eastern flyway populations, such as the Tall Grass Prairie or the Western Prairie, are not as numerous as they once were; nevertheless, the strong cooperative attitude which presently exists between provinces, states and federal agencies in Canada and the United States indicates that the future of these populations will be safeguarded.

Western Flyway populations, including both the Short Grass Prairie and the Highline, are in good shape. Numbers of both populations are generally increasing at a satisfying rate under current harvest conditions.

If there is any conclusion to be drawn, perhaps it is that the eastern populations are feeling the influence of increased human pressures and demand. This may be the reason for a general leveling off or perhaps even a slight decrease in Canada goose numbers. Whatever the reason the time is not too late to institute corrective procedures to improve the status of these populations. With the type and quality of management information we are now beginning to gather, and with the tremendous cooperative spirit exhibited by all management agencies, we can anticipate that future management of these Canada goose populations will fully exploit their recreation potential to provide the maximum amount of hunting for the sportsmen of Canada and the United States.

SEVEN SUBSPECIES of Canada geese winter in the Pacific Flyway. Most of them come from Alaska. Most of them are physically and numerically smaller than their eastern cousins. Three subspecies require special management measures at the present time.

The Aleutian Canada goose is on the official list of rare and endangered species. Introduced foxes are the culprit. Through aerial application of treated bait we may be able to rehabilitate enough nesting islands to save the race. The Great Basin population of the western Canada goose has been under such heavy hunting pressure that curtailed seasons and bag limits have been in effect since 1955. These self-imposed restrictions have resulted in significant increases in the various flocks. The dusky Canada goose is a small, well-defined subspecies whose population dynamics is well understood but whose destiny hinges on the practices of a few hunting clubs within a 20-mile radius of Corvallis, Oregon.

These examples illustrate the importance of coming to understand cause-and-effect relationships in goose ecology and the equal importance of accepting responsibility for indicated management decisions.

4

PACIFIC FLYWAY CANADA GOOSE MANAGEMENT—FEDERAL AND STATE COOPERATION

Henry A. Hansen

ONLY THOSE WESTERN populations of Canada geese that require special management measures at the present time are discussed here: (1) Aleutian Canada goose, Branta canadensis leucopareia, (2) the Great Basin segment of the Western Canada goose, B. c. moffitti, and (3) dusky Canada goose, B. c. occidentalis. These three populations illustrate quite well the possibility for varying degrees of federal and state cooperation in management of migratory birds. Under the Migratory Bird Treaty Act ultimate responsibility for management of waterfowl clearly rests with the federal government through the Secretary of the Interior. There are specific instances, however, where states can and do show much leadership in the management of waterfowl as they do for resident species. As data on life history, geographic range, and population dymanics grow in volume and quality these opportunities increase.

With but one or two exceptions the seven subspecies of Canada geese* that winter in the Pacific Flyway originate from breeding grounds entirely west of the Continental Divide, primarily Alaska (Hansen and Nelson, 1964). Most of them are numerically smaller than their eastern cousins. Only one of them, the cackling Canada goose, B. c. minima, may number as many as 200,000-250,000 individuals in a good fall flight. At the other end of that it is on the official list of rare and endangered birds.

Aleutian Canada Geese

The Aleutian Canada goose provides a special challange. Murie (1959) searched the literature in conjunction with his extensive studies in the Aleutian Islands prior to World War II and documented the decline of this goose from abundance to near-extinction. A review of this case history leaves little doubt that foxes were the primary cause for extirpation of nesting geese from all the islands on which foxes had been introduced.

Aerial application of treated bait for eradication of the fox has already been developed and applied to Amchitka Island. The logistics of extending the technique throughout the vast domain of the Aleutians is another matter, however. The isolation of the outer Aleutian Islands, spawning area of what may very well be the world's most disagreeable flying weather, makes rehabilitation of the habitat both expensive and difficult. Turner (1886) kept weather records in many parts of the Aleutians (Table 13) from which Murie (1959) gave a very accurate verbal picture that describes the obstacles to flying. "A striking feature of the Aleutian climate is the prevalence of foggy or cloudy weather, the abundance of rain summer, and the frequent violent winds that arise suddenly and unexpectedly. . . . Briefly, then, one might say that although the temperature is mild – neither very low in winter nor very high

*Based on Delacour's work in 1954 in which he recognizes 11 living subspecies. The taxonomy of Branta canadensis is the subject of current extensive study and possible realignment.

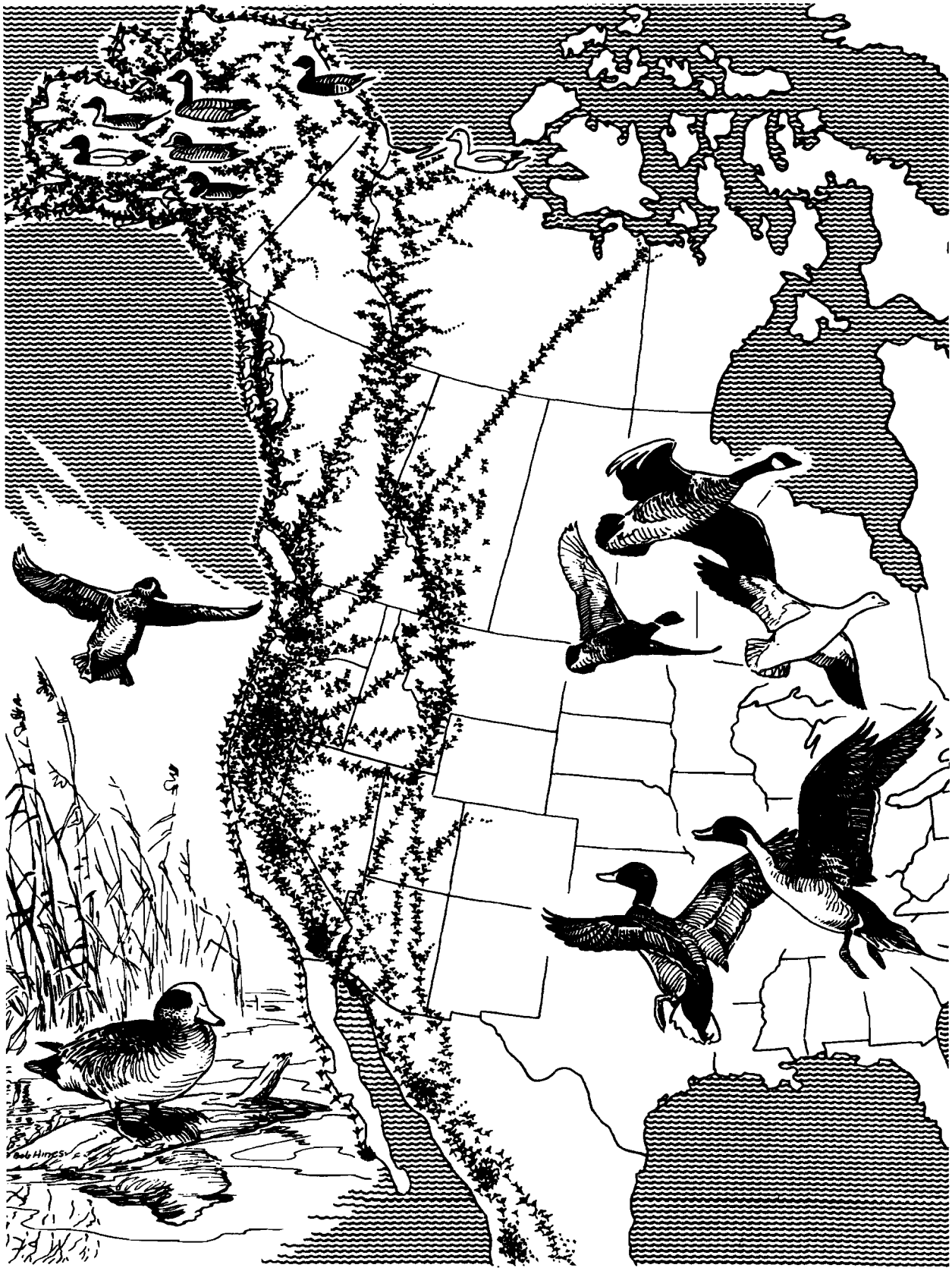


TABLE 13. Weather Records From Atka Island, 1879, and Attu Island, 1880-81, Alaska (Turner, 1886)

Month	Temperature (F.)			Number of Days	
	Mean	Maximum	Minimum	Clear	Fair
Atka Island					
May	39.90	65	30	0	0
June	42.08	64	30	0	2
July	48.96	65	38	2	4
August	50.31	69	45	0	0
Attu Island					
July	52.35	66	42	5	3
August	51.56	66	38	3	5
September	47.75	58	36	6	6
October	41.12	49	30	0	4
November	35.45	46	25	0	4
December	33.91	44	22	0	1
January	31.17	42	17	1	6
February	31.95	41	17	0	8
March	29.02	41	11	1	7
April	36.70	52	26	0	3
May	39.55	49	31	0	1

in summer – there is a minimum of sunshine and a maximum of fog and storm."

As money and manpower can be allocated to the project, fox control on the islands will be expanded in a gradual stepping-stone operation from Amchitka Island. The control will be designed to keep pace with the capacity for raising brood stock in captivity for restocking purposes. In the summer of 1962, Robert D. Jones, Manager of the Aleutian Islands National Wildlife Refuge, located a small breeding colony of geese on Buldir Island where foxes had never been introduced. A few goslings were brought back to start a captive flock which is now established and reproducing. There is a total of 44 Aleutian Canada geese in captivity, 37 at the Endangered Wildlife Research Station at the Patuxent Research Center, and 7 others shared among 3 private propagators. As soon as the captive flock has increased enough to produce about 50 young geese in one season these will be used to experimentally restock one of the rehabilitated Aleutian Islands. The program should accelerate rapidly from that point, hopefully within a very few years.

In the meantime there is still much to be learned about the travels and traditions of the wild birds themselves. With so few individuals mixed among hordes of Canada geese of other races on the wintering grounds there is little opportunity for knowledgeable, interested people to observe them, either among living populations or in hunters' bags. Therefore, we know practically nothing about the route and timing of Aleutian Canada goose migrations, the location of their wintering grounds, their mortality rate from hunting and other causes or their total abundance. Old records indicate that they wintered along the coast of Washington and Oregon, in the interior valleys of California down to northwestern Mexico, and down the western side of the Pacific to Japan. Two years ago Dr. John Aldrich made a sight record of one Aleutian Canada goose among cacklers and lesser Canadas on the Grizzly Island management area of the Suisun Marsh in San Francisco Bay. Chapman (1967) lists B. c. leucopareia among the races of Canada geese identified in hunters' bags in the Willamette Valley of Oregon in the fall of 1966. There are also recent records of Canada geese from Japan (tentatively ascribed to B. c. leucopareia).

From a practical standpoint would it be sound management to close the season on a thrifty, heavily utilized, mixed population of Canada geese to protect the Aleutian subspecies if they were, in fact, discovered to be scattered thinly among the large flocks? Or would it be sufficient to restore them as quickly as possible on the breeding grounds, hopeful that they would mingle widely enough among others on the wintering grounds to protect them adequately? The latter course would seem to be the more prudent one inasmuch as a remnant population has survived for years under such a system of "management".

Because of the rare status of the Aleutian Canada goose and the difficult logistics required for its restoration there appears to be little question about the federal government's primary responsibility for research and management. State personnel should be made aware of informational gaps and alerted to the contribution they can make through observations on the wintering grounds and in hunters' bags.

What of the future status of the Aleutian Canada goose? Early records concerning its abundance are

somewhat hazy and fragmentary. Based on the available evidence, however, Murie (1959) concluded that they must have been both widely distributed and numerous prior to the introduction of foxes. If their nesting islands can be restored, there seems to be no reason, other than possible overharvest, why these geese cannot regain their historical abundance.

Great Basin Canada Geese

The subspecies, Western Canada goose, is comprised of many populations extending from the eastern slopes of the Cascade Mountains well out onto the plains east of the Continental Divide and from California, Nevada, Utah and Colorado north into British Columbia, Alberta and Saskatchewan. Contrasted to this far-flung empire, each of the other subspecies has a breeding range much more restricted and their line of flight between breeding and wintering grounds is simple and direct although considerably longer in most cases. The Great Basin population of the Western Canada goose is a loose aggregation of numerous isolated flocks in Utah, Idaho, Colorado, Wyoming, Montana and Alberta which may total up to 40,000 in the fall flight (Fig. 9). The remainder of this subspecies, scattered from southeastern British Columbia down to northern California, has roughly another 60,000 geese, for a total population of about 100,000.

It is interesting to note that the hunting pressure on the Great Basin flocks is such that they have required curtailed seasons and bag limits since 1955 in order to maintain their numbers, while restrictions have been unnecessary for the western flocks. The Great Basin segment comprises about 38 percent of this subspecies in a geographic area containing only 25 percent of the hunters in the flyway, whereas the western flocks (62 percent of the total geese) occur in those states containing 75 percent of the hunters. Perhaps the latter population has been diluted among flocks of other subspecies of Canada geese, snow geese, Chen hyperborea, and white-fronted geese, Anser albifrons, whereas there are few geese of other species within the range of the Great Basin goose to help divert gun pressure.

Be that as it may, a significant feature of the hunting restrictions on the Great Basin flocks was the manner in which they came about. Although published as federal regulations, the need for restrictions was identified by the Flyway Technical Committee and recommended to the Flyway Council which in turn requested a curtailment in season and bag limit. Even more important was the fact that some states willingly agreed to differential regulations whereby they would be restricted to a greater degree than their neighbors. In fact, California and Arizona accepted a complete closure adjacent to the Colorado River. This was not done to protect California-raised geese but to help restore breeding populations in Wyoming and Idaho which had already sustained maximum hunting mortality before they reached their ancestral wintering grounds along the

FIGURE 9. Breeding and Wintering Grounds of the Great Basin Segment of the Western Canada Goose and the Dusky Canada Goose in the Pacific Flyway.

lower Colorado River. Other states have subsequently requested further restrictions where the need has been shown.

In conjunction with the self-imposed restrictions, the Flyway Technical Committee launched a well-coordinated study with the Bureau of Sport Fisheries and Wildlife among all the states involved to determine annually the status of each of the breeding flocks contributing to the Great Basin population. The responsible action of the Pacific Flyway Council, collectively, and its several members individually, has been rewarded. During the first 10 years in which the restrictive daily bag was in effect all of the flocks increased, some as much or more than 200 percent since their low numbers in 1955.

It is difficult to predict how large this intermountain aggragation of geese could eventually become or how large it may have been historically. There is reason to believe that several flocks, along the major river systems in particular, increased substantially after the Indians were concentrated on reservations and forced from their nomadic life. Nests, young geese and flightless adults much have been exceptionally vulnerable to foraging Indians along the rivers. Some of the early settlers and boatmen on the Snake and Columbia Rivers noted the slow but gradual increase of summer resident geese after Indian activity on the rivers declined (Yocom, 1962).

In the past quarter of a century much of the prime island nesting habitat has been flooded behind hydroelectric dams. On the other hand, several man-made marshes and irrigation reservoirs have created new, attractive nesting habitat. How much one has offset the other is debatable, but the fact that the population continues to grow indicates that unsaturated breeding habitat still exists. Whatever potential this habitat may have will eventually be utilized as long as the Flyway Council continues to match its past responsibility in concert with the Bureau.

Dusky Canada Geese

In contrast to the collective measures undertaken on behalf of the Great Basin goose, responsibility for action in behalf of the dusky Canada goose stands in lonely isolation. With regard to the former, any one state could rally the support of and share the responsibility with several neighbors should its sportsmen seriously question the need for restrictions. The destiny of the dusky Canada goose is controlled by the hunting pressure, not only in one state, but in a restricted area in one small river valley. Two-thirds of the total recoveries from 5,692 geese banded since 1952 have come from the Willamette Valley of Oregon – most of them within a 20-mile radius of Corvallis. The remainder have come from scattered small areas in Alaska, British Columbia, and Washington where manipulation of regulations would have little if any effect on population control.

The dusky Canada goose is a numerically small, well-defined subspecies whose population dynamics is probably better understood now than for any other group of Canada geese. The post-hunting season population has fluctuated between 10,000 and 20,000 birds since 1953 (Table 14) with an annual harvest of 4,000 to 5,000 in the Willamette Valley and 2,500 to 3,500 elsewhere. The numerical margin for error in the allowable harvest of a small population is proportionately less than for a larger population, and with a heavily concentrated hunting pressure producing high mortality rates, responsive regulations are essential.

Fortunately, detailed studies on both the breeding and wintering grounds in conjunction with an intensive annual banding program furnish the information necessary to establish such regulations. Hansen (1962) developed a formula based on an analysis of the first 10 years of banding to show how season length and/or bag limit manipulation in the Willamette Valley could be used to predictably alter the population. Chapman (1967) and Henny (1967) have subsequently completed more detailed analyses spanning 15 years of banding in conjunction with recent field studies in the Willamette Valley. Their work not only corroborates the earlier analysis but establishes a firmer base from which to adjust regulations with greater assurance.

Although the dusky Canada goose population has remained relatively stable numerically, it has acquired an unfavorable age ratio. Years of hunting with a maximum harvest rate on the adult component leaves the flock overbalanced with nonbreeding birds when it returns to the nesting gounds. There is a marked differential in the age structure of the kill as the season progresses beyond December 20. Most of the relatively more vulnerable immature geese have been removed from the population by then, but even though the total population has declined, the heavy rate of harvest remains constant. In order to maintain a constant kill from a shrunken population in which the immature component has been depleted the slack would have to be taken up by adult geese. An analysis of the data from 1952-1960 showed that 81 percent of the immature kill, but only 52 percent of the adult kill, was made prior to December 20 (Hansen, 1962).

For the two hunting seasons of 1965 and 1966, Chapman (1967) calculated that about 90 percent of the immature kill and 70 percent of the adult kill occurred by December 20. In contrast, during the latter two years, with a reduction in daily bag limit from 3 geese to 2 there would have been a reduction of 22 percent immatures and 13 percent adults in the seasonal kill. In this case "adult" refers to yearlings and older, that component of population which constitutes a breeding stock for the ensuing year.

An analysis of banding data shows that the major factor limiting a population increase is hunting mortality (Henny, 1967). A choice of four solutions has been suggested to reduce the kill in Oregon: (1) an annual closure of the season no later than December 25, (2) a reduction in the bag limit from 3 daily to 2 daily and in possession, (3) establishment of a kill quota with the season to be closed whenever the quota is attained, and (4) a season bag limit to be controlled with nontransferable tags or punch cards.

The primary advantage of an early closure would be to protect the brood stock. Harvest management through a reduction in the daily bag limit would

TABLE 14. Canada Goose Season, Band Recovery Rates, and Population Size, Willamette Valley, Oregon, 1952-1965

Year	Length of Season*		Date Season Ended	Bag Limit (Daily and Possession)	No. Geese Banded		Percent First-Year Recoveries		Winter Inventory (Immediately Following Season)**
	Total	Effective			Adult	Local	Adult	Local	
1952-53	70	58	Jan. 1	2	16	132	6.3	24.2	5,080
1953-54	75	56	Dec. 30	3	141	340	14.2	21.7	7,570
1954-55	80	60	Jan. 3	3	72	684	11.1	21.3	6,660
1955-56	80	65	Jan. 9	2	101	309	7.9	12.3	8,370
1956-57	64	41	Dec. 15	2	66	341	6.1	11.7	12,220
1957-58	95	71	Jan. 14	2	76	286	13.2	20.3	14,450
1958-59	95	70	Jan. 13	3	48	308	18.3	16.9	7,580
1959-60	94	65	Jan. 8	3	39	415	2.6	15.7	25,100
1960-61	90	65	Jan. 8	3	75	360	16.0	20.8	16,200
1961-62	75	59	Jan. 3	3	--	--	--	--	13,780
1962-63	75	59	Jan. 2	3	172	323	7.3	13.3	13,800
1963-64	90	62	Jan. 5	3	241	260	14.1	14.3	12,800
1964-65	90	64	Jan. 7	3	--	--	--	--	15,000
1965-66	90	63	Jan. 6	3	236	198	11.0	13.6	14,100
1966-67	90	62	Jan. 5	3	94	244			17,800

* Total season is number of days established by regulation. Effective season arbitrarily picked to start Nov. 5 when geese normally arrive in the valley.

**Add 3,000 geese each year from Washington and Oregon for approximate flyway total.

Includes an undetermined number of small Canada geese.

No banding attempted.

probably distribute the kill more equitably among hunters inasmuch as the third goose in the bag benefited specialized hunters in a very restricted area. The population in the Willamette Valley is adaptable to a kill quota system with an adequate annual inventory on the nesting grounds to predict the size of the fall flight. The season would then be closed when the desired harvest had occurred, although this method would not necessarily distribute the kill more equitably among hunters unless used in conjunction with a reduced daily bag limit. By using this method, however, the harvest would occur early in the season so that a higher proportion of adult breeding birds would be saved.

The season bag limit would undoubtedly distribute the kill among more hunters but it would not necessarily reduce the total annual harvest. This system might force some of the large hunting clubs to disband or to change their practices from a yearly fee with few members to a daily fee with many hunters. Either of these changes could be detrimental to the goose population. If the clubs went out of business, much prime winter goose habitat would be lost in an area where winter habitat is already limited. If clubs changed their operations to a moderate daily fee, the expected influx of hunters would undoubtedly harvest a higher proportion of the population than at present. Currently the major goose hunting club in the Willamette Valley is operating at only a small percentage of its potential efficiency (Henny, 1967). With a season bag, the operators might choose to offset loss of revenue by managing for the maximum number of hunters daily.

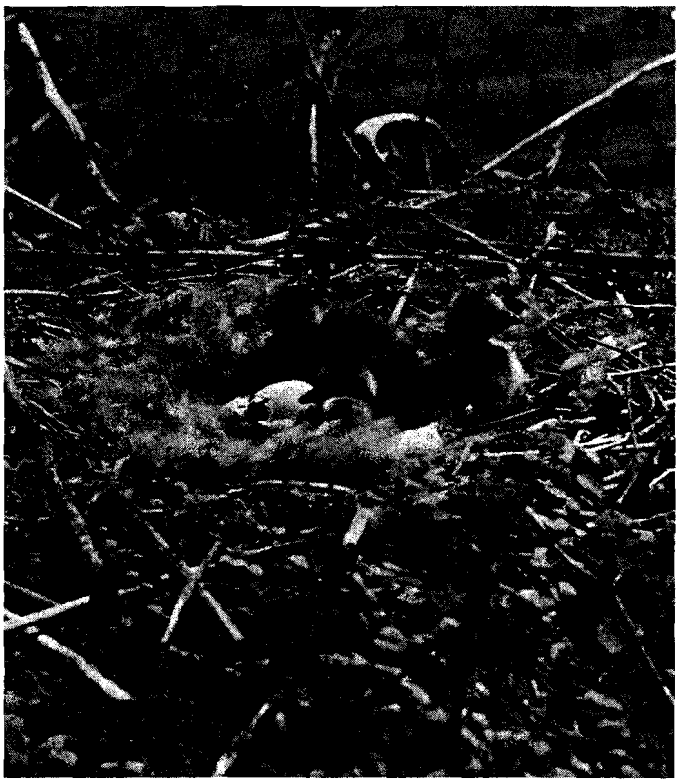
In light of the research showing how various regulations would effect the pattern of the kill and population structure, and determining that a reduction in kill would be desirable, the Bureau established a daily bag and possession limit of 2 Canada geese in the Willamette Valley in 1967. If this, or one of the alternative restrictions, is kept in effect for a period of years it is reasonable to expect the dusky Canada goose population to expand – how much is difficult to forecast. There is no evidence that this subspecies was ever abundant. When one considers its limited breeding habitat and even more restricted wintering range, it may have been as abundant during recent highs as at any time in its history.

Unless the Alaska earthquake of 1964, which elevated the nesting grounds of the dusky Canada goose several feet, created an adverse ecological condition, biologists familiar with the nesting grounds believe that a considerably larger breeding population can be accommodated. Two Willamette Valley units in the federal refuge system were established in 1964 and 1965 in an effort to increase winter habitat. The dusky Canada goose responded favorably to restrictive regulations from 1955 to 1957 when the limit was reduced from 3 to 2, indicating that lack of winter habitat may not have been the limiting factor at that time. It seems logical, then, that hunting mortality is the limiting factor and should be restricted long enough to allow the

population to attain its potential size, whatever that may be.

The goose management cases presented here are simple illustrations of what can be done if we are willing to accept the challenge. As we understand more fully the cause and effect relationship of regulations, more opportunities for prudent management of Canada geese will arise. Our challenge, both state and federal, is to ferret out these possibilities and to share cooperative responsibility to make them become realities.

To achieve real success the Golden Rule for both state and federal administrators must be to seek restrictions when necessary with the same diligence that relaxations are advocated where possible.



Studies in Population Dynamics and Distribution

WE ASSUME that each race of Canada geese has unique taxonomic, physiological, ecological, and geographic dimensions. We know, as Williams says, that nature stacks the cards so that different levels of goose abundance are the usual among different populations of Canadas. There is good evidence to suggest that natural and man-made environmental factors make some goose flocks discrete entities from a management point of view. All this is leading more and more to the concept of management units. Crissey recommends "the individual winter population" as the basic management unit. Jahn speaks of "goose harvest" management units. Williams writes of "constituent flights." Whatever the approach the tactic is clear: to separate the continental and flyway masses of geese into manageable entities, each with its own set of habitat improvement guidelines and harvest regulations.

Before we can generally administer geese on the basis of discrete units, however, much has to be accomplished. As Leopold wrote, "It is futile to attempt the practical in advance of the fundamental." First, we have to determine which flocks or flights can indeed be managed as separate entities. To do so will require a well designed research program that will identify for each hunting and wintering area the source or sources of goose supply, and define the boundaries of distribution to and from the hunting and wintering grounds. Once we know these things, then we will have to determine continuously the "health" of each population and adjust cropping rules accordingly. The Gabrielson dictum is still valid: "Only so long as we regulate the kill according to the crop produced can we believe we are managing waterfowl on a rational basis."

We are beginning to make some headway at identifying goose management units, exploring goose population dynamics, and assessing flock status. The papers in this section are representative of research currently underway.

ONE OF THE phenomena characteristic of continental Canada goose population trends is the decided shift in mass from south to north. Southern wintering grounds once heavily occupied are now comparatively empty, birds concentrating instead farther up the flyways. While this trend has been in evidence somewhat since the early part of the century, it has become significant in the past 20 years, and the velocity of change may be accelerating. At least that is the impression to be gained from goose population studies conducted at Mattamuskeet, North Carolina, site of one of the most dramatic and best documented "disappearances." When the study began in 1959–60 the Mattamuskeet population numbered 135,000. In 1967–68 the population was inventoried at 20,000. That is an 85 percent decline in 9 years. During the same period the overall North Carolina population dropped nearly 66 percent from 189,000 to 65,000. Yet again during the same period the count of Atlantic Canadas in the Atlantic Flyway as a whole was holding at a record high number."

What happened to the North Carolina winter goose population in general and the Mattamuskeet birds in particular? Were they "shot out?" The losses to hunting at Mattamuskeet never exceeded 24 percent of the fall population in any one year and averaged at most 14 percent for the period. As Crissey suggests elsewhere, however, this pressure could have been a straw that broke the back of the flock. At least we know the birds did not go farther south; there has been no jump in Georgia and Florida winter counts. On the other hand, wintering geese have been increasing steadily in the Chesapeake Bay complex. It seems logical, therefore, to assume that many of the birds that formerly came to Mattamuskeet are now being "shortstopped" to the north by more favorable food and cover conditions. That large numbers of birds can respond so rapidly to environmental changes represents a crucial problem—and the key opportunity —in Canada goose management.

5

CANADA GOOSE POPULATIONS, HUNTING PRESSURE, KILL, CRIPPLING LOSS, AND AGE RATIOS AT MATTAMUSKEET, NORTH CAROLINA

Otto Florschutz, Jr.

A STUDY OF the goose population at Mattamuskeet was begun with the 1959-60 hunting season. This was a time when over 100,000 Canada geese were overwintering on the National Wildlife Refuge and flying to adjacent private fields twice daily to feed on harvested corn and soybean crops.

Thirty-two blinds had been established within portions of the National Refuge, which were assigned to hunters by the state, using a public drawing system. Guides were employed to accompany the hunters on all hunting trips throughout the season, and were obligated to tally hunter-data. For this reason we had an accurate account of hunting pressure, harvests and successes on the lake. Private field hunting information before their time, however, was very sparse and contradictory. Data are reported here through the 1966-67 hunting season.

Populations

Aerial population estimates were conducted on Lake Mattamuskeet every two weeks beginning in late September and ending in early April for the first two years of the study. Flights were made so that each was conducted by the same observers at approximately the same time of day, when the geese were out of the fields and back in the lake. Monthly flights were conducted after 1962 and were supplemented by bi-monthly estimates in certain months. All flight routes included three smaller lakes, Pungo, Phelps and Alligator, which are within 20 air miles of Mattamuskeet and occasional flights included the east and south sides of Pamlico Sound, Pungo River, Pamlico River and Alligator River. Only at Pungo Lake was there any sizeable concentration of Canada geese which possibly were related to Mattamuskeet goose populations.

The results of the aerial estimates of Canada geese overwintering on Lake Mattamuskeet since 1959 are presented in Table 15. The highest number of geese estimated on Mattamuskeet occurred immediately prior to the start of the 1959-60 hunting season, when 135,000 were recorded. Numbers dropped slightly the following year, rose again the next two years and in the 1964-65 season began a snow-balling decline. In that year the peak goose estimate was in mid-December rather than just prior to the start of the hunting season as in all other years of the study. Since 1964-65, the goose decline has been very regular, not only at Mattamuskeet but throughout North Carolina. This is substantiated by the last column in Table 15 which shows the entire North Carolina Canada goose population during the same period. Meanwhile, Atlantic Flyway-wide data show a record high number of Canada geese in the flyway during this same period.

Hunting Pressure

Hunting pressure on the Lake Mattamuskeet goose flock is well known because we have guides collecting the information and turning it in daily at the checking station. Since 1959 we have collected private field use data to supplement the known lake hunting information collected at out checking station. However, pressure data on the flock enroute to Mattamuskeet or in the breeding grounds are very incomplete. Band returns show harvests of Mattamuskeet-banded

TABLE 15. Canada Goose Population Estimates, Lake Mattamuskeet, 1959-67

Year	Population Estimates				Peak Dates	Statewide Midwinter
	Pre-Season	In-Season Average	Post-Season	Peak		
1959-60	135,000	92,000	70,000	135,000	Nov. 12	148,200
1960-61	94,500	88,000	75,000	94,500	Oct. 27	189,100
1961-62	109,000	73,550	58,000	109,000	Nov. 9	128,100
1962-63	103,000	60,000	41,000	105,000	Nov. 15	149,500
1963-64	85,000	60,000	50,000	100,000	Nov. 9	162,200
1964-65	43,000	43,700	26,000	56,000	Dec. 15	99,500
1965-66	46,600	35,634	26,300	46,600	Nov. 3	91,500
1966-67	39,700	27,483	23,000	39,700	Nov. 1	65,000
1967-68	19,700	--	--		Nov. 1	--

birds in Canada and all along the eastern seaboard, especially in the Chesapeake Bay area. This section will deal with the hunting pressure in and around Lake Mattamuskeet.

The data are expressed in goose hunter-days, and were collected from permit stubs on Lake Mattamuskeet and through landowner and field guide cooperation in the private fields. The field cooperators were supplied daily kill cards which were collected and tallied weekly. A fee of 20 cents per completed card was paid to each cooperator at the end of the season. For the first 6 years of the study between 30 and 40 cooperators were used which accounted for approximately 90 percent of the most huntable private acreage. For the past few years a representative sample of these, accounting for 50 percent of the pressure and harvest were retained for data collection purposes.

Lake Mattamuskeet Refuge hunters accounted for approximately one-third of the total hunting pressure, with private field hunters comprising the other two-thirds. In the 8 study years, an average of slightly under 11,000 goose hunter-days annually were expended at Mattamuskeet (Table 16). This varied from a high of 13,084 in the 1963-64 season to a low of 8,900 in 1966-67. In total, 29,605 goose hunter-days were spent on Mattamuskeet from 1959 to 1967 while 58,046 hunter-days were spent in private fields.

TABLE 16. Mattamuskeet Goose Hunt Data, 1959-67

Season	Goose Hunters			Goose Kill			Goose Success		
	Lake	Field	Total	Lake	Field	Total	Lake	Field	Total
1959-60	3,844	6,623	10,467	2,014	4,973	6,987	0.516	0.751	0.668
1960-61	4,389	7,819	12,208	3,020	5,397	8,417	0.688	0.690	0.689
1961-62	3,867	7,386	11,253	2,045	3,568	5,613	0.529	0.483	0.499
1962-63	3,753	7,729	11,482	3,933	7,820	11,753	1.048	1.012	1.024
1963-64	4,216	8,868	13,084	2,614	7,762	10,376	0.620	0.875	0.789
1964-65	3,745	7,277	11,021	1,345	3,133	4,478	0.359	0.431	0.406
1965-66	2,896	6,341	9,237	599	2,051	2,650	0.207	0.323	0.287
1966-67	2,895	6,003	8,898	895	3,623	4,518	0.309	0.602	0.508
Total	29,605	58,046	87,650	16,465	38,327	54,792			
Average	3,701	7,256	10,956	2,058	4,791	6,849	0.556	0.660	0.625

Harvests and Hunter Success

Mattamuskeet goose harvest data for the 8 years were collected by the same procedures and on the same forms as the hunting pressure information. Some cross-checking of information received was done by observation, personal contact and questioning of neighbors. However, once confidence of the cooperators was gained and assurances made that individual cooperator data would not be made public, information received was surprisingly accurate.

Mattamuskeet Refuge blinds accounted for approximately 30 percent of the total 8-year goose kill, while private field hunters took 70 percent of the 54,800 total goose kill. Total annual harvests varied from a low of 2,650 in 1965-66 to a high of 11,753 in 1962-63, with an 8-year average of 6,849 geese harvested each year (Table 16).

Hunter success expressed as geese per hunter-day was tabulated daily in the 8-year study, and revealed some very interesting data. In all but 2 of the 8 years, hunter success was greater in the fields (Table 16). Likewise, field hunter success was 0.660 or 18.7 percent higher in the combined 8-year field data than the 0.556 geese per hunter-day lake average. Combined lake and field success averaged 0.625 geese per hunter-day for the 8-year period at Mattamuskeet. The poorest year was in the 1965-66 season when all hunters harvested only 0.287 geese per hunter-day, while the best year was in 1962-63 when all hunters averaged 1.024 geese per trip.

Crippling Losses

These data were collected from lake guides after the 1961-62 season by inserting a crippling loss space on the daily permit tally kept by the guide for each hunter in his party. The term crippling loss was explained as any bird knocked down but not retrieved. Field cooperators also were asked to record similar data and a space was provided on their daily kill card. At the end of the hunting season, many cards and permit stubs were left blank on the crippling loss question. Since it was not known whether this signified no geese crippled or forgetfulness, these were not recorded. Rather data were tabulated by counting the number of geese crippled per number of geese bagged and expanded accordingly.

Crippling losses in the private fields were 5 percent higher (22.3 %) than those in the lake (17.3 %) (Table 17). Many lake guides use retrievers whereas very few field guides or hunters do. Also all lake shooting is done over decoys while much of the field hunting is pass or line shooting. Numerical losses totaled nearly 12,000 geese in the 8 years, averaged about 1,500 per season and varied between 634 and 2,452 for a combined 8-year loss of 21.9 percent. This signifies that slightly over 1 in 5 geese shot down is not recovered. Examination of the annual results does show a trend of higher crippling losses in poorer seasons although the differences are not great.

Relation of Total Kill to Population

The percentage loss of the in-season goose flock due to hunting was calculated by dividing the total expanded kill and crippling losses by the average in-season population estimates obtained from aerial inventories. For comparative purposes, the same calculation was also made using the year's peak estimate to provide a percentage of peak flock loss prior to off-refuge dispersal by hunting and food shortages. This population difference between peak numbers and dispersal has been around 30 percent.

The loss to hunting of Mattamuskeet geese during the peak population period averaged 9.9 percent (Table 18), varying from 6.0 percent to 13.8 percent of the peak population. When calculating goose population losses from hunting using the average in-season population, percentage losses were higher and

TABLE 17. Goose Crippling Losses at Mattamuskeet, 1959-67

Season	Percent Geese Crippled			Number Crippled
	Lake	Field	Combined	
1959-60	--	15.4	--	1,077
1960-61	--	27.2	--	2,289
1961-62	--	31.2	--	1,751
1962-63	20.8	20.9	20.9	2,452
1963-64	14.8	21.0	16.2	2,013
1964-65	14.7	22.4	20.1	900
1965-66	22.0	24.5	23.9	634
1966-67	17.8	19.8	19.4	876
Average and Total	17.3	22.3	21.9	11,992

TABLE 18. Percentage of Mattamuskeet Goose Population Lost to Hunting, 1959-67

Season	Peak Population		Average In-Season Population		Total Hunting Loss	Relation to Flyway	
	Number	Percent Loss	Number	Percent Loss		Percent of Pop.	Percent of Kill
1959-60	135,000	6.0	92,000	8.8	8,063	35.4	--
1960-61	94,500	11.3	88,000	12.2	10,706	17.6	--
1961-62	109,000	6.8	73,550	10.0	7,364	26.0	10.1
1962-63	105,000	13.5	60,000	23.7	14,205	21.8	14.3
1963-64	90,000	13.8	60,000	20.6	12,389	17.0	8.9
1964-65	55,700	9.7	43,700	12.3	5,378	11.5	3.9
1965-66	46,600	7.0	35,634	9.2	3,284	7.8	3.6
1966-67	39,700	13.6	27,483	19.6	5,394	6.6	3.4
Average	84,500	9.9	60,046	13.9	8,348	16.8	6.8

varied from a low of 8.8 percent to a high of 23.7 percent with a 13.9 percent average.

There were at least 4 years in the 8 that the harvest of Canada geese in the Mattamuskeet flock was fairly high if we consider losses occurring in Canada and in other harvest areas north of Mattamuskeet (Table 18). The percentage of Atlantic Flyway geese at Mattamuskeet since the 1960 midwinter inventory has varied between a low last year of 6.6 percent to a high in 1959-60 of 35.4 percent, with an 8-year average of 16.8 percent. The percentage of the flyway's Canada goose kill occurring at Mattamuskeet has varied from a low of 3.4 percent last year to a 1962-63 high of 14.3 percent, with a 6-year average of 6.8 percent not including the Canadian kill which is reportedly on an increase. These data point out that in the past 8 years, 1 out of every 6 Canada geese in the Atlantic Flyway utilized Lake Mattamuskeet, and 1 in every 15 geese killed in the flyway was bagged there.

Age Ratios

Since the beginning of the study with the 1959-60 season, lake guides were requested to collect the 4 outer tail feathers of each Canada goose bagged. They were furnished envelopes and instructed to keep the feathers separated and dated and to turn them in at the checking station at the conclusion of each day's hunt. The results were tabulated weekly to show progressive changes of age ratios in the goose bag and annual results are presented in Table 19.

In the 8 years, 13,898 sets of goose tail feathers or 25.4 percent of the total Mattamuskeet kill were examined and aged. Of these, 50.7 percent were from juveniles and 48.1 percent were from yearlings and adults (Table 19). Annual ratios ranged widely and were clearly on the juvenile side 5 years while adults dominated the remaining 3 years. It is interesting to note that despite the wide age ratio range, the 8-year average is very close to 1 juvenile bagged per 1 adult bagged.

Summary

Mattamuskeet Canada goose populations dropped over 85 percent from 135,000 in 1959 to 20,000 in 1967. The overall North Carolina Canada goose population dropped nearly 66 percent from 189,100 to 65,000 during the same period. This decline began in the 1964-65 season and has continued to date.

Goose hunting pressure averaged nearly 11,000 hunter-days per season and has been 32 percent below the 8-year high of 1963-64 since the population decline.

The goose harvest has varied as much as 77.5 percent in the last 8 years while averaging an annual kill of just under 7,000 birds. The lowest kills and successes have occurred in the last 3 seasons. During this study, seasonal hunter success has varied from 1.024 geese per hunter-day to 0.287 with an 8-year average of 0.625.

Lake Mattamuskeet goose crippling losses averaged 17.3 percent during the study while private field crippling losses averaged 22.3 percent and combined losses averaged 21.9 percent and totaled nearly 12,000 geese.

The average loss of the Mattamuskeet peak goose population to hunting was 9.9 percent while the loss of the average in-season population was 13.9 percent. In the past 8 hunting seasons as high as 35.4 percent of all the geese in the Atlantic Flyway were at Mattamuskeet and up to 14.3 percent of the entire flyway kill occurred there.

Nearly 14,000 sets of Canada goose tail feathers were aged in the study. This was 25.4 percent of the kill. Juvenile to adult-yearling ratios varied widely during the study but averaged 50.7 : 48.1.

TABLE 19. Percentage of Goose Ages in Mattamuskeet Harvest, 1959-67

Season	Juveniles	Adults	Unknowns	Sample Size	Percent of Bag
1959-60	59.5	38.9	1.6	1,563	22.4
1960-61	59.5	38.6	1.9	2,362	28.1
1961-62	18.4	80.4	1.2	1,738	31.0
1962-63	56.3	42.8	0.9	3,475	29.6
1963-64	56.3	43.1	0.6	2,224	21.4
1964-65	39.8	59.5	0.7	1,229	27.4
1965-66	44.5	54.1	1.4	553	20.9
1966-67	58.8	39.7	1.5	754	16.7
Average	50.7	48.1	1.2		25.4

ROCHESTER, Minnesota, known the world around for many years as the home of the Mayo Clinic, is probably even better known in the goose world at least as the winter home of a famous flock of Canadas. Here it was where Dr. H. C. Hanson identified in 1962 a subspecies of Branta canadensis long believed to be either non existent or extinct—the giant Canada goose (B. c. maxima). (It is perhaps typical of the hazards and hopes in professional wildlife management, incidentally, that the belief in a separate race of giant Canadas was kept alive not so much by bright young ornithologists as by old hunters, and that when the birds were finally "rediscovered" they were found not in the fastnesses of the Arctic but in a city, on a man-made lake warmed by heated water from a power plant!)

Since 1962 the Rochester flock has been intensively observed in order both to shed light on the natural history of B. c. maxima and to determine management techniques for husbanding a particular goose population in a northern urban environment. Why the Rochester flock has been able to thrive handsomely seems to be due to a number of fortuitous factors. First, central Minnesota is probably well within the historic natural wintering range of the giant Canada. At least there is no evidence that usual winter temperatures and snow depths in the Rochester area have an adverse effect on these big, rugged birds. Second, the Rochester area provides two essential ingredients—an adequate expanse of year-round open water and an adequate supply of natural forage. Third, reproduction on the Manitoba breeding grounds is good. Fourth, predator and hunting pressure are light, thanks to an extended refuge. Finally, the flock is widely recognized as a community asset. The Mayo Clinic sends patients to Silver Lake to relax and shoot pictures, and the local Izaak Walton League is inordinantly protective of "it's" geese. Fortunately, recent fears that the birds were spreading human or poultry disease organisms have proved to be unfounded.

All of these factors have combined to make possible an increase in the Rochester maximas from 250 in 1951 to 8,650 in 1967. As Jahn says, "Herein lies the promise for a bright future for Canada goose flocks with unique distributional and behavioral characteristics if managers will capitalize on all known discrete populations and those identified or restored in the future."

6

HISTORY, BEHAVIOR AND MANAGEMENT OF A FLOCK OF GIANT CANADA GEESE IN SOUTHEASTERN MINNESOTA

Nicholas A. Gulden and Leon L. Johnson

THE FLOCK OF wild Canada geese that winters at the city of Rochester, in southeastern Minnesota is made up mostly of the giant Canada goose (Branta canadensis maxima). It is one of the most northern wintering flocks of Canada geese. Its wintering area, Silver Lake, is within the city limits and this poses several special management problems. The adjacent area is intensely farmed and there has been concern, thus far unjustified, that this flock may be a source of human and poultry diseases.

The city of Rochester, with a population of 47,000, is located in Olmsted County (Latitude 43° 55' N, Longitude 92° 30' W). Here the climate is characterized by hot, humid summers and cold winters. Average annual temperature is 44.3° F, and average monthly temperature ranges from 12.6° F in January to 71.4° F in July. Average annual precipitation is 28.6 inches and the growing season is 140 days. The topography is hilly and rolling.

Silver Lake, which is located in the northeastern part of Rochester, is the home of both a resident and a wintering flock of giant Canada geese B. c. maxima. This lake, of about 25 acres, was created in 1936 by a dam on the South Branch Zumbro River. A municipal power plant that is located a quarter mile upstream from the lake utilizes river water for cooling steam turbines. The warmed water is returned to the river in the immediate vicinity of the lake. During prolonged periods of subzero temperatures all but about 5 acres of lake freeze over, but a slight increase in air temperatures will cause the ice to thaw over most of the lake in a day or two.

The geese also use Mayowood Lake, which is 40 acres in size and located southwest of Rochester approximately 4 air miles from Silver Lake. This lake is used by the geese during the fall prior to freeze-up, and again in the spring before migration. Mayowood lake was created in 1913 by a dam on the South Branch Zumbro River. More recently the dam impounding it has been relocated approximately 200 yards east of the old site.

In 1926, a statutory game refuge of 48 square miles was established around the city of Rochester. In 1961, the original refuge was expanded to aid law enforcement and to give added protection to the geese. The expansion which was principally to the west and south, increased the total refuge area to 66.5 square miles, or 42,560 acres.

The corporate limits of Rochester occupy 15 percent of the refuge area, and an additional 10 percent is occupied by suburban developments. Of the remaining 75 percent, 15 is woodland, 43 is cropland (predominantly corn, soybeans, oats and alfalfa) and 17 percent pasture and grassland. Dairying is the principal type of farming.

Early History of the Goose Flock

Canada geese have long been known to frequent the Rochester area, but only in about the last decade have they increased markedly in numbers and aroused widespread public interest. Previously small numbers

of geese apparently utilized surrounding farmlands and river bottoms, particularly in the suburban section of Rochester known as Mayowood; an area named after the famous Mayo brothers whose homes are located here.

The Mayo Clinic archives contain a game breeder permit issued to Charles H. Mayo and dated May 24, 1929. This indicates that he then had "22 domesticated geese". We now have reason to believe that these were actually "giant" Canada geese; most likely the remnants of a live-decoy flock established at an earlier time from goslings captured on marshes in the Midwest. Dr. Mayo recalls having purchased at least one pair in the early 1920's from "Dekota or Michigan".

In May of 1939, a letter from Dr. Charles H. Mayo to the National Association of Audubon Societies stated "I am very much interested in the preservation of wildlife and on my farm feed between 500 and 600 Canadian geese . . . ." This suggests that his reference was to an over-wintering group of geese and not to fall migrants alone. At this same time, Hiram Southwick, now a regional game manager with the Minnesota Conservation Department, and Matt Saari, a former game warden now deceased, both observed use of the general area by several thousand geese in the vicinity of Rochester. In the fall of 1943, Saari estimated the population at 4,000 birds.

At the time that geese were using surrounding farmlands and river bottoms near Rochester, the Rochester Park Board also established a resident flock on Silver Lake. Six geese were purchased in 1936 from an unknown source. These same 6 birds remained on Silver Lake but did not raise young until 1945, when 3 goslings were reared. The following winter vandals killed 7 of the birds. To replace this loss, the Park Board purchased 3 geese the next year from a farm near Owatonna, and obtained 2 more from a farm near High Forest, 10 miles south-southwest of Rochester.

At about the same time, an elderly patient at the Mayo Clinic willed 12 Canada geese to the Rochester Park Board and these were received after his death. These birds came from an unknown source in Nebraska. The 19 geese then present at Silver Lake appear to have served as a decoy flock for wild birds in the vicinity. There are newspaper accounts on the use of Silver Lake by migrant geese as early as 1945. Following the construction and operation of the municipal power plant in 1948, a wintering flock of geese started using the lake. Dr. Walter Breckenridge of the Minnesota Museum of Natural History reported about 500 Canada geese on Silver Lake in February, 1948. This group probably contained most of the birds formerly wintering in the Zumbro River valley in Mayowood. Nearly a thousand geese were recorded as using Silver Lake by the fall of 1949 – evidence that the flock was increasing.

Arrival and Departure Dates

Records maintained at the game management headquarters in Rochester for the years 1961 and 1963 to 1966 show that the first fall migrants started to arrive at Silver Lake during the last week of September (Table 20). The date of the first arrivals was determined from daily counts beginning about September 15. Since the resident summer population was known, any increase in numbers was evidence of the arrival of migrating geese. A late departure from the breeding grounds, a late arrival at Rochester, and a late build-up of a peak population is shown by the dates of recovery of banded birds (Table 21).

TABLE 20. Arrival and Departure Dates of Canada Geese Wintering at Rochester, Minnesota, During the Winter of 1961-67

Winter	Fall Arrival	Spring Departure
1961-62	September 28	April 8
1962-63	--	March 30
1963-64	September 29	April 8
1964-65	September 24	April 13
1965-66	September 25	March 20
1966-67	September 23	--

The date of departure from Rochester for the breeding grounds was somewhat difficult to determine since the geese spread out over the surrounding countryside and used flooded river bottom lands concurrently with spring break-up. The date on which the last group of geese left the Rochester area was considered to be the departure date (Table 20). The earliest recorded departure date was March 20, 1966. In that year, an estimated 400-500 geese returned to Silver Lake following a 7-inch snowfall on March 23 and another of 4 inches on March 24.

Population Build-Up

As fall progressed, the wintering population continued to build until a peak was reached sometime during the last half of November. Periodic Canada goose counts conducted since 1961 show that the earliest date the peak had been reached was November 9, 1961. The most spectacular increase of geese at Rochester occurred between the dates of November 3, 1961 and November 9, 1961 when the population jumped from 2,190 to an estimated 6,000 geese.

The latest date at which the peak was reached was on December 15, 1964. Although the date of the peak in 1966 is not known, 8,650 geese were observed on December 14 and this is the largest number of geese ever recorded at Silver Lake (Figure 10).

Midwinter inventories of the geese using Silver Lake were begun in 1951 when 250 birds were counted. The wintering population has shown a steady increase since that time and reached a peak of 8,650 on December 14, 1966 (Table 22). It is our opinion that the differences in numbers between the peak and wintering

TABLE 21. Numbers and Dates of Band Recoveries From Canada Geese Banded at Rochester, Minnesota, and Later Reported Shot by Hunters, 1961-66

	Dates Reported Shot							
	September		October		November		December	
Recovery Area	1-15	16-30	1-15	16-31	1-15	16-31	1-15	16-31
Manitoba	1	16	27	8	1	0	0	0
Minnesota*	0	0	2	4	3	2	2	0
Elsewhere in U. S.			3	4	5	1	1	4

*Goose hunting in Minnesota starts October 1.

populations can be attributed to departure of predominantly non-maxima subspecies, primarily B. c. interior. The proportion of B. c. interior trapped during cannon-netting ranged from 1 to 8 percent, yet casual observation of the geese indicated a somewhat higher proportion of interior prior to the midwinter inventory. Band recoveries, however, indicated that there was also a movement of maxima to other wintering areas, and therefore the decline in numbers from the peak to the wintering population might also have reflected this movement.

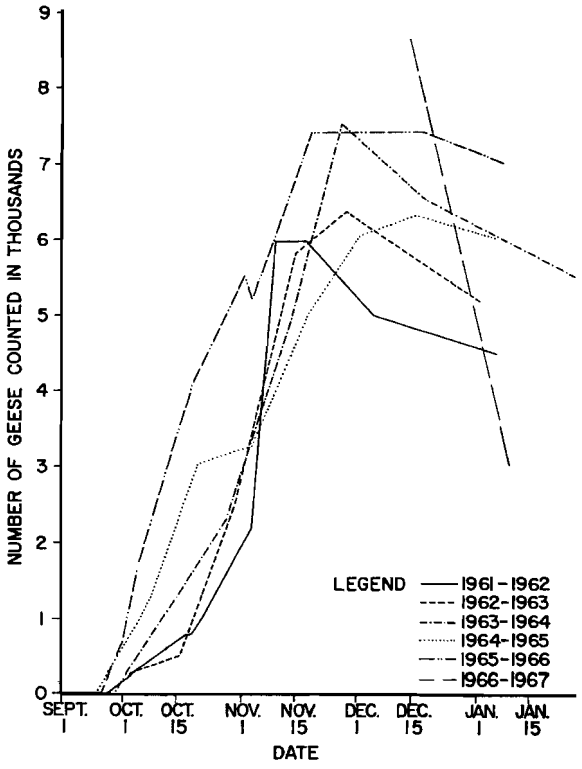


FIGURE 10. Chronology of Canada Geese Wintering at Rochester, Minnesota, 1961-67.

Winter Conditions and Their Effect

During the winters of 1961-62 through 1966-67, weather conditions fluctuated widely as to temperature, snowfall, and the number of days during which snow cover was 5 inches or more. For example: January 1966 and 1963 were, respectively, the second and third coldest Januarys on record, with average monthly temperatures 8 to 9° F below the normal mean of 12.6°. In contrast, in January and February 1964 the monthly temperatures were much above normal (Table 23).

Snowfall during the months of December-March also fluctuated widely and ranged from a minimum

TABLE 22. Estimated Numbers of Canada Geese Wintering on Silver Lake, Rochester, Minnesota, 1948-1967*

Winter	Number of Geese	Winter	Number of Geese
1948-49	500	1958-59	2,400
1949-50	400	1959-60	2,700
1950-51	250	1960-61	4,000
1951-52	325	1961-62	4,500
1952-53	650	1962-63	5,200
1953-54	800	1963-64	6,000
1954-55	1,200	1964-65	6,000
1955-56	1,250	1965-66	7,400
1956-57	1,300	1966-67	8,650
1957-58	1,400		

*Records of wintering geese taken from U. S. Fish and Wildlife Service midwinter inventories for the years 1950-1961. Records for other years are from State Department of Conservation records.

TABLE 23. Mean Monthly Winter Temperatures Recorded at Rochester Airport, Minnesota, for the years 1961-67.

Winter	Mean Temperature			
	December	January	February	March
1961-62	15.2	9.0	13.3	24.0
1962-63	19.3	4.7	13.1	32.4
1963-64	9.6	21.3	24.1	25.6
1964-65	15.4	9.3	11.6	18.1
1965-66	28.5	3.2	15.2	34.0
1966-67	19.4	15.5	10.5	31.2
Long-term mean (1929-1964)	18.9	12.6	16.6	29.0

of 28.1 inches in 1963-64 to a maximum of 56.1 inches in 1961-62 (Table 24). The same is true of days during which 5 inches or more of snow cover remained on the ground (Table 25). Less than 5 inches of snow had little effect on the geese here.

Mean weights for all sex and age classes of trapped geese were compared during the 6 winters in an attempt to determine what effect, if any, climate factors had on the physical condition of the geese (Table 26). Deviations from mean weights resulting from weather conditions appear to be negligible. The greatest difference in mean weights was 9.5 percent for immature females when weights for 1964 and 1966 are compared, and also 9.5 percent for adult males when weights for 1966 and 1967 are compared. For example, the average mean weight of immature females dropped from 3.77 kilograms in 1964 to 3.41 kilograms in 1966.

Neither snow depth nor length of periods of prolonged snow cover appeared to have bearing on the physical condition of the geese but the lowest mean body weights were obtained during years of extremely prolonged cold temperatures. During the winters of 1966 and 1963, there were periods of 32 and 20 days of continuous snow cover (1 inch or more) prior to the trapping and capture of the geese. However, there were also 30 days of continuous snow cover in 1967 and 39 days in 1962, and in neither of these years did the geese exhibit signs of stress as great as 1966 or 1963. Geese trapped in these two years did not show normal strength when first handled, but after a few days of confinement appeared to have regained some of it.

It is worthwhile noting that in 1962 the winter was severe enough to require emergency feeding of pheasants by the Minnesota Conservation Department and in 1967 the winter was almost as severe. The St. Patrick's Day blizzard of 1965 destroyed an estimated 60 percent of the state's pheasant population. However, during these winters there were no losses of geese at any time which could be directly

TABLE 24. Monthly Snowfall Recorded at the Rochester, Minnesota, Airport for the Winters of 1961-67

Winter	Monthly Snowfall (Inches)				
	December	January	February	March	Total
1961-62	18.3	2.5	19.1	16.2	56.1
1962-63	4.5	11.8	5.7	12.6	34.6
1963-64	8.3	5.9	0.8	13.1	28.1
1964-65	6.4	11.1	8.8	12.2	38.5
1965-66	0.9	10.5	7.3	12.2	30.9
1966-67	10.3	12.4	13.4	5.6	41.7
Average	8.1	9.0	9.2	12.0	38.3

TABLE 25. Duration of Ground Snow Cover During the Winters of 1961-1967 at Rochester, Minnesota

Year	Period of Snow Cover*	Days With Snow Cover	
		1-4 Inches	5 + Inches
1961-62	December 8 - April 4	21	84
1962-63	December 26 - March 22	51	32
1963-64	December 4 - April 1	57	1
1964-65	November 20 - April 5	106	30
1965-66	January 1 - March 31	24	35
1966-67	December 28 - March 22	32	44

*The period of snow cover is considered to be that period between the first and last record of 1 inch of snow cover.

attributed to climate factors. The local game warden who has lived in Rochester for the past 13 years has never observed losses of geese that could be attributed solely to adverse weather.

The rolling and hilly topography of the Rochester area is important to the welfare of the flock. Corn stubble is usually not plowed to prevent soil erosion. In warm weather the south and southwest-facing slopes become free from snow much faster than the flat, level terrain characteristic of the prairie farmland farther west. Winds also tend to remove snow from hilltops and knolls. Therefore, food and its availability are not considered to be important problems. Corn remaining in picked fields provides the primary source of food for the geese throughout their stay. Occasionally, however, they enter the outer 3 or 4 rows of unpicked cornfields. In this area standing corn is uncommon during the winter months and is used by the geese only after prolonged periods of deep snow cover which reduces the availability of corn stubble. During 1962, the geese were observed feeding heavily in an unpicked 20-acre soybean field. Aside from this one instance, no serious depredations on crops have been reported.

During the winter of 1966-67 there was an exceptional major emigration of geese assumed to be wintering residents. On December 14, 8,650 geese were counted at Silver Lake and these were still

TABLE 26. Mean Weights of the Various Sex and Age Classes of Canada Geese Wintering at Rochester, Minnesota, 1962-67*

Age and Sex	1962	1963	1964	1965	1966	1967	All Years
Adult male	4.69** (N=26)	4.54 (N=9)	4.69 (N=31)	4.82 (N=6)	4.46 (N=40)	4.93 (N=29)	4.69 (N=141)
Adult female	3.91 (N=15)	3.83 (N=3)	4.21 (N=23)	3.99 (N=11)	3.85 (N=37)	4.02 (N=54)	3.97 (N=143)
Sub-adult male	4.33 (N=11)	-- --	4.55 (N=10)	4.54 (N=5)	4.16 (N=12)	4.54 (N=15)	4.42 (N=53)
Sub-adult female	3.63 (N=14)	3.70 (N=2)	3.71 (N=7)	3.74 (N=7)	3.62 (N=29)	3.85 (N=10)	3.71 (N=69)
Immature male	4.08 (N=26)	4.14 (N=7)	4.35 (N=48)	4.01 (N=16)	4.03 (N=55)	4.20 (N=16)	4.14 (N=168)
Immature female	3.71 (N=34)	3.62 (N=9)	3.77 (N=41)	3.61 (N=21)	3.41 (N=74)	3.71 (N=24)	3.64 (N=203)

* Weights of geese were frequently obtained after the birds had been held in confinement for some time and furnished corn and water. Weights given here are slightly greater than true flock weights.
**Weights expressed in kilograms.

present during the "holidays". The count on January 9, 1962 was 2,500 to 3,000 geese, 5,500 to 6,000 fewer than the December count. Several sources of information confirming this exit of geese sometime between January 2 and 9 resulting from difficulty in obtaining food. It is the first time such an event has been observed. Eight inches of snow fell on December 28 and 29, 1966 and not less than 6 inches of snow continued on the ground until January 7, 1967. By January 8 snow depths had reached 10 inches. It is important to note that more corn stubble than usual had been plowed under during the very mild fall. Extensive plowing and snow depths plus the record number of geese competing for the corn probably triggered the unusually large departure of geese. It is not known where this group of geese spent the remainder of the winter.

Although counts were not entirely satisfactory, estimates of the goose population in late February and early March were usually 500 to 1,000 lower than those made in late December and early January, suggesting some emigration from the area in late winter of each year. These geese probably left as a result of minor stresses associated with adverse weather conditions.

We feel that weather conditions are not a serious problem for the geese wintering at Rochester, and that stress conditions, as reflected in weights of the different sex and age classes, are well within the tolerance of maxima. We also believe that if the climatic stresses become too severe, the inherent behavior pattern of the geese is such that they emigrate to more favorable areas. Hanson (1965) stated that the foremost factor appearing to limit the local distribution of flocks of giant Canada geese is the availability of open water. LeFebvre and Raveling (1967) concluded that heat balance in Canada geese limits the northern distribution of various subspecies, and that the behavior pattern of the geese and the availability of food and open water also are important factors. Observations on the Rochester flock of B. c. maxima confirms this.

Banding

As the Canada goose populations at Rochester increased, the need for banding became apparent. Early attempts to capture geese in walk-in traps were unsuccessful. During the years 1961 through 1963 the U. S. Fish and Wildlife Service provided cannon-net trapping equipment at the request of the Minnesota Conservation Department and furnished assistance throughout the seven trapping years. Since 1964, Miller-type cannon-net traps, purchased by the Minnesota Division of Game and Fish, have been used at Rochester. The trapping was done annually for 2 weeks during the period from mid-January to mid-February. The trapping area was prebaited with ear corn beginning 2 weeks prior to trapping and ear corn was used during the trapping. The catches were often small and there were many exasperating problems associated with attempts to capture these geese in the heart of the city.

During the years 1961-67, 1,087 Canada geese were banded (1,067 B. c. maxima and 20 B. c. interior) by post-season trapping at Rochester (Table 27). The banding data presented in this paper include only those bands placed on the B. c. maxima. The geese were sexed and aged by the method described by Hanson (1962). Dr. Hanson was present in all the years and determined age, sex, and subspecies of all the geese caught in 1962 through 1964, and for some of the geese caught in 1965 through 1967.

Age Ratios

The age ratios presented in Table 28 may be unrealistic due to the small sample size and biases associated with cannon-net trapping as described by Nass (1964) and Raveling (1966). Hanson (1965) also expressed some skepticism but indicated these

TABLE 27. Number of Canada Geese Banded at Rochester, Minnesota, 1961-1967

Year	Total Number Banded	Adult		Yearling		Immature	
		Male	Female	Male	Female	Male	Female
1961	6	3	2	--	--	--	1
1962	132	32	19	15	17	28	21
1963	339	70	62	11	23	89	84
1964	177	33	24	9	12	50	49
1965	73	10	10	3	8	16	26
1966	236	34	30	12	29	55	76
1967	124	25	48	12	8	12	19
Totals	1,087	207	195	62	97	250	276

TABLE 28. Age and Sex Composition of Canada Geese (B. c. maxima) Trapped With Cannon Nets at Rochester, Minnesota, 1962-1967

	1962	1963	1964	1965	1966	1967
Adults	33	110	64	19	87	83
Yearlings	29	32	17	11	41	25
Immatures	40	149	94	40	129	44
Percent immature	39	51	57	57	50	29
Number of adult females	13	48	22	11	38	49
Immature per adult females	3.1	3.1	4.3	3.8	3.4	.9

age ratios could be achieved in some years. Since his interpretation of the age ratio data from 1962-64 of the Rochester flock, three additional years of age ratio information have been obtained showing 3.8 young per adult female in 1965 and 3.4 young per female in 1966. There was a sharp drop to 0.9 young per female in 1967 and this may have resulted from the departure of 6,000 geese prior to trapping. A large proportion of the departed geese may have been family groups with young. At Dog Lake, Manitoba, which lies near the center of the breeding range of the Rochester flock, Hanson (1965) and Klopman (1958) recorded 129 young produced from 44 nests in 1954 and 115 produced from 61 nests in 1955 – an average production of 2.9 and 1.9 young per nesting female in the respective years.

Although the age ratios for geese trapped by cannon-net are uncertain, they may be useful for comparing annual reproductive success of the Rochester flock with other populations of Canada geese if the same capture methods are used.

During seven years of trapping at Rochester, the average catch per cannon-net fired was about 20 geese and the largest catch was 89 geese. The net was usually detonated between 15 and 30 minutes after the geese moved onto the baited sites. Under these conditions family groups were probably still common on the trap sites and the displacement of young birds by older geese characteristic of a "mobbed site" condition was probably not common. In consequence we obtained high young-to-adult age ratios.

A further indication of productivity is available from a study of post-season family flock counts made at Rochester in 1962-64 and 1966. During the 1962-64 period family counts were made of outbound geese, 100-200 feet from lift-off, during the morning. Groups of 1-10 birds were considered to be families and were tallied. The average family flock size for those years was 4.1, 4.5 and 4.7. In all, 101,587, and 249 flocks were tabbed in the respective years. These counts suggest a range from 2.1 to 2.6 young per breeding pair, post-season, indicating high productivity. In 1966, five family-flock counts were made during the period January-March. In that year average family flock size was 3.2 for 839 counts. All of these were made immediately after lift-off and may provide a more realistic index of productivity. Even though flock size was less in 1965 than in the earlier years cited, we believe it still reflects good reproduction. In general, it appears that the most usual production has been between 2.0 and 2.5 young per adult female per year.

Distribution of Harvest

Of the Canada geese (B. c. maxima) banded at Rochester that were taken by hunters, 75 percent were shot either on their breeding or wintering grounds (Table 29, Fig. 11). It appears that about 65 percent of the total harvest from this flock occurred on their breeding grounds, as described by Hanson (1965), in the region between Lake Manitoba and Lake Winnipeg. The greatest single area of harvest was at Dog Lake, Manitoba. Ten percent of the total kill was taken at Rochester, which is a relatively safe wintering area. The kill of geese in the Rochester area averaged about 200 per year since the refuge was expanded in 1961. Estimated kill for 1964 was 200-250 and for 1965 was 170. Kill figures for previous years was unavailable.

Half-day goose hunting was tried in Olmsted County during the 1964 season with the intent of increasing local harvest. Although this appears to have succeeded to some extent, the results are inconclusive because drought that summer produced a poor corn crop and forced geese to feed outside the refuge, which increased hunting pressure on them.

Data on 5 spring recoveries of bands have been received, all from Manitoba, but locations are

TABLE 29. Locations of Shot Recoveries From Canada Geese (B. c. maxima) Banded at Rochester, Minnesota during 1961-66

State or Province	Banded Birds Shot	
	Number	Percent
Manitoba	74	65
Minnesota	15	13
(Rochester)	(12)	(10)
Wisconsin	6	5
South Dakota	5	5
Saskatchewan	3	3
Illinois	3	3
Iowa	2	2
Nebraska	2	2
Missouri	1	1
Oklahoma	1	1
Colorado	1	1
	113	101

known for only 3. These were Lake St. Martin, the Mantagao River and near Fisher Bay on Lake Winnipeg – all in the nesting area. Of the 6 band recoveries from Wisconsin, 4 were from near Hancock (Waushara County) and 1 was from Walworth County. In both areas there are established B. c. maxima flocks. There were no band returns from the Horicon area. In South Dakota all recoveries came from the Lake Andes and Fort Randall Reservoir area. One recovery was made at Swan Lake, Missouri, and 2 at Horseshoe Lake, Illinois. Only one banded goose was recovered between the nesting and wintering grounds and this was taken in Polk County, Minnesota. It would appear, therefore, that the fall migration from the nesting area to wintering area (a distance of 480-500 miles) is for the most part nonstop.

In addition to the geese banded at Rochester, 84 bands from banding done elsewhere have been recorded at Rochester. These have been obtained from sight records or retraps. These geese were originally banded at the following locations: 36 in the Keewatin District, N. W. T.; 34 in Manitoba (31 from Oak Point and 3 from Delta); 4 in Wisconsin (Crex Meadows); 4 in Illinois; 3 in Arkansas; 2 in Missouri and 1 in South Dakota. The 36 geese banded in the Keewatin District, N. W. T. (Thelon River and Beverly Lake area) were trapped during the summers of 1963-65 by Tom Sterling and his Ducks Unlimited crews. During this same operation he also re-captured 47 geese that had been banded at Rochester (Table 30). The Thelon River and Beverly Lake area is used for molting by the Rochester geese (Hanson, 1965).

During the years 1962-66, 20 of the smaller Canada geese, B. c. interior, were banded at Rochester. Most of these geese were identified by Harold C. Hanson, and by the authors on the basis of physical characteristics. Four of these geese were subsequently shot and these recoveries conformed to the pattern of recoveries for the Eastern Prairie Population of B. c. interior. One was shot at Swan Lake, Missouri, 2 in Iowa and 1 was taken in the spring about 100 miles inland from the Hudson Bay near the Severn River, Ontario.

Hunting Pressure from Incidence of Embedded Shot

During the winters of 1964-67 (after the hunting season), 499 of the geese trapped at Rochester were examined by a combination of x-ray fluoroscopy and x-ray film techniques to determine the number carrying embedded lead shot and the location of shot in their bodies. Dr. David M. Witten, Section of Diagnostic Roentgenology, Mayo Clinic did the fluoroscopy.

As pointed out by Elder (1950), the proportion of live ducks carrying lead pellets after the hunting season should accurately reflect changes in rates of hunting mortality. However, determination of these changes requires adequate samples of immature birds from the population studied. It is not known whether or not the biases created by shell limits, kill quotas, and "firing line" versus decoy

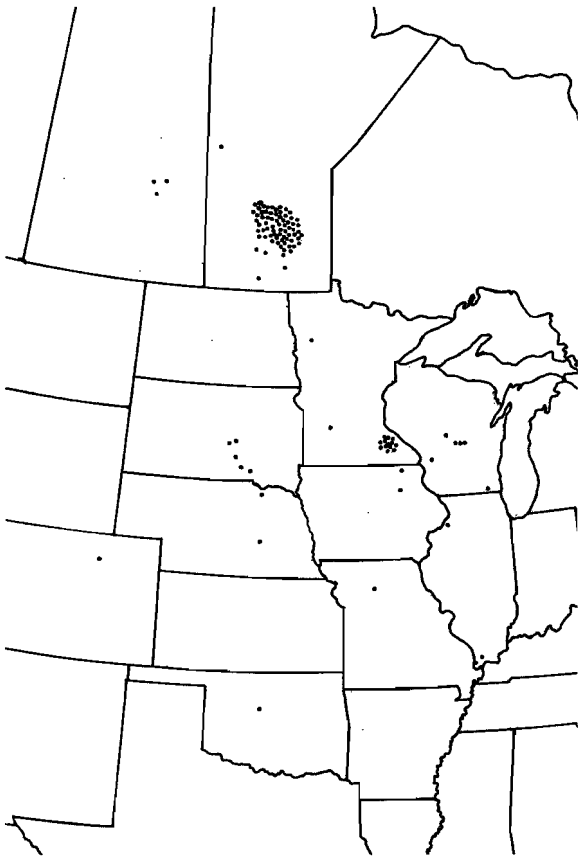


FIGURE 11. Location of Canada goose (B. c. maxima) band recoveries of geese banded at Rochester, Minnesota, 1961-66.

TABLE 30. Age and Sex of Canada Geese When Retrapped in the Keewatin District, N.W.T., 1963-65 and Banded at Rochester, Minnesota

	2 Years Old		3 Years or More	
Yearlings	Male	Female	Male	Female
13	5	3	12	14

shooting are greater or less than the biases associated with hunter questionnaires, band recovery rates, duck stamp sales, etc. that are ordinarily used to determine changes in annual hunting mortality. At Rochester, we are confident that the immature geese we have examined are from the same population; however, the numbers fluoroscoped each year may be too small to provide reliable data.

The incidence of embedded lead shot in the Rochester geese indicates that 14 percent of the immatures, 34 percent of the yearlings and slightly better than half of the adults carry shot (Table 31). The number of embedded shot in the adult geese examined ranged from 1 to 24 with a mean of 3.1 per bird.

Some postseason fluoroscopy data are available from other sources. Following the hunting season in 1964-66, about 14 percent of immature male mallards in the Mississippi Flyway carried embedded lead shot. Examination of 596 immature Canada geese (B. c. interior) in Missouri in 1949 showed 21 percent with embedded shot (Elder, 1953). In the immature segment of a wintering Canada goose flock in southeastern Colorado there were 31 and 34 percent with embedded shot in 1961 and 1962, respectively (Funk and Grieb, 1965). At the time these geese in Missouri and Colorado were examined, shell limits and kill quotas had not yet been imposed. Special hunting regulations have not been needed or imposed at Rochester.

"Refuge line" hunting and shooting at a distance of 60-80 yards is the most common method of hunting at Rochester. This often temporarily cripples large geese and tends to increase the proportion carrying lead shot, as indicated by fluoroscopy. Only a small number of geese at Rochester, however find it necessary to cross the refuge line. The methods of hunting directed at the Rochester flock in other states or provinces is not well known, but we are unaware of any similar "refuge line" hunting situations. Only 10 percent of the annual kill from this flock takes place on the wintering grounds at Rochester. From fluoroscopic examination it would appear that only light hunting pressure is presently being exerted upon the Rochester flock.

Mortality as Determined from Banding

Mortality estimates were made on the basis of band recoveries using the methods and assumptions discussed by Geis and Taber (1963). For immature geese (young of the previous spring) banded after the hunting season, there was a 7.0 percent band recovery rate the first fall following banding. Geese banded as yearlings (these in their second year of life) and adults (those older) on the wintering grounds at the same time showed a 5.4 percent first-year band recovery rate (Tables 32 and 33). From these recoveries a first-year total mortality rate of 42 percent for adults and 36 percent for immature birds is calculated. The higher mortality indicated for the adults is probably real because of losses associated with breeding. However, the calculated total mortality for both age groups is high and may be too high, especially since the first-year total mortality of adult geese (B. c. interior) banded at Swan Lake, Missouri has been estimated at about 30 percent (Vaught and Kirsch, 1966).

The high calculated mortality of the Rochester birds may well be influenced by the comparatively short period of time that banding has been carried on here, especially since the Canada goose is a long-lived bird. Obviously there will be more recoveries of birds in the future and this will reduce the calculated mortality now assigned to the first year. Hunting mortality, including a 25 percent

TABLE 31. Results of Post-Season Fluoroscopic Examination of Canada Geese (B. c. maxima) From the Rochester Flock, 1964-67

	Adults				Yearlings				Immatures			
	1964	1965	1966	1967	1964	1965	1966	1967	1964	1965	1966	1967
Number fluoroscoped	35	21	66	20	10	12	37	15	51	42	124	26
Number with shot	25	15	33	23	3	5	10	7	6	5	21	3
Percent with shot	71	67	50	38	30	45	27	47	12	12	17	12

TABLE 32. An Abridged Composite Life Table of Giant Canada Geese Banded as Yearlings at Rochester, Minnesota, 1961-66

Years After Banding*	Banded Birds Available	Number Recovered	Mortality Series**	Survival Series	Mortality Rate[1]
0-1	486	34	70.0	192.8	36.3
1-2	357	18	50.4	122.8	
2-3	317	13	41.0	72.4	
3-4	223	7	31.4	31.4	54.2
4-5	50	0	00.0	00.0	
5-6	1	0	00.0	00.0	
Totals and means		72	192.8	419.4	46.0

* Each year is considered to start March 1.
**Represents the number of recoveries per 1,000 banded birds available at each yearly interval.
[1]Percent per year. Years 1-6 averaged.

crippling loss, is estimated to make up about 15 percent of the total mortality, based on an assumed 50 percent band reporting rate.

Our conclusion that only light hunting pressure is being exerted upon the Rochester flock is based upon the low incidence of embedded lead shot (14 percent of the immature birds after one hunting season), rapid build-up of the wintering flock, relatively high productivity as indicated by age ratios in trapped samples and family flock counts, and moderate hunting mortality as indicated from return of bands.

Disease Studies

In conjunction with the banding program during the years 1964-67, blood serum was collected from 242 geese on the possibility that these geese might transmit Salmonella infections, Newcastle disease, infectious sinusitis, and ornithosis to domestic turkeys in the Rochester area.

Standard tube-agglutination was used to test for antibodies of Salmonella pullorum, S. typhimurium and S. anatum. Compliment fixation was used to test for antibodies of ornithosis and plate agglutination tests made to detect antibodies of Mycoplasma gallisepticum, S_6 strain. The hemagglutination-inhibition test was used for Newcastle disease antibodies. Tests for all diseases were negative (Table 34). The Rochester City Health Department has been concerned that the presence of large numbers of geese in the municipal area might be a potential health hazard, especially as carriers of Salmonella and Shigella bacteria. They requested the Section

TABLE 33. An Abridged Composite Life Table of Giant Canada Geese Banded as 2 Year Olds, or Older, at Rochester, Minnesota 1961-66

Years After Banding*	Banded Birds Available	Number Recovered	Mortality Series**	Survival Series	Mortality Rate[1]
0-1	456	25	54.9	130.7	41.8
1-2	353	11	31.2	75.8	
2-3	326	7	21.4	44.6	
3-4	254	3	11.8	23.2	48.6
4-5	88	1	11.4	11.4	
5-6	5	0	0.0	0.0	
Totals and means		47	130.7	285.7	45.8

* Each year is considered to start March 1.
**Represents the number of recoveries per 1,000 banded birds available at each yearly interval.
[1] Percent per year. Years 1-6 averaged.

TABLE 34. Results of Serologic Tests From Canada Geese Wintering at Rochester, Minnesota 1964-67*

Disease or Organism	1964	1965	1966	1967	All Years
Newcastle disease	0/32	0/28	0/36	0/93	0/189
Ornithosis	0/32	0/10	0/34	0/20	0/96
Salmonella pullorum	0/32	0/28	Not tested	0/93	0/153
Salmonella typhimurium	0/32	0/28	" "	0/93	0/153
Salmonella anatum	0/32	0/28	" "	0/93	0/153
Mycoplasma gallisepticum S_6	0/32	0/28	0/40	0/93	0/193

*The number of positive sera (numerator) is listed over the total number tested (denominator).

of Microbiology, Mayo Clinic, to determine the occurrence of disease-bearing organisms in water samples and fecal material from the geese. No information has been received on this and since local concern over the geese as a vector of harmful bacteria has abated, we must assume that their findings were negative also.

Bradshaw and Trainer (1966) made serological tests on flocks of Canada geese (mostly B. c. interior) in Wisconsin for antibodies of Salmonella pullorum and S. typhimurium, Mycoplasma gallisepticum, Newcastle disease, and ornithosis. They used the same procedures used by the University of Minnesota at Rochester. Their results from 12 geese tested for Salmonella and Mycoplasma and 11 geese tested for ornithosis were all negative. However, they concluded that the negative results indicated a need for an expanded survey on a larger number of birds, over a longer period of time, and in several consecutive years.

In the Wisconsin study, 40 of 236 Canada geese (17%) reacted positively for Newcastle disease virus (NDV) antibody. This rate of reaction to Newcastle disease antibodies was considered to indicate that either the geese are being exposed to NDV-infected poultry or poultry products, or else NDV is enzootic in the waterfowl population. It appears that Newcastle disease is not enzootic in the Rochester flock of B. c. maxima, and that they evidently have not been exposed to it either on breeding or wintering grounds to the extent that they have developed antibodies.

Although the number of geese tested for these diseases at Rochester is too small to draw definite conclusions, we believe that the geese wintering at Rochester are, for practical purposes, not a threat to the health of persons or livestock. Postmortem examinations and tests were made on several dead or sick geese collected at or in the vicinity of Silver Lake during the past 6 years. Cultural studies of lung tissue confirmed the cause of death in one goose as aspergillosis. It has previously been reported by Hanson and Smith (1950) that an immature female of the Horseshoe Lake flock died from an Aspergillus fumigatus infection.

Two Canada geese that were found dead contained 7 micrograms of lead per gram of liver tissue and 16 micrograms of lead per gram of kidney tissue. No pellets were found in the gizzards. On the basis of these findings, as well as the emaciated condition of the birds, it appears that death was due to lead poisoning. Cook and Trainer (1966) made lead analyses on livers of experimentally poisoned Canada geese in Wisconsin, and concluded that lead levels in liver tissue of 5-32 micrograms per gram were diagnostic of lead poisoning.

Two additional Canada geese, upon examination, yielded cultures of a bacterium morphologically and culturally indistinguishable from Hemophilus gallinarum, a bacillus which causes respiratory infections similar to pneumonia. Attempts at subculturing this organism to confirm identity were not successful.

Summary

A flock of the giant Canada goose (Branta canadensis maxima) which winters on a small lake in a refuge area at Rochester, southeastern Minnesota, has been under intensive observation since 1962. The lake on which the geese winter is kept at least partly free of ice all winter by heated cooling water from a power plant. The geese feed mostly on waste corn in nearby unplowed stubble fields. The number of geese wintering here has increased from 250 in 1951 to 8,650 in 1966-67.

There is no evidence that winter temperatures or snow depths usual here have an adverse effect on the geese. Data obtained from cannon-net trapping and family group counts indicate that production of young to post-hunting-season age ranged from 0.9 to 3.8 per adult female with the usual produc-

tion between 2.0 and 2.5 per year. This latter figure is similar to those obtained by other investigators on the summer breeding grounds of this flock at Dog Lake, Manitoba.

Calculations based on band recoveries indicate a total mortality the first year after banding of 42 percent for adults and 36 percent for immature birds, but these figures may well be too high as more bands remain to be reported. About 15 percent of the total mortality is attributed to hunting, mostly on the breeding grounds.

X-ray and fluoroscopy indicate that the percentage of geese carrying embedded shot is 14 for immatures, 34 for yearlings, and slightly more than 50 for adults. There has been concern that this flock, which winters in a municipal area surrounded by farmlands, might carry human or poultry diseases, but tests have not indicated this to be the case.

ANOTHER much-studied flock of giant Canadas is the population breeding on the Seney National Wildlife Refuge in Michigan's Upper Peninsula. A major thrust of the field research there has been to determine the factors limiting expansion of the flock, which has stabilized at around a thousand birds after having risen from 332 in 1936.

One limiting factor is clearly predation, principally by coyotes and raccoons destroying eggs and killing goslings. The problem is not simply one of too many vermin, however. It is a case of habitat balance being tipped in favor of the predators through lack of enough safe nesting islands for the geese. Intensive trapping seems to have relieved the pressure somewhat, but predator control appears neither as effective nor as economical as habitat improvement through island construction and brush clearing. Artificial nesting structures are not popular either with the geese or sight-seers.

The second limiting factor is disease. Leucocytozoon, a blood parasite, claimed 700 goslings in 1960 and 500 in 1964. We don't really know how to solve this problem.

A third limiting factor, gun mortality, was not considered a serious matter until 1965, when the Seney flock suffered a 43 percent kill rate, mostly locally. In 1966 and 1967 a substantial area around the refuge was closed to goose hunting. This provided pretty effective added protection.

Taken together, the lessons from Rochester and Seney suggest that flocks of giant Canadas can be nurtured provided some rather special environmental requirements are met, either naturally or artificially, and provided we keep on learning what these requirements are at a faster clip than the processes of environmental deterioration.

7

FACTORS LIMITING PRODUCTION AND EXPANSION OF LOCAL POPULATIONS OF CANADA GEESE

Glen A. Sherwood

THE FACTORS limiting a wild population of Canada geese at the Seney National Wildlife Refuge in Michigan's Upper Peninsula and aspects of goose behavior were intensively studied from June, 1962, to August, 1965 (Sherwood, 1966a and 1967). Those findings concerned with factors limiting production and expansion of the breeding flock at the refuge are presented here along with a look at similar problems confronting other local breeding populations of Canada geese in the North Central states.

The Seney flock had its origin in 1936 when 332 pinioned Canada geese were donated to the refuge by Henry M. Wallace of Detroit (Johnson, 1947). All offspring of the pinioned flock were allowed to fly free and they eventually established a migration and homing tradition. Hanson (1965) has identified these birds as giant Canada geese, Branta canadensis maxima.

During the course of the study the size of the flock fluctuated between 800 and 1,200. Annual production to flight stage ranged from 100 to 490 (Table 35).

The Study Area

Seney is part of the Great Manistique Swamp. Halladay (1965) described the area as follows:

> The region is characterized by vast expanses of lowlands consisting of a black spruce bog condition interspersed with patches of sedge glade and strips of high ground which support white, red, and jack pine... The soil and subsoil throughout this region is pure, medium sand. Only a few inches of the surface layer have weathered and contain organic matter. Accumulations of peat and muck have formed throughout most of the bog and wet areas.

The 95,535-acre refuge is composed of four broad habitat types: cropland, 416 acres; upland (brush and timber), 26,911 acres; marshland, 60,965 acres; and openwater, 7,243 acres (Fig. 12). Twenty-one pools, in which water levels can be controlled, contain most of the open-water acreage. The pools range in size from 27 to over 1,000 acres. They contain numerous islands which are used by the geese for nesting.

Methods

Extensive field surveys and observations were necessary to determine reproductive success; extent and influence of predation, disease and accidental losses; and limitations of the available habitat for the Seney flock. Band recovery data were used to determine annual mortality rates.

Much of the over-all study required rapid and accurate identification of individual geese. Flexible plastic collars were developed for this purpose (Sherwood, 1966b). Observations of collared geese were useful in determining day-to-day mortality of goslings in known family groups (Fig. 13).

A questionnaire was used to determine the factors currently limiting other local flocks of Canada geese in the North Central states.

TABLE 35. Canada Goose Production and Population Data at Seney Refuge, 1963-65

	1963	1964	1965
Total nests	181	235	227
Destroyed			
Number	43	90	61
Percent	24	38	27
Deserted			
Number	11	7	12
Percent	6	3	5
Unhatched			
Number	0	0	2
Percent	0	0	1
Hatched			
Number	127	138	152
Percent	70	59	67
Total eggs	896	1121	1078
Destroyed			
Number	197	410	267
Percent	22	37	25
Deserted			
Number	47	25	43
Percent	5	2	4
Unhatched			
Number	43	59	92
Percent	5	5	8
Hatched			
Number	609	627	676
Percent	68	56	63
No. goslings to flight	475	100	490
Fall flock size	1100	800	1000

Scientific names of plants and animals are presented in Table 41.

Predation

Losses

During the course of the study covering three nesting seasons, predators destroyed 194 nests and 874 eggs (Table 35). They also killed a minimum of 12 adults and approximately 175 goslings.

Nesting losses to predators were considered serious from 1963 to 1965. In 1964 it was apparent that predation had developed into a formidable limiting factor when 38 percent of the nests were destroyed and 9 incubating females were killed on the nest. The nesting effort was nearly wiped out on two pools in 1964 – in one, 13 of 15 nests were lost, and in another, 17 of 20.

Positive evidence was frequently lacking, but when present it pointed to coyote and raccoon as the major predatory offenders. Both animals took eggs, but the coyote was responsible for killing the incubating females. In one case, a coyote defecated squarely in the middle of the nest after killing the goose and eating the eggs.

Investigators in other areas have found predation to be a serious limiting factor on goose production. Murie (1959) and Jones (1963) felt that predation by blue foxes was a major contributing factor in the almost complete reduction of the Aleutian Canada goose. Hanson and Smith (1950) indicated that foxes were periodically a major controlling factor on the Canada goose hatch in the James Bay area. Craighead and Craighead (1949) found that raven predation was critical. Again, in the north, MacInnes (1962) found that jaegers, gulls and foxes were sometimes responsible for heavy losses in Canada geese, and Sherwood (1961) concluded that glaucous gull production on black brant goslings was a significant limiting factor.

The Problem

While it may appear that the problem was simply one of too many mammalian predators, it was actually one of habitat limitations. There were not enough safe nesting islands for the geese. The habitat balance was tipped in favor of the predators. Seney Refuge, in spite of its large size, had a limited number of safe and adequately spaced nesting islands. Of the approximately 750 nesting islands at Seney, only about 200 could be considered satisfactorily located.

Expansion of the breeding goose population at Seney was limited by these conditions. When the population built to about 225 breeding pairs and further expansion appeared to be assured, predation trimmed back the flock. The additional breeders were forced to nest on unsafe islands and thus became easy prey. In 1963, 181 nesting pairs of geese hatched 609 goslings (Table 35). Yet in 1964, 235 pairs produced a hatch of only 627 – an increase of 54 breeding pairs, but only 18 more goslings. Clutch size averaged $5.3 \pm .2$ in 1963 and $5.2 \pm .2$ in 1964. Occasionally, of course, in years of low predator populations or high buffer species populations (e. g. snowshoe hare), nests on some of the marginal islands would be spared. Apparently, this was part of the reason for the somewhat better hatch in 1965 (676 goslings from 227 pairs). The hare population was up and predator numbers, especially coyote, was down as a result of control efforts and possibly a natural winter die-off.

The relationship between location of nesting islands and nesting success on two pools is vividly illustrated in Figure 14. This pattern was the same on all refuge pools. The vulnerable nesting sites were: (1) on islands less than 200 feet offshore; (2) on islands arranged in a "hopscotch" pattern leading out from shore; and (3) on long peninsulas. Hammond and Mann (1956) found a somewhat similar

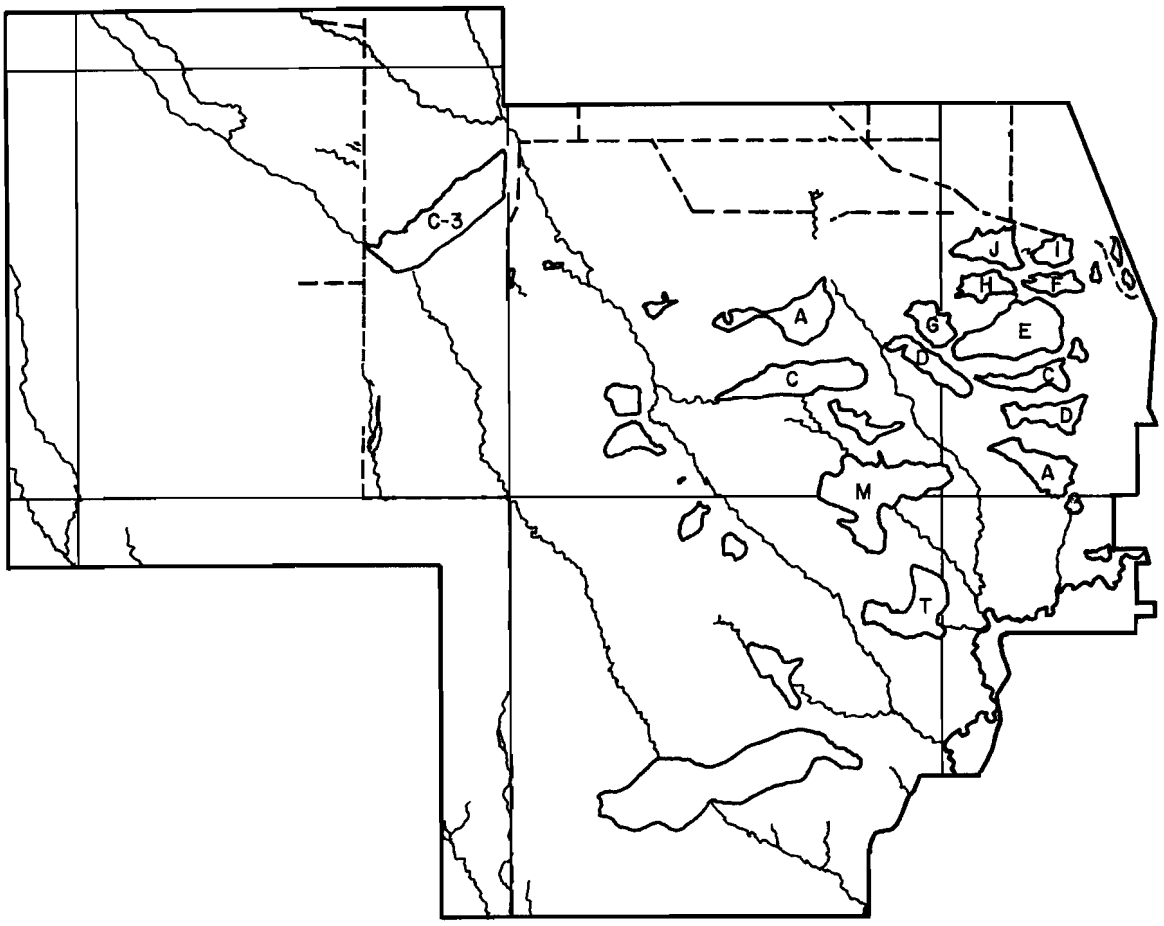


FIGURE 12. Map of the Seney National Wildlife Refuge, showing pools.

situation at the Lower Souris National Wildlife Refuge.

Water depth was an important factor in relation to safe distance offshore. Some islands that appeared to be safe sites based on distance alone were not because the water depth was too shallow (less than 12 inches) between island and shore.

Predators naturally take advantage of the shallow waters and "hopscotch" island patterns. On May 15, 1963 from 11:15 to 11:33 a. m., I watched two male coyotes methodically search 6 islands along the north side of C-3 Pool. They were able to wade to 5 islands. One coyote voluntarily swan about 35-40 feet to the sixth island which was about 600 feet from shore. Shallow water and the island patterns made the distance an ineffective barrier.

Mammalian predators also traveled over the ice to prey on eggs laid in early nests. Each year the geese began to nest as soon as the islands started to clear of snow. Because many of the exposed islands cleared 10 days to 2 weeks ahead of ice breakup, a number of nests were vulnerable during that period. A direct observation of this was recorded on April 18, 1965 when a large coyote was spotted moving cautiously over the soft ice after departing from an island nearly 300 yards offshore. A destroyed nest containing 3 eggs was later found on the island.

Avian predation on eggs prior to incubation was of some significance but did not approach the extent of mammalian activity. Several hundred crows moved into the refuge area early each spring. Pairs dispersed about the refuge, and a substantial number remained in several loose flocks for 2 to 3 weeks before moving on.

Other potential predators at Seney included red fox, mink, weasel, striped skunk, bald eagle, great horned owl, snapping turtle, and northern pike.

Seney had a large population of otters, but since most nests were successful on islands frequented by otter, they apparently were not predators on goose nests. George J. Knudsen, otter expert and Chief Parks Naturalist for the Wisconsin Department of Natural Resources, wrote (pers. comm., 1965):

> In all my field work on this animal I have never found evidence of their feeding on eggs. If they ate them, they probably would not eat the shells in their entirety, though a few fragments would probably be ingested.

FIGURE 13. Observations of collared geese were useful in determining day-to-day mortality of goslings.

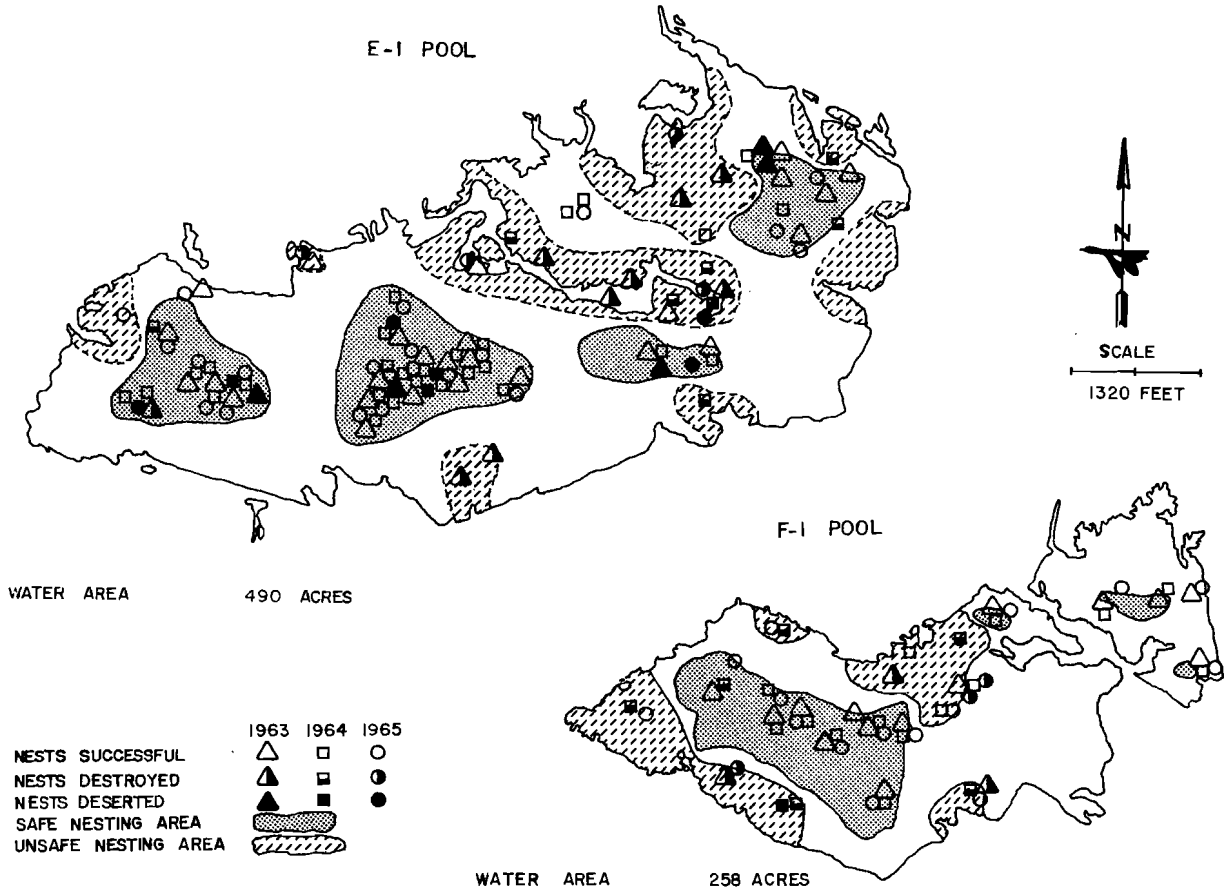


FIGURE 14. Map of E-1 and F-1 Pools, Seney National Wildlife Refuge, showing nest site locations, nesting success, and safe and unsafe nesting areas as determined by the fate of the nests, 1963-65.

I have not seen even the smallest fragments of egg shell in their droppings.

The bald eagle, even though chiefly a fish and carrion eater, was closely observed. No actual kills or nest predation were directly observed; however, the following incidents suggest that the eagle probably did cause some minor losses.

1. Refuge records show that on August 23, 1959, an adult male goose was killed by a bald eagle. The event was witnessed by Axel Mortenson, longtime refuge maintenanceman.
2. On May 3, 1963, a goose was found on a large island in E-1 Pool incubating 4 eggs in a nest located about 150 feet from the base of a red pine which contained an active bald eagle's nest. A second check of the nest on May 20 revealed 2 eggs destroyed outside of the nest, but the remaining 2 were pipping. The nest was left immediately, but a final check on May 28 showed that something had destroyed the pipping goslings. Egg shells were found beneath the eagle's nest.
3. On June 13, 1963, an adult bald eagle was observed feeding on an adult male Canada goose on an island in D-1 Pool. The goose may have been sick or dead before the eagle was involved.
4. On April 9, 1965, two refuge maintenancemen watched an adult bald eagle swoop down three times to attack a pair of adult Canadas standing on the ice of C-3 Pool. On the third pass, one of the geese caught the eagle with a sharp wing-blow and drove it off.
5. On June 29, 1965, William Taylor, biologist with the U. S. Forest Service, found feathers of an adult goose below an eagle nest on M-2 Pool.

Northern pike abound in the refuge pools, but no evidence was recorded of pike predation on goslings. Lagler (1956) found that predation by pike on Seney goslings and ducklings was negligible.

There was no evidence that the other predators – red fox, mink, weasel, striped skunk, great horned owl, or snapping turtle – caused significant losses; but more intensive study of this group is needed for an accurate assessment of predation.

Control Efforts

In an effort to reduce over-the-ice mammalian predation, some pools were lowered 1 to 2 feet in the fall of 1963 and 1964. Then, when the birds returned in the following spring, the pool levels were raised as rapidly as possible to accelerate ice break up. As a result, I-1 Pool opened up on April 13, 1965, but E-1 (not involved in the drawdown) did not clear of ice until April 26. In 1964, F-1 and I-1 opened up several days in advance of J-1 and B-1 Pools, which had not been drawn down. The overall effect in reducing predation was difficult to measure, but some relief from predation may have resulted.

Following excessive nest and egg losses in the spring of 1964, three trappers were granted permits to remove predators (particularly coyotes and raccoons) from the refuge. Their take included 64 coyotes, 52 raccoons, 11 red foxes, 9 striped skunks, 3 porcupines, and 1 dog. An additional 24 raccoons were trapped by refuge personnel during the duck banding program.

In the spring of 1965, refuge personnel put out 130 live traps (for raccoons) and 24 steel traps (for coyotes). The live traps were out from April 12 to May 26 and were checked daily, while the steel traps were out from about May 1 to June 15 and were checked every 3 days. Results were not very satisfactory as only 17 raccoons were taken in the live traps and only 2 raccoons, 2 showshoe hares, and 2 porcupines were caught in steel traps. The traps were placed by a professional trapper and by two refuge men with over 50 years of combined trapping skills.

Live-trapping efforts were effective to some degree in controlling raccoon predation on small areas or in protecting goose nests on a few islands close to shore. For example, when 4 nests were destroyed in the Lower Goose Pen Pool, live traps were set out and 7 raccoons were removed; the remaining 8 nests hatched successfully.

Predation losses were reduced by 11 percent in 1965, suggesting that the 1964 and 1965 trapping may have provided some relief from predators.

The 1965 spring trapping program required about 360 man-hours at the cost of approximately $1,000. At a similar cost, about 25-30 safe, well spaced, earthen nesting islands could be constructed annually. In the long run, this would appear to be a more worthwhile management practice. Gerald Updike, Seney Refuge biologist, informed me that a recent habitat and island improvement program on the lower Goose Pen Pool at Seney resulted in complete elimination of mammalian predation in 1967 (pers. comm., 1967). In the past, this pool has frequently been hard-hit by predators.

Limitations of Available Nesting Habitat

General Observations

During each nesting season, observations were recorded of gross habitat factors which appeared to influence utilization of available nesting habitat. Significant observations were as follows:

1. While there were a few notable exceptions, most of the geese tended to select islands that were free of dense, high brush, such as tag alder, and trees such as jack and red pine. Tag alder reduced visibility and collected great drifts of snow that failed to clear in time for nesting. The geese preferred islands with grass and sparse brush 6 to 20 inches high (Fig. 15).
2. Island spacing was important. Rarely were seemingly good nesting islands used if adjacent islands were closer than about 150 feet and occupied by another goose. Desertion usually resulted on one island or the other if an attempt was made. The typical situation was for the goose to nest on one island and the gander to post himself on the next nearest island. In some cases, a pair might claim a cluster of 3 or 4 small islands within 150 to 200 feet of one another.

Only on the very largest islands (in excess of 250 feet long) did more than one pair attempt to

FIGURE 15. Typical preferred nesting island and habitat at Seney Refuge.

nest. On these islands as many as 5 pairs attempted to nest. Desertion rates were considerably higher in these cases – probably because of the increased intraspecific strife.

3. On narrow pools such as C-3, there was a marked tendency for the geese to select islands in the middle of the pool because shallow water along the north side made many islands vulnerable to predation. This suggests some type of learning process because the geese that did nest on islands within 200 feet of shore had a very high percentage of nest losses. The tendency to select islands well offshore was apparent in all pools. Unfortunately, safe, well-spaced and unclaimed islands were at a premium, and many geese were forced to use the unsafe islands near shore.

4. The nests were frequently placed beside low stumps (10 to 24 inches high) or alongside old fallen timber in light stands of black huckleberry and/or mixed stands of grasses and sedges. They were lined with varying amounts of down mixed with whatever material was available, including tag alder, and arbutus leaves, raspberry and goldenrod stems, fern parts, moss, twigs, grasses, other bits of organic detritus and in one case, boughs trimmed from red pine trees. The geese were obviously not specific in their requirements for nesting materials, and this factor probably had little influence on the utilization of nesting habitat.

Habitat Improvement Work

With much of the foregoing information in mind, it was decided to manipulate the habitat in one pool (I-1 Pool) through island construction and brush and timber clearing in an attempt to produce conditions similar to those apparently preferred by the geese.

To provide grazing areas the dikes around the pool were cleared of choking stands of tag alder in November 1963, and jack pine and red pine were removed along the north side of the pool in December 1963 and January 1964. Also, in January 1964, after I-1 Pool had been completely drawn down in the late fall, 46 nesting islands were improved or constructed. The work was accomplished by tractors with bulldozer blades. Several large islands were divided into 3 or more islands. Four islands too close to shore were removed, and an old spoil bank through the pool, which provided predator access, was removed.

Response by the geese to these efforts in the spring of 1964 was gratifying and showed where additional work was needed. There were 14 nests on I-1 Pool that spring, an increase of 5 over the 1963 total, but the predation problem was still there. The geese did not accept the new raw islands that had only a hay mulch for cover. The increase came on the islands that had been divided and left with natural cover.

I-1 Pool was drawn down again in July 1964. Some of the smaller, poorly spaced islands were removed, and shallow areas that served as predator approaches were deepened. A dragline was used to put up 12 nesting islands in soft areas that could not be reached with bulldozers. The bulldozers were used to construct 18 additional islands, some of which were improvements on the previous winter's work. Crown size of the 30 islands ranged from 10 feet x 18 feet

to 25 feet x 50 feet. All islands were limed (2 tons/acre), fertilized (300 lbs./acre with 23-28-14), and seeded with rye (100 lbs./acre) and other grasses (32 lbs./acre including 15 lbs. Canadian blue grass, 12 lbs. Canadian brome grass, 3 lbs. alsike clover, and 2 lbs. fescue). The seeding was covered with a light hay mulch, branches, and later with some red pine boughs. It was possible to transport and place some "clumps" of natural vegetation on most of the islands reached by bulldozers. Final work on the islands was completed in July 1965 when rushes and sedges were transplanted around the island to prevent washing and erosion. Island construction costs were $21 each by bulldozer and $52 each by dragline. Average total cost per island, including costs of construction, fertilizing, liming, seeding, mulching, etc., was approximately $40.

Following the work in 1964 the geese immediately responded to the new islands by browsing on the sprouting greens and by loafing and preening. Then, in the spring of 1965, both resident geese and migrants moved onto the newly cleared north spoil bank and adjacent areas to graze on the upland cleared of red pine and jack pine.

Since there had not been much opportunity for natural cover to get started, little increase in nesting was anticipated for 1965 on I-1 Pool, even though 45 improved islands awaited the return of the geese. However, nesting exceeded expectations when 20 pairs used the islands in the pool. This was an increase of 6 (30%) over the previous year despite a slightly decreased number of nesting pairs for the entire refuge. Predation was sharply reduced, although not eliminated. Because each gander usually claimed at least one additional island, it was believed that the pool nearly reached maximum nesting density in 1965. A breakdown of nest distribution showed 6 nests on natural islands, 6 on divided islands, 4 on new islands constructed by bulldozer, and 4 on new islands constructed by dragline.

Table 36 indicates the potential for compressing the Seney flock by the above habitat manipulation methods. Of major significance is the fact that I-1 Pool and the Lower Goose Pen Pool had the highest nesting density up to 1965, and they were the pools that had an island construction program (Lower Goose Pen in 1936-37, and I-1 Pool in 1964).

TABLE 36. Nesting Density of Canada Geese in Relation to Pool Size at Seney Refuge, 1965

Pool	Size (Acres)	No. Nests	No. Nests Deserted	Nests/100 Acres
I-1	129	20	1	15.5
A-1	259	6	0	2.3
B-1	243	8	0	3.3
C-1	302	8	1	2.7
D-1	197	11	1	5.6
E-1	490	29	4	5.9
F-1	258	15	0	5.8
G-1	202	14	1	6.9
H-1	111	6	1	5.4
J-1	214	14	0	6.5
LGP	93	12	0	12.9
UGP	27	1	0	3.7
Show	57	2	0	3.5
A-2	282	11	2	3.9
C-2	501	18	0	3.6
M-2	863	17	0	2.0
T-2	410	6	0	1.5
C-3	702	16	1	2.3
Riverside	1000*	5[a]	0[a]	0.5*

*Estimated

Disease and Accidents

Gosling Die-off, 1964

The first indication of a die-off came on June 4, 1964, when a dead gosling was found in B-1 Pool. A brood count through Unit 1 on the evening of the same day confirmed suspicions that a die-off might be occurring. Brood numbers were sharply reduced, and brood size had tumbled from a previous average of 3.9 to 3.2, and by the next day was down to 2.6. Brood size was actually much lower because broods that were already completely decimated were not averaged in. Observations of a number of marked parents with broods made this apparent (Table 37).

Only 10 broods were observed on an early morning survey through Unit 1 (exclusive of headquarters) on June 8. Normally, a brood count on a similar quiet morning would have recorded 35-50 broods through the same area. By this time the broods had been so decimated that a realistic average brood size could not be calculated. Losses were estimated at 400 and average brood size at 1.6.

Most of the goslings died between June 3 and 10. They were 2 to 3 weeks old at the time. Total losses were calculated at 500 goslings, fully 80 percent of the hatch.

Survival varied, as some pools were hit harder than others. Following the die-off, the headquarters area (F-1 and Upper F-1 Pools) still had 7 broods; but 3 counts on C-3 Pool failed to turn up a single brood, even though 13 nests had successfully hatched there. In fact, the 7 headquarters broods containing 27 goslings (one-fourth of the remaining survivors) had by far the best survival on the refuge.

During the die-off, only 18 goslings were found dead or dying. This was a very small proportion of the calculated 500 loss. The recovery of the 18 was considered satisfactory in view of the number of predators present. When stricken, the goslings in the last stages of the disease lingered and stumbled along the shore. They were reluctant or unable to follow the parent birds into the water and consequently became easy victims for the numerous predators. Laboratory examinations by Drs. James Barrow of Hiram College, Ohio and I. Barry Tarshis of the Patuxent Wildlife Research Center implicated

TABLE 37. Effect of Gosling Die-off on Single Broods Observed with Marked Parents at Seney Refuge, 1964

Marked Parents	Location	Date Observed	Number of Young
Orange W7 and female	J-1 Pool	May 25	6
		May 29	6
		June 4	1 (sick)
		June 5	0
Orange R8 and female	E-1 Pool	June 1	6
		June 4	1
		June 5	0
Orange L6 and male	B-1 Pool	June 1	5
		June 2	5
		June 5	2
		June 8	2
		June 10	0
White W4 and C1	Show Pool	May 22	3
		June 12	0
Orange O2 and female	D-1 Pool	May 31	3
		June 1 a. m.	3
		June 1 p. m.	2
		June 4	0
White B4 and Y1	D-1 Pool	May 27	4
		June 1	4
		June 4	0
Orange I1 and female	G-1 Pool	May 29	7
		June 10	0
Orange T9 and P5	Headquarters Area	June 4	4
		June 5 a. m.	4 (1 sick)
		June 5 p. m.	3
		June 6	2
		June 9	1
White A4 and X1	Show Pool	May 28	3
	E-1 Pool	June 8	0
White Y5 and female	Show Pool	May 28	7
		June 5	6
		September 4	3

Leucocytozoon, a blood parasite, as the probable cause of the die-off.

Black flies (Simulium sp.), often linked with Leucocytozoon (Fallis and Trainer, 1964), were extremely numerous that spring. Swarms of the flies were frequently observed at nest sites and were a constant source of harassment to the broods after hatching. It is conceivable that the unrelenting attacks of swarms of flies could, in themselves, have had a debilitating or even fatal effect on the goslings. Dr. David Clark of Michigan State University suggested that the goslings might actually have been bled to death. Such a possibility does not seem remote to those who experienced the outbreak of flies at Seney in the spring of 1964.

The effects of the 1964 die-off were evidenced many times through 1964 and 1965. The extent of the loss, including nest predation, was substantiated when 82 female geese bearing incubation patches were trapped in early July of 1964. They had no broods, but the incubation patches indicated that the birds had nested (Hanson, 1959). In 1965 only 550 geese including about 100 nonbreeders returned to Seney, again reflecting the severity of the 1964 loss. Molting geese in 1965, exclusive of parents with broods, also reflected the loss because they

represented a record low of only 65 birds each on A-1 and B-1 Pools. There were no geese on the traditional molting pool, E-1, where 200 to 300 usually molted. Summer drive-trapping operations in 1965 yielded only 47 birds, exclusive of broods.

A comparison of the number of goslings in the headquarters area for 1964 and 1965 showed dramatically what happened – only 6 broods with 23 goslings on July 1, 1964, but 20 broods with 104 goslings on the same date in 1965.

The 1964 losses continued to be felt in the population in 1966 and 1967 when the age group that died should have been making a contribution to the breeding potential of the flock.

Die-off History at Seney

The major die-off of goslings at Seney in 1964, with Leucocytozoon as the probable cause was not a new phenomenon. Biological records at Seney indicate that about 690 of 790 goslings died from Leucocytozoon in 1960. The flock had just completed a good recovery from those losses when production was again drastically reduced in 1964.

Records on the flock were not always entirely accurate, but they indicated that something had caused noticeable setbacks to flock growth several times prior to the more clearly documented losses in 1960 and 1964 (Fig. 16).

The somewhat cyclic nature of the disease losses has puzzled researchers. It may be caused by weather factors, timing of the hatch of flies with the hatch of goslings, population density of geese, lack of a necessary good nutrient, or some completely unknown or unrelated timing mechanism. The fact that the goslings survived better at headquarters, where there was excellent grazing which was superior to that elsewhere on the refuge, indicates the possibility that nutrition was a factor.

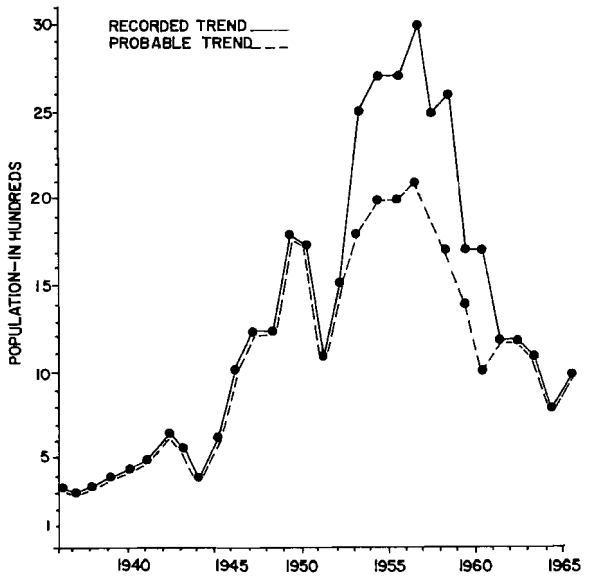


FIGURE 16. Seney Refuge local Canada goose populations for early September, 1936-65, showing flock growth and decline. For explanation of recorded versus probable trend see Sherwood 1966a.

Because of the cyclic pattern of the outbreaks, there is reason to believe that another substantial die-off will occur in 1968 or 1969.

Other Losses

Aspergillosis has apparently taken a minor toll of goslings and possibly a few older birds each year. In 1964 a brood of 5 goslings that hatched after the Leucocytozoon die-off all died between July 4 and July 18. Two were examined by pathologists at the Patuxent Wildlife Research Center and the cause of death was found to be Aspergillosis.

In 1965, 14 goslings were found sick or dead. All but 3 were a week old or less, contrasting sharply with the 2-to 3-week old goslings that died from Leucocytozoon in 1964. Most of the sick goslings in 1965 became crippled from some unknown malady and were unable to keep up with the brood, whereupon they died quickly either of the ailment or exposure to weather.

A small number of adult birds also showed signs of being crippled each year (in May and June). One bird in particular (X2-male) became so afflicted in 1965 that he was observed many times falling back on his tail or stumbling flat on his breast. Yet, he and other older birds recovered. A few of the birds in the crippled condition had swollen legs and joints.

Accidents

Accidents were of no major significance but are mentioned because of the interest they engender. During the course of the study, 11 geese were found dead from accidental causes, including 6 that were run down by vehicles on State Highway M-77 near the Show Pools, 1 that had been caught in a steel trap, 1 that had its head entangled in wire underwater while trying to probe for corn in a floating duck trap, 1 that had flown into a highline wire near headquarters, and 2 that died from banding accidents.

Kill and Annual Mortality

Seney Refuge personnel banded 1,048 Canada geese from 1962 to 1965. Gun mortality was not considered a serious limiting factor until 1965, when the first-year band recovery rate jumped to 18.5 percent from the previous year's 4.4 percent (Table 38).

The mortality figures in Table 39 are based on a 36 percent band reporting rate (Martinson and McCann, 1966), a 22.5 percent crippling loss rate (Green, Nelson, Lemke, 1963), and on banding data shown in Table 38. One exception to the foregoing was necessary in calculations for 1965-66. Of the 31 first-year returns reported for that fall, 20 came from areas immediately adjacent to the refuge. Refuge personnel collected a major portion of those bands, making the 36 percent band reporting rate

TABLE 38. Banding and Recovery Data on Canada Geese Banded at Seney Refuge, 1962-65

Year	Number Banded	Number Retrapped	Total Trapped	Geese Recovered		
				Total	First Year	
					Number	Percent
1965	168	107	275	66	31	18.5
1964	316	225	541	31	14	4.4
1963	219	155	374	36	15	6.8
1962	345	86	431	47	19	5.5

unuseable. As a result, I arbitrarily applied an 80 percent reporting rate to those 20 bands.

The variation of the data on "other mortality" in Table 39 is disconcerting. It indicates one or more of the following unknowns: (1) that the band reporting rate fluctuates widely from year to year (probably depending on where the birds are shot); (2) that off-refuge dispersal of geese in the spring accounts for a significant part of the flock; or (3) that census efforts at Seney still need additional refinement.

Because of the excessive gunning mortality in 1965, which followed the heavy disease losses in 1964, the Michigan Department of Conservation gave the Seney flock additional protection in 1966 and 1967 by closing a substantial area around the refuge to hunting. About 60 percent of the total kill occurred in this area in 1965. This management effort appeared to be effective. Gerald Updike reported (pers. comm., 1967) that the 1967 pre-hunting season population of local Canadas totaled about 1,300.

Factors Limiting Production and Expansion in Other Local Populations

The current status of other local flocks of Canada geese in the North Central states and factors limiting their production and expansion is shown in Table 40. Many of the individuals who generously made these data available to me have not had the opportunity to study their flocks in depth and their present assessments of the major limiting factors are subject to change.

Of the 28 contributors reporting limiting factors to their flocks, 19 considered gun mortality a major limiting factor, and 11 of the 19 felt that the gun was the only serious factor they had to contend with at present. Nine contributors listed lack of suitable nesting habitat as limiting to their flocks and 6 others indicated predation as a major factor. Periodic flooding of nests was a problem on 2 areas, as was dispersal of yearlings to other areas without return. Vandalism of nests by the public was a serious problem on one area.

Conclusions

Predation, habitat limitations, gun mortality, and disease have combined to hold the Seney Canada goose population in check and, at times, to severely depress it. Attempts to minimize these limiting factors have been mentioned. Predator control was

TABLE 39. Calculated Mortality Rate of Seney Refuge Goose Flock, 1962-66*

Year	Fall Population	Spring Population	Kill**		Other Mortality[1]		Total Mortality	
			Number	Percent	Number	Percent	Number	Percent
1965-66	1000	500	429	42.9	71	7.1	500	50.0
1964-65	800	550	126	15.8	124	15.5	250	31.3
1963-64	1100	750	272	24.7	78	7.1	350	31.8
1962-63	1200	700	236	19.7	264	22.0	500	41.7

* These figures do not include production or brood mortality.
**Includes crippling loss.
[1] Includes accidents and disease.

TABLE 40. Current Status and Limiting Factors of Other Local Flocks of Canada Geese

Flock	State	Project Started	Current Size	Current Status	Limiting Factors	Contributor
Lower Souris NWR	N. D.	1938	640	Static	Habitat and gun	J. Wilson
Upper Souris NWR	N. D.	1957	400	Increasing slowly	Habitat and predation	J. Dahl
Audubon NWR	N. D.	1957	90	Increasing	Habitat and dispersal	D. McGlauchlin
Lostwood NWR	N. D.	1963	152	Increasing	Habitat and gun	J. Matthews
Sand Lake NWR	S. D.	1939	200	Static	Gun and flooding	L. Schoonover
Waubay NWR	S. D.	1937	721	Static	Gun	R. Johnson
LaCreek NWR	S. D.	1963	300	Increasing		J. Ellis
Crescent L. NWR	Nebr.	1948	150	Static	Gun	J. Wilbrecht
Valentine NWR	Nebr.	1950	100	Static	Habitat and predation	N. Peabody
Agassiz NWR	Minn.	1951	350	Decreasing	Gun and weather	D. Cline
Tamarac NWR	Minn.	1953	400	Increasing	Pop. density and predation	N. Nelson
Rice Lake NWR	Minn.	1951	450	Static	Predation	C. Pospichal
Thief Lake	Minn.	1959	125	Decreasing	Gun	N. Ordal
Lac Qui Parle	Minn.	1958	400	Increasing slowly	Predation and dispersal	R. Benson
Heron Lake	Minn.	1965	250	Increasing	Gun and winter food	J. Thompson
Necedah NWR	Wisc.	1939	250	Static	Predation and habitat	E. Collins D. Brown
Horicon Marsh	Wisc.	1946	105	Increasing slowly	Gun	R. Hunt
Crex Meadows	Wisc.	1952	433	Increasing	Gun	R. Hunt
Green Bay	Wisc.	1932	355	Static	Habitat and gun	R. Hunt
Huron Valley*	Mich.	1920's	3000	Increasing	Gun	E. Mikula
Kensington	Mich.	1948	600	Increasing	Vandalism	R. Mortemore
Shiawassee NWR	Mich.	1959	600	Increasing	Gun and floods	J. Frye
Kalamazoo Valley**	Mich.	–	500	Increasing	Gun	E. Mikula
Kellogg	Mich.	1930	1000	Increasing	Habitat and gun	R. Van Deusen J. Johnson
Thumb Area	Mich.	–	350	Static	Gun	E. Mikula
Ludington	Mich.	1957	300	Static	Gun	E. Mikula
Rifle River	Mich.	1948	200	Increasing	Habitat	E. Mikula
Wilderness Park	Mich.	1934	150	Static	Gun	E. Mikula
Alpena	Mich.	1939	100	Static	Gun	E. Mikula

* Not including Kensington flock.
**Not including Kellogg flock.

reasonably effective, but expensive and time consuming. In the long run I believe habitat improvement through construction of safe, well-spaced nesting islands to be a wiser expenditure of funds. It serves a two-fold purpose by providing nesting sites and by sharply reducing mammalian predation. Gun mortality will, of course, always have to be contended with. Active banding programs are necessary to adequately determine these losses. If a flock suggests too great a gunning loss, such as at Seney in 1965, additional protection can be given the flock by closing a larger area to hunting, providing that a substantial part of the kill occurs locally.

There is general concensus among persons associated with the management of local flocks of Canada geese that certain aspects of the present framework

TABLE 41. Scientific Names of Animals and Plants Mentioned in Text

Common Name	Scientific Name	Authority*
Canada goose (Seney)	Branta canadensis maxima	A.O.U.
Canada goose (migrant)	Branta canadensis interior	"
Aleutian Canada goose	Branta canadensis leucopareia	"
Black brant	Branta nigricans	"
Parasitic Jaeger	Stercorarias parasiticus	"
Herring gull	Larus argentatus	"
Glaucous-winged gull	Larus glaucescens	"
Bald eagle	Haliaeetus leucocephalus	"
Great horned owl	Bubo virginianus	"
Common raven	Corvus corvus	"
Common crow	Corvus brachyrhynchos	"
Blue jay	Cyanocitta cristata	"
Common grackle	Quiscalus quiscula	"
Northern pike	Esox lucius	Blair, et al.
Common toad	Bufo americanus	"
Snapping turtle	Chelydra serpentina	"
Red squirrel	Tamiasciurus hudsonicus	"
Eastern chipmunk	Tamias striatus	"
Snowshoe hare	Lepus americanus	"
Porcupine	Erethizon dorsatum	"
Coyote	Canis latrans	Blair, et al.
Red fox	Vulpes fulva	"
Arctic fox (Blue)	Alopex lagopus	Burt and Grossenheider
Raccoon	Procyon lotor	Blair, et al.
Weasel	Mustela sp.	"
Mink	Mustela vison	"
Striped skunk	Mephitis mephitis	"
Otter	Lutra canadensis	"
Bracken fern	Pteridium aquilinum	Gleason and Cronquist
Red pine	Pinus resinosa	"
Jack pine	Pinus banksiana	"
Brome grass	Bromus sp.	"
Fescue	Festuca sp.	"
Canada blue grass	Poa compressa	"
Rye	Secale cereale	"
Carex	Carex sp.	Fassett
Bulrush	Scirpus sp.	"
Tag alder	Alnus rugosa	"
Raspberry	Rubus strigosus	Gleason and Cronquist
Alsike clover	Trifolium hybridum	"
Arbutus	Epigaea repens	"
Huckleberry	Gaylussacia baccata	"
Goldenrod	Solidago sp.	"

*See Literature Cited for complete citation

of federal waterfowl hunting regulations operates against the establishment and further increase of these flocks. Both the early opening on geese, prior to the duck season, and the extended goose season appear to have a decided detrimental effect on some local breeding flocks of Canada geese. Some state game and fish departments have assumed the responsibility of establishing more restrictive regulations to protect local breeding flocks. Michigan has provided more protection for both the Seney and Shiawassee flocks by reducing the season length for taking geese on a statewide basis and a 5-year area closure on hunting of Canada geese around the Shiawassee Project while the flock was building. Wisconsin has had a large portion of Burnett County closed to goose hunting for a number of years to protect the Crex Meadows flock. Minnesota has closed a substantial area around the Twin Cities to protect that metropolitan flock the last 2 years. South Dakota has closed all or parts of specific counties in the state to goose hunting to protect local breeding flocks of Canadas, and North Dakota

has closed a substantial area around the Audubon National Wildlife Refuge to protect the small, but increasing, flock there. Even though the need for more protection for local breeding flocks is recognized, many state game and fish departments, including some mentioned above, find it difficult, if not impossible, to convince their law-making bodies of this need when the federal regulations are more lenient.

The disease problem, at least at Seney, is not so easily solved. More research will be needed before effective management practices can be initiated.

Summary

Factors limiting production and expansion in a wild population of Canada geese were studied at the Seney National Wildlife Refuge in Michigan's Upper Peninsula from June 1962 to August 1965.

Major limiting factors at Seney included predation (heightened by certain habitat factors), disease, and hunting mortality.

Predators, principally coyote and raccoon, destroyed 194 nests and 874 eggs during the 1963 to 1965 breeding seasons. They also killed a minimum of 12 adults and approximately 175 goslings. Predator control and habitat improvement work helped to reduce losses in 1965. However, predator control is expensive and does not have the long-term beneficial aspects that habitat improvement has.

Disease, probably Leucocytozoon, claimed 500 goslings in 1964.

Gun mortality was not considered a serious limiting factor in recent years until 1965, when the flock suffered a 42.9 percent kill rate. Most of the increased kill took place locally. A substantial area around the refuge was closed to goose hunting in 1966 and 1967 and has been effective in giving the flock additional protection.

Individuals associated with 29 other local flocks of Canada geese were queried as to the major factors limiting their flocks. Gun mortality and lack of suitable nesting habitat, were, by far, the most important factors limiting these flocks.

THE NEXT TWO PAPERS are among the more provocative contributions to this book. While they may raise more questions than they answer, they represent imaginative approaches to one of the more perplexing problems in Canada goose management; namely, how do you determine annual reproductive success promptly enough and accurately enough to effect wise harvest regulations? Collecting data on goose population structure is a tough job, because most breeding areas are almost inaccessible. Raveling proposes to assess production by analyzing groups of birds in fall before extensive hunting mortality has occurred. The essential assumption is that groups of flying Canada geese represent families or aggregate of family units. By following radio- and color-marked geese, he finds that while groups taking off or in flight do not represent true family sizes or ratios of singles and pairs, upon the moment of landing goose groups do reveal their social composition. From this Raveling suggests that group counts of landing geese can provide an appraisal of production prior to hunting. It may well be, however, that this technique will be found to apply only to the Mississippi Valley Population which he studied. Further research is continuing into the operational significance of the fact that these birds regularly land as recognizable families or aggregates of family units.

8

CAN COUNTS OF GROUP SIZES OF CANADA GEESE REVEAL POPULATION STRUCTURE?

Dennis G. Raveling

DETERMINATION of annual reproductive success of Canada goose populations is one of several phases of data collection necessary for an understanding of population dynamics and for the implementing of effective harvest management. This is especially true when increasing knowledge of the identity of various population units and subspecies (Hanson and Smith, 1950; Hanson, 1965) has led to the development of differential regulations (quota zones, e.g.) and to recognition of the misleading nature of data representing a composite from two or more divergent populations.

Population structure is used here to indicate proportion of age classes (adults, yearlings, immatures) and proportion of breeding age adults successful in rearing a brood, and average brood size. Collection of data on population structure is a difficult task. Many nesting areas are remote, and it is presently difficult, if not impossible, to gather information on population structure before hunting. Present population statistics are usually based on age ratios of geese killed by hunters or live-trapped, combined with analyses of banding and harvest data. All these methods may introduce large bias to results (Hanson and Smith, 1950:168; Nass, 1964; Sherwood, 1966: Raveling, 1966; Martinson and McCann, 1966). Furthermore, most data cannot be gathered until after large shooting losses have occurred. This makes extrapolation of results to pre-hunting estimates difficult.

Another method of gathering population composition data relies on visual identification of the size and number of families in a flock. Until recently, little conclusive evidence existed to prove the continuing unity of goose families (Boyd, 1953:88), even though most authors accepted and utilized the concept of family cohesiveness. Recent studies with individually marked Canada geese have amply demonstrated the intact-unit nature of families (Martin, 1964: 9-10; Sherwood, 1966: 100-122; Raveling, 1967:41-47). Because it had long been thought that geese maintained close family ties for almost a year, interest developed in methods of identifying families in a flock.

Phillips (1916) concluded that groups of flying Canada geese were families or aggregates of family units. Elder and Elder (1949) and Hanson and Smith (1950:152-153, 172) demonstrated that the frequency of different sizes of flying groups changed after hunting. They suggested that group counts might be used to assess production and hunting mortality. Hewitt (1950) observed fall migrating blue and snow geese (Anser caerulescens) and substantiated the Elders' opinion that many small flocks were made up of families, but pointed out that the presence of nonbreeding adults in these flocks prevented determination of the average numbers of young per brood. Based on similar work with white-fronted geese (Anser albifrons), Lebret (1956) concluded that Elder and Elder (1949) had underestimated the abundance of nonbreeding geese and barren pairs and that group counts would not be useful indices to production or shooting losses. Hanson (1965: 159) concluded that data from group counts were less reliable than results from trapping.

Lynch and Singleton (1964) formulated an extensive program of investigations on population dynamics based on group counts of blue, snow, and white-

fronted geese in which immatures were identifiable in the field because of plumage differences. Unlike previous group counting efforts, Lynch and Singleton's method of identifying families involved the recording of functional groups in the period between breakup of larger flocks and actual landing. While landing groups were considered the first choice for such analyses, these authors also suggested that groups departing from a settled flock would be suitable, as would birds in the air, if they moved only a short distance and did not merge. Lynch and Singleton proposed that average group counts might reveal the percentage of young in a Canada goose flock.

The purpose of this paper is: (1) to report results of observation of Canada geese of known social status (i.e. single, pair, family) in their flight behavior; (2) evaluate techniques of counting groups; and (3) discuss what criteria and further data are necessary for meaningful utilization of group counts as a measure of production.

Methods

Canada geese (B. c. interior) of known social status were regularly observed through the winters of 1963-64 and 1964-65 in their daily activities at Crab Orchard National Wildlife Refuge, Williamson County, Illinois. Individuals and families were color- and radio-marked. Details of these techniques and results relating to unity of families and other behavior may be found elsewhere (Raveling, 1967). The marked geese were frequently observed at the moment of taking flight, and their formations during flight to and from feeding areas were observed through a spotting scope. Because Lynch and Singleton (1964) suggested that the group formation at the time of landing was most revealing of family size and relationships, much time was spent in attempting to view marked geese when landing. Most sightings were made at an observation post where some of the radio-and color-marked geese were known to be regularly feeding. The receiver was kept on and the frequency range continually scanned until a signal from a marked goose was heard. I then attempted to observe the goose (or family) descend and land.

Results and Discussion

During this study it was apparent that counts of groups of geese in the air had little significance in determining average family size, percentage of singles, etc. Frequently, groups of geese in the air changed numbers. Numerous observations of the radio-and color-marked geese demonstrated that sizes of groups taking off or in flight often did not represent true family sizes or ratio of singles and pairs (Tables 42 and 43). Even though family members flew next to each other, it was common for other nearby geese to take off at virtually the same time and several groups of singles often coalesced and flew with each other. This behavior causes higher than true average group sizes to be counted. Assuming that one would count only groups of 10 or less as families, the results of this study demonstrate that 75 percent of the time the true size of the group would be identified at take off and only 45 percent of the time would identification of a group in flight be correct.

TABLE 42. Behavior of Radio-and Color-marked Canada Geese of Known Social Status at the Time of Flight Initiation

Group	Number of Observations	Number Observations When Individual or Group at Take-Off Was: Positively Identified*	In a Group of 10 or Less or Family was Separated**	In a Group of More Than 10
Singles	36	19 (53%)	7 (19%)	10 (28%)
Pairs	8	4 (50%)	--	4 (50%)
Families of 3	21	12 (57%)	5 (24%)	4 (19%)
Families of 4	16	6 (38%)	5 (31%)	5 (31%)
Families of 5	25	20 (80%)	3 (12%)	2 (8%)
TOTALS	106	61 (58%)	20 (19%)	25 (23%)

* e. g., single took off as a single, family of 3 took off as a 3, etc.
**Occasionally there was slight delay and separation of family members at take off that might cause an unmarked group to be interpreted as 1 and a 3 instead of a 4, for example.

TABLE 43. Behavior of Radio-and Color-marked Canada Geese of Known Social Status When in Steady Flight

Group	Number of Observations	Number Observations When Individual or Group While Flying Was: Positively Identified*	In a Group of 10 or Less	In a Group of More Than 10
Singles	22	5 (23%)	12 (54%)	5 (23%)
Pairs	5	2 (40%)	2 (40%)	1 (20%)
Families of 3	19	6 (31%)	8 (42%)	5 (27%)
Families of 4	16	4 (25%)	2 (12.5%)	10 (62.5%)
Families of 5	18	7 (39%)	5 (28%)	6 (33%)
TOTALS	80	24 (30%)	29 (36%)	27 (34%)

*e.g., single flying as a single, family of 3 flying as a 3, etc.

Observations of marked geese landing, however, yielded different results. On 10 occasions geese known to be singles were observed landing and on 9 of these the bird landed alone. The other observation was inconclusive in that the goose landed when great numbers of other geese were alighting at the same time and group counts were impossible. On 6 of the 10 observations the marked single was observed while descending, and on 5 of these, it was in close formation with other geese, yet it veered off and landed as a single. Pairs were observed landing on 4 occasions and on 3 of these the individuals landed right next to each other. Once a pair was split about 15-20 feet and they settle on the ground at slightly different times and might have been counted as singles. A family of 3 was twice observed descending in a larger group, but the family separated and landed as a distinct group of 3. On both occasions the adult female made a quick turn and "braked" and the gander and young followed in unison. The other geese in the flock continued gliding and landed elsewhere. A family of 4 was observed landing on one occasion. They broke apart from a flock and landed as a close-knit unit. A family of 5 was twice observed landing as a distinct unit. On one of these occasions the family split from a flock as it glided in to land.

In summary, geese of known social status landed according to their functional group on 17 of 18 different observations. While limited, these results offer confirmation of Lynch and Singleton's (1964) method of analyzing family sizes based on geese at the moment of landing, but not at the time of take off or in steady flight.

Close unity at the moment of landing does not always occur, however. Once an unmarked family landed at the same time a single landed 25 or 30 yards away, and this family and single ran toward each other and met in a Triumph Ceremony, an almost positive indication of familial relationship (Raveling, 1967:18-33). Nevertheless it appears that in the great majority of cases families land as close-knit units and split from unrelated geese. It was expected that family members would remain very close to each other, but not that multiples of families and singles flying together would almost always split apart completely enough to be identified. Singles apparently avoided landing right next to other geese with which they were flying. Family members apparently responded only to the final preparatory landing movements and vocalizations within the family. A key observation on the nature of goose behavior was provided by Konrad Lorenz who could not get his imprinted geese to land near him until he wildly spread his arms and fell after running (Tinbergen, 1953:111-112). This spreading of the arms more closely resembled movements a goose would make and the geese reacted by landing right beside Lorenz. The almost continual "contact" vocalizations within a family and the "braking" wing movements provide the cues that enable close physical proximity of family members to be maintained while landing.

A further proof that geese regularly land as recognizable groups was provided by a series of counts made within short time intervals at different periods of the winter (Table 44). These counts were made on the same "subflock" of geese which radio-tracking had demonstrated was habitually using the same roost area and flight pattern to feeding areas (Raveling, 1967:111-134). These results demonstrated a high degree of regularity in landing associations and the effects of mortality.

Census records in Wisconsin and Illinois showed that the geese observed prior to hunting at Crab Orchard were present before the Wisconsin hunting season. Since fall hunting mortality in Ontario was believed to be very slight relative to the total numbers

TABLE 44. Counts of Landing Groups of Canada Geese at Crab Orchard National Wildlife Refuge, 1964-65

Time Period	No. of Counts	Total No. Geese Counted (Avg. Per Sample)	Median Percent Single Geese (93% Confidence Limits)*	Median Percent Pairs (93% Confidence Limits)*	Median Group Size – Groups of 3 or More** (93% Confidence Limits)*
Prior to hunting October 17-23	10	4195 (420)	9.4 (8.6-10.1)	17.1 (16.9-19.5)	4.12 (4.02-4.13)
Range		244-601			
After hunting Dec. 19-Jan. 2	10	5746 (575)	20.1 (18.7-21.6)	25.1 (24.2-27.4)	3.78 (3.68-3.81)
Range		454-683			
Prior to spring migration Feb. 22-March 5	10	7164 (716)	22.6 (20.8-23.7)	29.9 (28.3-30.5)	3.62 (3.60-3.64)
Range		499-949			

* Walker and Lev (1953:440).
**Only groups of 9 birds or less were considered families.

in this Mississippi Valley population (J. B. Dawson and H. G. Lumsden, pers. comm.), I concluded that the pre-hunt sample was representative of the population prior to hunting, but after migration. Results (Table 44) thus represent the population available for harvest and most meaningful in terms of final reproductive success for the summer of 1964.

Families of geese maintained their unity throughout the winter (Raveling, 1967: 41-47) and the group counts reflected this behavior in quantitative terms which suggest population structure. Most groups of 3 to 9 represent adult pairs with their offspring. Pairs are mostly adult mated pairs without young; singles mostly represent unmated geese (especially yearlings). Comparison of the number of adult pairs with young to pairs without young thus indicates the proportion of adults successful in bringing a brood, or part of a brood, south and the average family size. However, certain obstacles must be overcome before these data may be utilized as the most accurate measure of production. Most yearling geese are singles (Raveling, 1967: 47-55) and most singles are yearlings (Raveling, unpubl. data) prior to hunting. However, yearlings may also be in pairs (sibling or mated), in sibling groups, or integral members of families (Raveling, 1967: 47-55). The prevalence of yearlings in each of these associations affects the ratio of young to old, thus making it difficult to derive age structure. Continued collection of data on group sizes before hunting will allow the computation of mortality and production rates when combined with kill estimates and mid-winter inventory. This, in turn, should enable estimation of presently unknown parameters or ones on which sparse data are available (e.g. percentage of singles which are yearlings). Additional data on the status of yearlings are needed along with information on the percentage of unmated adults (e.g. whether there is a disproportionate sex ratio) and of immatures lacking parents because of "natural" causes.

The technique of counting landing groups has great potential as it may produce precise population information quickly and economically (Lynch and Singleton, 1964). For example, harvest quotas for the Mississippi Valley population are presently based on long-term averages of winter population numbers, kill estimates, and apparent average production indices, but not on data for the current year. Group counts before hunting can provide data on the current crop, although after the time regulations are now set. Ultimately, these data may be utilized in determining allowable harvest. Group counts have been conducted every autumn before hunting since 1964 at Horicon National Wildlife Refuge in Wisconsin, in southern Illinois, or both (Raveling, unpubl. data). Results have paralleled population trends evident from retrospective analysis of harvest and inventory figures and have borne out prediction of poor reproductive success in 1967, based on observations in the nesting grounds of Ontario (Raveling and Lumsden, unpubl. data). Group counts can lead to the accumulation of data basic to understanding population oscillations and the formulation of life equations. Coupled with information on age ratios of the previous season's kill, magnitude of the kill, and winter population size, pre-hunt population structure appraisals have enabled population size estimates prior to hunting to be made that were in close agreement with a figure obtained by

adding the kill to the winter inventory population number (Raveling, unpubl. data). Continued compilation of these data are needed, however, before I can conclude that the prediction procedure is completely satisfactory; this research is continuing.

The Mississippi Valley population of B. c. interior is ideal in many ways for the use of group counts in analyzing production and prediction of total population size. Group counts on many other populations of Canada geese, unfortunately, would not be meaningful. Counts must be made prior to the times when significant mortality by hunting has occurred. Once families are disrupted, singles and pairs may represent many different combinations of different age geese.

Another prerequisite for the most meaningful type of group counts is that almost total migration away from nesting areas and concentration in large numbers at another area must occur before hunting. If counts are made on the first migrants, they may be biased to high numbers of yearlings and unsuccessful nesting adults (Vaught and Kirsch, 1966: 42), especially in years with retarded spring weather and delayed nesting. Flocks nesting in high densities may have large and "unnatural" brood sizes due to "adoption" and thus group counts may be misleading (Williams and Marshall, 1938; Brakhage, 1965; Sherwood, 1966:124-132; and many others). Brood-mixing is not considered prevalent among B. c. interior nesting in Ontario (Hanson, 1965: 152-154; Raveling, 1967: 45). Counts on nesting areas must be delayed until the young have developed full coordination of their flight abilities. Also, counts on nesting areas may be highly misleading as large numbers of the population representing yearlings and unsuccessful nesting geese may have gone elsewhere to molt (Hanson, 1965: 78-82; Kuyt, 1966). Counts on areas which contain a mixture of subspecies or population units which could not be clearly identified may be highly misleading as these units may have widely differing reproductive success in any one year.

Further factors conductive to reliable results such as counting undisturbed birds landing a few at a time, not counting when strong winds prevail, etc., were discussed by Lynch and Singleton (1964). All these items must be kept in mind when considering undertaking group counts, and care in the selection of time and place of such counts is essential to obtaining meaningful results.

Summary

Counting groups of Canada geese while they are initiating flight, in flight, or landing have all been suggested as means of analyzing population structure based on the number and size of families in a flock. Observations of radio- and color-marked Canada geese during winter proved family unity in daily activities, but revealed that size of functional groups could not be regularly or accurately measured by counts of geese at the moment of take off or in steady flight. However, group size could be identified at the moment of landing. Consecutive counts on the same "subflock" of geese made before and after hunting, and before spring migration, further proved the regularity with which geese land according to a pattern reflecting families, pairs, and singles.

Provided several criteria are met, group counts of landing geese can provide an accurate measure of production prior to hunting, and, coupled with reasonable estimates of the past year's harvest and post-hunting population size, indicate total population size before hunting. Certain prerequisites for use of this technique on other flocks and the need for additional information vital to accurate analysis of population structure are discussed.

THOROUGH KNOWLEDGE of goose population dynamics must await well conceived and comprehensive studies on the principal breeding grounds. What we know now about breeding behavior stems largely from observations of isolated flocks of the larger subspecies at accessible sites. MacInnes and Lieff have made a start at penetrating the mysteries of the behavior of Richardson's Canadas within a large area of continuous goose nesting habitat on the western coast of Hudson Bay. What they have found so far is upsetting enough to suggest there is a good deal yet to be confirmed about Canadas. For example, MacInnes and Lieff report that, far from being discrete enclaves, considerable immigration and emigration occurs between breeding units (or "demes.") Does this mean we can't ever pinpoint where a particular winter flock nests? For another example, MacInnes and Lieff have observed considerable evidence of non breeding on the part of adult geese. Does this mean the breeding ground lebensraum is not as extensive as we have assumed, or could it mean we are dealing with birds with some kind of debilitation? Perhaps the answers to these and other questions will be forthcoming from the continuing study at the mouth of the McConnell.

9

INDIVIDUAL BEHAVIOR AND COMPOSITION OF A LOCAL POPULATION OF CANADA GEESE

Charles D. MacInnes and Bernard C. Lieff

WINTERING populations of Canada geese are usually described as consisting of many small breeding units. These units, to which we shall apply the term "deme" (in the sense of Mayr, 1963: 137) are thought to maintain a high degree of genetic isolation from each other by behavioral means. This was proposed by Mayr (1942: 242) as a major factor in producing the great morphological variation characteristic of Canada geese. On the other hand, MacInnes (1966) proposed that within the Tall Grass Prairie population of Canada geese considerable immigration and emigration might occur between demes. The present paper represents a preliminary attempt to examine these hypotheses.

Locality

The study was undertaken at the mouth of the south branch of the McConnell River (60°50' N, 94° 25' W) near Eskimo Point, Northwest Territories. This area is on the western coast of Hudson Bay about 250 kilometers (150 miles) north of Churchill, Manitoba.

A 55-square-kilometer study area was permanently marked in 1964 (Fig. 17). Boundaries of the study area were chosen to include most of the Canada goose nesting habitat readily accessible from the base camp; no attempt was made to choose an area which would be statistically representative of goose habitat on the Hudson Bay coastal plain.

Materials and Methods

Canada geese marked with individually coded neckbands provided the basis for most field

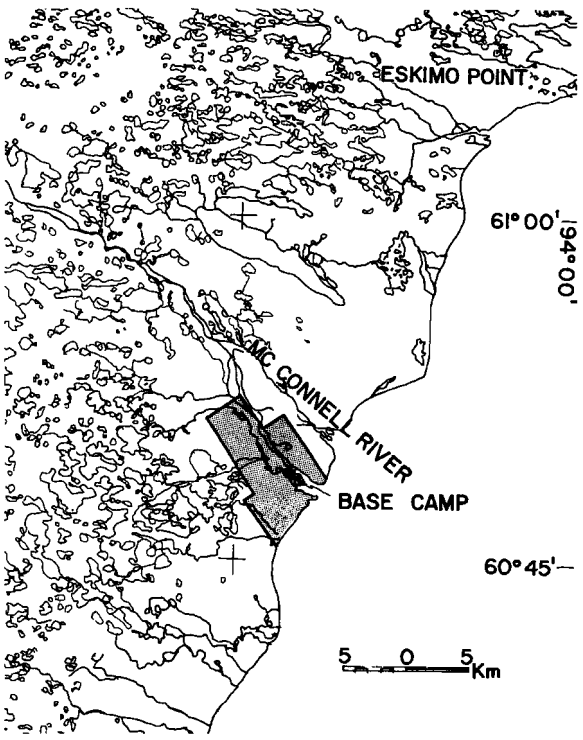


FIGURE 17. Position of the study area on the western coast of Hudson Bay.

observations. In 1964 and 1965 the bands were made from slices of 2" plastic pipe, the smallest diameter which would slip on over the head of an adult goose. Background color and lettering were added with 3M No. 471 plastic film tape (Minnesota Mining and Manufacturing Co.). This is a self-adhesive material which has proved extremely resistant to weathering, and entirely color-fast. A lightweight sizing strap was stapled inside the band to prevent it from falling off. These bands suffered three major disadvantages: (1) they fell off at a rate of about 25% per year; (2) large ice balls formed on the bands during the fall and winter; and (3) the bands were too large to be placed on goslings. We were unable to find a method of putting an insert strap into a band already on a goose. Even when almost capable of flight, goslings were able to shed adult-size neckbands.

Therefore, in 1966 we changed to aluminum neckbands. These were stamped from 5" x 2" strips of 40 mill aluminum sheet (Aluminum Co. of Canada 65ST6). The band was flared at the top and bottom to reduce feather wear. Background color and lettering were applied with the same plastic film tape. Bands were placed on the neck of a goose in the same way as a normal legband. These aluminum bands have proved highly successful. Not only do they overcome the objections to the plastic bands, but they are smaller, lighter in weight and more durable. Since few goslings were neckbanded before 1966, the results presented here chiefly concern birds which were adult when banded.

Neckbands have caused mortality to the geese concerned. In 1964 a sample of adult geese was released with legbands only. Comparison of these with their neckbanded counterparts is made in Table 45. The result indicates that over the 3-year period from 1965 to 1967 birds which were legbanded only were detected at the McConnell River 1.6 times more frequently than those which received neckbands. This result is particularly striking when one considers that legbanded birds could be detected initially only through trapping. A similar test of aluminum neckbands began in 1966, but since the geese involved were young when neckbanded, the results will not be available for another two years. From the figures of Table 45, we conclude that 60 neckbanded birds which should have been detected were not seen. This result indicates that quantitative comparisons from the data to follow must be viewed with extreme caution.

During incubation each year we systematically searched the study area for Canada goose nests, and carefully scanned all geese associated with nests for neckbands. In 1966 and 1967 Canada goose broods feeding in the delta of the south branch of the McConnell (Fig. 18, Area 1) were kept under constant observation from an elevated blind. Additional observations of neckbanded geese were made whenever the opportunity arose. No attempt was made to allot time systematically to search different areas. Increased familiarity with the area has made recent searches more efficient. In addition, greater observer experience and better quality telescopes have

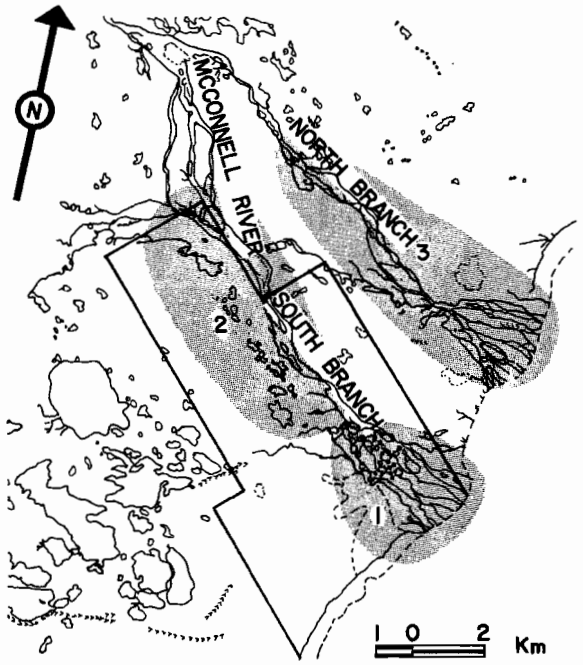


FIGURE 18. Banding drive locations. These areas include all summer feeding habitat accessible from the base camp. Area 1: South Branch Delta; Area 2: South Branch Upriver; Area 3: North Branch.

TABLE 45. Comparison of the Mortality of Neckbanded and Legbanded Canada Geese

	Total Banded In 1964	Geese Seen or Trapped at McConnell River 1965-67	Geese not Detected at McConnell River 1965-67	Reported Killed 1964-67
Legbanded	60	29 (48%)	31 (52%)	13 (22%)
Neckbanded	344	101 (30%)	233 (70%)	51 (15%)
		Adjusted χ^2, 1 d.f. = 6.74 ($p<0.01$)		

undoubtedly caused a larger proportion of neckbands to be read in the past two seasons.

Canada geese were captured for banding by mass drives during the flightless period of the adult molt. At least two drives were made each season in each of the three trapping zones shown in Fig. 18. These zones include all the Canada goose feeding areas accessible to our central banding pen. Drive trapping, the last major operation of the season, caused considerable disruption in normal behavior patterns. For this reason field observations were terminated at the beginning of banding.

Results and Discussion

It quickly became evident that the population with which we were concerned nested well beyond the confines of the marked study area. We have trapped and neckbanded more adult Canada geese than nested on the study area in each season except 1967, yet in the latter season the proportion of neckbanded birds in the nesting survey had only reached 40 percent (Table 46). Also, despite the large number of adult geese trapped, we have never succeeded in catching more than half of the marked birds which nested on the area. The results of searches made for marked nesting geese outside the study area are summarized in Figure 19. We found neckbanded geese on a nest 18 kilometers from the nearest boundary of the area. However, the proportion of marked to unmarked geese declined steadily as we moved farther from the study area. One of the principal aims of these surveys was to locate the nest sites of marked birds which regularly appear with broods in the south branch delta (Fig. 18, Area 1). Of 29 families with marked adults seen in this area in July, 1967 only 13 came from nests of known location, indicating that these surveys were incomplete. Since the nesting survey included most of the occupied nesting habitat within the radius of search, it is evident that many marked birds must nest over 10 kilometers from the study area.

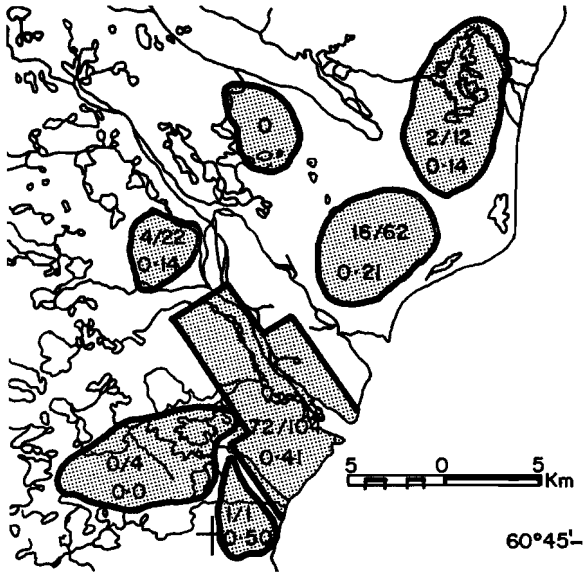


FIGURE 19. Results of searches for nests and neckbanded geese outside the main study area. The top row in each search indicates number of neckbanded geese/number of unmarked geese, while the lower number is the marked : unmarked ratio.

Canada geese were banded on the McConnell River in 1959, 1960, 1961 and, during the course of the present investigation, from 1964 to the present. Use of coded neckbands began only in 1964; birds banded before that date and retrapped since have been neckbanded. A summary of all recoveries of geese first banded as adults is presented in Table 47. A more detailed analysis of records of geese banded in 1964 is shown in Table 48. This indicates that the individual birds sighted often change from year to year, although the total number sighted remains relatively constant. This is a result of variations in behavior between individuals, and is further demonstrated in Table 49,

TABLE 46. Comparison of Neckbanded Sight Records and Trapping Results at McConnell River

	Numbers of Geese Associated With Study Area Nests				Numbers of Neckbanded Geese Seen With Broods in Zone 1		Total Number of Adult Geese Trapped		
	Number of Nests on Study Area	Unbanded	Neckbanded		Neckbanded		Unbanded	Legbanded or Neckbanded	Ratio Total Trapped
			Seen	Trapped	Seen	Trapped			Seen on Nests
1965	98	175	21 (11%)*	4 (20%)**	5	4 (80%)**	151	70 (32%)*	1.13
1966	125	194	56 (22%)	28 (50%)	40	30 (75%)	282	110 (28%)	1.57
1967	90	104	72 (41%)	29 (40%)	42	29 (69%)	70	68 (49%)	0.76

* Percent of total.
**Percent of birds seen.

TABLE 47. Recoveries at McConnell River, From 1964 to 1967, of Canada Geese First Banded as Adults

Year Banded	Number Banded			Number Recovered													
				1964		1965				1966				1967			
				Male	Female	Male		Female		Male		Female		Male		Female	
	Male	Female	Unknown	T	T	S	T	S	T	S	T	S	T	S	T	S	T
1959	48	46	--	0	1	0	0	0	1	0	0	0	2	0	0	2	0
1960	59	55	197	3	4	1	0	1	3	2	5	1	5	3	0	1	0
1961	--	--	221*	2	5	1	2	2	2	0	3	2	1	1	1	2	2
1964	202	192	--	--	--	16	24	23	17	32	32	29	31	27	16	19	13
1965	76	75	--	--	--	--	--	--	--	11	12	17	17	7	4	12	7
1966	138	131		--	--	--	--	--	--	--	--	--	--	40	12	37	13
Total	523	499	418	5	10	18	26	26	23	45	52	49	56	78	33	73	35
Total (sexes combined)		1440		T 15		S 44	T 49			S 94	T 108			S 151	T 68		

S = Seen
T = Trapped
* = Age Unknown

Total Geese Neckbanded 769
Total Geese Recovered 290
Males Recovered 146
Females Recovered 144

TABLE 48. Detailed Examination of McConnell River Recoveries of Canada Geese First Banded as Adults in 1964 (Each Row of the Table Traces the Records of a Different Group of Birds)

	Male						Female					
	1965		1966		1967		1965		1966		1967	
	S	T	S	T	S	T	S	T	S	T	S	T
Neckbanded 1964	16	2	8	5	6	5	23	8	13	9	5	2
	--	17	7	7	3	1	--	6	4	4	2	1
	--	--	13	4	6	3	--	--	9	2	6	3
	--	--	--	7	2	0	--	--	--	7	2	0
	--	--	--	--	1	0	--	--	--	--	0	1
Legbanded 1964	--	5	4	1	3	1	--	3	3	2	1	1
	--	--	--	8	6	4	--	--	--	7	3	1
	--	--	--	--	--	2	--	--	--	--	--	4
Total	16	24	32	32	27	16	23	17	29	31	19	13

S = Seen
T = Trapped

TABLE 49. Complete Recovery Histories of Sixteen Adult Male Canada Geese Banded in 1964 and First Seen in the Field in 1965

Neckband Code	Year Recovered							
	1965			1966			1967	
	S	T	K	S	T	K	S	T
∠	X	X	--	X	--	--	--	X*
CH	X	--	--	X	--	--	--	X*
JU	X	--	--	X	X	--	X	X
CY	X	--	--	--	X	--	X	X
51	X	--	--	X	X	X	--	--
DH	X	X	--	X	--	--	X	--
38	X	--	--	X	--	--	X	X
DU	X	--	--	X	--	--	X	--
61	X	--	--	X	X	--	X	--
32	X	--	X	--	--	--	--	--
LA	X	--	X	--	--	--	--	--
AH	X	--	--	**	--	--	--	--
HD	X	--	--	--	X	--	--	--
FD	X	--	--	--	--	--	--	--
AL	X	--	--	--	--	--	--	--
37	X	--	--	--	--	--	--	--
Totals	16	2	2	8	5	1	6	5

S = Seen
T = Trapped
K = Killed
* = Neckband Lost
** = Neckband Probably Lost

which gives the histories of the 16 males shown in Table 48 as first seen in 1965.

No difference was detected between the sexes in the rates of return of geese first banded as adults or banded as goslings and seen as yearlings. However, females banded as goslings were seen much more frequently than males when of potential breeding age, i.e. two years or older (Table 50). A tentative explanation is that some young birds formed pairs while on migration, and, when this happened, the male followed the female back to her nesting ground. We have no direct evidence to support this theory.

In contrast to the Canada geese studied by Martin (1964) in Utah, McConnell River birds did not use the same nest site year after year. Of 98 nest sites used in 1967, 17 had been used in 1966, and 4 of these in 1965. An additional 4 sites were used in 1965 and 1967. Of the 17 sites used in 1966 and 1967, 2 were used by different pairs in the two seasons. However, actual movement was not as great as implied by these figures. The normal pattern was that a pair of geese nested in the same area year after year, but usually on different nest sites. Observed shifting of nest site between seasons and even within a season was as great as 5 kilometers within the study area and 10 kilometers from outside to inside the area. One season a marked female began a nest inside the study area which was destroyed after 2 eggs were laid. Later in the summer this female was found with 3 eggs in a nest 10.5 kilometers south of the original site. The hatching date on the second nest indicated that it was not a re-nest but rather a continuation of the original clutch. Coincident with the change in nest sites, this female changed mates.

A summary of nesting histories appear in Table 51. While only 5 geese have been seen at nests during all three seasons of study, this nonetheless represents one quarter of the marked geese seen nesting in 1965. Nine of the 21 geese nesting in 1965 were observed in 1967.

The distribution of nesting birds in 1966 and 1967 is shown in Figure 20. We are unable to explain the shifts in nesting densities which occurred between these two years. It is possible that thaw and flood conditions might render some sections unavailable at the start of nesting in one year, but we have been unable to substantiate this. Cooch (1958) suggested that blue geese which lost a nest on one site were likely to move some distance the following season. We have failed to confirm any relation between

TABLE 50. Recoveries at McConnell River of Canada Geese First Banded as Local Goslings

Year Banded	Number Banded			Year Recovered											
				1964		1965			1966				1967			
				Male	Female	Male		Female	Male		Female		Male		Female	
	Male	Female	Unknown	T	T	T	S	T	S	T	S	T	S	T	S	T
1959	2	1	48	1	3	--	2	2	1	0	1	2	0	0	3	1
1960	--	--	221	0	1	--	0	0	0	0	0	1	0	0	1	0
1964	114	112		--	--	2	0	2	2	1	1	7	1	1	5	6
1965	136	141		--	--	--	--	--	3	1	6	0	0	1	5	2
1966	263	415		--	--	--	--	--	--	--	--	--	15	--	15	0
Total	515	669	269	1	4	2	2	4	6	2	8	10	16	2	29	9
Total (sexes combined)	1453			T: 5		S: 2	T: 6		S: 14	T: 12			S: 45	T: 11		

	Number of Individuals Recovered		
	Total	As Yearlings	Two Years or Older
Male	24	21	5
Female	44	23	22
Adjusted χ^2, 1 d.f. Test of Recovery Sex Ratio VS Ratio at Banding		0.07	9.74 ($p < 0.001$)

U = Sex Unknown
S = Seen
T = Trapped

TABLE 51. Summary of Nesting Records of Neckbanded Canada Geese, Including Nests Found Outside the Marked Study Area

Nest Seen			Number of Geese		
1965	1966	1967	Male	Female	Total
X	--	--	2	5	7
--	X	--	14	13	27
--	--	X	32	33	65
X	X	--	2	5	7
--	X	X	6	9	15
X	X	X	2	3	5
X	--	X	1	0	1
X	0	X	0	1	1
X	X	0	0	2	2
--	X	0	2	3	5

X = Nest Seen
0 = Goose Seen, But did not Attempt to Nest

	0 3(0/6)	0 3(0/6)	0 0		
	0 0	3(0/6) 3(2/4)	0 2(0/4)		
	0 0	6(0/12) 1(0/2)	5(0/10) 6(5/7)		
	0 0	12(3/21) 5(6/4)	2(1/3) 8(6/10)	1(0/2) 0	6(1/11) 5(2/8)
	0 0	12(7/17) 2(4/0)	5(2/8) 7(3/11)	2(1/3) 3(2/4)	3(0/6) 1(1/1)
	1(1/1) 0	4(5/3) 1(2/0)	2(2/2) 2(2/2)	2(1/3) 1(0/2)	0 0
	0 1(2/0)	3(1/5) 0	0 0	0 0	0 0
0 3(2/4)	5(4/6) 2(0/4)	4(2/6) 2(1/3)	0 0	0 0	0 0
9(4/14) 10(9/11)	13(5/21) 4(4/4)	3(0/6) 3(0/6)	0 0	3(1/5) 2(1/3)	0 0
1(2/0) 0	3(1/5) 1(0/2)	7(3/11) 2(0/4)	1(1/1) 2(0/4)	2(0/4) 6(4/8)	1(0/2) 0
0 2(1/3)	2(3/1) 4(3/5)	1(0/2) 1(0/2)	0 0	3(2/4) 1(1/1)	0 0
0 0	0 0	0 0	0 0	0 0	0 0

FIGURE 20. Number of Canada goose nests in each kilometer square of the surveyed study area in 1966 and 1967. Each square shows the number of nests (number of neckbanded geese/number of unmarked geese), with the 1966 figure in the top row and 1967 below. Areas showing the greatest changes are in the upper center in the third, fourth and fifth rows, and on the lower left, third and fourth rows from the bottom.

success on one nest site and the tendency to move a long distance to another, although the number of observations is too small for rigorous testing.

In 1967 we found 7 geese (5 females and 2 males) which had nested successfully in 1966 and which did not attempt to nest in 1967. The former mate of one of the nonbreeding males raised a brood with a new male. Also, one female which failed to nest in 1966 after losing a clutch in 1965 was found nesting near her original site in 1967. These nonbreeding adults were usually seen in the company of several other Canada geese, even at the beginning of the laying period. Most marked members of these groups were yearlings. Since nonbreeding geese are more difficult to approach than nesting birds, and since they wander widely, we feel that the probability of identifying such birds is lower than that for nesting birds. Therefore, the 7 birds known not to have nested in 1967 represent a minimum number. In addition to these formerly successful breeders, at least 3 geese which were banded in adult plumage in 1964 or 1965 were on the study area and not breeding. One of these was a male, now at least 4 years old, which has been found in the same 2-square-kilometer area each summer and yet has never been associated with a nest. Throughout most of the incubation period in 1967 this bird was completely alone. Failure of experienced breeders to nest in one season may allow other geese to pre-empt their nesting area. This could result in a forced change of nest site the following season.

Balham (1954) documented clearly the formation of multi-family flocks during the brood rearing period. He described these flocks as being highly organized, and as resisting the entry of "new" families into the flock. We have observed many broods of geese feeding in the south branch delta during the past two seasons. It was quite evident from the distribution of geese in the delta that they did operate in groups of families. However, the number of families in a flock varied greatly from day to day, and associations of neckbanded birds seemed also labile. This situation was complicated by the fact that the south branch delta is not a closed feeding area. Canada goose broods moved in and out of the delta by largely unknown routes from day to day, so that a particular family might be seen in the delta for several days, be absent for a week, and then return to the delta. In a few cases, association of two or three families were maintained for several weeks, but this was an infrequent occurrence.

There appears to be some pattern in the association between nesting area and feeding area, but this is very complex, and has not yet been elucidated. Figures 21 and 22 show the relation between nest site and the location in which a bird was trapped later in the season. While it is quite evident that birds feeding in the south branch delta come chiefly from the nesting area to the south and west of the base camp, these birds represented only about half of the geese nesting in that area. Most marked geese which hatched broods in the delta itself were not seen feeding there for more than a few days after hatching. Further complication is added by the fact that half the broods seen in the delta each year came from unknown nesting sites. Since we believe that our nest search within the study area missed no more than 5 percent of the active nests each year, it is evident that these birds must have come from outside the study area. It is unexpected therefore to find that this group of birds were as faithful to the delta for summer feeding as birds which nested within the study area (Table 52). Furthermore, as mentioned earlier, during the 1967 surveys outside the study area, emphasis was placed on finding the nests of this group of birds without success. In addition to variations in composition, the total number of Canada goose families in the delta dropped from an average of 45 in 1966 to about 25 in 1967.

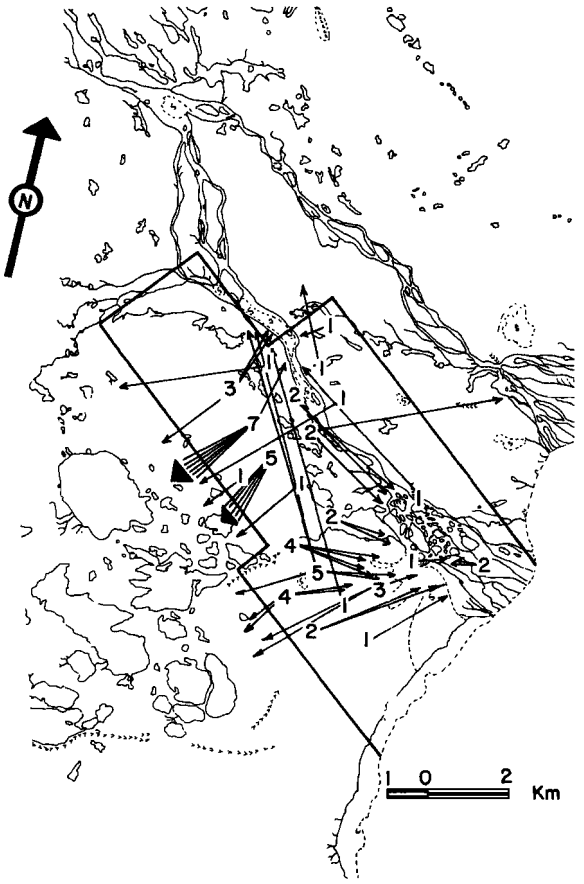


FIGURE 21. Relation between the nest sites and subsequent trapping localities of neckbanded Canada geese in 1966. The number indicate the number of marked geese in a kilometer square (from Fig. 20) while each arrow shows the movement of one goose after hatch. Arrows which terminate in one of the trapping areas indicate that a goose was caught, while arrows pointing outside these regions denote geese which were not seen after their young hatched. The actual direction of movement of the latter birds is unknown.

The present study differs from earlier investigations of the behavior of Canada geese in being located within a large area of continuous Canada goose habitat. The reports of Balham (1954) and Sherwood (1965) dealt with highly isolated flocks, while Martin's (1964) study concerned a partially isolated group. There are other important differences. The three studies cited were concerned with large Canada geese (probably B. c. maxima or moffitti) while the present one deals with a smaller form (probably B. c. hutchinsii in the broadest sense). Also, differences in behavior were no doubt conditioned by the great differences in habitat between prairie marshes and the Hudson Bay coastal plain.

Balham's study clearly supported the hypothesis that the deme of Canada geese is a highly isolated unit. He further postulated that the local breeding population banded together during the brood-rearing period, and possibly stayed together throughout the migration and winter period. On the other hand, Martin was able to trace emigration of at least two birds from his study flock to the nearby Bear River Refuge. The present study provided only fragments of evidence concerning the integrity of the deme with which it is concerned. Decreasing frequency of neckbands at greater distances from the McConnell River indicated that the boundaries of the local population are diffuse and grade insensibly into the edge of the next deme. Blue and snow geese which nested in a large colony on the island between the branches of the McConnell River moved at least 100 kilometers (60 miles) from the colony in the brood-rearing period. There is no reason to assume that Canada geese are not capable of comparable movements. The McConnell River lies in a strip of occupied Canada goose habitat which is at least 275 kilometers (170 miles) long and averages about 12 kilometers (8 miles) wide. Within this area we feel we are unable to draw any boundaries concerning the extent of the McConnell River deme. Furthermore, since the possibility exists that some pair formation occurs on migration, a significant number of McConnell River birds might find their way to distant nesting areas.

Conclusion

We conclude that the deme centered at the McConnell River is relatively large, involving an

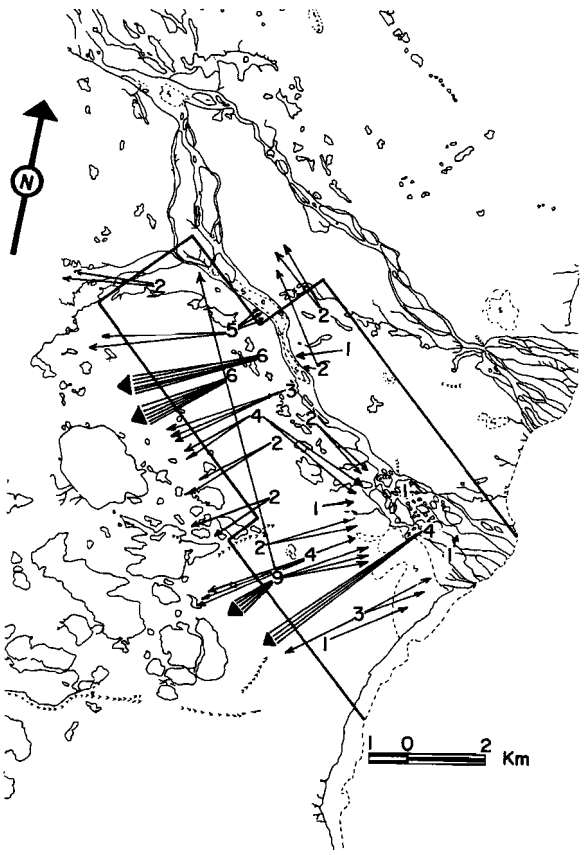


FIGURE 22. Relation between the nest sites and trapping localities of neckbanded Canada geese in 1967. The format of this map is the same as in Figure 21.

TABLE 52. Examination of the Origin of the Parents With Respect to Nest Site of Canada Goose Broods Feeding in the Delta of the South Branch of the McConnell River

Year(s) Seen in South Branch Delta	Nest Not Located 1966 or 1967	Nest Located		
		In 1966 But Not in 1967	In 1966 and 1967	In 1967 But Not in 1966
1966 only	5	6	2	--
1966 and 1967	8	--	5	1
1967 only	6*	1	--	7*

*Includes 5 pairs first neckbanded in 1966.

unknown number of birds in excess of 500 breeding pairs. Evidence from the variation in behavior between individuals as well as variations in the behavior of the same individual from one season to the next strongly indicates a lack of isolation for this deme. It is likely that, based on adult behavior, considerable immigration and emigration between demes takes place. We emphasize again that this report brings to bear little evidence on the behavior of young birds comint into the breeding population for the first time. This is a continuing study, and we expect to report further results.

Current Issues in Canada Goose Management

A GENERATION AGO, when waterfowl management was in its infancy, we were fairly confident that if we simply sprinkled enough safe havens along the flyways, all would be well. Today we find ourselves attempting to manage geese in a scene of intricate socioeconomic factors, of vacuums in basic biological knowledge, and of frequently intense political pressures.

Current issues in Canada goose management, then, can span a rather bewildering array of topics. For example, Addy and Heyland have pointed out the considerable contribution of private landowners to the welfare of the Canada goose, the Maryland bird population alone consuming an estimated 10,500,000 pounds of farm food from November through February. Are farmers to be protected from depredations and/or reimbursed for grain?

Attempting to break up a large concentration of geese at Horicon Marsh, Wisconsin, federal personnel proposed to haze the birds south with noisemakers and planes. The agents were publicly threatened with arrest. By whom? By a member of the Wisconsin Conservation Commission. Where does the authority and responsibility of the U.S. Bureau of Sport Fisheries and Wildlife begin and end?

The city of Rochester, Minnesota, harbors a flock of 8,500 giant Canadas from September to March. The Rochester Board of Health has calculated that the amount of fecal material deposited by 8 geese in a day is equal to the excrement of 1 human. When does goose conservation become goose pollution?

Williams has called for a swing away from a few large refuges and shooting areas to the development of many such areas disposed along the flyways. But getting birds to start re-using such areas in the deep South has so far been futile, as Hankla recounts.

There is general agreement that we must reverse the trend toward concentration, depredation, excessive kill, and unequalized recreation. But this becomes at least as much a matter of managing hunters as of managing geese, Hunt suggests.

The point at which a goose flock becomes overshot is not dependent alone on the size of the kill in one area but on the composition of that kill and its relationship to the take at all other spots and from all other factors, Williams emphasizes. How do we really determine whether production is offsetting mortality? And how do we convince both sportsmen and birdwatchers that our regulations are sound from all perspectives?

If Canada geese are not to lose their wildness and hence their quality as a trophy bird, Hanson and Smith have advised that contact between human beings and geese be reduced so far as possible. How can this be made to square with a recent recommendation that refuges be opened up to more general public recreational use?

The bulk of our goose refuges have been financed by special taxes imposed on hunters. Yet the birdwatching public is growing much faster than the hunting public. How can the costs of goose management be apportioned more equitably?

The goose recognizes no man-made boundaries. To measure his status and control his mortality require rather sophisticated cooperative census procedures and harvest quotas among states. How can such arrangements better be conceived and implemented?

These and other problems suggest that we are scarcely at the end of the beginning in Canada goose management. The papers that follow are typical of the reports on field investigations and practices that are increasingly enlivening the literature. Of particular import is the Crissey agenda for action.

TRANSPLANTING is one of a number of techniques that has been used in Canada goose management. Sometimes it works. The Blackwater and Seney flocks, for example, are at least partially the result of transplanting. Sometimes it doesn't work. Between 1953 and 1965 we were engaged in the largest man-made movement of migratory waterfowl ever undertaken—20,740 Canada geese transplanted to 9 national wildlife refuges in 4 southeastern states from flocks wintering in Illinois and Missouri, in an attempt to rehabilitate or re-establish birds in the deep South. The results: practically nil; only in one spot has there been a "take." Why remains to be evaluated. Perhaps our transplanting techniques are faulty. Perhaps the predator pressure on food in the South is unacceptable. Or perhaps the strain of geese adapted to Dixie has been exterminated.

10

SUMMARY OF CANADA GOOSE TRANSPLANT PROGRAM ON NINE NATIONAL WILDLIFE REFUGES IN THE SOUTHEAST, 1953-1965

Donald J. Hankla

TRANSPLANTING is one of many techniques that has been employed to solve some of the problems associated with Canada goose management, with both successful and unsuccessful results. The earliest record of transplanting Canada geese dates to 1935 when a group of 41 geese was moved to Blackwater National Wildlife Refuge in Dorchester County, Maryland. During the following two years, geese were transplanted to Seney National Wildlife Refuge in Michigan and to Lower Souris National Wildlife Refuge in North Dakota. By the fall of 1940, transplants had been made to 10 additional national wildlife refuges, and by the mid-1950's transplants had been made to over 40 federal refuges.

It was not until the early 1950's that serious consideration was given to attempting the restoration and enlargement of the wintering range of Canada geese through the use of the transplant method. Up until this time, most transplant efforts had been designed to establish new breeding flocks, alter the existing migration routes, or simply to intercept migrants for brief periods during their trek to more southerly wintering areas.

In 1953, a major transplant program was undertaken in the Southeast which resulted in the largest man-controlled movement of migratory waterfowl ever undertaken. During a period of 12 years, 1953-1965, about 20,734 Canada geese were transplanted to 9 national wildlife refuges in 4 southeastern states (Table 53). The general objectives of the program were to: (1) break the established wintering tradition of a portion of the flocks wintering in the Horseshoe Lake and Swan Lake areas; (2) rehabilitate and restore certain deep south wintering flocks to their previous high levels; and (3) establish new wintering flocks in selected areas where conditions were believed suitable but where there were no wintering Canada geese.

Through the course of 12 years the transplant program evolved through four phases or approaches:

1. The freeing of transplanted geese, full-winged, immediately upon completing their transfer to a release site;
2. Pulling the primary feathers from either one or both wings to render the transplanted geese temporarily flightless. During the 6-week interval required for the missing primaries to be replaced the transplanted geese might become acclimated and influenced to select the release site as a permanent winter home;
3. Penning immature birds on a release site for 2 years until the birds were of breeding age. The birds, after being held until breeding age, might migrate to the breeding grounds and return with their young to the only winter home they knew. The birds involved were wing-clipped to keep them flightless during their confinement;
4. Making mass transplants of immature birds, releasing them with primaries pulled, to render them semi-flightless for 6 weeks while they became acquainted with the area.

Results of Transplanting Program

Chassahowitzka National Wildlife Refuge

The transplant program began on Chassahowitzka Refuge in 1953 with the transfer of 28 birds from

TABLE 53. Summary of Canada Goose Transplant Data

Refuge	Number Transplanted				Source of Geese	Condition of Transplants			
	Year	Adult	Juvenile	Total		Full Winged	Primaries Pulled	Primaries clipped	Pinioned
Chassahowitzka	1953			28	Horseshoe		15	13	
	1954			25	Santee				25
	1954			76	St. Marks	35	18	17	
	1955			120	St. Marks	22	98		
	1956			103	St. Marks		103		
	1957			199	Horseshoe		184	15	
	1958	172	87	259	St. Marks	17	193	49	
	1959			24	St. Marks			24	
	1959			52	Wheeler			52	
	1960			91	Wheeler			91	
Subtotal				970					
Loxahatchee	1955			66	St. Marks		32		34
	1956	73	66	139	St. Marks	48	6	85	
	1957			33	St. Marks		33		
	1958	95	57	152	St. Marks	43	59	18	25
	1960			46	St. Marks			46	
Subtotal				436					
Delta	1954			156	Horseshoe	156			
	1955			99	Horseshoe	99			
Subtotal				255					
Lacassine	1955			146	Horseshoe	146			
	1955			100	Seney	100			
	1956			199	Swan Lake		199		
	1958			404	Swan Lake	199	204		
	1963		742	742	Swan Lake		742		
	1964		750	750	Swan Lake		750		
	1965	87	660	747	Swan Lake		747		
Subtotal				3,088					
Noxubee	1953		18	18	Horseshoe		9	9	
	1955			150	Horseshoe	150			
	1956	84	116	200	Horseshoe		200		
	1957			200	Horseshoe		200		
	1957			32	Wheeler		32		
	1958-59			229	Wheeler		229		
	1958			200	Horseshoe	50	50	100	
	1959		100	100	Horseshoe			100	
	1960		100	100	Horseshoe			100	
	1961		99	99	Horseshoe			99	
Subtotal				1,328					

TABLE 53. Continued

Refuge	Number Transplanted				Source of Geese	Condition of Transplants			
	Year	Adult	Juvenile	Total		Full Winged	Primaries Pulled	Primaries Clipped	Pinioned
Yazoo	1957	60	8	93	Swan Lake			68	22
	1958			206	Horseshoe	56	75	75	
	1958			46	Swan Lake				46
	1958			72	Horseshoe	72	(Cripples)		
	1959		100	100	Horseshoe			100	
	1960		100	100	Horseshoe			100	
	1961		99	99	Horseshoe			99	
	1965			139	Crab Orchard		139		
Subtotal				855					
Holla Bend	1957			100	Swan Lake		50		50
	1957	62	36	98	Horseshoe	23	75		
	1958	166	38	204	Swan Lake	51	153		
	1958			120	Swan Lake	75	(Cripples)		45
	1959		100	100	Swan Lake			100	
	1960		100	100	Swan Lake			100	
	1961		100	100	Swan Lake			100	
	1962			2,057	Swan Lake		2,046		
	1963		1,500	1,500	Swan Lake		1,500		
	1964		1,505	1,505	Swan Lake		1,505		
	1965		1,495	1,500	Swan Lake		1,495		
Subtotal				7,384					
White River	1962			640	Swan Lake	640			
	1963		1,500	1,500	Swan Lake		1,500		
	1964		1,500	1,500	Swan Lake		1,500		
	1965		1,500	1,500	Swan Lake		1,500		
Subtotal				5,140					
Wapanocca	1963		412	412	Horseshoe		408		
	1964		500	500	Horseshoe		500		
	1965		365	365	Horseshoe		365		
Subtotal				1,277					
TOTAL				20,734		1,835	16,914	1,560	247

Horseshoe Lake Refuge in southern Illinois. During the next 8 years, a total of 970 geese was transplanted to Chassahowitzka from the Horseshoe Lake Refuge and the St. Marks, Wheeler, and Santee National Wildlife Refuges. Transplanted birds were handled in a variety of ways: 74 were released full-winged immediately upon arrival; 25 were pinioned to serve as decoys; 611 had their primaries pulled to temporarily detain them from migrating; and 261 had their wings clipped to prevent their migration for one to two years. The last three lots of geese transplanted were wing-clipped and held 2 years before release.

The success of 8 years of transplanting geese to Chassahowitzka was not encouraging. Even though this refuge is within the historic wintering range of Canada geese, none of the transplanted birds are known to have returned following their migration north. At present there are no birds wintering on

the refuge. Of the total number of transplants released at Chassahowitzka, 36 band returns have been received as follows:

Ontario - 8	NW Territories - 2
Quebec - 5	Wisconsin - 2
Michigan - 4	Minnesota - 1
N. Carolina - 3	Indiana - 1
Virginia - 3	New Jersey - 1
Maryland - 2	Florida - 1
Alabama - 2	New York 1

Loxahatchee National Wildlife Refuge

The transplanting of Canada geese to Loxahatchee Refuge began in 1955 and continued through 1960. During this period, 436 birds were moved from St. Marks Refuge to this southeast Florida refuge. Of this total, 91 were released full-winged, 149 had their primary feathers clipped, 130 had their primaries pulled from one wing, and 59 were pinioned.

The success of transplanting geese to Loxahatchee was nil. At one time, 6 birds were observed on the refuge that were thought to be transplants that had migrated and returned but the observation was not confirmed.

Of the total number of transplants released, there were no confirmed reports that any returned to Loxahatchee after once migrating north. Band returns were received from 48 Loxahatchee transplants, as follows:

Quebec - 8	Delaware - 1
N. Carolina - 3	Michigan - 1
Florida - 17*	S. Carolina - 1
Tennessee - 1	Maryland - 3
Ohio - 2	New York - 2
Virginia - 4	Pennsylvania - 1
Missouri - 1	Alabama - 1

*11 returns were retraps at St. Marks

Delta National Wildlife Refuge

The number of migrant geese that historically wintered at Delta Refuge began to decrease in the 1940's and by early in the 1950's only a few hundred remained. The purpose of transplanting geese to Delta was to bolster the migrant population and cause the downward trend to be reversed. In 1954 and 1955, a total of 255 Canada geese were live-trapped at Horseshoe Lake and transferred by truck and boat to Delta Refuge.

Transplants were released full-winged and left the refuge almost immediately. A significant number were killed by local hunters and some were reported killed the same season by hunters located as far north as illinois. Band returns from transplanted birds totaled 56 as of 1959, as follows:

Louisiana - 30*	Tennessee - 3
Illinois - 9	Missouri - 1
Ontario - 5	Iowa - 1
Michigan - 3	Wisconsin - 1
Mississippi - 3	

*killed during same year of release

No transplants were known to have returned to Louisiana during the year following their release.

Lacassine National Wildlife Refuge

The transplanting of Canada geese to Lacassine was undertaken in 1955 and was continued sporadically through 1965. A total of 3,088 geese was transplanted from Horseshoe Lake Refuge and from Swan Lake and Seney National Wildlife Refuges. All birds were either released full-winged or with their primaries pulled in one wing to render them temporarily incapable of flight.

Periodic inventories revealed no significant increase in the number of geese wintering in the Lacassine area during or following the transplant program. In fact, the reverse was evident. During the 1963-64 wintering period, when the first of three 750-bird transplants was made, the peak wintering concentration on Lacassine was estimated to be about 6,000 geese. During the wintering period a year later, the peak concentration on the refuge was 4,000. In 1965-66, the peak number on the refuge dropped to 1,750 and during 1966-67 a further decline to 1,300 was evidenced. Half of the 2,239 birds transplanted during the 1963-65 period were neck-banded to facilitate observation. Less than 1 percent of the neck-banded birds returned to Lacassine the year following their release. A breakdown of band returns from birds released during the 1955-58 period follows:

Swan Lake Trapped Birds (603)

Manitoba - 12	Illinois - 6
Ontario - 1	Missouri - 37
Minnesota - 5	Kentucky - 2
Wisconsin - 5	Arkansas - 1
N. Dakota - 1	Louisiana - 23*
S. Dakota - 5	Texas - 2
Nebraska - 1	Mississippi - 1
Iowa - 6	

Seney Trapped Birds (100)

Michigan - 1	Illinois - 2
Wisconsin - 1	Louisiana - 15*
Indiana - 1	

Horseshoe Lake Trapped Birds (146)

Ontario - 8	Illinois - 11
Minnesota - 1	Missouri - 1
Wisconsin - 4	Tennessee - 2
Iowa - 1	Louisiana - 27*
Indiana - 1	Texas - 1

*killed the same season as released

Noxubee National Wildlife Refuge

The transplant program involving Noxubee was initiated in 1953 and was continued through 1960 with no birds being transplanted in 1954. A total of 1,328 birds was trapped and moved to Noxubee from Horseshoe and Wheeler Refuges. Of this total, 200 were released full-winged, 720 were released with the primaries pulled from one wing, and 408 were released after being held for 2 years with clipped primaries.

The Noxubee transplant program was almost a complete failure. No transplanted birds ever

returned to Noxubee once they migrated. Through the period during which the transplant program was carried on, however, a small group of migrant Canadas, sometimes numbering as many as 100 birds, wintered on the refuge. They carried no bands to indicate they were transplant birds. During the 1966-67 season, the migrant group peaked at 75 birds.

Band returns from birds transplanted to Noxubee were received from 17 states and 5 provinces. Following is a current band return breakdown:

Saskatchewan - 2	Michigan - 23
Manitoba - 4	Mississippi - 68
Kewatin - 3	Missouri - 59
Quebec - 9	Minnesota - 2
Ontario - 77	N. Dakota - 1
Alabama - 22	Ohio - 6
Arkansas - 2	Tennessee - 7
Illinois - 27	Kentucky - 15
Indiana - 12	Virginia - 1
Iowa - 4	Wisconsin - 45
Maryland - 3	Pennsylvania - 2

Yazoo National Wildlife Refuge

The goose transplant program, as it affected Yazoo, began in 1957 and continued through 1961 with one transplant also being made in 1965. A total of 855 geese was trapped at Horseshoe, Swan Lake, and Crab Orchard Refuges and moved to Yazoo. Of this total, 56 were released full-winged, 214 were released with primaries pulled, 68 were pinioned, and 442 were wing clipped and held for varying periods of time before being released. Of the latter group, 300 were held for 2 years before being permitted to migrate in order that their selection of Yazoo as a permanent wintering area might be firmly influenced.

Like Noxubee, the Yazoo phase of the transplant program was unsuccessful. While a small flock of 50 to 75 free-flying migrants have taken up winter residence at Yazoo, the transplants are thought to have had no direct bearing on this development except through their influence as decoys.

There have been 77 returns from Yazoo-banded transplants since the program began in 1957. Following is a breakdown by states and provinces:

Arkansas - 6	Missouri - 14
Illinois - 18	Mississippi - 6
Indiana - 1	Ontario - 16
Manitoba - 1	Wisconsin - 14
Michigan - 1	

Holla Bend National Wildlife Refuge

A goose transplant program was begun at Holla Bend in 1957 and continued through 1965. A total of 7,384 geese was transplanted to Holla Bend from Swan Lake and Horseshoe Lake Refuges. Of this total, 149 were released full-winged, 6,824 were released with their primaries pulled, 300 were released with primaries clipped and 95 were pinioned.

When the program was undertaken, there were no geese wintering in the Holla Bend Refuge area. As the program progressed, wintering birds appeared on the scene and steadily increased in number until in 1965 approximately 7,000 geese, including current year transplants, were recorded on the refuge. This number declined to 2,000 in 1966, the year after the final transplant was made. It is too early to evaluate the effects of the program, but a small wintering flock may become permanently established as a direct or indirect result of the transplant program. Whether this can be attributed to anything more than the decoying influence of the transplants is conjecture at this time. A trapping program is underway to determine the number of transplants present in the refuge wintering flock.

The three final transplants to Holla Bend, of 1,500 birds each, were neck-banded and/or leg-banded with colored, anodized bands. The refuge manager noted that the first-year return of color-marked birds to the release site was approximately 10 percent of the original number released. It is doubtful, therefore, that the small number of transplants that have been returning have been responsible for the build-up of the 2,000-bird flock observed using the refuge last winter. A more plausible explanation is that the transplants served as decoys and influenced geese to stop at Holla Bend that were destined for Louisiana or some other location.

Band returns from transplants released at Holla Bend through 1962 reveal a widely divergent kill distribution pattern. A breakdown by state and province follows:

Manitoba - 12	N. Dakota - 4
Ontario - 13	S. Dakota - 2
Wisconsin - 12	Kansas - 2
Minnesota - 10	Missouri - 39
Michigan - 4	Arkansas - 5
Illinois - 6	Kentucky - 2
Iowa - 4	

White River National Wildlife Refuge

White River Refuge is an historic Canada goose wintering area and although the flock using that refuge has been declining since the late 1940's, it was not until 1962 that it was desirable to bolster the flock by transplanting geese from concentration areas in the north. In 1962, 640 geese were transplanted to White River and released full-winged with the flock that was wintering there. During each of the next 3 years, 1,500 immature geese were released at White River with their primary wing feathers pulled to render them semi-flightless.

The results of the transplant program at White River were very disappointing. The wintering flock of migrants appeared at first to be increasing following the 1963 and 1964 release, but the increase was short-lived. The peak number of birds on the refuge in 1965-66 was below the 1964-65 peak and the wintering flock declined even further in 1966-67. During the 4 years of the transplant program, 1962-66, the refuge population declined from 2,400 to 1,665 geese.

No band return information from White River transplant birds is available. It is interesting to note, however, that band returns from migrants trapped on the refuge indicate that the bulk of the

wintering flock at White River may migrate through Illinois rather than through Missouri, as formerly suspected. The transplant program, therefore, might have been more successful had the transplants come from Horseshoe rather than Swan Lake.

Wapanocca National Wildlife Refuge

A transplant program was not undertaken on Wapanocca until 1963, when 412 geese were transferred from Horseshoe Lake. During 1964 and 1965, 500 and 365 geese, respectively, were transplanted to Wapanocca from Horseshoe Lake Refuge. The primary wing feathers were pulled from all.

The project netted no increase in geese at Wapanocca. There were about 200 migrants on the refuge when the transfers were undertaken and there remains about the same number of migrants today. Based on the observations of the refuge manager, the transplant geese behaved about the same each year. As soon as their wing feathers had grown in and they were capable of flight, they were not seen again in the vicinity of the refuge.

Marking Geese for Observation

Throughout the transplant program, problems were experienced in marking birds. All or most of the transplants, during the early phases of the program, were neck-banded and some birds were even dyed to make them more easily distinguishable from free-flying wild migrants. During the later phases of transplanting, neck-banding was abandoned in favor of leg banding with special, anodized, colored bands. When anodized bands began to fade, a plastic band was placed on the leg with the anodized band. This frequently resulted in injury to the bird and this type of marking was later abandoned in favor of neck-banding, once again.

Relatively few observations of neck-banded geese were reported, considering the total number marked in this manner, and in only a few instances are the observations thought to have any real meaning. Examples of the type of observations received are shown in Table 54, compiled by the refuge manager of White River Refuge concerning the transplants released on his refuge during the 1963-65 period.

Losses from Trapping, Handling, and Transplanting

The records regarding losses that resulted from trapping, handling, and transporting are not complete. There are indications, however, that such losses were never great and through the years have been reduced to a very low level.

In the mid-1950's when large numbers were first being transplanted, losses occasionally were as high as 8 to 9 percent. During the 1963-65 period

TABLE 54. Observations of Neck-Banded Transplant Geese Released on White River Refuge, 1963-65

Location of Observation	1963		1964		1965	
	Number	Date	Number	Date	Number	Date
Swan Lake NWR	3	3/27/64			3	3/28/66
	1	4/3/67				
White River NWR	1	11/23/64	2	12/27/65		
	10	1/13/66	25	1/4/66		
	5	11/7/64	2	11/7/67		
Holla Bend NWR	2	12/8/64			1	3/22/66
	2	3/12/67				
Horseshoe Lake, Ill.	1	12/16/64	1	1/12/65		
	2	1/27/65	4	2/2/65		
			2	2/4/65		
Lacassine NWR	1	12/14/64	2	1/3/66	1	12/23/65
Wapanocca NWR	1	2/6/65				
Gueydan, La.	1	2/65				
Necedah NWR	1	10/13/65	1	10/28/65		
			2	10/13/65		

when mass transplants were being made, losses were estimated to be as low as 3 percent.

Summary

Transplanting was employed during the 1953-1965 period to restore and enlarge wintering concentrations of Canada geese on 9 national wildlife refuges in the Southeast. A total of 20,734 geese were live-trapped and transferred from Horseshoe Lake Refuge and the Crab Orchard, Santee, Wheeler, St. Marks, and Swan Lake National Wildlife Refuges. Release points were the Holla Bend, White River, Lacassine, Delta, Noxubee, Yazoo, Wapanocca, Chassahowitzka, and Loxahatchee National Wildlife Refuges.

Of the total number of geese transferred, 1,835 were released full-winged, 16,914 were released with the primary feathers pulled in one or both wings, 1,560 were wing-clipped and held for varying periods of time before being released, and 247 were pinioned to serve as decoys. No record was made of how 180 were handled.

With regard to the intended objectives, the project was unsuccessful, except at Holla Bend where the results are still being evaluated. Canada geese did not become established at Loxahatchee and Chassahowitzka Refuges; flocks of less than 100 birds are winter residents at Yazoo and Noxubee Refuges; and the flocks wintering at White River, Lacassine, Delta, and Wapanocca were not increased in size. It does appear that a flock is becoming established at Holla Bend; however, this may have come about as a result of the decoying influence of the transplants rather than from the transplants themselves accepting Holla Bend as a winter home.

This type of transplant program is not an effective method for extending the wintering range of Canada geese to more southerly locations.

THERE HAS BEEN nothing automatic about the comeback of the Canada goose in the Mississippi Flyway. As Arthur says, essential ingredients have been sanctuaries and productive croplands. Acquiring the former has involved an investment of a million and a half dollars in southern Illinois alone. Maintaining the latter involves more dollars and a good deal of special sense. Just how many dollars and how much skill go into goose farming may come as a surprise to readers of this paper. For example, the Illinois Department of Conservation has spent $111,000 for the tractors it takes to till its 8,000 goose acres, and pays out $100,000 a year for farm wages.

What geese select to eat depends on availability and time of year, Arthur reports. In general, ladino clover is at the top of the browse menu, and among the grains foxtail millet is preferred over corn. Such field observations suggest that the establishment of native grasses and weeds on the uplands would get the goose vote, even though an agronomist would say the protein yield per acre is too low. It might just be, Arthur says, that a flock of Canadas would prefer to roam over several thousand acres of seed and browse plants than jam into a few hundred acres of hybrid corn.

Besides manipulating his fields to satisfy geese, Arthur handles them to satisfy hunters, who prefer a private atmosphere but not one so private that the birds are not available to the gun. All told, Arthur's out-of-pocket operating costs figure out to something like $6 per bird bagged in the area, which may raise some questions about the viability of America's whole system of "free" hunting. At any rate, the net message of the Arthur experience in goose farming is simply this: Make no little plans.

11

FARMING FOR CANADA GEESE

George C. Arthur

THE IMPORTANCE OF farm management has only recently been given emphasis by waterfowl managers. This is particularly true in the case of farming for Canada geese in the Mississippi Flyway, where such farming is expensive and necessary, but unspectacular. The most important goose management tools therefore include the sanctuary sign, productive cropland, the 65-drawbar-horsepower tractor with all the equipment it can pull, refuge managers with farming know-how, skilled farm hands, and competent farm managers. Without such tools, the management which can be accomplished on goose migration and wintering areas is insufficient.

In the Mississippi Flyway there are more than 75,000 agricultural acres being managed for Canada geese. Wisconsin has 7,400 acres, half of them on federal refuges and half on state-owned lands; Tennessee has 14,000 acres involving 5 refuges, of which Tennessee National Wildlife Refuge is the largest; Alabama has 6,500 acres at Wheeler; Arkansas, 2,700 acres at White River and Holla Bend; Ohio, 8,000 acres; Michigan, 9,000 acres, of which the largest is Shiawassee National Wildlife Refuge with 3,100 acres, and including almost 6,000 acres of state-owned lands at 10 locations; and Illinois, 18,000 acres at 3 southern Illinois refuges, one of which is federal and two are state-owned. Although two-thirds of these lands are sharecropped, their crops could be available in their entirety if needed for increased goose population.

The Illinois management operations indicate the scope of management costs. More than $1.5 million has been spent on land acquisition for the southern Illinois refuges. Per acre prices varied from $60 in the early 1940's to $350 in the mid-1950's. The same lands purchased today would cost more than $2 million.

Maintenance and operation of the approximately 17,000 state-owned acres in southern Illinois represents an investment of about $600,000. Of the 17,000 acres, 8,000 are tillable. Farming these acres for maximum yields of goose foods requires $250,000 worth of machinery, of which tractors alone account for $111,000. The balance is in corn planters, cultivators, discs, combines and other farm equipment. The second largest investment is in buildings, including grain dryers, storage bins, machine sheds and dwellings. Machinery and buildings comprise almost 70 percent of the expense of refuge development.

The single largest annual expense is nearly $100,000 for wages. This is split about evenly between supervisory personnel, regular help, and extra seasonal help. There are 2,500 man-days of field labor totalling more than 20,000 man-hours involved.

The second largest annual expense is in replacement of machinery, which amounts to approximately $30,000 per year. Other items of expense are $15,000 for seed supplies, $11,000 for fertilizer, $8,000 for vehicles, $7,000 for tractor fuel, and $1,000 for oil and grease. Wheat seed may amount to $8,000 per year. Other seed items include $1,300 for barley and $1,000 for clover. The most used fertilizer is anhydrous ammonia at $7,600 per year.

Aerial view showing cleared slot field concept. These are intensively farmed and place the public hunter in a more private atmosphere.

After the Illinois refuges were purchased and the machinery inventory built up, annual operating expenses amounted to about $175,000. Using an overwintering population of 200,000 geese, this approximates an expense of $.88 per bird airborne and about $6.00 per bird bagged by hunters. This can be related to a survey by Joselyn (1958) which found that in Alexander County, Illinois, every live bird was worth $11 to the county and every bird bagged accounted for almost $45 spent by hunters in the county.

In past years the Illinois management program was satisfactory with sharecropping, but as the wintering goose population increased, we felt that each acre purchased for goose management should be used for goose management and consequently our sharecroppong program ended. Due to lack of machinery we entered into contracts for farming the refuges at an average cost of $15 per acre for planting labor only. This included corn and wheat planting, and establishment of pastures. This practice resulted in poor farming with correspondingly low crop yields and was discontinued after 2 years.

Finally, in the mid-1950's, the two state refuges were sufficiently equipped to produce with their own personnel and machinery 1,500 acres of corn, 3,000 acres of wheat, and 1,200 acres of improved permanent pasture. Costs of this type of farming were $45 per acre for corn, $22 per acre for wheat or clover, and $10 per acre for summer fallowing.

In 1967, this system provided 120,000 bushels (nearly 3,400 tons) of corn for feed. Browse was estimated at 15,000 tons in annual pastures plus 2,400 tons in clover and permanent grasses. This production provided approximately 33 pounds of corn per wintering goose per season, or 1/4 pound per bird per day for more than 130 days. This amount may change with varying goose populations and the number of mallards present. Total pasture is available at the rate of 174 pounds per bird per season, or in excess of 900 square feet per bird, which equals a bit less than 50 birds per pasture acre.

Wheat sown in mid-August at 3 to 4 bushels per acre produces upwards of 8 tons of green browse per acre. Barley produces 6 tons per acre. On the other hand, fall-sown alfalfa may yield as little as 1/2 ton per acre. Good stands of ladino clover have been easy to produce, and they may yield 3 or 4 tons of high protein green browse. The various sorghums, milos, and buckwheat have been disappointing in tonnages produced.

There is certainly a link between availability, selectivity, and productivity in crops grown for geese. Late in the winter, geese seem to prefer high carbohydrate-yielding grain, but they might prefer a lush field of ladino clover if it was available in January. The University of Illinois Agricultural Department (Morrison, 1956) showed that crude protein in ladino clover was 14.7 percent, while that of corn varied from 8 to 9 percent. Just the stems of ladino clover have slightly more protein than field corn. Percentages of crude protein present in other plants was: 14.4, alfalfa; 12.1, foxtail millet; 9.9, brome grass; and 5.9, wheat browse.

Canada geese often will browse a crop that is not intended as a browse crop. For example, in the mid-1950's on Horseshoe Island, an extremely dry condition resulted in little or no wheat above ground. In that year for the first time, geese stripped the green leaves from dwarf sorghum and upland millet.

(1) Ladino clover, a preferred food crop, yields 3-4 tons of high protein browse. (2) The first pass over removes most of the leaves. (3) Revisited all leaves and most stems are taken until only the crowns remain.

It is difficult to say whether this could be a substitute for green browse usually provided by wheat.

Geese and ducks frequently prefer native foods. I have observed several cases where geese entered standing corn and ate the weed seeds before starting on the corn. Weeds were mostly crabgrass and foxtail which had undoubtedly been enhanced by generous applications of fertilizer. Mallards have returned again and again to lush stands of rice cutgrass in the Illinois River valley bottomlands. Where millet was used, one period of heavy feeding ended the use of the plantings. A flock of 5,000 blue and snow geese left green wheat and rye fields to devour a small patch of spike rush that had just recently been flooded. Observations such as these may suggest that establishing native grasses and weeds on uplands would be desirable for geese even though from the management standpoint yields would be quite low. A flock of Canada geese might prefer to roam over several thousand acres of seed- and browse-producing plants rather than a few hundred acres of high-producing corn land. This is further evident in the preference of Canada geese for the foxtail millets that have been intentionally over-sown and dwarfed to prevent blackbird damage. When millet is sown with corn, it is initially much preferred over the corn itself.

Selectivity apparently depends on availability and the time of year. Geese arriving in early fall in southern Illinois seem to be content to pick about weedy fields, borders and freshly sprouted wheat fields. Later they move to clover fields, seed-bearing oats, millet and newly opened corn fields. In winter standing corn is used and remaining wheat browse is visited daily. Only in extremely cold weather do the birds fail to make daily feeding flights.

Preferred browse for geese as determined by field observations put ladino clover first, followed in order by alsike clover, red clover, birdsfoot trefoil, barley, wheat, rye, and alfalfa. Next come brome grass, rye grass, orchard grass, bluegrass, creeping red fescue, timothy, and Kentucky fescue. Geese will also readily use spinach, turnips, collards, and lettuce. Grain preferences not including weed seeds, are topped by upland German proso and foxtail millets. Corn is next, followed by oats, buckwheat, and lastly, the grain sorghums. Soybeans are not used on the southern Illinois refuges, although occasionally field peas are planted.

And so we have learned that the number of geese on a goose refuge may depend on its shade of green which in turn depends on the seed bag, land management methods, signs, tractors, and use regulations. This combination has increased the population of the Mississippi Valley Canada goose flock 500 percent during the past few years (U. S. Fish and Wildlife Service, 1945-1966). Surely the farming operations are at least in part responsible.

THE GREAT BASIN POPULATION is composed of western Canada geese that inhabit portions of the states of Utah, Colorado, Idaho, Nevada, Wyoming, Montana, Arizona, and California. Heavy hunting pressure and poor breeding conditions combined in the mid and late 1950's to produce a marked decline in bird numbers. A special task force of technical people recommended some rather drastic restrictions on the take, to include reduced daily and possession limits, shorter seasons, and seasonal limits. The results were dramatic. Great Basin goose numbers increased to the point that hunting regulations could be relaxed somewhat in 1963. Since then various states in the region have continued to experiment with variations on the seasonal limit. What they have learned offers guidelines to goose managers throughout the continent:

(1) A season bag limit on Canada geese can reduce the total harvest in an area. (2) A seasonal limit is most effective in situations where a small percentage of the hunters take a large percentage of the geese. Where a heavy goose harvest is spread among many hunters, a season limit alone is not enough. (3) A season limit based on voluntary compliance won't work; it penalizes honest hunters. (4) Tags are one answer. They must be of a type that can't possibly be reused. (5) Tagging regulations appear to discourage large-scale leasing of private lands for goose hunting and make for more public or semi-public hunting opportunities. (6) Introducing a tagging system will invariably produce "fireworks," but the opposition rapidly fizzles out once the program is understood. (7) Determining the season bag limit and the number of tags to be issued must be based on a careful analysis of goose and hunter population dynamics in the area in question. (8) Administering a tagging system is expensive.

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THE IMPACT OF SEASON LIMITS ON GREAT BASIN GOOSE HARVESTS

John E. Nagel and George F. Wrakestraw

DURING THE SUMMER of 1965 the Utah State Fish and Game Commission restricted hunters to an individual total of 8 Canada geese per season. This restriction was implemented through a tagging regulation which has been in effect throughout the 1965-66, 1966-67, and 1967-68 waterfowl seasons. The objectives of a seasonal bag limit were to reduce the total kill of Canada geese and to restrict the activities of a minority group of goose hunters who killed excessive numbers of Canada geese.

Geese belonging to the Great Basin Population are western Canada geese Branta canadensis moffitti (USDI, 1964), which breed in Utah, western Colorado, southeastern Idaho, eastern Nevada, western Wyoming, southwestern Montana and southern Alberta. Population data indicate the current size of the Great Basin Flock is approximately 60,000 birds. Geese in this population are largely semi-migratory, not susceptible to mixing with Canada geese from other populations, concentrated by limited habitat, and subjected to heavy hunting pressure on breeding, migration and wintering areas. In the mid-and late 1950's these conditions, combined with poor breeding conditions, resulted in a general decline of the Great Basin goose flock.

To curtail this downward trend in the population a special Great Basin Canada Goose Subcommittee was formed. This subcommittee consisted of Flyway Technical Committee members from states in both the Pacific and Central Flyways which were concerned with the Great Basin goose flock – Montana, Idaho, Wyoming, Colorado, Utah, Nevada, Arizona, California – and the Bureau of Sport Fisheries and Wildlife. The function of this body was to review all information relating to the status of Great Basin geese and to make management recommendations to both the Pacific and Central Flyway Councils which would effectively combat the population decline.

The most obvious and immediate method of halting this decline, although least popular from the hunter's standpoint, was to reduce daily bag and possession limits and to shorten seasons in areas frequented by these geese. Recommendations by the subcommittee to reduce bag limits and shorten seasons in certain areas were made to the respective Flyway Councils and were subsequently included in waterfowl regulations during the late 1950's and early 1960's. Bag and possession limits in many areas were reduced from 3 to 2 and eventually to 1 bird for both bag and possession limits. Harvests in goose concentration areas close to centers of high human populations, particularly the Imperial Valley of California were further restricted through shortened seasons and periods of hunting which did not correspond with peak goose populations. In addition, research projects dealing with the impact of hunting on populations of Canada geese in the Great Basin were initiated by several states.

The result of restricting hunting opportunities was dramatic. Goose populations increased until in 1962, the subcommittee recommended that some relaxation of hunting regulations could be initiated without damaging the resource. These recommendations were adopted and since 1963 regulations controlling the harvest of Great Basin Canada geese have been more liberal than they were in the period

1958-1962, but more restrictive than regulations prior to 1958.

Several states represented on the Great Basin Goose Subcommittee felt that while the above restrictions solved the immediate crisis, it would be well to explore other methods of effectively limiting the goose kill in their respective areas. These technicians felt that methods to refine harvest techniques should most logically be experimented with during periods when population levels were not critical. One method mentioned often as having promise was that of a seasonal limit. This method held the interest of technicians because it appeared to be possible to reduce the total goose harvest in a given area without unduly restricting the activities of the average waterfowl hunter in the process.

Techniques Used and Results

Wyoming

During the years 1960-62 Wyoming goose hunters were limited to a seasonal total of 6 Canada geese. This restriction was enforced through a tagging regulation. The objectives of this program were: (1) to determine if statewide goose harvests could be reduced and controlled through such a system, and (2) to discourage leasing of private ground by a relatively small number of individuals who wished to control hunting rights on preferred goose shooting areas. Both of these objectives were accomplished.

Goose hunting in Wyoming is not a particularly popular sport in terms of hunter participation. Questionnaire data indicate that there are approximately 3,500 successful goose hunters in the entire state. However, many of these hunters are extremely successful in making spectacular individual seasonal kills. During 1958-59 it was not unusual for one or two individuals, who had leased hunting rights, to kill individual totals of 30 to 60 geese during a single waterfowl season.

The impact of these high individual harvests on goose populations has never been adequately assessed since steps to rectify the situation, by imposing a seasonal bag limit, were initiated immediately. However, the effect that leasing of private hunting areas had, was fairly drastic.

Large portions of Wyoming are arid, and consequently, available waterfowl hunting opportunities are limited. Leasing of private lands by small groups of hunters removed substantial acreages of hunting area from the hunting public. This effectively limited the opportunity for goose hunting by a large portion of Wyoming's waterfowl hunters. At the same time, leasing of lands by one group of hunters was often followed by leasing of adjacent lands by other hunters, who felt they were forced to lease lands to assure themselves a place to hunt.

The Wyoming Game and Fish Department believed that a season limit and tagging regulation were justified to combat both the high individual goose kills and large-scale leasing of private lands previously open to public or semipublic hunting.

Wyoming Goose hunter participation and harvest for the years 1959-1964 are listed in Table 55. Both hunter participation and the total harvest of geese was reduced during 1960-62 when season limits were in effect. Goose hunter field checks and inspection of picking plant records also indicated a decline in total harvest, and to a limited degree hunter participation during this same period. Both field checks and picking plant records verified that a small percentage of hunters were taking a large portion of the total harvest prior to initiation of a seasonal limit.

The second objective, that of discouraging leasing, was also accomplished. Hunters who formerly leased land and hunted practically every day of the season often killing as many as 60 geese annually were reluctant to pay several hundred dollars for a hunting lease if their total seasonal bag was limited to 6 birds. As goose habitat and hunters in Wyoming are limited, it was possible to observe known goose hunters closely to make sure they complied with the seasonal bag and tagging regulations.

Since both the total goose kill and leasing problems were effectively handled through a season bag limit restriction, why has this regulation not been used in Wyoming since 1962? This action was taken because the primary objectives of the original program were accomplished. Leasing of private lands has been drastically curtailed, and the threat of a season bag is now being held over hunters who are inclined to lease hunting areas. Canada goose populations in Wyoming are increasing under existing hunting seasons and regulations, and there is

TABLE 55. Wyoming Canada Goose Harvests, 1959-1964

	1959	1960	1961	1962	1963	1964
Estimated number hunters	--	3,740	2,579	2,069	2,069	3,345
Estimated kill	2,219	1,708	1,191	895	1,391	2,661

therefore little reason to restrict harvest and subsequent hunter participation at this time.

Under present conditions, there are no plans for returning to a seasonal bag limit on Canada geese in Wyoming during the near future; however, because the system has proved to be an effective tool in reducing goose harvests, there would almost surely be a return to this system if conditions decline sufficiently to warrant this action.

Montana

During 1959, 1960 and 1961 a seasonal bag limit of 6 Canada geese was imposed on Montana goose hunters west of the Continental Divide in the Flathead Valley This regulation was the result of considerable pressure from hunters toward the Montana Fish and Game Department to further restrict and equalize the kill of geese in this area. No provision was made to implement the regulation through the use of goose tags. Participation of hunters in the regulation was strictly voluntary and based on the honor system.

The effect of this regulation has never been adequately assessed. No attempt was made to evaluate the regulation in terms of total harvest and hunter participation prior to, during or following the period of regulation. However, it is doubtful that the seasonal limit was successful in reducing the kill of Canada geese, primarily due to the lack of a system which would assure that each hunter took no more than 6 geese. Information from the Montana Fish and Game Department personnel indicates that the only effect a voluntary season limit had was to penalize the honest hunter.

Utah

Martin (1964) and Dey (1966) found that breeding populations of Canada geese in Utah were unable to sustain themselves with daily bag limits of more than 2 birds. Utah geese were apparently able to sustain themselves with a 2-bird limit if breeding conditions were optimum and the number of waterfowl hunters did not increase appreciably. However, the long-term outlook for these birds with a 2-bird limit and a 90-day season did not appear bright.

Waterfowl data collected in Utah during 1960, 1961, 1962, and 1963 indicated that less than 30 percent of the hunters afield were taking more than 60 percent of the Canada geese harvested during the course of a waterfowl season. A regulation which would restrict the activities of fewer than 30 percent of the hunters seemed preferable to fluctuating daily bag limits which would affect all hunters and would in all probability be most restrictive against the average hunter who was limited by the number of times he could go afield during a season. The question of imposing a season limit on Canada geese was debated by waterfowl technicians in Utah as early as 1960 but no action was taken on the matter until 1965.

In 1965 an 8-bird season limit was imposed on individuals hunting Canada geese in Utah. This regulation has been in effect during the 1965, 1966 and 1967 waterfowl seasons. To implement the seasonal limit a tagging system was initiated.

The kill of Canada geese by number of geese taken per hunter for the period 1962-64 is listed in Table 56. Analysis of these kill data, derived from waterfowl mail questionnaires, indicates a seasonal limit of 8 geese would lower the total goose kill slightly, and at the same time not curtail goose hunting activities of the majority of Utah's waterfowl hunters. A seasonal limit of 10 birds would appear to have little or no effect in reducing total goose kill, and a 6-bird season limit would appear to be more stringent than necessary.

From the outset, the tagging regulation was the target of many unfavorable comments. The most prevalent complaint concerned the method of tag distribution. Hunters felt that tags should be available from all license agents. This method of distribution was considered but there would be little control over such distribution since licenses had already been on sale for some time. Many hunters felt they were unnecessarily inconvenienced in having to make a special trip to obtain tags. Other hunters felt they would rather have a 1-bird daily bag with no seasonal restriction, and yet another group felt the tagging regulation was an infringement on their natural hunting rights. However, the problems associated with the tagging system were not insurmountable, and much of the criticism stemmed from the fact the system was new and unfamiliar. As waterfowl hunters in the state became better acquainted with the restrictions, opposition significantly diminished.

The relative success or failure of any regulation is determined by how well it accomplishes its primary purpose. Data from the 1965-66 waterfowl hunter mail questionnaire indicated a significant reduction in Canada goose kill in the state, particularly among those hunters who hunted Canada geese exclusively.

One of the primary reasons for initiating a tagging program was to control excessive harvests of Canada geese being made by a few ardent goose hunters in the state. Surveys conducted by the Department indicated that less than 1 percent of the waterfowl hunters were harvesting slightly over 23 percent of Canada geese taken in Utah during any waterfowl hunting season. The seasonal limit restriction was implemented with the idea of curtailing the activities of this minority group, while at the same time allowing the average hunter the opportunity to harvest 2 birds under a daily bag limit, if the occasion presented itself.

In considering the 1965 Canada goose harvest, one point is clearly made – the goose tagging and seasonal bag limit restriction had no effect on the average goose hunter in Utah. In 1964 waterfowl hunters harvested 4,741 Canada geese while hunting ducks (Table 57). In 1965, this same group of hunters took 5,435 Canada geese, or an increase of 694 birds. However, hunters who pursued Canada geese specifically, took 8,905 geese in 1964. This same segment of Utah's waterfowl hunting population killed 4,913 Canada geese in 1965, or a reduction of some 3,992. On the basis of this informa-

TABLE 56. Projected Reductions in Utah Canada Goose Kill Through Season Limits, 1962-64 (Daily Bag of 2 Birds Throughout)

Number Geese Killed/ Hunter	1962	1963	1964	Total Hunters 1962-64	Total Geese Killed	Calculated Kill Under Season Limits* 10 Birds	8 Birds	7 Birds	6 Birds
1	204	183	137	524	524	524	524	524	524
2	74	92	67	233	466	466	466	466	466
3	26	28	30	84	252	252	252	252	252
4	17	23	23	63	252	252	252	252	252
5	8	12	14	34	170	170	170	170	170
6	3	14	12	29	174	174	174	174	174
7	--	9	2	11	77	77	77	77	66
8	4	9	11	24	192	192	192	168	144
9	--	2	4	6	54	54	48	42	36
10	2	1	2	5	50	50	40	35	30
11	1	4	--	5	55	50	40	35	30
12	1	6	2	9	108	90	72	63	54
13	--	2	3	5	65	50	40	35	30
14	--	3	--	3	42	30	24	21	18
15	--	3	--	3	45	30	24	21	18
20	2	2	1	5	100	50	40	35	30
25	--	1	1	2	50	20	16	14	12
30	1	2	1	4	120	40	32	28	24
Total					2,796	2,571	2,483	2,412	2,330
Percent savings						8.1	11.2	13.7	16.7

*No consideration given to season length.

tion, it would appear that the seasonal bag limit was at least partially successful in reducing the total harvest of Canada geese without unduly restricting the hunting opportunities of the average hunter.

Unfortunately, data for the 1966 season indicated that the tagging regulation had little effect in depressing the goose kill. However, information collected from field checks indicated that hunters were reusing the 1966 goose tag. A change in tags was made in 1966 to permit distribution of tags as an integral part of the license. While being easily distributed, the tags were extremely simple to use more than once, and it was practically impossible to determine if a tag was being re-used unless an individual had been checked earlier using the same tag. The design of the goose tag was modified in 1967 to assure that tags would be used only once.

Nevada

In 1965 the Nevada Fish and Game Commission established a 15-bird season limit and tagging regulation in an attempt to limit Canada goose kills in the state. This action was apparently the result of Utah's decision to adopt a season limit on Canada geese. Both the regulation and goose tags were practically identical with those used in Utah.

Information from Nevada Fish and Game Department personnel indicates the program was adopted by their Commission without benefit of analysis of either total harvest or individual hunter kill data. Earlier analysis of these data by both Utah and Nevada technicians indicated that Nevada hunters would have to be limited to 6 geese a season before any substantial reduction in kill could be realized.

Under these conditions it is not surprising that the regulation had no effect on the 1965 Nevada goose harvest. The tagging regulation was dropped in 1966; however, the season limit was continued on a voluntary participation basis. As in the case of Montana, voluntary participation in a regulation of this type probably does little to reduce the harvest. It penalizes the honest hunter and has no effect on the activities of unscrupulous individuals who have the opportunity to hunt during the entire season.

TABLE 57. Utah Canada Goose Harvest, 1962-66

Year	Number Canada Geese Taken by Duck Hunters	Number Canada Geese Taken by Goose Hunters	Total Harvest
1962	5,269	4,370	9,639
1963	6,582	9,306	15,888
1964	4,741	8,905	13,646
1965	5,435	4,913	10,348
1966	7,565	10,053	17,997

Management Implications

Season bag limits for Canada geese appear to be sound management tools in certain situations and can reduce the total harvest of geese in an area without adversely affecting hunting opportunities of the average hunter.

Season bag limits are best implemented through a regulation which requires the use of a prescribed number of tags. Determination of the season bag limit and number of tags issued should be based upon analysis of both total and individual goose harvests. Season bags initiated without this analysis are generally ineffective and do little but complicate hunting regulations and confuse hunters.

A seasonal limit is most effective in reducing total kill in situations where a small percentage of the hunters take a large percentage of geese in a given harvest area. In areas where large numbers of hunters kill large numbers of geese as a group but harvests on an individual basis are small, it is doubtful that tagging regulations would reduce the total kill. Under these situations the kill could be reduced through shortening the season, lowering the daily limit, or limiting the number of hunters in a given area.

There are indications that season limits are at least partially effective in distributing the kill of Canada geese over a larger portion of the hunting population.

Tagging regulations and season limits have effectively discouraged large-scale leasing of private lands for goose hunting in some areas of the West.

GOOSE HUNTING REGULATIONS in recent years have shown a marked trend away from rather simple rules aimed essentially at limiting the take and toward more complicated restrictions directed in part at improving distribution of hunting opportunity and harvest. A number of programs and practices can be applied during the course of a goose season to meet the needs of the goose resource and the consuming public: shell limits, hunting fees, advance registration, reserved blinds, blind spacing, hunting day restrictions, restrictive shooting hours, gun gauge limits, shot size limits, species bans and bonuses, daily and seasonal bag limits, rules about dogs, decoys, and calls, and so on. Hunt offers a detailed evaluation of one of these tools: shell limits.

Prior to the imposition of a 6-shell limit on hunters using state-controlled blinds at Horicon, Wisconsin, "sky busting" and high crippling losses were chronic problems. In one year, for example, it took 40 shots to down a Canada, and crippling loss stood at a staggering 42 percent. Following the use of the shell limit, shots fired per trip, shots required to bag a goose, and success per hunter trip all showed marked improvement, while crippling loss stabilized at an acceptable 10–15 percent. Hunt's conclusion: a shell limit on a managed area can help produce a better quality hunt, less crippling loss, and less lead available for lead poisoning.

In a general assessment of other managed goose hunt tools, Hunt argues for a daily fee in at least the $5 range, for advance registration by computer as against first-come first-served waiting lines, for blind intervals of at least 200 yards, against hour and day manipulations that in fact increase the kill, for bans on too-small and too-big gun gauges, against the use of buckshot, and for a one-bird-a-day bag limit.

13

SHELL LIMITS AND OTHER REGULATIONS USED IN MANAGED GOOSE HUNTING

Richard A. Hunt

MODERN GOOSE HUNTING regulations are aimed at maximum allowable harvests under reasonable standards of quality. The quantity aspects of harvests are influenced by refuge management, goose use and manipulation of regulations; quality aspects are more difficult to influence, perhaps because of the recruitment of many new and/or relatively inexperienced goose hunters to public shooting areas. Sky-busting with resulting high crippling losses is a chronic ailment with such participants, and "high and wide" shooters frequently offset other regulations established to improve hunting. The primary purpose of this paper is to review what I consider a significant management technique to control the sky-buster: limitations on shooting by a shell-limit regulation. A brief review of other regulations at some major goose management areas will also be presented.

Background

Information on managed goose hunting in Wisconsin has been obtained at the Horicon National Wildlife Refuge located in Dodge and Fond du Lac Counties. A state-operated public shooting program involving 114 blinds was established in 1953 on the periphery of the 20,000-acre refuge. Hunting activities, goose use and refuge management have been described in detail (Hunt et al., 1962; and 1963; Green et al., 1963; and Hunt, 1964).

Horicon Marsh developed as a major concentration site for Canada geese of the Mississippi Valley population (Hanson and Smith, 1950) in the early 1950's, reached peak fall population levels of 100,000 plus in the early 1960's (150,000 in 1966), and, on an annual basis, is the focal point for the bulk of this population for about five months during the spring and fall migrations. Harvests increased from a few thousand in the early 1950's to about 30,000 in 1959. Beginning in 1960, kill quotas have been assigned to the area, ranging from 7,000 to 20,000 geese annually. Controversy over regulating harvests, fall goose populations and crop depredations have completely overshadowed quality aspects of management, such as the shell limit. Attempts to solve the Horicon situation have progressed to the point of a federally operated statewide goose-tag system to control the kill and even the elimination of the managed goose hunting program in 1967 to provide more cropland on the refuge.

For many years, the managed goose blinds accounted for about one-third of the total estimated harvest at Horicon. The program was also important in evaluating the effects of regulations. It was evident from observing goose hunters that control of shooting activities was needed. This may be related to the kinds of shooting, for the bulk of the kill occurs in pass shooting without the aid of decoys. In 1953, 40 shots were expended to bag a goose and success was only 0.04 geese per trip (season kill of 655). As goose populations increased and hunters gained some experience, shots fired declined to about 15 per goose in 1957, a level maintained through 1961. Hunter success increased in that period to 0.25 geese per trip in 1957 (bag of 3,308) and about 0.5 geese per trip in the early 1960's. Reported crippling loss declined from 42 percent in 1953 to a fairly constant level of 15 percent by 1957. Restrictions on shooting were

considered desirable because of apparent influence on success and crippling. Almost annual rejection of field-level recommendations for shell limit control in our program was based on (1) legal interpretations related to search and enforcement, (2) possible discrimination in relation to unlimited shooting by goose hunters on private land, and (3) lack of a precedent for shell limits in other states.

To my knowledge the initial break-through in shell-limit regulations on public goose shooting areas occurred at the Willow Slough State Fish and Game Area in Indiana. William E. Madden, project manager, deserves credit for doing something about the sky-buster. After watching goose hunters spoil hunting for themselves and others with wild shooting, he established a 6-shell limit during the first week of the 1959 season. Results were good; the wild shooter either quickly eliminated himself or learned to control his actions if he wanted to kill a goose. While the shell limit was used again in 1960, the technique did not become widely known until the 1961 season when Richardson (1961) made an evaluation with the aid of hunter interviews. The success obtained in Indiana provided impetus for shell-limit restrictions in Illinois in 1962, Wisconsin in 1963 and other states in recent years.

Pre-Shell-Limit Shooting Data at Horicon Marsh

Study of hunter shooting activities in the managed blinds was undertaken in 1962 to provide background data for comparative purposes. Each party of hunters was provided a score card, instructed to record their shooting experiences, and return the completed card when checking out. Only one goose of any species was legal game. Reliability of reports was based on observations during routine hunter surveillance in the public shooting area. A summary of 1962 shooting data are shown in Table 58, with major points outlined below:

1. Hunter trips totaled 3,672. On these trips, 56 percent of the hunters got their goose, 25 percent had shooting but were unsuccessful, and 19 percent had no shooting. Of the hunters who had shooting, 69 percent were successful.
2. Successful hunters fired 12,755 shells, unsuccessful hunters, 5.574 shells. Shots per hunter averaged about 6.7 for both successful and unsuccessful hunters.
3. An average of 9.7 shots were fired per goose bagged.
4. Of the hunters getting geese, 10 percent killed their goose with one shot and 11 percent required more than 12 shots. It took 25 hunters a box (25) or more of shells to bag a goose. Of the unsuccessful hunters, 16 fired 25 or more shells and 5 fired 35 or more shots.
5. Had there been a 6-shell limit, shooting would have been reduced 34 percent (6,149 shots) and the kill potentially reduced 41 percent (based on the number of hunters requiring more than 6 shells to bag a goose).
6. Crippling loss was reported at 11 percent. Observation showed crippling loss to be 21 percent.

TABLE 58. Number of Shells Fired by Hunters in the 1962 Horicon Managed Goose Hunt *

	Successful Trips				Unsuccessful Trips**			
	Hunters		Shots Fired		Hunters		Shots Fired	
Number Shots	Number	Percent	Number	Percent	Number	Percent	Number	Percent
1	189	10.0	189	1.5	45	5.4	45	0.8
2	258	13.6	516	4.0	98	11.1	196	3.5
3	226	11.9	678	5.3	111	13.3	333	6.0
4	124	6.5	496	3.9	79	9.4	316	5.7
5	127	6.7	635	5.0	62	7.4	310	5.6
6	192	10.1	1,158	9.1	89	10.6	534	9.6
Sub-Total 1-6	1,116	58.9	3,660	28.7	484	57.8	1,734	31.1
7-12	562	29.7	5,321	41.7	259	30.9	2,149	38.6
13+	216	11.4	3,774	29.6	94	11.3	1,691	30.3
Totals	1,894	100.0	12,755	100.0	837	100.0	5,574	100.0

* Based on voluntary reports of hunting without a shell limit. Other regulations included daily bag limit of one goose of any species, only geese legal game, shooting hours 7:00 a.m. to 2:00 p.m. and 3 hunters per party. Refuge goose population increased from 21,200 to 36,000 during hunting period. Quota of 7,200 killed in 8 days (October 1-8).

**Does not include 944 hunters who had no shooting.

Our conclusions at that time were (1) hunters firing 0-6 shots were generally accurate reporters, (2) successful hunters were more reliable than unsuccessful hunters, and (3) hunters firing more than 6 shots tended to round off their reports at 5-shot intervals of 10, 15, 20, etc., and with decreasing accuracy in the higher ranges.

Goose Hunting Activities with a Shell-Limit Regulation at Horicon

1963 Season

On the basis of information from the 1962 season, showing that the average hunter only fired about 6 shells per trip, and supported by evidence of good results with a shell limit in Illinois as well as in Indiana, a 6-shell limit was approved for the 1963 Horicon managed goose blinds. All hunters participating in the managed goose hunt were advised of the regulation. Evaluation was based on hunter reports, pre- and posthunting interviews and spy blind observations of shooting activities. Hunters under observation were, in most cases, permitted to complete hunting activities for the day.

Hunter reports of shooting activities are presented in Table 59. Points of interest regarding these data are:

1. In a total of 7,837 hunter trips, 27 percent had no shooting, 32 percent had shooting but got nothing, and 41 percent bagged a goose. Of the hunters who had shooting, 56 percent were successful.
2. For all hunters, there were 2.6 shots per trip; successful hunters averaged 3.4 shots, unsuccessful hunters with shooting, 3.8 shots.
3. An average of 6.4 shots were fired per goose bagged.
4. Hunters getting geese with one shot totaled 18 percent and 22 percent required 6 shots.
5. About 32 percent of the hunters were eliminated from the managed hunt because they fired 6 shots without bagging a goose.
6. Crippling loss was reported at 10.4 percent. Our best estimate from observations was 13.8 percent.

Hunter interviews were used in a pre- and post-hunt sample to evaluate various aspects of the managed goose hunt. Opinions of 566 hunters with no experience in goose hunting under a shell limit showed 49 percent approved of the regulation, 32 percent opposed it and 19 percent had no opinion. After experiencing the shell limit, 692 hunters sampled reported 64 percent in favor of it, 32 percent did not like it and 4 percent did not care one way or the other. When asked if the shell limit restricted their shooting, 36 percent said it did influence their activities and 64 percent reported no influence. Hunter success for the posthunting interview sample was 0.43 geese per trip and shooting activities were very similar to the data in Table 59. About 40 percent of the hunters reported no previous trips in the state blinds and 60 percent no previous goose hunting in the Horicon area. For those hunters who had participated in the managed hunt in previous years, 59 percent had been unsuccessful in bagging a goose. These data support the point that much of the shooting in public goose hunting programs must be by the relatively inexperienced hunters.

Hunter observations in 1963 were made from parking lots, roadsides or other inconspicuous

TABLE 59. Number of Shells Fired by Hunters in the 1963 Horicon Managed Goose Hunt*

	Successful Trips				Unsuccessful Trips**			
	Hunters		Shots Fired		Hunters		Shots Fired	
Number Shots	Number	Percent	Number	Percent	Number	Percent	Number	Percent
1	600	18.6	600	5.4	375	14.9	375	4.0
2	624	19.5	1,284	11.6	457	18.2	914	9.7
3	457	14.2	1,371	12.4	375	14.9	1,125	11.9
4	437	13.6	1,748	15.8	281	11.2	1,124	11.9
5	426	13.2	2,130	19.2	213	8.5	1,065	11.3
6	660	21.5	3,960	35.7	810	32.3	4,860	51.3
Totals	3,224	100.0	11,093	100.0	2,511	100.0	9,463	100.0

* Based on voluntary reports of hunting with a 6-shell limit. Other regulations included daily limit one goose of any species, only geese legal game, two-man party size, one trip per season limit, flexible shooting hours: 9:00 a.m. – 2:00 p.m. from October 5-18; 8:00 a.m. – 2:00 p.m. October 19-31; sunrise – 2:00 p.m. November 1-9. Refuge goose populations increased from 43,000 on October 5 to 100,000 level in late October and a decline to 50,000 on November 12. Quota of 12,000 taken in 36 day season of October 5 – November 9.

**Does not include 2,102 hunter trips with no shooting.

vantage points. Hunters were frequently observed and contacted by enforcement personnel to check on regulations related to trespass on the refuge, shooting outside of blinds, etc., but including number of shells fired and in possession. An enforcement awareness has been built up over the years in the managed hunting program as a result of such contact. Spy blind observations were specific assignments to evaluate shooting activities. Shot counts were related to party size (either one or two hunters). Violations were determined on the bases of 6 shots for one man in a blind and 12 shots for 2 men in a blind, regardless of who actually fired the shells in a two-man party. A total of 159 hunting trips were observed with 149 carried to completion. Ten parties were not followed to completion of their hunt due to violations terminating their hunting or the need to investigate another violation, not all of which pertained to shell-limit infractions. Hunter and observer reports are compared in Figure 23.

1. In the 149 completed observations, there were 39 instances (26%) where neither hunter nor observer reported shooting. When shooting occurred, 69 of the 110 observations (63%) were the same as reported by the hunters. Thus, agreement occurred in 72 percent of the observations (39+69+149).

2. Hunters sometimes reported more shots than observed. In 19 parties reporting more shots (13%), 14 of these were in the one- and two-shot range. Possible explanations are that observers could not determine when both hunters in a party fired simultaneously, that hunters did not count their shots or unused shells accurately, and that perhaps some hunters reported false information. Why a few hunters would report as many as 5-6 shots more than observed is unknown.

3. There may be a tendency for unsuccessful hunters to report fewer shots than taken, as only 29 percent of those hunters observed bagged geese compared to an average of 41 percent for all hunters in 1963.

4. If these data are assumed accurate, 564 shots were observed and 513 reported, a 9 percent lower reporting rate.

5. For all hunting parties observed, 14.7 percent reported less shots fired than observed. In this group 137 shots were observed but only 40 shots, or 29 percent, were reported.

6. As an indication of accuracy in observation, hunters registered 92 geese. Observers recorded all these geese and one additional goose which was loaded in a car but not registered at check-out time. Crippling loss was reported to be 7 geese knocked down and lost. Observers noted 10 geese downed and not recovered. Observers, however, generally have better visibility and can often see geese fall in the refuge out of the view of hunters.

Violations of the shell-limit regulation occurred on only 2 occasions in 149 observations. In one case, 2 hunters fired 13 shots without killing or crippling a goose and left the blind when shooting opportunities declined in mid-day. The second violation involved an arrest of 2 hunters who had shot 12 times but remained in the blind for some time. They were contacted and each had 2 more shells in their guns. During the entire 36-day hunting period, several hundred enforcement contacts were made of hunting parties in the state blinds. Only 9 arrests were involved with the shell-limit regulation. These included 3 cases of shooting more than 6 shots, 2 cases of shooting 6 times and possessing more shells, and 4 cases of shooting less than 6 times but possessing more than 6 shells. Evidence suggested that hunters generally carried only 6 shells into the blinds but returned to their cars for additional ammunition on the pretense of getting food, clothing, to get warm or other reasons.

1964 Season

Regulations were essentially the same as in 1963 except that hunters who were unsuccessful on their initial trip in the state blinds, because they did not

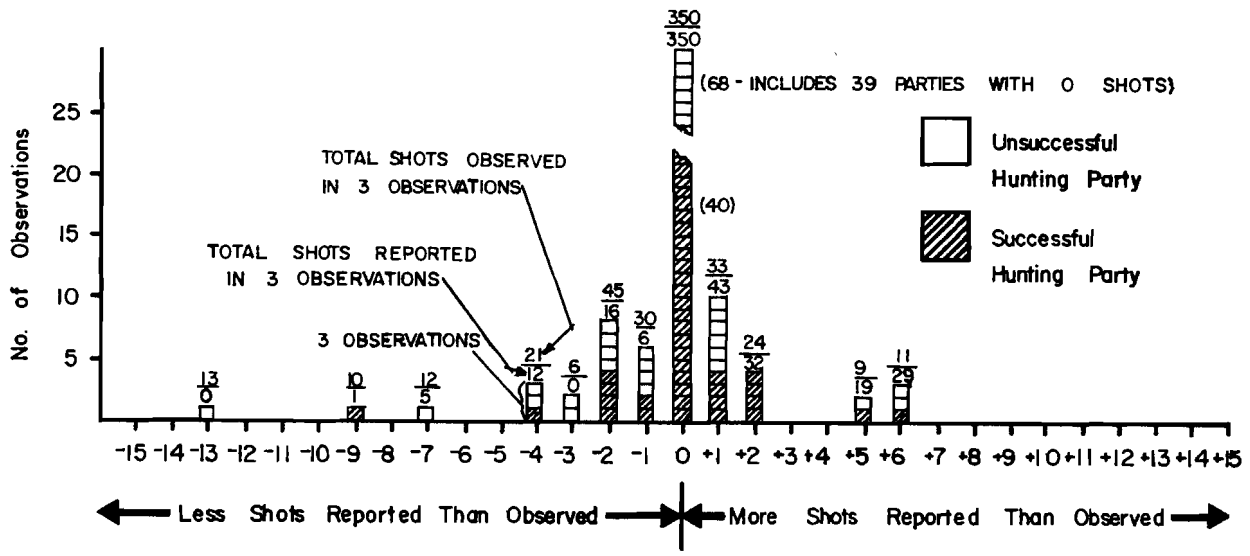


FIGURE 23. Frequency of difference in shots fired in hunting under a 6-shell limit as reported by hunters and as recorded by observers in the 1963 Horicon Managed Goose Hunt.

bag a goose or were eliminated because they shot their 6 shells, could make a second trip. A return to high daily kill rates of about 1,000 geese per day resulted in a short hunting season (October 10-21) and less use of the managed goose blinds.

Hunter reports of shooting activities for 1964 are shown in Table 60. Major points related to the 6-shell limit are:

1. In 2,907 hunter trips, 4 percent had no shooting, 72 percent bagged a goose and 24 percent had shooting but no success.
2. Shots per hunter averaged 3.8, but successful hunters fired 3.7 shots.
3. An average of 5.2 shots were fired per goose bagged.
4. Hunters shooting 6 shells totaled 26 percent. Of the unsuccessful hunters, 41 percent were eliminated by the shell limit. For the successful hunters 21 percent reported 6 shots to bag a goose.
5. Only 70 of the 753 unsuccessful hunters utilized the second trip opportunity but 78 percent were successful in bagging a goose.
6. Hunter opinion showed 65 percent favored the shell limit, but 45 percent said it restricted their shooting.
7. Crippling loss was reported at 6.7 percent. Our best estimate was about 15 percent.

Observations of hunters were carried out on 47 hunting trips in the state blinds. Shooting was recorded in every observation and hunters reported shooting in every blind. Differences between reported and observed shot counts are shown in Figure 24. These data are quite similar to results in 1963:

1. Observers and hunters were in agreement on 59.2 percent of the hunting trips (63% on trips with shooting in 1963).
2. Observers recorded less shots than reported in 12 percent of the trips (13% in 1963).
3. If all observations are accurate, 442 shots were observed and 398 reported by hunters, a 10 percent lower reporting rate (9% lower in 1963).
4. For all hunting parties observed, 29 percent reported less shooting than observed (14% in 1963). On these 14 trips, 172 shots were observed but only 61 percent reported.
5. Hunters reported bagging 70 geese, all of which were observed. In two cases 3 geese were reported shot by two 2-men parties (one over the bag limit) and also noted by the observer. Crippling loss was reported as 6 geese downed and not recovered (8%). Observers reported 12 geese downed and lost (15%).
6. Hunter opinion in the sample of 92 hunters observed in 1963 showed 80 percent in favor of the shell limit but 57 percent said it restricted their shooting activities.

Violations of the 6-shell limit increased in 1964 to 14.5 percent (1.3% in 1963). The 7 violations observed all involved 2-man parties and were as follows: (1) shot 12, 3 in possession at check out but reported only 5 shots fired; (2) shot 13 shells, reported 12; (3) shot 14, reported 7; (4) shot 14, 3 in possession at check-out and reported 12; (5) shot 16, reported 12, bagged 3 geese; (6) shot 17, 24 in possession but reported 7 at check-out; (7) shot 18, reported only 1 shot fired. No arrests were made in these cases because of the interest in determining hunter behavior. Although only 3 arrests were made for violation of the shell limit, a number of warnings

TABLE 60. Number of Shells Fired by Hunters in the 1964 Horicon Managed Goose Hunt*

	Successful Trips*				Unsuccessful Trips**			
	Hunters		Shots Fired		Hunters		Shots Fired	
Number Shots	Number	Percent	Number	Percent	Number	Percent	Number	Percent
1	284	14.0	284	3.8	34	5.3	34	1.1
2	343	16.9	686	9.2	68	10.5	136	4.5
3	320	15.8	960	12.9	74	11.5	222	7.4
4	339	16.7	1,356	18.2	60	9.3	240	8.0
5	298	14.7	1,490	20.0	74	11.5	370	12.3
6	444	21.9	2,664	35.8	335	51.9	2,010	66.7
Totals	2,028	100.0	7,440	100.0	645	100.0	3,012	100.0

* Excluded are 108 hunters with no shooting and 126 hunters who did not report. Regulations in the 106 blinds included a 6-shell limit, daily bag limit of one goose of any species, only geese as legal game, one goose or two trips per hunter per season, 9:00 a.m. - 2:00 p.m. shooting. Refuge goose populations of about 100,000 in shooting period of October 10-21. Harvest of 13,066 (quota 11,000) taken in 12 days shooting with state blinds closed on October 18 and 20.

**70 hunters unsuccessful on first trip made a second trip, with 55 bagging a goose on the second trip. Shooting activities on the unsuccessful trips were not separated for these 70 hunters.

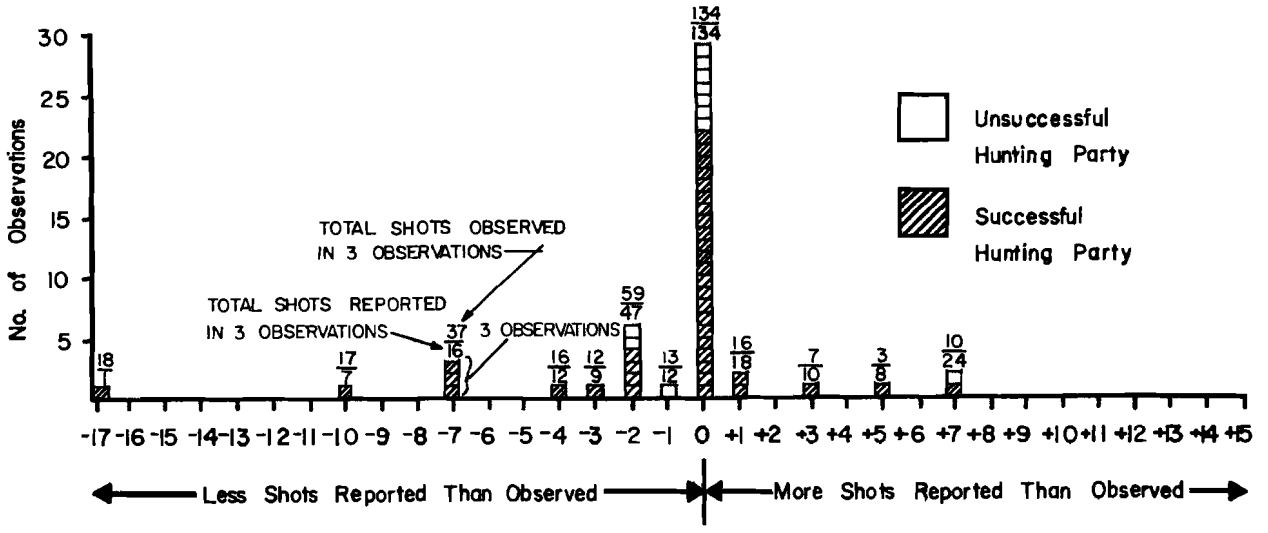


FIGURE 24. Frequency of difference in shots fired in hunting under a 6-shell limit as reported by hunters and as recorded by observers in the 1964 Horicon Managed Goose Hunt.

were issued for parties that had shot the limit or slightly exceeded it.

Shots fired per opportunity were also recorded during some hunter performance observations as an indication of the shell-limit effect. Prior to the shell limit it was generally the practice of most hunters to fire 2 or 3 times at geese they thought were in range. Our regulation of shot size no larger than BB did eliminate the very high shooting that used to occur when buckshot was permitted. With the 6-shot limit, it was often possible to see hunters aim at geese and then hold their fire on high or wide flocks. Or if shooting occurred, 3-shot volleys per hunter seemed the exception. Data from 18 observations on 2-man parties are:

1. All 18 parties had shooting at 1 or more geese, 3 parties were unsuccessful, 2 parties got one goose and 13 parties each killed 2 geese. Total bag was 29 geese and 6 additional geese were knocked down and lost. Six birds were bagged as singles and 1 single was crippled, all other shooting was at flocks of 2-13 birds.
2. One or more shots were fired at 76 different groups of geese. Total shots fired was 148 for an average of 1.9 shots per opportunity.
3. The distribution of shots per opportunity was: 1 shot – 36 percent; 2 shots – 33 percent; 3 shots – 18 percent; 4 shots – 9 percent; 5 shots – 3 percent; 6 shots – 1 percent.

1965 and 1966 Seasons

No detailed observations on hunter compliance with the 6-shell rule were made in 1965. Both management and enforcement personnel continued to inform hunters about the regulation. The one shell-limit arrest was in conjunction with violation of other regulations. Warnings were sometimes issued, particularly to unsuccessful hunters who had shot their shells and remained in the blinds. Hunter attitude remained generally good on the value of the shell limit.

In 1966, some hunter performance observations were again conducted in anticipation of poor hunter reaction to the hazing operation which attempted to move geese out of the Horicon Refuge and on south. Unfortunately, the goose hunting season lasted only 2 ½ days and too few observations were obtained for a meaningful review. Two arrests were processed from 932 hunter trips in the managed goose hunt blinds. These two arrests were detected during 28 spy-type observations. Fortunately there were lots of geese (80,000+) and hunter success was sufficiently high (averaged 0.7 geese per hunter with a 1-bird limit) to preclude the need for much wild shooting.

General appraisal of the shell-limit regulation at Horicon

From a review of the above data which are summarized in Table 61, it is evident that the 6-shell limit in the Horicon Managed Goose Hunt did have a significant impact on hunter shooting activities. The number of shots fired per hunter trip, the shots fired per bird bagged, and the success per hunter trip showed marked improvement from the pre-shell-limit period. We recognize, of course, that other factors such as refuge management, increased goose populations, changing goose behavior, and other regulations have also influenced shooting activities. Nevertheless, individual hunters appeared directly affected by the shell limit as shown by the shots fired per opportunity and their opinions that the shell limit restricted shooting. The results of less shooting were reflected in a reported crippling loss of less than 10 percent. However, it is doubtful if the real loss will be significantly lower than 15 percent. Unmeasured effects of the shell limit over the long haul are the increased shooting opportunities provided to adjoining public blind hunters and private land hunters behind the managed blinds.

TABLE 61. Goose Hunting Data Related to a 6-Shell Limit at Horicon Managed Goose Hunt, 1962-64

	No Shell Limit	6-Shell Limit/Hunter	
Hunter Reports	1962	1963	1964
Total Trips	3,672	7,837	2,907
Total Kill	2,047	3,222	2,110
Trip Success			
No shooting	19%	27%	4%
Shooting but no kill	25%	32%	24%
Successful	56%	41%	72%
Shots Fired			
Per hunter trip	5.0	2.6	3.8
Per unsuccessful hunter	6.7	3.8	4.7
Per successful hunter	6.7	3.5	3.7
Per goose bagged	9.7	6.4	5.2
Percent of geese bagged			
On 1st shot	10%	18%	14%
On 6th shot	10%	22%	21%
Crippling loss			
Reported	11%	10%	7%
Observed	21%	14%	15%
Hunters firing 6 shells but not bagging a goose	41%	10%	12%
Spy Blind Observations			
Hunter parties observed		149 (280)*	47 (98)
Geese reported bagged		92	70
Geese observed bagged		93	70
Crippling loss reported		7%	8%
Crippling loss observed		10%	15%
Violations of 6-shell limit		2	7
Comparison of Shooting Activities:			
Hunters and observers same		73%	59%
Hunters report more shots		13%	12%
Hunters report less shots		14%	29%

*Number of hunters observed.

Our observations showed that the majority of hunters using state blinds respected the regulations. Most of the cases involving overshooting were in the 1-2 range. We found too that some hunters were hiding loaded shells in the blinds, apparently for use of future hunters. In 1963, 75 shells were picked up in the removal of about 40 blinds from crop fields. In 1964, 38 shells were found, usually 1 and never more than 3 in a blind. Some hunters are very honest too. In two spy-blind observations in 1964, one of the hunters in each party got their goose with 1 and 2 shots respectively. Their partners then shot 6 shells each without getting a goose. Each party then left the blind despite the fact that some shells were still available. Some hunters also apparently learned something about goose hunting. In 1964, 70 hunters who had been eliminated by the shell limit on their first trip made a second trip and 78 percent got a goose.

It is our conclusion that the hunter and the goose both benefit from the shell-limit regulation. The key to its success lies in an effective and respected enforcement atmosphere in the managed hunting program.

Shell-Limit Regulations in Other States

A review of published data on shell-limit regulations used in managed goose hunting programs provides relatively little numerical material for comparative purposes. Before and after comparisons related to hunter shooting and behavior

characteristics need documentation and evaluation despite the apparent obvious benefits of a shell limit. Presented below in summary form are some managerial experiences from various states in which I have found information on shell-limit regulations in goose hunting.

Indiana

Pioneering efforts in the shell-limit technique were at Willow Slough Fish and Game Area. A 6-shell limit has been used from 1959 through 1967 despite daily bag limits of 2 geese per hunter. The shell-limit evaluation report at Willow Slough by Richardson (1961, 1962) was an "opinion survey to determine hunter reaction and attitude." No before and after data were cited. However, reference is made to shot counts on various pits with the statement: "Declaration of shots fired from the pit usually coincided with those counted." A total of 4,408 hunter trips and 433 geese were recorded on the area in 1961. Interviewers sampled 1,166 hunters who shot 122 geese. Shots fired per hunter averaged 0.9 but only 32 percent of the hunters (373) had shooting. An average of 9 shots were fired for each goose bagged but successful hunters fired only 3.3 shots per goose. Of the 373 hunters who had shooting, 45 (12%) fired 6 shots (3 hunters reported 7 shots). Only 16 hunters with shooting (4.3%) were eliminated by shooting their 6 shots without success. The report concluded that a shell limit (1) was effective in restricting wild shooting, (2) will not eradicate high shooting but will have the noticeable effect of clearing the pit area of high and wide shooters before they would normally leave, and (3) to be effective as a management tool should be strictly enforced. Detailed comparisons of shooting data and other findings were not made with our study because goose concentrations and harvest are so vastly different. Over a thousand geese may be shot in one day at Horicon compared to a few hundred for the entire season at Willow Slough. If there had been data on opportunities to shoot, it might have been possible to compare results. In any event, Richardson's report contains much more information on hunter characteristics than mentioned above and it should be read by anyone interested in managed goose hunting.

Illinois

A 10-shell limit was established at both the Horseshoe Lake and Union County public goose shooting areas in 1962. Arthur (1963, and in litt. Nov. 22, 1967) surveyed hunters in 1961 prior to shell-limit restrictions. At the Horseshoe Lake Public Hunting Area, 92 percent of the hunters had shooting and 11 shots were fired per trip. Average success was 0.7 geese per hunter and 16 shots were taken for each goose bagged. Unsuccessful hunters accounted for 45 percent of the trips, 42 percent of the shells fired and averaged 10 shots per trip. For all hunters, 65 percent shot more than 6 times, 52 percent more than 8 times, 40 percent more than 10 times and 18 percent more than 20 times. For the Union County goose area, success was the same (0.7) but shooting figures somewhat lower: 86 percent had shooting, 36 percent were unsuccessful, 6 shots were fired per trip, 9 shots were fired per goose bagged, 53 percent shot over 6 times and 21 percent more than 10 times. Observations showed that hunters under-estimated the number of shots fired by 15 percent. In total about 35,000 shots were fired to bag 3,000 geese.

In 1962, a 10-shell limit was established on both public shooting areas. Shots fired decreased to 4.5 per trip and 6.6 per bird bagged. In 1963, shots per hunter averaged 2.4 and the average of shots per goose bagged was 5.1.

Observations revealed few violations and self-policing by other hunters was noted. There appeared to be much better distribution of the geese over the shooting area and better distribution among the hunters. To quote Mr. Arthur, "I believe this shell-limit regulation is a must for the goose areas".

Oklahoma

Managed goose hunting activities have been carried out on the Tishomingo National Wildlife Refuge since 1960 (Copelin, et al., 1964). There are 18 pits on 210 acres in the public goose hunting area. Long-range shooting in 1960 and 1961 resulted in the adoption of an 8-shell-limit regulation starting in 1962. In 1960 and 1961, prior to the shell limit, about 500 hunters harvested 0.12 geese per trip. After the shell limit, hunter use, harvest and success increased. Data for 1963 showed a kill of 355 geese, 26.9 percent successful hunters and 0.43 geese per trip. Crippling loss in 1962 was 9.6 percent. In a sample of 73 hunters on opening day in 1962, shots per hunter averaged 3.3 per trip and 5.2 shots per goose bagged. Copelin (et al. 1964: 5) states: "The 8-shell limit was well accepted by nearly all hunters. Someday it may be necessary to reduce the number of shells even further, but for the time being we feel like we have accomplished the needed reduction in sky-busting". Copelin (in litt. April 2, 1967) stated: "We are well pleased with the apparent good results of the shell limit but are not trying very hard to enforce it. I think, however, that the psychological effect on the hunter of conserving ammunition has been helpful in our case".

Tennessee

The Blythe Ferry Goose Management Area has been in operation since 1964 (Allen, 1967). Hunting occurs in 12 blinds on 525 acres. An 8-shell limit was established in the first year of hunting and has remained in effect. Hunter trips increased from 751 in 1964 to 1,025 in 1966. During those 3 consecutive years, hunter success averaged 0.4, 0.2 and 0.3 geese per trip respectively. Shots fired per goose bagged averaged 5.0, 6.4 and 6.6 and reported crippling loss was 16.7, 19.8 and 18.2 respectively. No adverse comments on the shell limit were made except perhaps a reference to 1965 conditions when fewer geese were on the refuge and "hunters shot at almost any goose that came into the area, regardless of range or 8-shell limit; a resulting high crippling loss occurred" (Allen, 1967:10).

Missouri

A 10-shell limit was established in the managed goose hunting program at the Swan Lake National Wildlife Refuge in 1965. Dunkeson (1965) described

general objectives related to the shell limit at Swan Lake. The only data available for review here pertain to the 1967 season, provided by Richard W. Vaught (in litt. Nov. 27, 1967) and Mike Milonski (in litt. Dec. 1 and 4, 1967). In 12 days of observations on 30 pits, 22 hunting parties were in violation (54 arrests) for shooting over the 10-shell limit. The distribution of shots in excess of 10 per hunter occurred in the following ranges: 1-5=1, 6-10=6, 11-15=5, 16-20=4, 21-25=4, 31=1, 38=1. Hunters at Swan Lake (and at other managed areas) were advised of the shell limit. Very few violations were noted in previous years but data are lacking. Some effect on reducing crippling loss was suggested. At the nearby Fountain Grove area where shells are not limited, reported crippling loss was 13.6 percent in 1967 compared to 9.4 percent at the Swan Lake shell-limit area. Commenting on the regulation Milonski stated; "I am positive that the 10-shell limit has helped reduce crippling loss and high shooting even though we have had such flagrant violation of this rule this past year. Anyone who has been around Swan Lake before the 10-shell limit was introduced will tell you that there are fewer shots fired".

General Appraisal of Shell Limits

Shell-limit regulations in managed goose hunting have proven to be a useful tool for the game manager and a generally acceptable rule by the hunter. Every managed area discussed here has retained the regulation once it was established. There is some evidence that hunters under-report shooting by about 15 percent. I wish to emphasize again that more evaluation data are needed. The real biological gain from the regulation is less crippling loss. Frequency of body-shot carried by geese probably is reduced in some areas. Arthur (in litt. Nov. 23, 1967) pointed out that shooting at geese declined in the Union County (Illinois) public blinds from 35,000 shots in 1961 with no shell limit to 8,000 shots in 1963 with a 10-shell limit. On some major goose shooting areas a very real relationship may also exist with respect to reduced shooting and lead poisoning potential. The history of most public shooting areas shows they eventually attract or develop the "sky-buster". Shell limits do not eliminate such shooters but they are quickly weeded out. The shell-limit regulation, however, will be no more effective than the enforcement effort that is made to keep hunters honest.

Other Regulations Used in Managed Goose Hunting

A review of rules and procedures used in a number of managed goose hunting programs is presented in Tables 62 and 63. My intent is to show some of the variations in techniques used to control hunters, harvest and quality aspects on intensively used public shooting areas. Some comments are made in relation to various regulations.

Public Use

Few managed goose hunting areas are now operated without a fee being charged. The cost per hunter is generally in the $2 to $5 range. Hunting fees on private land in areas of comparable or even considerably less potential for killing a goose often exceed by several times the above price. In some states such fees cannot be directly applied to the cost of operating state blinds. Our managed goose hunt at Horicon even operated at a loss of several thousand dollars each year in the 1960's due to very short seasons caused by high daily kill rates and harvest quotas. It does not seem unreasonable for a hunter to be charged a fee in the $5 range in view of the high chance for success, the costs to provide his hunting opportunity, the big investment by the hunter himself in equipment, etc., and the comparative costs of other recreation.

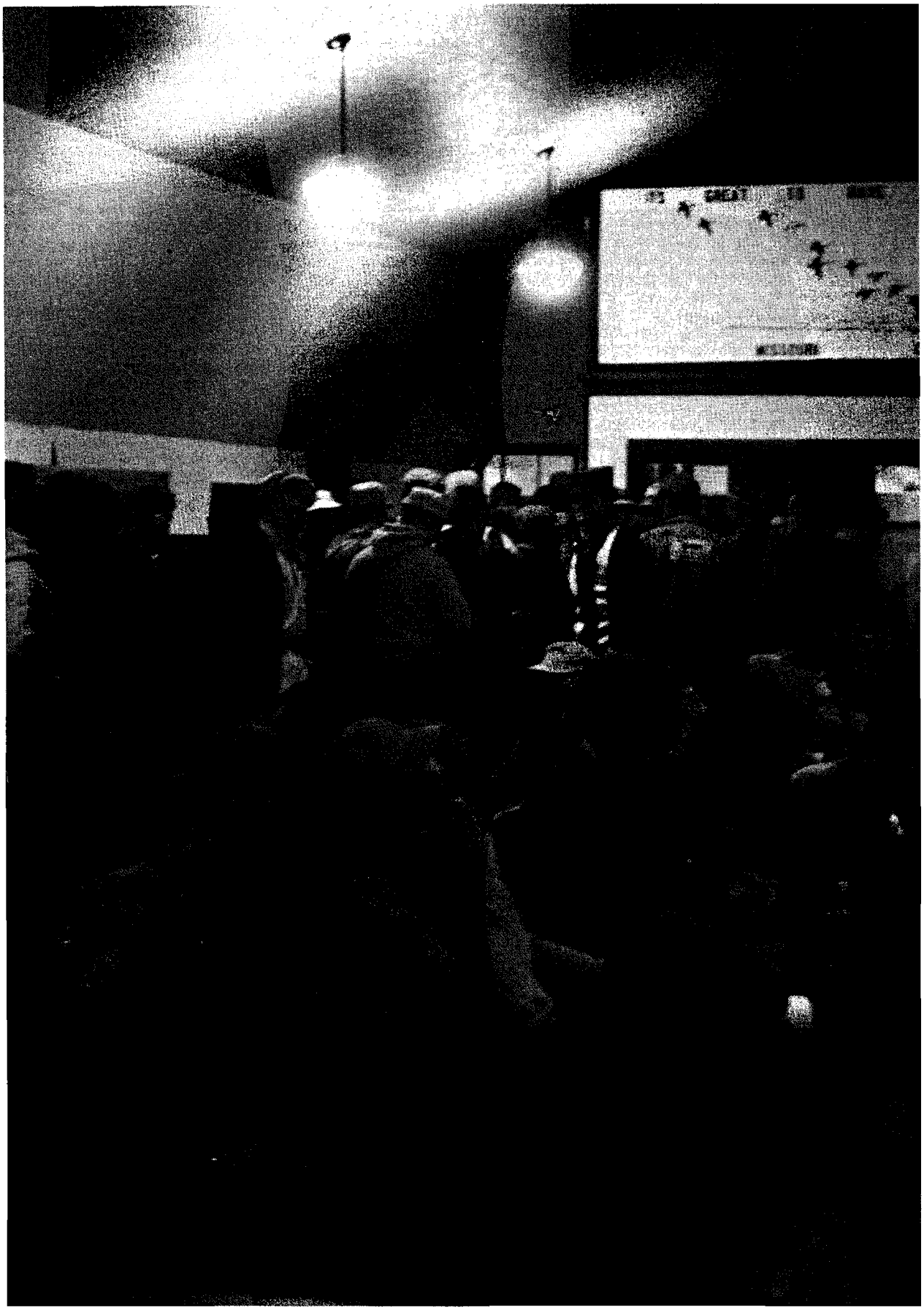
The availability of IBM data processing equipment and trained personnel in most state agencies has contributed significantly to better distribution of both hunting opportunities and harvest in managed hunting. Waiting lines and first-come first-serve systems tend to (1) favor local hunters or the very persistent hunter, and (2) cause a great deal of lost time and sometimes unnecessary hardship in cold weather. Advance reservations using machine processes have been of considerable value here.

Hunting Sites

Most of the managed goose hunting programs have recognized the need for adequate blind spacing. About 200 yards between blinds seems adequate. This has proven to be a very good way to protect the hunters from each other and to improve hunting quality. Leadership in this aspect of goose hunting originated in Illinois. Pit blinds do add more to hunting quality. However, there is ample evidence at areas like Horicon which demonstrates that geese of the 1960 era can be too easily killed even in surface blinds with no camouflage.

Hunting Periods

Manipulation of days hunted and restrictions in shooting hours would at first glance suggest their use in attempting to reduce the harvest. At Horicon, shooting hours were restricted in 1957 to a 2 p.m. closing as one of the regulations to increase the kill. The early closing hour and other regulations were actually too successful (Hunt, et al., 1962). Restrictive morning shooting hours were also judged to be a technique to reduce the high daily kill rates and prolong the goose season at Horicon. Time-of-kill data showed that about 30 percent of the kill occurred by 8 a.m. and about 50 percent by 9 a.m. It was assumed that a significant reduction in daily kill would occur if shooting started at 9 a.m. Three years of such regulations proved otherwise. There were other complicating factors, of course. The 9 a.m. starting hour, however, permitted mass off-refuge feeding flights and contributed to a continuous movement of geese in the area and consequent high vulnerability. Late in the 1965 season we also tried alternate days of hunting. This regulation merely doubled our kill on the days when shooting occurred. In general, the practice of restricting days of hunting and/or shooting hours on most goose management areas suggests the primary effect is an increased



kill rather than providing more recreational opportunity.

Shooting Restrictions

Shell-limit regulations have been discussed for some areas. More widespread use of this technique has occurred than I realized; 11 of the 13 areas reviewed here use it. The custom is 5 to 6 shells per goose, but Indiana is most restrictive with 3 shells per bird.

Gun-gauge restrictions have received little attention. Restrictions on 20-gauge and smaller guns have occurred at the Allegan goose hunting areas in Michigan. This looks like a good regulation for the average goose hunter. I was particularly pleased to see that the Oak Orchard Game Management Area at Oakfield, New York, restricted shotguns larger than 12-gauge in waterfowl hunting (Robert F. Perry, in litt. April 23, 1962). The 10-gauge and 10-gauge magnum, in my opinion, should be prohibited by federal law in modern waterfowl hunting. Average hunters, observing long-range kills by the big-bore shooters, think they can do it too and merely contribute to the sky-busting group who only cripple birds and pollute the habitat with lead.

Shot size in goose hunting is being restricted in many areas, thanks to the work of Frank Bellrose and despite the relatively recent introduction of and claims for such cartridges as the "3-4B" and polyethylene granular cushioned buckshot loads. Of the major goose harvest areas in this review, only Swan Lake, Missouri and Allegan, Michigan permit buckshot. These loads certainly encourage high shooting. The finding by Richardson (1961) that kill per effort with BB shot was twice as great as with No. 2 shot but that the crippling loss with BB was 3 times as great deserves further investigation. At four areas shot size has been limited to nothing larger than No. 2. The relationship of crippling loss to shot size in goose hunting has been poorly studied. Perhaps the current studies with iron shot and other substitutes for lead shot will contribute to this matter.

Species-hunted restrictions on managed goose areas have been applied only at Horicon and Willow Slough where geese are the only legal game. Duck hunting at Horicon was prohibited in 1956. Observations of hunters in the managed unit in 1955 suggested that shooting at ducks was at least flaring geese or causing them to increase their altitudes on many occasions. The harvest of 3,471 ducks and crippling of another 964 ducks in the managed blinds is ample evidence of frequent shooting. Hunters with a chance at ducks seldom passed up a shot despite the opportunity for a shot at geese in nearby blinds. Certainly part of the 28 percent increase in hunter success in 1956 and improved success in later years was due to the rule prohibiting duck shooting. Many goose management areas do not have to limit duck shooting because there are few ducks to shoot. Where both ducks and geese are in abundance in the shooting area, goose harvests probably can be increased if only geese are legal game.

Bag limits generally conform to those within the Flyway. Exceptions occurred at Horicon and Pymatuning where only 1 goose per day was allowed. A 1-goose-per-day limit was used at Horicon late in the 1958 and 1959 seasons to slow down the kill and has been a standard rule since 1960. Our supply of geese is much less than the demand (potentially 100,000 waterfowl hunters and annual harvest quotas of 20,000 or less). The 1-bird limit does help to distribute the kill. Illinois tried the 1-goose-per-day limit in 1962. Initial interpretation from a game management viewpoint was favorable, but a postmortem on the local economy showed it greatly reduced upstate and nonresident hunting interests. Conditions in that area may justify the return to 2 geese per day. The Swan Lake area also used a 1-goose limit for the first part of the 1967 season to slow down the kill and then advanced to 2 geese per day for the remainder of the season. In view of the increasing demands on the goose resource and its habitat, a 1-goose-per-day bag limit probably should be the rule rather than the exception. This rule should be set at the federal level.

Other Regulations

Decoys are either furnished or available for rental on many major goose hunting areas. The objective, of course, is to get the geese into range where they can be killed. Use of decoys should be encouraged as the way to hunt geese. Silhouettes are most frequently used (about 12-20 per blind) but shell-type decoys are often rentable at $1 to $2 per dozen.

Dogs are permitted for retrieving on all but Horicon and Allegan managed goose hunting areas. Control is of some concern, although generally geese are not hard to find if dropped within shooting range. Also, few dogs can really retrieve a dead goose. Goose calls on the other hand probably should be restricted in some cases. Few hunters in public shooting areas have shot enough geese or hunted them enough to be really skilled callers.

Summary Comments

Managed goose hunting regulations have shown an evolutionary trend directed at improving distribution of hunting opportunity and distribution of the harvest. "Quality" rules, artificial in many respects but the best that can be applied to the mass of hunters, are reasonably successful. Further regimentation on some areas will be needed and some new techniques tried. New management areas, however, have good guide-lines to follow. The watchword probably should be "flexibility". A host of current rules and practices can be manipulated during the course of a goose season to meet the needs of the goose resource. This can apply to hunting outside as well as within the managed area.

TABLE 62. Regulations and Other Information For Some Managed Goose Hunting Areas

	Horicon Refuge Wisconsin*	Horseshoe Lake Refuge, Ill.	Union County Refuge, Ill.	Swan Lake Refuge, Mo.	Willow Slough Area, Ind.
Public Use					
Fee	$4/blind	$5/person	$5/person	$5/blind and $1/person	$1/hunter
Party size	2	2	2	4	3
Advance reservation	1/yr. blind assigned	1/yr. drawn on date	1/yr. drawn on date	1/yr. draw	No – daily draw
Guests included	Yes	Yes	Yes	Yes	Yes
Unclaimed reservation	Fill – waiting line in order	Fill – drawing	Fill – drawing	Fill – drawing	--
Refill after 1st party	1/day	No	No	No	No
Use limitation	1 goose or 2 trips/season	Waiting line – unlimited	Waiting line – unlimited	Waiting line – unlimited	5/season
Permits transferable	No	No	No	No	No
Hunting Sites					
Type – No. structures	106 blinds	53 pits and blinds	50 pits and blinds	59 pits and blinds	25 pits
Spacing	225 yds.	200 yds.	200 yds.	440 yds.	200 yds.
Acres in shooting area	1,400	600	860	2,500	1,100
Hunting Periods					
Days not hunted/week	0	Monday	Monday	0	0
Hours hunted	9 am – 4 pm	Sunrise – Noon	Sunrise – Noon	Federal reg.	Sunrise – Noon
Shooting Regulations					
Shell limits and year started	6 – 1963	10 – 1962	10 – 1962	10 – 1965	6 – 1959
Gun size	Federal reg.	Federal reg.	Federal reg.	Federal reg.	Federal reg.
Shot size	BB or smaller	BB or smaller	BB or smaller	Unlimited	BB or smaller
Species hunted	Only geese	All waterfowl	All waterfowl	Only geese	Only geese
Bag Limits	1 goose/day	2 geese/day	2 geese/day	1/day (1st 12 days; 2/day bal. 1967)	2/day
Other Regulations					
Decoys	Hunter's	Furnished	Furnished	Rented or hunter's	Hunter's
Dogs permitted	No	Yes	Yes	No	Yes
Calls permitted	Yes	Yes	Yes	Yes	Yes

* Managed hunting terminated after 1966.
**Rules differ somewhat at Highbanks (H) and Farm (F) units.

TABLE 62. Continued

	Allegan State Area, Mich**	Blythe Ferry Area, Tenn.	Pymatuning Area, Penn.	Tishomingo Area Oklahoma
Public Use				
Fee	None	$3/person	None	None
Party size	3	3	4	3
Advance reservation	No – daily draw	1/yr. – draw on date assigned	1/yr. – draw on date assigned	No
Guests included	Yes	Yes	Yes	
Unclaimed reservation	--	Fill – draw	Fill – drawing	
Refill after 1st party	No (H); week days (F)	Yes until 10 am	No	Yes
Use limitation	1/yr. (H) 2/yr. (F)	Unlimited from line	2 trips/year	None
Permits transferable	No	No	No	
Hunting Sites				
Type – No. structures	58 posts (H) 44 blinds and extra zones (F)	12 pits	40 blinds	30 blinds
Spacing	58 yds.	300-650 yds. 1/52A	200 yds.	80 yds.
Acres in shooting area		600	2200	3170
Hunting Periods				
Days not hunted/week	0	Sun., Mon., Wed., Fri.	Sun., Tues., Thurs.	Mon., Wed., Fri.
Hours hunted	Sunrise – Noon (H) 3 pm (F)	Sunrise – Noon	Federal to Noon	Federal reg.
Shooting Regulations				
Shell limits and year started	0	8 – 1964	10	8
Gun size	Only 10, 12 and 16 ga.	Federal reg.	Federal reg.	Federal reg.
Shot size	No. 4 Buck to 4	2 or smaller	2 or smaller	Federal reg.
Species hunted	All waterfowl	Only geese	All waterfowl	All waterfowl
Bag Limits	Federal reg.	Federal reg.	1 goose	Federal reg.
Other Regulations				
Decoys	Hunter's	Furnished 20/pit	Rented or hunter's	Furnished and hunter's
Dogs permitted.	No	Yes	Yes	Yes
Calls permitted	Yes	Yes	Yes	Yes

TABLE 62. Continued

	Mattamuskeet Area North Carolina	Wheeler Refuge Alabama	Ballard Co. Kentucky	Tenn. National Refuge, Tenn.
Public Use				
Fee	1-2=$15, 3=$21, 4=$24 - guide included	$4/blind	$3/person	$4/blind
Party size	1-4	2	3	2
Advance reservation	1/yr. draw date punchboard for blind	1/yr. for 2 days draw date punchboard for blind	Yes. 1/yr.	1/yr. for 1 day draw date and blind
Guests included	Yes	Yes	Yes	Yes
Unclaimed reservation	First come - first serve	Draw	Fill - waiting line	Draw
Refill after 1st party	2/day 1st come 1st serve	1/day 1st come 1st serve		No
Use limitation	None		Wait line - unlimited	1/season
Permits transferable	No	No	Yes	No
Hunting Sites				
Type - No. structures	28 - 36 blinds	50 blinds	107 blinds and pits use only 37/day	20
Spacing	400 yds.	400 yds.	200 yds.	400 yds.
Acres in shooting area	5,000-10,000	6,000	5,700	5,000
Hunting Periods				
Days not hunted/week	Sunday	Sun., Mon., Tues.	Sunday	Mon., Tues.
Hours hunted	Federal to 4 pm	Federal to Noon	Federal to Noon	Federal to Noon
Shooting Regulations				
Shell limits and year started	None	12 - 1965	10 - 1964	12 - 1967
Gun size	Federal reg.	Federal reg.	Federal reg.	Federal reg.
Shot size	BB or smaller	2 or smaller	BB or smaller	2 or smaller
Species hunted	All waterfowl	All waterfowl	All waterfowl	All waterfowl
Bag Limits	Federal reg.	Federal reg.	Federal reg.	2 geese/day
Other Regulations				
Decoys	Furnished (guides)	Hunter	Furnished	Furnished
Dogs permitted	Yes	Yes	Yes	Yes
Calls permitted	Yes	Yes	Yes	Yes

TABLE 63. General Information on Some Managed Goose Hunting Areas

	Horicon Refuge Wisconsin*	Horseshoe Lake Refuge, Ill.	Union County Refuge, Ill.	Swan Lake Refuge, Mo.	Willow Slough Area, Ind.
Ownership	Federal	State	State	Federal	State
Managed hunt control	State	State	State	State	State
Year managed hunting started	1953	1950	1950	1955	1954
Acres in refuge area	20,000	9,000	7,200	10,967	1,700
In harvest quota area	Yes	Yes	Yes	Yes	No
Hunting data (year)	1966	1967	1967	1967	1967
Days of hunting	2½ days	31	31	24	70
Hunter trips	932	1,998	2,509	4,215	1,500
Average bag/trip	0.7	0.7	1.0	1.3	0.10 avg./yr.
Reported crippling loss	10%	10%	10%	9.4%	--
Harvest in mgt. unit	654	1,396	2,385	5,274	111 avg./yr.
Harvest in area	9,617 registered	11,600	7,240		250
Percent of total kill in mgt. hunt	7%	12%	35%	18.9%	30.8%
Peak refuge population	147,000	45,000	20,000	127,000	2,500
Reporters for each area	R. A. Hunt	G. C. Arthur	G. C. Arthur	R. W. Vaught M. Milonski	W. E. Ginn W. E. Madden

* Managed hunting terminated after 1966.
**Rules differ somewhat at Highbanks (H) and Farm (F) units.

TABLE 63. Continued

	Allegan State Area, Mich. **	Blythe Ferry Area, Tenn.	Pymatuning Area, Penn.	Tishomingo Area Oklahoma
Ownership	State	State	State	Federal
Managed hunt control	State	State	State	State
Year managed hunting started	1950	1964	1962	1961
Acres in refuge area	540 (H) 1,150 (F)	7,000	3,500	13,400
In harvest quota area	No	No	No	No
Hunting data (year)	1967	1966	1967	1966
Days of hunting	50	30	29	40
Hunter trips	3,606(H) 7,641(F)	1,025	3,573	4,789
Average bag/trip	0.16 (H) 0.04 (F)	0.34	0.59	0.26
Reported crippling loss	--	18.2%	10%	?
Harvest in mgt. unit	564 (H) 372 (F)	345	2,101	1,149
Harvest in area	2,600	600	2,956	--
Percent of total kill in mgt. hunt	36%	58%	71%	--
Peak refuge population	6,000	6,500	20,000	36,000
Reporters for each area	E. Mikula C. Friley	C. J. Barstow W. Allen	R. Sickles	C. Gilliam F. Copelin

TABLE 63. Continued

	Mattamuskeet Area North Carolina	Wheeler Refuge Alabama	Ballard Co. Kentucky	Tenn. National Refuge, Tenn.
Ownership	Federal	Federal	State	Federal
Managed hunt control	State	Federal	State	Federal
Year managed hunting started	1934	1964	1957	1967
Acres in refuge area	50,000	34,988	3,000	51,249
In harvest quota area	No	No	No	No
Hunting data (year)	1966	1967	1967	1967
Days of hunting	60	36	37	36
Hunter trips	2,895	3,720	3,611	937
Average bag/trip	0.31	0.21	0.3	0.4
Reported crippling loss	17.8%	33%	10%	--
Harvest in mgt. unit	895	2,720	991	296
Harvest in area	4,518	--	--	--
Percent of total kill in mgt. hunt	19.8%	--	--	--
Peak refuge population	40,000	46,000	20,000	31,000
Reporters for each area	O. Florschutz	D. Hankla	J.O. Moynahan	D. Hankla

WHILE WE MAY have come a long way in our knowledge of Canada geese since 1940, what we still don't know is hurting us as we strive to increase the size of the population and to better distribute the opportunity for birdwatching and hunting. Two major tools are available to the goose manager: habitat acquisition and manipulations, and hunting regulations. The problem, as Crissey sees it, is to collect information which can show us how to focus our tools effectively on the attainment of our two-pronged objective.

At the outset, Crissey makes a point of the fact that geese are not just "big ducks," and hence that they require unique research and management approaches. For example, the basic management unit for Canada geese, Crissey suggests, is the individual winter concentration. He is not sure annual breeding ground surveys would be worth the logistical effort. He is confident, however, that the annual goose kill ordinarily is directly related to duck stamp sales; that is, the more duck hunters afield, the greater the exposure of geese to opportunistic shooting—except where a permit/quota system is in effect. What we need to have, he says, are breeding, migration, and wintering population dynamics data based on "hard" research.

Against this background Crissey calls for (1) better fall and winter counts, (2) better surveys of kill size and distribution, (3) surveys to measure age ratio in the kill, (4) a preseason banding program, and (5) a postseason banding program.

Crissey concludes that because Canada goose breeding habitat is under-stocked and because about all that Canada geese require the balance of the year is a 5-acre pond and waste grain, it ought to be possible to have a harvestable flock of Canadas just about anywhere in the United States we want, provided we collect enough data, analyze it effectively, and apply the guidelines efficiently.

14

INFORMATIONAL NEEDS FOR CANADA GOOSE MANAGEMENT PROGRAMS

Walter F. Crissey

WHAT DO WE need to know in order to adequately manage Canada geese? The answer to this question depends in fair measure on what we are trying to accomplish. A review of flyway management plans and management programs currently underway reveals that there is general agreement on two objectives:

1. To increase the size of the Canada goose populations.
2. To manage the birds to better distribute the opportunity for harvest within and among states and provinces.

Of particular importance, at least in the Atlantic and Mississippi Flyways, is management aimed at increasing the number and size of concentrations wintering in the Deep South since these concentrations hold the key to the most desirable pattern of migration and, consequently, the distribution of harvest opportunity. Perhaps of equal importance is management to prevent northern states from taking all of the harvestable surplus.

Inherent in these objectives is the philosophy that Canada geese are being managed for the benefit of people. Although benefit is obtained both from bird watching and hunting, the discussions in this paper are confined mostly to recreation provided by hunting. It is assumed that if a good job is done of increasing the number of birds and distributing them for hunting, people who enjoy seeing the birds will benefit as well.

Two of the major tools available for managing Canada geese are (1) habitat acquisition and manipulations, and (2) hunting regulations. The problem, then, is to collect information which will lead to discovery of methods for using these management tools efficiently for attaining the objectives.

Nature of the Problem

Before presenting a recommended list of data-collecting programs, it seems appropriate to attempt to develop a current perspective of what the problem is all about. To begin with, it appears to me there is a tendency for some people involved with waterfowl management to apply the same management principles to geese as they do to ducks. I believe the two groups of species are not alike in several important ways and present different management problems as a result. For example, geese migrate in family groups, while ducks do not. This difference has many ramifications. Adult geese lead their young to a particular wintering area and there is a strong tendency for the young to return to the same area in subsequent years. Also, banding data demonstrate that in following years most of the birds stop at the same places enroute south as they did with their parents. The significance of this from a management standpoint is that, for geese, each wintering area is a self contained unit to a much greater extent than is true for ducks. A duck wintering area can be overshot, and immature birds will volunteer to the area the following year. On the other hand, young geese are being lead by their parents and are not free to be attracted to an area where a vacuum, so to speak, has been created by excess harvest.

There has been a marked reduction or elimination of some wintering concentrations during the past

decade, particularly in the south, during a period when the overall Canada goose population was increasing. There are two possible reasons for these decreases. Current thought is that development of attractive habitat in the northern portions of the wintering grounds has "shortstopped" birds that had wintered farther south in prior years. Another possibility is that most of the harvestable surplus associated with southern wintering concentrations has been removed as the birds migrated through northern areas. When what appears to be no more than a reasonable kill was taken after the birds reached their southern wintering areas, the combined kill north and south probably resulted in a total mortality which exceeded production, and the number of birds declined. It is possible, of course, that reduction or elimination of some southern concentrations has been due to a combination of shortstopping and overshooting (Hankla and Rudolph, 1967).

Two situations are worthy of examination. During the early 1950's most of the Canada geese at Swan Lake National Wildlife Refuge in north central Missouri migrated southward late in the season and wintered mostly in western Louisiana and eastern Texas (Vaught and Kirch, 1966). The kill at Swan Lake was rather closely controlled to keep it within allowable limits. For several years a quota of 20 percent of the peak fall flight was established as the allowable bag. During the period when there was a strong southward migration from Swan Lake, up to 25 percent of the band recoveries of birds banded at Swan Lake was taken in states to the south. Another 25 percent, approximately, was taken north of Missouri, and the remaining 50 percent came mostly from the vicinity of Swan Lake.

Quite rapidly the wintering population at Swan Lake built up and band recoveries south of there have decreased essentially to zero in recent years. If 20 percent of the population was bagged at Swan Lake and crippling loss is considered, then the loss due to shooting in the vicinity of Swan Lake must have totaled 25 to 30 percent, at least. Band recoveries suggest that this was about half of the total loss to hunting suffered by the population. It is not hard to visualize that the population unit wintering in Texas and Louisiana had its harvestable surplus removed before the birds left Swan Lake. The additional harvest south of there was more than the Louisiana-Texas unit could withstand. On the other hand, the segment of the population that remained at Swan Lake increased because it was not subjected to additional kill. The rate of decrease of the southern unit and the rate of increase of the Swan Lake unit is such that probable differences in harvest and/or mortality rates could explain most of the change. Shortstopping at Swan Lake may have been involved but it need not have been an important factor to account for what happened.

The situation at St. Marks National Wildlife Refuge in northwestern Florida is similar to Swan Lake in several respects and different in others. Recoveries of birds banded at St. Marks revealed that two migration routes supplied birds to the refuge. One group of birds came in via the eastern portion of the Mississippi Flyway, while the other arrived via the Atlantic coast. During the period when St. Marks enjoyed wintering populations of more than 20,000 Canada geese, harvest rates in the vicinity of the refuge were quite high, perhaps 20 percent of the wintering population. Beginning in about 1957 a steady decrease in population began which leveled off around 1963 at about 6,000 to 7,000 birds. Following the decrease in population at St. Marks, all northern recoveries of birds banded there have been taken along the Atlantic coast. Thus, it is obvious that the birds migrating south via the Mississippi Flyway were either eliminated by overshooting or were shortstopped at such locations as Wheeler Refuge in Alabama. Again, an examination of the proportionate distribution of band recoveries combined with magnitude of kill in the vicinity of St. Marks suggests that a harvest rate existed which it is doubtful the population could withstand.

Another situation which relates to the problem is the recent change in distribution of kill associated with the Tall Grass Prairie Population of Canada geese (Brazda and Pospichal, 1966, unpubl.). Prior to about 1956 the bulk of the harvest of this population was taken in the Central Flyway between Sand Lake, South Dakota, and southern Texas. Beginning in about 1956 the kill of these birds has been increasing in North Dakota. Since 1965 it is estimated that nearly half of the total harvest of this population has been taken in North Dakota. This is a new harvest area for these birds. Although the proportion of the kill in southern states has decreased, the additional kill in North Dakota has not yet been compensated for by a sufficient decrease in southern areas and the total population appears to be declining.

The conclusion seems inescapable that the basic management unit for Canada geese is the individual winter concentration. This is true even though part of the problem of managing these concentrations may involve shortstopping at other wintering locations further north and/or control of harvest in northern migration areas.

If the individual wintering concentration is the basic management unit, is it feasible to obtain information concerning population status by means of breeding ground surveys? In my opinion, the answer is "no" insofar as the many small concentrations are concerned. For some of the larger concentrations, such as the Mississippi Valley Population, an annual breeding population and production survey may be possible. There is question, however, as to whether such a survey is worth the effort.

Several characteristics of Canada geese relate to the question concerning the need for a breeding ground survey. First, some breeding areas are known to supply birds to more than one wintering area (MacInnes, 1966). Since geese migrate as family groups, the distribution of young from a given breeding area supplying more than one wintering area can change as the survival of birds in the two or more wintering areas varies. The population in one wintering area might be increasing while it was decreasing in another and both changes might be of management significance. If the increase balanced the decrease, and if the populations in both wintering areas came from the same breeding area, these changes could not be detected by surveying the breeding area. Also, in the final analysis, we

are interested in the vicissitudes of a large number of wintering concentrations of Canada geese, many of which number less than 5,000 birds. Even if there were no mixing of birds from various wintering concentrations on the breeding areas, the problem of sorting out the specific breeding locations of each of the many concentrations and then conducting meaningful surveys relating to each does not seem to be economically feasible.

Second, Canada geese have a low production rate as compared to most ducks. Most Canadas do not nest until their third year. As a result, young birds usually make up a lesser portion of the fall flight than is true for a species such as the mallard and variations in production success have a lesser influence on size of fall flight. Also, Canada geese seem to have a different pattern of production than do most ducks nesting in the prairies. Prairie nesting ducks are subject to prolonged periods of either wet or dry conditions which means that several years of good production may be followed by several poor years. In contrast, Canada geese nest primarily in northern habitat not affected by periodic drought. Storms, low temperatures, late spring break-up and flooding seem to be the major adverse factors. Production rates can vary sharply from year to year but it is unusual for more than 2 poor years to occur in succession. With geese it appears that a poor year is as likely to be followed by a good one as another poor one. As a matter of fact, a poor year production-wise has a better than even chance of being followed by one with a good rate of increase. This is so because, following a poor year, a larger proportion of the remaining population is adult and eligible to breed.

Third, once a Canada goose is fledged, natural mortality appears to be very low. For those concentrations where sufficient data are available, such as the Mississippi Valley and Arkansas Valley concentrations, it seems possible to account for most of the annual losses either as birds bagged or crippled. It appears that among some of the more heavily shot concentrations annual loss due to natural causes may be as low as 10 percent of the fall population. From a practical standpoint, the low rate of natural loss means that birds not harvested one year will likely be available for harvest in following years. Underharvest in a given year is not a serious management error.

Another problem area related to the potential value of a breeding ground survey is the need for current information concerning expected size of fall flight on which to base annual hunting regulations. If breeding ground survey data are of value, this occurs only for those populations or concentrations where kill is actually being controlled by the regulations that are established. This appears to be so at such locations as Horicon, Horseshoe Lake, and Swan Lake, and perhaps at some locations in the west.

In many parts of the country Canada geese respond to hunting regulations much differently than do most ducks. For example, Table 64 presents the Canada goose hunting regulations for the Mississippi Flyway for the period 1956 through 1966 together with the estimated kill, the estimated wintering population and the number of duck stamps sold in the flyway. There appears to be little relationship between number of birds killed and either the size of the population as determined by the winter survey the following January or the shooting regulations that were established. There is, however, a suggestion that a relationship exists between number of people buying duck stamps and the number of Canada geese killed (Fig. 25). Although this relationship is significant at the 1 percent level of probability, there may be some question about cause and effect because the two sets of data are not independent.

In the Mississippi Flyway the number of duck stamps sold has varied during the past decade from a high of 1,023,000 in 1956 to a low of 412,000 in 1962. The obvious reason for variation is hunting regulations for ducks. They were liberal in the mid-1950's and very restrictive in the early 1960's. An examination of related information supports the idea that this wide fluctuation in number of hunters afield has had considerable influence on Canada goose kill, irrespective of either the shooting regulations designed specifically for geese or the supply of birds available. First, it has been known for some time that a summation of kill at known harvest areas such as Horicon, Horseshoe Lake, Swan Lake, etc., usually totaled no more than about half of the estimated Canada goose kill throughout the flyway. Two factors are involved. First, kill at the recognized shooting areas often was larger than estimated. Second, there is considerable evidence of a widespread kill, probably taken from scattered flocks during migration by duck hunters. It is my opinion that the more duck hunters afield, the greater the exposure of Canada geese to what I would class as an opportunistic type of harvest.

When an individual is primarily hunting for ducks or other game, it is probably unusual for him to take more than one goose in the course of a year or to kill geese regularly year after year. It follows that restrictive or liberal goose hunting regulations, unless the season is very short, will not likely have a material effect on increasing or decreasing "opportunistic" kill. If opportunistic kill is a significant part of the total kill, then adjustment of season length in the 70-day bracket, or bag limits in the 1 to 3 bird bracket, will have small effect on number of birds taken.

It is important to note that the majority of Canada goose populations across the country have reached peak populations during the period when duck shooting regulations were most restrictive and duck stamp sales were sharply down. It is possible that this is a chance relationship but the odds appear to favor the idea that the increase in goose populations was the result of a decrease in kill related to fewer waterfowl hunters afield.

There are two additional aspects of shooting regulations which should be kept in mind when deciding on informational needs. The first is the difference between adults and young in vulnerability to shooting. At Swan Lake, Vaught and Kirch (1966) found that immatures were about twice as vulnerable to shooting as adults throughout the season but vulnerability changed as the season progressed. During the first 5 days, immatures were 4.4 times as vulnerable

TABLE 64. Canada Goose Statistics From the Mississippi Flyway, 1956-1966

Year	Bag and Possession* Limit	Season Length*	Framework Dates	Duck Stamp Sale	Estimated Bag	January Survey (Following)
1956	2-2	70	Oct. 1-Jan. 15	1,023,000	178,000	327,000
1957	2-2	70	Oct. 1-Jan. 15	1,004,000	163,000	320,000
1958	2-2	70	Oct. 1-Jan. 15	932,000	213,000	339,000
1959	2-2	70	Oct. 1-Jan. 8	708,000	140,000	257,000
1960	2-2	70	Oct. 7-Jan. 8	747,000	115,000	345,000
1961	2-2	60	Oct. 1-Jan. 8	528,000	107,000	334,000
1962	2-2	60	Oct. 1-Jan. 13	412,000	81,000	435,000
1963	2-2	70	Oct. 1-Jan. 15	572,000	106,000	422,000
1964	2-2	70	Oct. 1-Jan. 15	663,000	148,000	445,000
1965	2-2	70	Oct. 1-Jan. 15	636,000	140,000	381,000
1966	2-2	70	Oct. 1-Jan. 15	759,000	153,000	482,000

*There are basic flyway regulations. There have been shorter seasons and smaller bag limits in several states or portions of states during the period.

as adults and were 3.8 times as vulnerable during the first 10 days. Hanson and Smith (1950) found that immatures were 8.3 times more vulnerable to shooting than adults at Horseshoe Lake in 1943. It is apparent that vulnerability of the population to shooting decreases considerably during years when production is poor and only a small percentage of the fall flight is immature. To a degree, therefore, adjusting kill to changes in size of fall flight is self-regulating.

Second, it has become obvious in recent years, particularly in northern areas, that by establishing rest days and/or limited shooting hours, Canada geese can be induced to remain in an area longer than they might stay otherwise and be more vulnerable to shooting at the same time. It may seem odd that kill can be increased by reducing the number of shooting days or hours but this seems to be the result if the proper pattern of rest periods is established. It is my opinion that the much publicized problem at Horicon began with the application of the rest-period principle. The recent increase in harvest in North Dakota was brought about by half-day shooting and establishment of closed "rest areas" (Schoonover and Reeves, 1966). I think it is obvious also that it has proven easier to increase vulnerability and kill in a northern area than it has to decrease it.

Finally, it is obvious that problems about which we need information involve breeding, migration, and wintering habitat. One of the objectives of the program is to discover methods for managing the distribution of harvest among states. One tool for accomplishing this is acquisition and development of habitat along migration routes and on the wintering grounds where protection and food are provided.

The potential amount of migration and wintering habitat appears to be unlimited in relation to the probable number of Canada geese that will ever exist. Based on the situation at such locations as Jack Miner's Sanctuary in Ontario, Gaddy's Pond in North Carolina, and even Horseshoe Lake, it is obvious that practically any body of water more than 5 or 10 acres in size located in a rather wide variety of agricultural land and along or near a migration route has a potential carrying capacity for several thousand Canada geese. The existing number of such sites is very large. The problem is, first, to get birds to use a desirable location and, second, to manage the overall situation so that a harvestable surplus exists in the flock at the new location.

Getting birds to use a new location is not easy, particularly in the south, but with patience it can usually be accomplished with (1) transplants and/or decoy flocks; (2) protection from shooting and other disturbance; (3) habitat development; and (4) possibly making related areas less attractive. However, having a flock in a desirable location and being able to take a reasonable harvest in the vicinity may present problems more difficult to solve. For example, if the harvestable surplus has already been taken before the birds arrive at the area in question, then it may be possible to maintain a flock in the desirable location but the birds can only be looked at and not

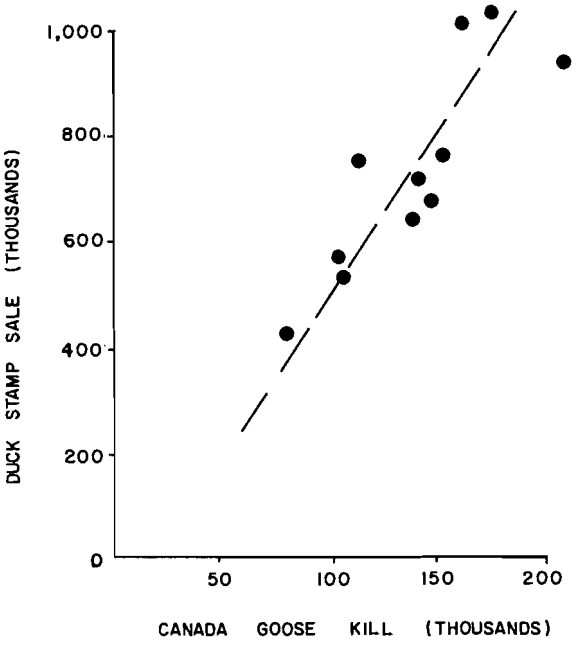


FIGURE 25. Relationship between duck stamp sale and Canada goose kill in the Mississippi Flyway, 1956-1966.

shot. Related to this is the probability that development of a concentration along a migration route in a northern location with no wintering potential will result in a harvest which must be subtracted from the number of birds that would otherwise have been available farther south. The situations that exist between Horicon and Horseshoe Lake and between North Dakota and farther south in the Central Flyway are good examples. Northern states with neither breeding nor wintering potential are certainly entitled to share in the harvest of the resource. The problem is to arrange for this share to be equitable.

What about breeding habitat? From the vantage point of an airplane flying at 100 feet, I have seen a large portion of the Canada goose nesting habitat in North America. It is my opinion, which is shared by others, that considerably greater numbers of Canada geese could nest successfully in this vast area. Substantiation of this opinion is provided by production rates that have remained high in spite of the peak populations recorded in recent years. This means that increasing numbers of adults are still able to find places to breed successfully. It is difficult for humans to view breeding habitat adequacy through the eyes of a goose. In the final analysis it may be that a measure of the capacity of Canada goose breeding habitat will be obtained only from age ratio data which will reveal a lowering of average production rates when the breeding area is overstocked. This will require a trial and error approach and will take considerable time. In the meantime a management policy based on the assumption that breeding habitat is understocked seems to be quite logical.

Recommended Surveys

With these considerations in mind, what information do we need in order to meet the objectives? In my opinion, the following annual surveys should be adequate:

1. A periodic fall and winter census: In general, it seems to be agreed that the present distribution of Canada geese leaves something to be desired. Various steps are being taken to improve this distribution. Obviously a determination of the number of birds by time and place during the fall and winter is a necessary prerequisite both for planning what needs to be done and for evaluating correctional programs.

Periodic fall and winter censuses ending with the annual winter survey have been or are being conducted with varying degrees of intensity in all four flyways. A review of data from these surveys reveals a degree of irregularity from one coverage to the next or from year to year which suggests either a lack of sufficient coverage or inaccurate estimates of the number of birds present in areas of concentration. Experiences such as occurred in California in January 1966 suggest that under a condition which causes the birds to scatter our surveys are not sufficiently intensive to obtain an accurate estimate. In January 1966 a rainy period caused the foothills east of the Central Valley in California to become green much earlier than usual. This new grass apparently attracted large numbers of geese which split up into small groups as they moved into the foothills. Goose counts the previous year and the following year using standard census techniques demonstrated that this scattering of geese reduced the 1966 January count perhaps by as much as 50 percent. It appears, therefore, that research to improve Canada goose census techniques is needed.

2. A survey to measure size and distribution of the kill: By reason of the need for understanding the mortality factors associated with individual goose flocks, it is important that a kill survey be conducted which yeilds reasonably accurate measures of kill for at least major harvest areas within states. Also, when kill estimates are combined with estimates of rate of kill obtained from banding data, it is often possible to calculate the size of the population from which the kill was taken.

It is judged that the mail questionnaire survey conducted by the Bureau of Sport Fisheries and Wildlife is the most efficient method of obtaining kill statistics. There is question, however, as to whether the survey is conducted with sufficient intensity to measure goose kill by areas within states, particularly when kill is concentrated in a small area.

3. A survey to measure age ratio in the kill: In order to determine the population dynamics of the various flocks, it is necessary to know production rates as well as mortality rates. Experience has shown that it is difficult or impossible to do this with breeding ground surveys directly. A more feasible approach is to measure the ratio of adults to immatures in the fall population. One method of accomplishing this is to measure the ratio of adults to immatures in the kill by hunters and then to adjust this ratio by the difference in likelihood that one age group will be taken by hunters at a greater rate than the other. A measure of the difference in likelihood

of being shot can be obtained by comparing first hunting season recovery rates from adults and immatures banded immediately prior to the season.

Age ratio in the kill has been determined by examining birds in hunters' bags and by supplying envelopes to hunters preseason with a request that they furnish the tail-fan from each goose they shoot. Each system has limitations. It is difficult to collect bag check data in a representative manner. Tail-fan collections seem to provide usable data in the Atlantic, Mississippi, and portions of the Central Flyways. In parts of the Central Flyway and in the Pacific Flyway, the data are difficult to interpret. Of the methods used so far, it is judged that the tail-fan collection survey shows most promise, although further research is indicated and there may be need for an entirely new method, at least in the Pacific and parts of the Central Flyway.

4. A preseason banding program: In addition to providing a measure of the difference in vulnerability of adults and immatures to shooting, recovery data from preseason banding provides a basis for estimating mortality rates for both age groups. The problem is to find locations where the preseason banding can be done in such a manner that at least the major populations are sampled. Preferably, all birds banded during the preseason period should be flying birds.

5. A postseason banding program: A major problem is to determine the time and the place where the birds associated with each wintering concentration are harvested. This can be accomplished in part with recoveries from postseason banding of birds in each of the wintering concentrations. Recoveries during following hunting seasons will yield a comparative measure of the distribution of adult harvest. The distribution of the harvest of immatures will be related to the distribution of adult harvest but there is reason to believe that a higher portion of the immature harvest will occur earlier and northward. Also, postseason banding provides essential information on annual mortality rates and harvest rates.

A determined effort should be made to seek out all wintering concentrations of Canada geese numbering 500 birds or more and band a sample of each concentration. Until recently, trapping techniques made it feasible to band only when fairly large numbers of birds were involved. The development of drug techniques for catching geese hopefully will make it possible to band significant samples of smaller population units.

Discussion

The greatest informational need for management of Canada geese today, in my opinion, is data leading to an understanding of the population dynamics of individual wintering concentrations, particularly those in the South. Understanding mortality, particularly hunting mortality, is a must. This cannot be accomplished without postseason banding. Among other things, postseason banding reveals when and where harvest of at least the adult segment associated with a given wintering concentration occurs. For example, according to personal notes taken during the Atlantic Flyway Council meeting in Easton, Maryland on August 3, 1967, Dale Crider, Florida waterfowl biologist, has determined from distribution of band recoveries from postseason banding at St. Marks Refuge in Florida that in recent years most of his northern recoveries have been coming from Delaware and Maryland prior to about November 15. He made recommendations to the Council that Canada goose seasons in Delaware and Maryland be delayed until after mid-November so as to allow birds enroute to Florida to move through these two states before shooting began. His request was not accepted by the Council due to an argument that lack of shooting until after mid-November would encourage additional "shortstopping" and might decrease further the traditional migration of Canadas to wintering areas in Florida. It is my opinion that birds enroute to Florida will go there without being driven by gunfire and within a reasonably predictable period of time. This, however, is only an opinion. I am also of the opinion that if southern wintering populations are dependent on birds being driven southward by disturbance caused by gunfire, the future of these southern populations is bleak. I suggest that developing an understanding of the population dynamics of southern wintering flocks, through banding and improved population surveys, be placed high on the research priority list.

Another item of great importance is improvement in our ability to adjust harvest by means of appropriate shooting regulations. Obviously flyway-wide shooting regulations have had little effect on size of the kill. Limiting the kill in the vicinity of the Horicon National Wildlife Refuge to a predetermined quota has so far been both difficult and expensive. Perhaps a tag system, such as the one used during the 1967 season, is the only solution. If it becomes necessary to expand the tag system to very many areas in order to keep the kill within desirable limits, the cost will be very high.

I recommend that the situation at the Horicon National Wildlife Refuge be studied very critically. For reasons not clearly understood the birds associated with the refuge have lost much of the wariness which makes the Canada goose so desirable as a game bird. Perhaps the cause is overuse of rest periods, or perhaps it has something to do with either the size of the refuge or the way it is managed. Related to this is the need for discovering ways of reducing the size of the concentration at Horicon. Also, there is need to develop methods for keeping future concentrations from increasing beyond about 50,000 birds.

Summary

The Canada Goose is, I believe, the waterfowl species most likely to supply hunting recreation far into the future. Breeding habitat for this species is present in large quantities and appears to be understocked at the present time. Most of this habitat is located in a part of the continent not likely to be disturbed by man's activities and management is not required to maintain either quantity or quality. The problem seems to be one of controlling harvest rates

so that an appropriate breeding stock is returned northward each year.

During the migration and wintering periods about all that Canada geese seem to require is a pond of water 5 or more acres in size surrounded by agricultural land where the birds can either graze or feed on waste grain. The number of potential sites is very large; the problem is to get the birds to use them. I would like to think that it is feasible to have a harvestable population of Canada geese practically anywhere in the United States that management objectives dictate. I believe that collection and analysis of data from the five data collection programs that were recommended will provide information necessary to accomplish this.

A Case Study

THE STORY of the Mississippi Valley Canada Goose Population in the past 30 years includes one of the brightest chapters in the history of wildlife management—and one of the darkest. On the one hand, we have brought the birds back from a low of 50,000 to an estimated peak of 300,000. On the other hand, we have shot more geese in one short span at one spot than were taken that year in the rest of the whole flyway. The volume of birds, alive and dead, has been exceeded only by the volume of birdwatchers who produce Sunday traffic jams around one refuge, by the volume of excited newsprint and letters to legislators, by the anguished cries of farmers scorned and hunters restricted, and by the hours spent by technical people wrestling with what may well be one of the country's most perplexing game problems.

While the story of the Canada goose in the Mississippi Valley is to some extent atypical, one over-riding generalization emerges from this case history: that geese and people are a lot alike, and you can't manage one without managing the other.

Like people, geese are flexible, versatile creatures. They will nest, for instance, on trees, banks, sand bars, haystacks, islands, cliffs; in meadows, tundra, marshes, muskeg. Their migration routes are unallayed by desert, mountain, or megalopolis. And their wintering grounds may be a remote swamp or a municipal park. Both species can learn to adapt. When its original Mississippi River sandbar haunts became overrun with brush and hunters, the Valley Population funneled into Horseshoe Lake. The hunters followed. Although wild honkers normally have an aversion for tall vegetation of any type, they have learned to feed in standing corn. To help them out, goose managers have learned to plant stunted varieties.

At the same time, both people and geese have certain minimum habitat requirements that must be met, if life, liberty, and happiness are to be achieved. For neither species are we absolutely sure in detail what these thresholds of survival are. We do know that both species respond to what may seem like relatively simple habitat manipulations, but neither the direction nor the intensity of change can always be predicted with any certainty. For example, when the federal and state governments created a 30,000-acre refuge at Horicon, Wisconsin, the aim was to salvage ducks. Nobody dreamed it would one day accommodate 150,000 Canadas. But it has. Likewise, changes in waterfowl season lengths and bag limits can produce perverse swings in the number of hunters who purchase migratory bird stamps.

It is in their times and places of stress that geese and people are the most alike. When abnormal numbers of geese and hunters are crowded into comparatively circumscribed areas, strange things take place in both species. The geese tend to lose their traditional caution. What ought to be the proverbial "wild goose chase" can become a shooting gallery situation. Hanson even postulates that the visual stimulus of massed flocks and the accelerated social conflicts associated with crowding have a depressive feedback on the endocrine system which, in turn, suppresses reproduction the following spring. Hunters at "inner-core" areas likewise fall victim to a mob psychology. Denied the normal rituals of the waterfowler, they concentrate not on more fun per gun but on more birds per trip. The juveniles of both species seem particularly prone to the effects of over-population. It is not too much to speculate that the Horseshoe Lakes and Horicons of the country may actually be producing new strains of birds and shooters with unattractive characteristics. Certainly Williams is right when he suggests that when, in both geese and humans, native traits become too greatly modified by pampering and crowding, something of real value is lost.

Fortunately, the Mississippi Valley story suggests that the "cure" for the problems of both Canadas and hunters is symbiotic: a system of traffic controls that will regulate the impact of the two species on each other. The activities of geese and hunters must be more widely dispersed in time, place, and intensity. We probably have the esthetic sense and the ecological knowledge to do this now. What is lacking is the economic commitment and the political savvy.

A CASE STUDY IN CANADA GOOSE MANAGEMENT: THE MISSISSIPPI VALLEY POPULATION

Henry M. Reeves, Herbert H. Dill and Arthur S. Hawkins

SELDOM, IF EVER, has wildlife been subjected to a greater variety of management efforts than have geese of the Mississippi Valley Population. Various management techniques and special regulations have been tried. Some have proven successful; others have failed. The basic principles in Canada goose management are involved in this case history; therefore, the story of these geese is told in the following pages.

For over three decades, problems associated with the Mississippi Valley Population have plagued management biologists and administrators in the central corridor of the Mississippi Flyway. In fact, if judged by volume of newsprint, correspondence with legislators, and the hours spent by game managers in meetings relating to hunting regulations, the perplexities posed by these geese seem unequalled by any other species of game!

The traffic jams every nice Sunday during the fall or spring on Highway 49 where it transects Horicon National Wildlife Refuge attests to the great popularity of the honker among nonhunters. But most of the problems which we shall discuss are related directly or indirectly to harvesting these birds, which are the most hightly prized of all the waterfowl of the flyway.

With the decline in numbers of ducks in the Mississippi Flyway from 1956 through the following decade, the sale of waterfowl hunting stamps declined about 26 percent (Table 65). But in Wisconsin, duck stamp sales declined only 17 percent. In Illinois during this period, sales fell off 47 percent! Because both states are favored with large numbers of ducks and geese in the fall, this suggests that more people in Wisconsin actively participated in goose hunting than in Illinois. This statement is further supported by the fact that more than 45,000 applications for Canada goose hunting permits were received by the Bureau in 1967 from Wisconsin hunters. In both cases, it appears that most duck stamp buyers are potential goose hunters and that the Canada goose is of major interest to all wildfowlers.

The following account of the Mississippi Valley Population of Canada geese has been placed in chronological order, but with greater emphasis on more recent years as management problems intensified.

Original Status

Our knowledge of the original size and distribution of the Canada geese now referred to as the Mississippi Valley Population is incomplete. Hankla and Rudolph (1967) attempted to consolidate early records of Canada geese in southern states, especially along the lower Mississippi River and the adjacent Gulf Coast. Their studies, and reports of others (Hanson and Smith, 1950; Crider, 1967), substantiate the fact that scattered wintering populations of Canada geese, totaling tens of thousands, existed over wide areas in the south as late as the turn of the century. Since this period predates the development of flyway concepts, integrated censuses, and most important, banding or marking programs, it is impossible to identify migration routes of these overwintering geese in the south. It is agreed,

TABLE 65. Statistics on the Principal Canada Goose Areas of Illinois and Wisconsin

County	Area (Square Miles)	Human Population 1950	Human Population 1960	Cropland Acreage – 1965 Corn	Cropland Acreage – 1965 Soybeans	Cropland Acreage – 1965 Total Cropland	Duck Stamp Sales 1956	Duck Stamp Sales 1967
Wisconsin								
Dodge	892	57,611	63,170				131,101	108,833
Fond du Lac	724	67,829	75,085					
Totals	1,616	125,440	138,255	124,100	4,200	1,034,000	Percent Change: -17%	
Illinois								
Alexander	224	20,316	16,061	13,300	22,900		125,185	66,180
Union	414	20,500	17,645	25,800	10,700			
Jackson	603	38,124	42,151	44,700	35,400			
Williamson	427	48,621	46,117	12,300	13,000			
Totals	1,668	127,561	121,974	96,100	82,000	1,067,200	Percent Change: -47%	
Mississippi Flyway							1,019,145	756,768
							Percent Change: -26%	

however, that most of these wintering concentrations dwindled, and larger midflyway wintering flocks have appeared.

Two theories seek to explain these changes. One asserts that these shifts in wintering areas occurred simply because the southern population was overharvested. The northern populations had mortality rates lower than productive rates; therefore, they increased. The second postulates that improved habitat in the north, created by the production and harvest of corn and other grain, simply intercepted geese migrating farther south to traditional wintering areas. It seems reasonable that both explanations, when combined, account for the shifts in overwintering populations. Generally speaking, we did not recognize manageable goose populations until the flyway management concept evolved, goose banding was initiated, and national and state wildlife refuges were established in the 1930's.

Through the pioneering efforts of Hanson and Smith (1950), the results of early banding were analyzed. This included bandings by Jack Miner near Kingsville, Ontario. The theory of managing definable populations of Canada geese resulted from this work. This study showed that the Mississippi Valley Population nested in the Hudson Bay Lowlands of Ontario from the south end of James Bay north and west to about the Manitoba border (Fig. 26). The migration route extended southward to central Iowa and northwestern Ohio, narrowing to the junction of the Mississippi and Ohio Rivers, and continued southward along the Mississippi River to its delta and a short distance westward along the Gulf Coast. Another population of Canada geese to the west was termed the Eastern Prairie Population. Canada geese to the east were named the Southeast and South Atlantic Populations; in recent years, much of the Southeast Population has been included in the Tennessee Valley Population. Band recovery data indicate varying degrees of overlap between these management populations.

Geese of the Mississippi Valley Population typically consist of the Todd's or interior Canada goose, Branta canadensis interior, although geese of other subspecies are intermixed. Within the migration and wintering areas described are scattered populations of giant Canada geese, Branta canadensis maxima; however, these usually do not mix with those of the interior subspecies.

Exploitation

Regulations during the early period of Canada goose abundance were lenient, or nonexistent, and countless birds were transported to markets for sale. Hawkins (1941, unpubl.) relates the following information concerning early distribution and commercialization of Canada geese in southern Illinois:

> It is possible to partially reconstruct the status of the "honker" in Alexander County during the nineties due to the recollections of old goose hunters.
>
> Mr. Emil Lieb, a market hunter, found it profitable to hunt along the sand bars between Chester, Illinois, and Wolf Island, Missouri, a river distance of about 75 miles. The bars

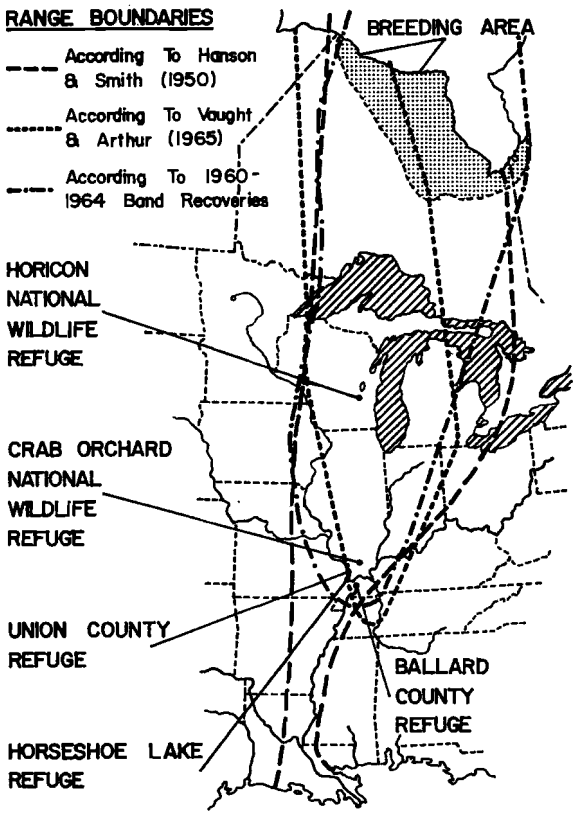


FIGURE 26. Range of the Mississippi Valley Population of Canada Geese.

between McClure and Cairo, however, offered the best shooting. In marked contrast to their highly concentrated range today, the range of the geese in the nineties was widely dispersed.

Some idea of former goose numbers can be obtained from the statement of Mr. Lieb that he and two partners in the market hunting business during 1895 killed 2,280 geese, as high as 50 geese a day. Mr. Edwin Halliday had this to say concerning goose numbers in 1895, "Wild geese were hanging in front of every market and even in front of restaurants along and near 8th Street in Cairo. As the weather was turning warm, the storekeepers were trying to dispose of the geese. I recall one price tag said forty cents. All the hotels had geese too." The old timers agree that there were more wintering geese then, than now.

Even after the passage of the Migratory Bird Treaty Act in 1918, the goose season extended 107 days, from September 16 to December 31, in the central portion of the Mississippi Flyway, and in the southern portion, from November 1 to January 31. The allowable daily bag of 8 and no possession limit, did little to restrict the kill although commercialization for the market was prohibited. Baiting and the use of live decoys was permissible, and these practices were widely used. Lenient regulations remained in effect until 1929 when the daily bag was reduced to 4 and an 8-bird possession limit was imposed. This seems to be the first federal regulation toward restricting the harvest. In 1935 and 1936, the seasons were shortened to 30 days and baiting and decoys banned. No doubt this was because of the shortage of ducks more than for any special concern for geese. In 1935, the Canada goose bag and possession limit was reduced to 4; the season was shortened to 30 days.

In 1936, the first attempt to census the wintering population of Canada geese was attempted in what is now the Mississippi Flyway. The total recorded was 47,510 (Fig. 27). It seems likely that this and subsequent early censuses represented minimum populations because of incomplete coverage. This seems reasonable since the 175,000 censused in 1939, just 4 years later, is biologically unlikely if the 1936 count was indeed correct. The early populations and kills shown are questionable since wide-area census and harvest methods had not yet been developed. Nevertheless, they do represent the best information available, and for that reason have historical significance.

In the early 1940's, it became evident that the number of Canada geese that traditionally wintered in the lower Mississippi Valley and central Gulf coastal area was decreasing. Also, it became apparent that Canada geese that traditionally wintered on the sandbars of the Mississippi River required more habitat. Increasing hunting pressure, channelization of the Mississippi, the discontinuance of floods which scoured the sandbars keeping them clear of brush and trees except willow sprouts which apparently were an important browse item, and changes in cropping from corn to soybeans were important factors in making the area south of St. Louis less attractive to geese (Davis, 1954).

The first deliberate expansion of goose range was in 1927, when the Illinois Department of Conservation purchased 3,500 acres, including Horseshoe Lake, an oxbow of the Mississippi River northwest of Cairo. Previously, only an occasional goose had stopped on the area and its major value was for duck hunting and fishing. Additional land was added and an agricultural program started to produce goose food. Geese were quickly attracted to the area and Horseshoe Lake had its beginning.

While the Horseshoe Lake Refuge served to concentrate geese, it also attracted hunters to its boundaries. Publicity, good accommodations, and high success rates resulted in exceptionally high hunting pressure with resulting heavy kills and crippling losses. The kill mounted as Horseshoe Lake became less capable of providing food and sanctuary for large numbers of geese. Its carrying capacity was soon exceeded and geese became dependent on private lands where selling hunting rights became more profitable than raising crops.

The Horseshoe Lake situation in 1941 was evaluated by Hawkins (unpubl.) as follows:

According to Pirnie (1935), "The primary function of refuges is to save game for breeding stock, not to make it easier to kill more." Horseshoe Lake cannot qualify as a refuge under this definition. However, let us not sit back and point an accusing finger at those who

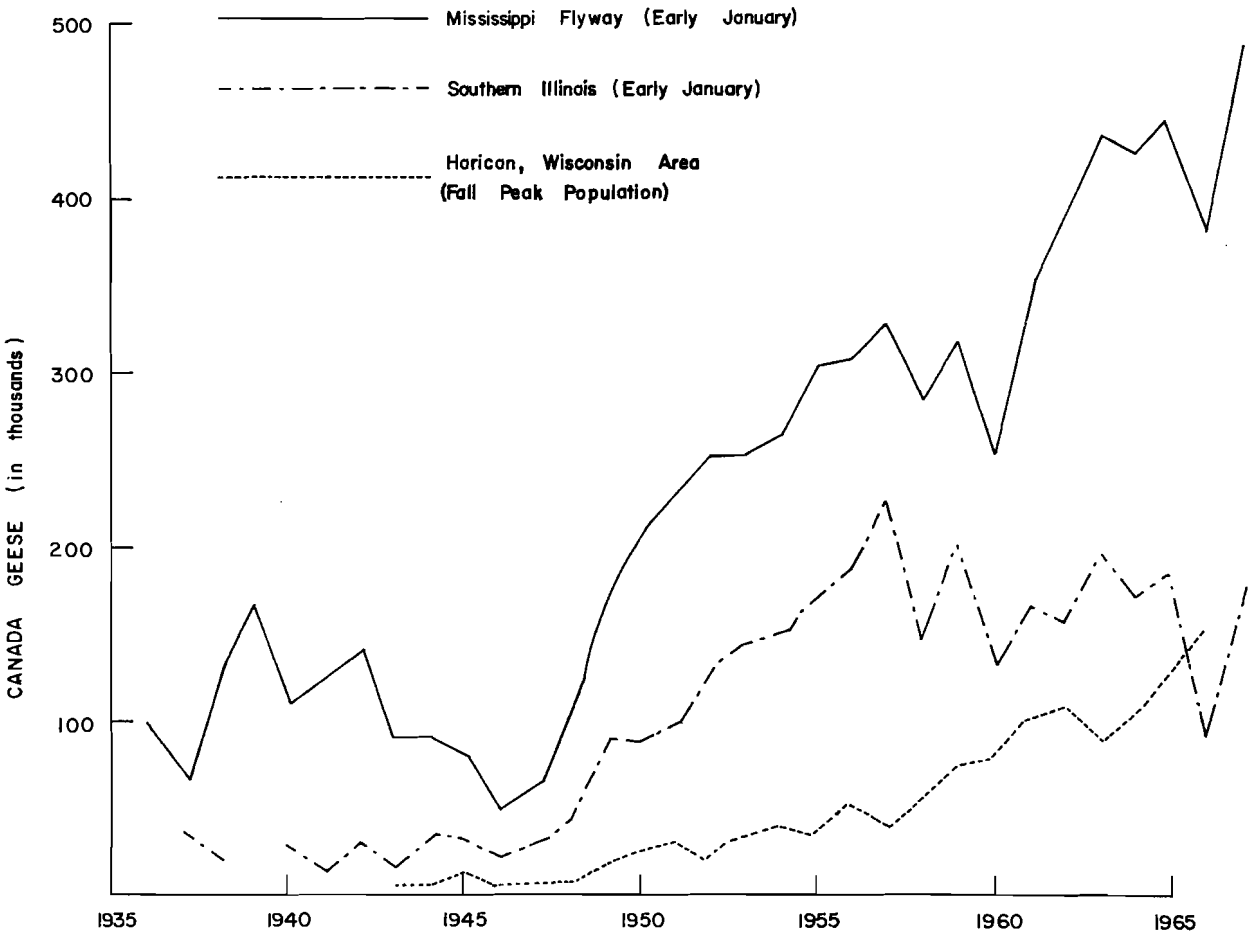


FIGURE 27. Numbers of Canada Geese in the Mississippi Flyway, and the Number of Canada Geese of the Mississippi Valley Population in Southern Illinois and at Horicon, Wisconsin.

originated the refuge. Their idea was a good one, and they should be commended for it. The present critical situation has resulted from a lack of information on how to maintain a true goose refuge, among waterfowl authorities as well as among government administrators. Nor is there any reason why the present so-called "refuge" cannot become a true refuge in the future.

The foregoing shows that the unfortunate goose situation in Alexander County is a problem of concentration. In the first place, it is an hereditary trait for geese to concentrate in or near Alexander County; the establishment of a refuge has intensified this gregarious habit. Secondly, hunters concentrate there because the geese do. The inevitable result is overshooting.

In commenting on quality hunting and increasing hunting pressure in southern Illinois, Hawkins continues:

> One answer to increased hunting pressure was the formation of goose hunting clubs, but since the time of the Egyptian Hunting and Fishing Club, organized in 1904, goose clubs have changed considerably in Alexander County. Present-day clubs, with one or two exceptions, have one function – to make money. In contrast, this first club, which had annual dues of five dollars, was organized to have fun. At one time, it boasted a membership of 50, all local sportsmen. There are at least two dozen clubs in Alexander County today that kill more geese annually than did the Egyptian Club, according to a direct comparison of kill records. The reason appears to be that these early hunters concentrated more on having an enjoyable outing than in bagging a limit with all possible haste, as is the modern philosophy of goose hunting in this area.
>
> Goose hunting first took on a commercial aspect when in 1913 an organization known locally as the "Chicago Millionaires Club" began to lease the sandbars most frequently used by the geese. By 1916 most of these bars were no longer open to public hunting. Up to that time field shooting had been scorned by most real goose hunters. Now that river shooting was largely under the control of a few wealthy men, it was field shooting or nothing.
>
> The purchase of Horseshoe Lake for a refuge in 1927 created a boom in commercialization

of goose shooting. Mediocre farm lands located near the refuge suddenly commanded fancy prices. In almost every field located along the goose flight line between the refuge and the river, pits were dug to make "blinds" for hunters. Some farmers even altered their cropping system to make their farms more attractive to geese. The goose hunting flourished until 1935 when the Federal government drastically curtailed hunting privileges as a measure to conserve our waterfowl resource which as the result of drought and other influences had declined to an alarmingly low point.

Horseshoe Lake became notorious for the goose slaughters that occurred in its vicinity. Public sentiment ran high but the kill continued as commercial interests resisted needed change. A severe population decline was inevitable.

In 1944, the situation became so serious that the Secretary of the Interior closed the goose season in Alexander County after only 21 days of shooting. In 1946, for the first time in history, the entire Mississippi Flyway was closed to Canada goose hunting. These were the first of numerous closures in Illinois and later in Wisconsin. In 1945, a similar closure was effected after only five $4\frac{1}{2}$-hour shooting days, or a total of $22\frac{1}{2}$ hours of shooting. In January 1946, the population of Canada geese numbered but 53,000 of which only 22,000 were located in Illinois. This marked the lowest level for this population ever recorded.

The seriousness of the Mississippi Flyway Canada goose situation is best described by a Department of the Interior news release dated April 4, 1946:

"The flock of Canada geese which winters at the Horseshoe Lake Refuge presents one of the most serious and difficult problems in wildlife conservation at the present time," stated Mr. Day. "The only way to maintain this flock of geese in numbers approximating its present size is to give it absolute protection from shooting for an indefinite period.

"In 1945, when the Fish and Wildlife Service was advised that 2,100 geese were killed during the first two days of shooting, the agency moved promptly to stop the organized slaughter by having the Secretary of the Interior issue a closing order, effective at 4:30 p. m. on November 28, in accordance with the provisions of the Migratory Bird Treaty Act....

"Had the shooting been permitted to continue at that rate," Mr. Day declared, "the entire flock of some 26,000 honkers might have been completely wiped out in a single season. Approximately 275 birds an hour – five a minute – fell to the hunters' guns in the $22\frac{1}{2}$-hour 1945 season, spread over five half days of $4\frac{1}{2}$ hours, from noon to 4:30 p. m. We discovered that on the opening day, from noon to 4:30 p. m., the total kill in that time equalled the total season's kill for 1938, and every day's kill in 1945 exceeded the top day in any previous year.

"Since the controls instituted by this Service and the Illinois Conservation Department have failed to achieve the desired results, the prohibition of shooting for an indefinite period is our only recourse if this flight of Canada geese is to be saved from serious damage or extinction."

Recovery

Public indignation finally resulted in the realization that harvests and management practices must be geared to habitat requirements and reproductive capabilities, even if it required subjugation of powerful economic and political interests not conducive to the welfare of the goose resource (Elder, 1946).

Presidential Proclamation No. 2748, dated October 1, 1947, (12 FR 6521) established an area of approximately 20,000 acres in Alexander County which was closed to goose hunting. Within the area closed were located privately owned hunting clubs which had previously accounted for many of the geese that were shot.

An interesting sidelight to the Presidential Proclamation was a damage suit of $3,000 brought against the government by a group of hunters for loss of shooting rights. On appeal, the 7th U.S. Circuit Court of Appeals, on February 13, 1950, affirmed a lower court's decision by holding that the Presidential Proclamation was constitutional, and that no one had property rights in migratory birds. Furthermore, it declared that the hunting of migratory game birds is illegal except as made legal by Presidential Proclamation; inasmuch as these lands were excluded by Presidential Proclamation, then the plaintiff suffered no loss of property rights (Landsen vs. Hart, 180 Fed. (2nd) 679).

In an attempt to relieve the situation at Horseshoe Lake, the Crab Orchard National Wildlife Refuge was also established in 1947 about 50 miles north of Horseshoe Lake in Jackson and Williamson Counties, Illinois. The large 44,000-acre area contained about 3,500 acres of cropland where food for geese and ducks could be raised. It was hoped that this new area, the first "satellite," would provide additional habitat for geese at Horseshoe Lake. Theoretically, by splitting the Horseshoe Lake concentration, problems of overharvests, poor kill distribution, and crop depredation threat could be resolved, In the winter of 1947, the refuge wintered 2,000 geese. Goose-use steadily increased in the years following.

Along with increasing Horseshoe Lake to about 7,000 acres, the Illinois Department of Conservation acquired the 6,500-acre Union County Refuge located approximately 25 miles north of Horseshoe Lake. The purchase of the Union County Refuge and the enlargement of Horseshoe Lake were made possible by a $375,000 special legislative appropriation. The Union County Refuge included 3,150 acres of cropland, 1,600 acres of water, and 1,500 acres of timber. Theoretically, this new refuge could provide each goose overwintering with 500 to 600 square feet of pasture and 14-16 pounds of corn. In addition,

large amounts of waste grain were available on the private farmlands near the refuge.

In 1947, the closed area, plus a season shortened to 30 days, a bag and possession limit of but 1 Canada goose reduced the kill. In January, 1948, 63,000 geese were censused; the number in southern Illinois had increased 9,000 from the previous year.

Besides land acquisition and management, a dispersal program was initiated at Horseshoe Lake and was continued in 1949. Hazing was conducted by the state and the Bureau between October 4 and 29 using aircraft, rifle-launched rockets and flares, and parachute-type flares; the crews operated on land and water. Altogether, 183 hours of flying time were logged by two pilots, and 202 cases of flares and exploding rockets were expended. The peak goose population on October 7, just after operations commenced, totaled 12,000; this number was sharply reduced as the geese were driven to islands in the Mississippi and into Missouri. By October 11, only 300 geese remained on the state refuge; continued hazing prevented a build-up from recurring. Despite a protest meeting held on October 17 at the Cairo courthouse, the hazing continued. The widely scattered geese provided excellent hunting but there were few reports of excess killing, large-scale commercialization, or crop depredations. An estimated 30,000 geese lingered throughout the winter in Mississippi and Scott Counties, Missouri, but there was no indication that geese had been forced farther south.

The area closed by Presidential Proclamation was reduced in size to 9,000 acres prior to the 1953 season. Hunters quickly responded and an unprecedented harvest estimated at 56,000 geese occurred. Aroused conservationists across the nation demanded action to prevent another slaughter of this magnitude (Schendel, 1954; East, 1954).

The high kill of 1953 was removed from a population which had increased three-fold since the low year, 1946. It caused a temporary set-back in population growth which was offset by greatly reduced kills the following two hunting seasons. By that time, three major goose management areas in southern Illinois were operating smoothly, apparently with sufficient control over the goose harvest to prevent further slaughters. But in 1957 the kill rate again erupted reaching the highest level ever recorded in southern Illinois. This coupled with a sharply increased kill at Horicon in 1958, set the stage for the quota system inaugurated in 1960. The southern Illinois harvest, brought under control in 1959, has remained so to date. However, to the north on the newly created Horicon National Wildlife Refuge, another problem associated with Canada geese of the Mississippi Valley was beginning.

Stabilization

The Horicon National Wildlife Refuge was established primarily for ducks, more specifically for redhead ducks. Even though it was situated directly astride the migration route for Canada geese, at the

outset no one thought that it might eventually attract tens of thousands of Canada geese.

In 1940, the federal refuge was established on the northern two-thirds of Horicon marsh which had been drained but later reclaimed. The state acquired the southern third bringing the total area to 31, 653 acres. Small, scattered tracts of cropland were added on the periphery to provide grasslands and to straighten out the boundary.

Geese did not immediately stop at Horicon. Refuge manager Jerome Stoudt commented in his 1942 Refuge Narrative Report as follows:

> There seems to quite a flight of geese through this part of Wisconsin, but few, if any, appeared to stop over on the Horicon Marsh. Only one Canada goose was observed actually resting on the marsh itself, and that may have been a cripple. Many flocks were observed flying southward from the first day of the hunting season and several flocks were within easy gunshot but none of these were seen to actually alight on the area.

Between 1946 and 1949, a breeding flock of Canadas was established on the state's end of the marsh which had produced nearly 500 goslings by 1957 (Hunt and Jahn, 1966), but when wild Canada geese finally began to stop at Horicon, it was in relatively small numbers. Everyone was delighted to see them. In 1951, the last major water control structure was completed and the marsh reflooded. In that year, the Canada goose peak population reached 24,000. By 1957, the Mississippi Valley Population had stabilized (Fig. 27). While year-to-year estimates have varied since then, the median number has remained about the same. Even though the fall population at Horicon continued to grow, it was not until the carrying capacity of the refuge had been exceeded that real concern developed.

The geese were encouraged to move out from the refuge onto private lands through the establishment of zones where shooting was permitted only part of each day. This type of management increased vulnerability to the gun. The geese became less wary. As wariness decreased, the bird lost some of its trophy value. Goose hunting had become goose shooting!

Behavioral Changes

No case history of the Mississippi Valley goose Population would be complete without noting how these birds responded to certain forced changes in their mode of living. Before Horseshoe Lake became a refuge, these geese wintered in widely scattered flocks along the sandbars of the Mississippi River between Chester, Illinois, and the Gulf of Mexico. Enroute to their wintering grounds the birds migrated through the flyway in small flocks, stopping to feed briefly until hunters discovered them and drove them out. When sanctuaries were established along these flightlanes, the birds soon discovered them and gradually built a tradition of returning to these areas bringing other members of their flock with them.

Most authors, lyricists, and wildfowlers of the past have lauded the honker as the symbol of wildness. But those who have observed the Canadas at Horseshoe Lake or Horicon Marsh have a different idea. At both places, these great birds often appear stupid. They readily fly over conspicuous blinds – even those containing poorly concealed hunters. At Horicon Marsh, we have observed several carloads of hunters in a parking lot slamming car doors, loading guns, and boisterously talking with several hundred geese feeding noisily around the nearest blinds scarcely a gunshot away. This was after the season had been open several days.

Yet these same birds elsewhere in the flyway may do honor to the best traditions of the species. Apparently the sheer weight of large numbers and freedom from harassment lulls these birds into complacency. This coupled with the great competition for food, especially on the sanctuary area, causes the type of behavior illustrated above, a pattern which apparently does not exist until concentrations build up to several thousand individuals.

The birds have adjusted to their new-found existence in other ways. Formerly, they shied away from standing corn, although this grain has long been a preferred food. An interesting account of a changing feeding behavior at Horicon has been provided by Jahn (unpubl.):

> Changes in feeding behavior of Canada geese using Horicon Marsh have, in certain respects, been rather spectacular over the past 20 years. On my first trip to Horicon in the spring of 1947, Canadas refused to feed into the edges of large fields or strips of standing corn. By the fall of 1950, geese in the Federal refuge fed under the husks on ears hanging down on upright stalks on the edges of strips or block-type fields of corn. Art Hughlett's thesis shows that kernels were consumed on ears up to about 38 inches from the ground.
>
> Our first boom nets were placed along the juncture of corn and hay fields to trap Canada geese in the fall of 1950. The birds landed in the hay field and walked toward and finally into edges of the standing corn. Our bait and traps intercepted these movements of the birds.
>
> In the early 1950's, feeding Canada geese worked through 100-foot strips of standing corn that were relatively weed-free. But only edges (a few rows) of strips of corn having heavy stands of weeds (i.e., foxtail, pigweed, lambs quarters, dock, smartweeds, bindweed, etc.) were used. Later on weed control became more efficient and the open stands of corn encouraged greater use by Canada geese. In the 1960's, geese would alight directly in strips and blocks of standing corn where they had fed previously.
>
> Behavior of the geese at a particular corn field seems to be conditioned by prior experience. When the field is first approached, the birds commonly land nearby, walk into the edges,

and, if undisturbed, ultimately feed throughout it. This pattern of use was evident in refuge corn fields in the 1950's and may now be observed in refuge fields and lightly shot or unshot private fields experiencing crop depredations.

Over the past two decades (1947-1967) Canada geese have adapted and perfected their habits for feeding in standing corn. Twenty years ago the birds rarely fed in standing corn. Today they readily feed there. A combination of factors seems involved in this behavioral change. Geese naturally prefer corn as food. Fields on the Horicon National Wildlife Refuge provided an opportunity for geese to feed in standing corn with only minor and infrequent disturbance. Improved weed control now provides relatively open standing cornfields that are more attractive to feeding Canada geese than the weed-choked fields commonly encountered twenty years ago. These factors interacted to permit repeated satisfying experiences from which evolved the feeding patterns now demonstrated by Canada geese using the Horicon National Wildlife Refuge.

Hanson and Smith (1950) speculated that "wariness is related to the total size of an aggregation and its size in proportion to the area it uses." They advised "insofar as possible, reduce contact between human beings (both the public and refuge personnel) and the geese." Part of the problem in managing the Mississippi Valley Population of geese may stem from failure to recognize the importance of this advice and to follow it.

From this, it is clear that goose behavior may change somewhat in adjusting to changing conditions. The flexibility of the species should be an asset to management if it is understood and used properly.

Gradually, the duration of the fall stay of geese at Horicon has increased with some variations due to weather. In 1961 and in 1966, over 12,000 geese were still present in January in the Horicon vicinity. Despite limitations pointed out by LeFebvre and Raveling (1967) Horicon, during these two mild winters, with low snowfall, became a wintering area. In 1965, approximately 65,000 geese remained at Horicon until mid-December and equal numbers were still present at the time of this writing (December 3, 1967).

In addition to the major concentration at Horicon, geese gathered on the numerous marshes and lakes of the rolling glacial terrain of eastern Wisconsin. Because of the wide area in Wisconsin and Illinois over which geese were being hunted, the problem of overharvest during the 70-day season was not immediately recognized. However, after 1957, the population failed to increase as had some other Canada goose populations in the flyway (Fig. 27).

Management Objectives and Guidelines

The Mississippi Valley Canada goose population includes nearly half the members of this species wintering in the Mississippi Flyway. So that the various agencies of the flyway involved in the research and management of Canada geese would work cooperatively toward common goals, the Flyway Council has included in its Management Plan a statement of objectives and guidelines for fulfilling them. According to Section 221.11 of the management Guide as revised July 8, 1965, the objective is to "distribute Canada geese throughout the Flyway in order to supply as many portions as possible with reasonable recreational opportunity of the highest possible quality."

To accomplish this end the following facets of management must be considered:

1. Improving distribution, and utilizing recreational opportunity by providing a wider choice of stopping places.
2. Managing by sub-units and even individual flocks.
3. Setting quotas in line with production.
4. More fully utilizing potential nesting grounds.
5. Reducing waste from various causes.
6. Improving the quality of the recreation provided by these birds.

The plan states that "the ideal pattern (of distribution) would include numerous stopping places between northern nesting grounds and southern wintering grounds. Through proper management the geese would be encouraged to proceed slowly but steadily down the Flyway spreading their benefits more or less evenly both enroute and at the terminals. The geese themselves determine their distributional pattern to a large extent because each population has its traditional range."

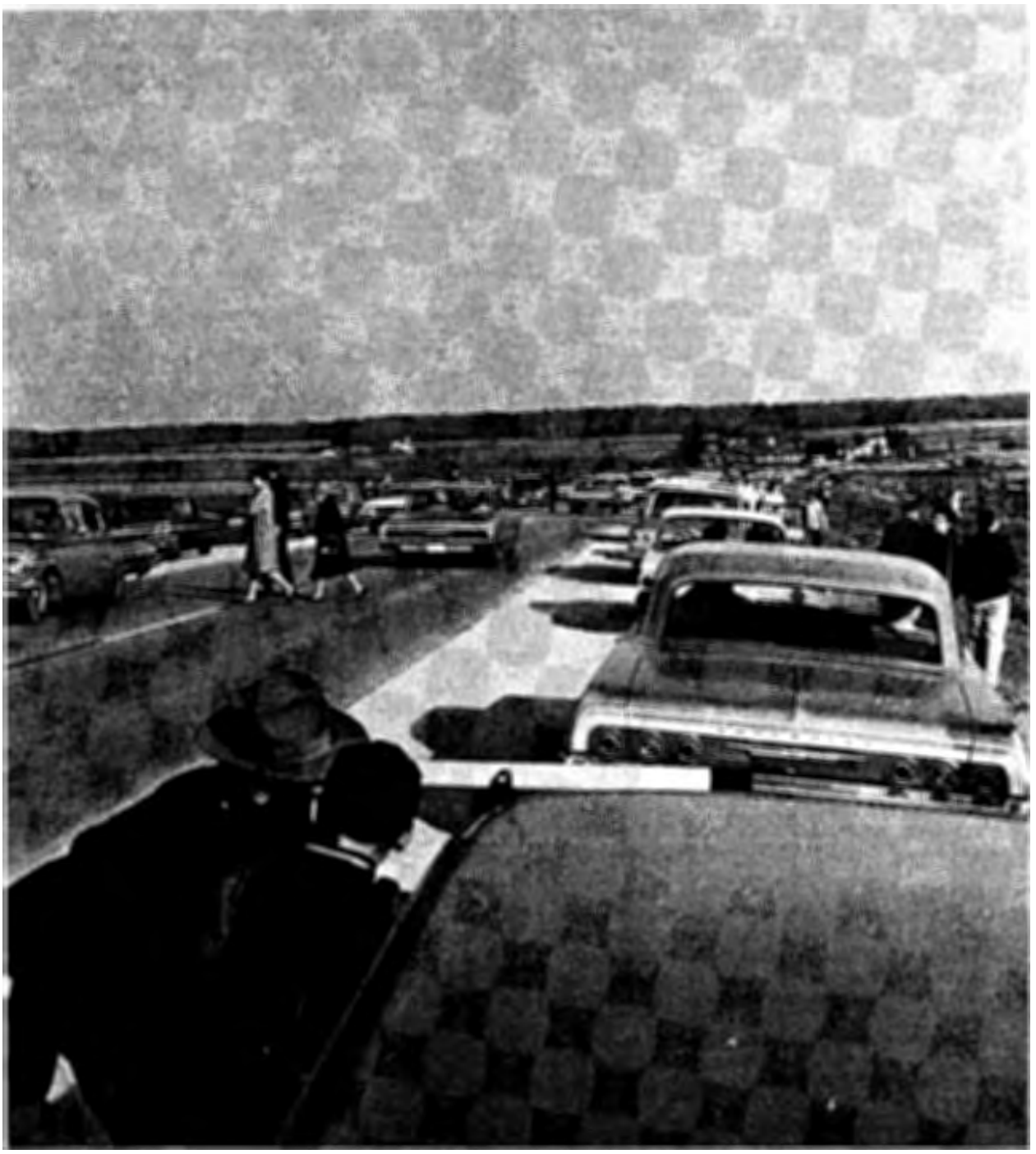
This arrangement is recognized as somewhat idealistic because the plan adds that "flocks firmly attached to a wintering area must be managed where they have chosen to remain. Methods of dispersion of such concentrations should be a research endeavor of high priority."

To date, efforts to move a substantial portion of this population farther south in the flyway have met with failure. Methods tried included the establishment of major refuges south of the Ohio River managed specifically for geese; trapping and transporting of these southern areas large numbers of geese hoping that they would return in future years; and dispersal tactics on wintering areas including food reduction in managed areas. There may be no other alternative left than to manage the geese on the areas of their choice even though the winter terminals are farther north than desirable or than originally existed.

Management objectives and guidelines should be reviewed from time to time in the light of new knowledge and experience. One of the Council's most active technical subcommittees spends long hours annually on this never-ending task.

Quota System

The principle of the quota system was not new in that it had been applied in the past to individual areas as a guide for terminating the season. For example, local allowable harvests were sometimes geared to a predetermined percentage of the peak



Thousands of persons gather during the fall to watch Canada geese from the highway at the Horicon National Wildlife Refuge in Wisconsin.

population. As early as 1949, Hawkins (unpubl.) stated:

> It looks to me like the best procedure is going to be (a) determine how much shooting the goose population can stand, (b) set a kill quota each year for the Horseshoe Lake area based on estimated breeding success, and (c) keep close tabs on the take and close the season when the quota is reached.

It was not until 1960 that a quota system involving the two major harvest states, Illinois and Wisconsin, came into being. This action was deemed necessary because of the 37 percent reduction in the 1960 winter inventory from the previous year (Green, Nelson, and Lemke, 1963).

Basic principles in the quota system followed those stated earlier by Hawkins. Because summer inventories were not being conducted on the breeding grounds of the Mississippi Valley Population of Canada geese, the estimate of the previous wintering population served as a base from which an expected fall flight was projected. Factors considered in these calculations included the proportion of potential breeding females, average gosling production per female of breeding age, natural mortality, kill by Indians, other Canadian harvest, and crippling loss, leaving an estimated number of geese that could safely be harvested in the United States. From the latter figure, a crippling loss was deducted and a kill set aside for states other than Illinois and Wisconsin. The respective Illinois and Wisconsin quotas were mutually agreed upon or set with the assistance of the Mississippi Flyway Council, or on rare occasions, set by the Bureau. While quotas determined in this manner are useful, they fail to reflect variations in the fall flight due to annual changes in nesting success. Furthermore, in retrospect it seems that biologists used several estimates made at different times during December and January for determining the winter population upon which the projection was based. This estimate was corrected for geese "known to be present but not actually observed." While the result represented a concensus based on the best data available, the population figure used was invariably the highest estimate made (Tables 66 and 67).

Two conditions must be met if the quota system is to function as a true control of harvest in a given area such as a state or portion of a state: (1) at least 75 percent of the kill must occur within the quota area (selected), and (2) a relatively accurate method must be available for measuring the kill.

TABLE 66. Canada Goose Quotas in Wisconsin and Illinois

WISCONSIN

Year	Horicon Zone*	Statewide	Total
1960	7,000	None	
1961	12,000	None	
1962	8,000	None	
1963	12,000	None	
1964	11,000	None	
1965	11,000	None	
1966	8,000	6,000	14,000
1967	15,000	5,000	20,000

ILLINOIS

Year	4-County Zone**	Statewide	Total
1960	14,000	None	
1961	20,000	None	
1962	10,000	None	
1963	20,000	None	
1964	15,000	None	
1965	15,000	None	
1966	18,000	2,000	20,000
1967	18,000	2,000	20,000

* Portions of Dodge, Fond du Lac, Juneau, Monroe and Wood Counties.
**Union, Jackson, Alexander and Williamson Counties.

TABLE 67. Estimated Harvest of Canada Geese in Wisconsin and Illinois

WISCONSIN

Year	Quota Zone*	Season Length (Days)	Statewide Harvest	Season Length
1960	10,900	9½	Unknown	70
1961	11,141	10½	Unknown	60
1962	7,093	7½	Unknown	60
1963	12,746	35½	20,300	70
1964	13,066	11½	25,400	70
1965	13,354	12½	31,800	70
1966	9,617	2½	31,193	70
1967		58		70

ILLINOIS

Year	Quota Zone**	Season Length (Days)	Statewide Harvest	Season Length
1960	14,900	42	Unknown	45
1961	18,500	40	Unknown	40
1962	10,717	44	Unknown	44
1963	9,635	45	Unknown	45
1964	16,159	29	Unknown	58
1965	15,079	45	Unknown	45
1966	18,724	40	21,990	47
1967				

* Portions of Dodge, Fond du Lac, Juneau, Monroe and Wood Counties.
**Union, Jackson, Alexander and Williamson Counties

In Illinois, the quota area comprised four counties totaling approximately 1,600 square miles (Table 65). The kill was recorded at goose hunting clubs licensed by the state within the quota area.

In Wisconsin, the quota area used in most years was much smaller than in Illinois. Actually, banding data reveal that Dodge and Fond du Lac Counties, which totaled about 1,600 square miles (Table 65) comprised the area in which most of the goose harvest occurred. The Horicon quota zone from 1963 through 1965 was approximately 238 square miles (Fig. 28). A number of methods for recording the kill in Wisconsin have been tried annually through 1966. These included spot checking at farms, mail questionnaires, and mandatory registration at manned and unmanned checking stations.

While the quota provides an equitable means on paper for distributing the allowable harvest, it does not plug certain "leaks" which result in an overharvest. The failure of this population to increase, despite the setting of quotas designed to insure for substantial increases, proves that a significant fraction of the kill went undetected. The key points of the quota system in Illinois and Wisconsin since 1960 are summarized in Table 68.

Feeding Shelled Corn

Frost limited the production of corn at Horicon in 1965. Because goose food was in short supply on the refuge, concern was felt for (1) the high rate of kill of geese flying off the refuge in search of food, and (2) the threat of depredations to corn on private lands. Wisconsin authorities pressed for a feeding program on the refuge to relieve these imminent threats. The feeding program was started September 29. A total of 467.5 tons of shelled corn was hauled and spread on the refuge dikes. Feeding continued until November 12. Although up to 50,000-60,000 geese at a time accepted this "bread line", a new record for daily kill was set on October 7 when 2,367 geese were registered, indicating strong off-refuge flights. The threat of serious depredations failed to materialize, however, because scaring devices, hazing with aircraft, and other control measures proved effective in protecting unharvested corn on private lands.

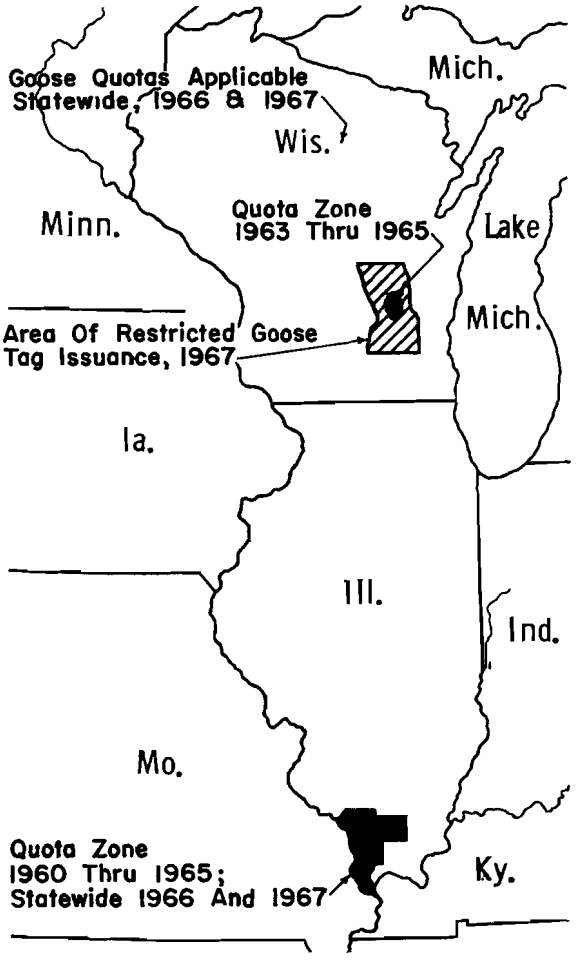


FIGURE 28. Canada Goose Quota Zones.

Conclusion: The feeding program, expensive though it was, failed to hold the majority of the geese on the refuge. At the time the total estimated goose population using Horicon was 120,000.

Hunting Pressure Used to Induce Migration

With larger and larger autumn concentrations of geese, more emphasis was placed on retarding, or even reversing this trend. In 1965 at the request of Wisconsin administrators, the Bureau agreed to try an earlier opening date in the quota zone. The season for Canada geese was opened September 25. The theory was that if the first geese arriving met shooting pressure, they might migrate. This in turn would reduce the rate of build-up on the area.

The result was that the regulation seemed to have no appreciable effect on the rate of kill. The season in 1965 was closed within the quota area (Horicon Zone), October 7, with the kill quota filled, plus some over-run (Table 67).

Hazing

Early in 1966, federal and state officials agreed that an attempt to haze geese from Horicon Refuge should be made during the ensuing fall. The objective would be to reduce the refuge population to about 50,000 geese. The plans for goose management, including hazing, were reviewed at a number of public meetings by state and federal personnel. The plans were also reviewed with members of the Mississippi Flyway Council in St. Louis, Missouri in February, 1966. While there was some concern in Wisconsin over the proposed hazing, no alternate plan was offered.

Planning for the cooperative experiment continued until suddenly, on September 9, a member of the Wisconsin Conservation Commission publicly threatened the arrest of federal agents participating in the experiment. In view of the reaction that these threats created, the hazing plan was modified so as to restrict federal aircraft and personnel engaged in hazing to federal lands. The hazing program got underway on September 20 under threat of legal action by the state. The Horicon hazing experiment became the subject of widespread publicity in the press, on nationwide television and radio, and in national magazines.

Wisconsin implemented its threatened action by a civil complaint filed in State Court on September 23 seeking to enjoin six named Bureau employees from engaging in hazing operations on the refuge proper or anywhere else in Wisconsin. The action was subsequently moved to U. S. District Court in Milwaukee. There it remained until October 2, 1967, when the state withdrew its complaint.

The experiment was pursued with vigor by the Bureau. At the peak of activity the week prior to the season's opening, this involved use of a helicopter, 2 fixed wing aircraft, 2 airboats, 2 marsh vehicles, 6 conventional boats, 15 floating platforms mounted with crop depredation exploders, 16 land-based exploders, and other frightening devices such as shot-shells and firecrackers. Thirty-nine individuals were directly involved in field work. Hazing was discontinued the morning of October 7, 24 hours before the season opened. Results of the experiment may be summarized as follows:

1. Hazing efforts were successful in removing most of the geese from the refuge during daylight hours; however, they returned to the refuge at dusk.
2. Predictions of wholesale crop damages failed to materialize; the damage that did occur was local and relatively small.
3. An unprecedented kill occurred in the $2\frac{1}{2}$ days of shooting allowed in a 7-county area before a closing order was issued. The remainder of the state stayed open to hunting for an additional 20 days. Distribution of the harvest in the 7-county area was to individual hunters over a relatively large geographical area.
4. There was no evidence that the hazing operations as conducted resulted directly in migration of geese to areas farther south.

TABLE 68. Synopsis of Special Management Practices Applied to the Mississippi Valley Population of Canada Geese *

Year	Location	Practice
1927	Horseshoe Lake, Illinois	Refuge established for geese (state)
1941	Alexander Co., Illinois	Weekly bag limit of geese imposed: 3 geese in any 7 consecutive day period (federal)
1941	Illinios	Licensed hunting club established (state)
1942	Alexander Co., Illinois	Restricted shooting hours, sunrise to noon (federal)
1944 and later years	Alexander Co., Illinois and later in Wisconsin	Emergency closure of goose hunting season (federal, state or both)
1946	Entire Mississippi Flyway	No goose hunting season proclaimed (federal)
1947	Portion (20,000 acres) of Alexander Co., Illinois	Limited area completely closed to goose hunting (federal and state)
1947	Crab Orchard National Wildlife Refuge, Illinois, Union County, Illinois	Dispersal of population by satellite management areas (federal and state)
1948-49	Horseshoe Lake, Illinois area	Population dispersal attempt by hazing (federal and state)
1954	Portion of Horicon National Wildlife Refuge, Wisconsin	State managed goose hunt allowed on federal lands (federal and state)
1957	Horicon area	Goose season opening delayed to allow geese to develop off-the-refuge feeding flights (federal and state)
1957	Horicon area	Goose shooting stopped at 2:00 p.m. to allow geese to develop off-the-refuge feeding flights (state)
1959 and later	Horicon area	Intensive field surveys undertaken to measure extent of goose kill
1960	Four counties in Illinois and areas surrounding Horicon and Necedah National Wildlife Refuges, Wisconsin	Kill quota system inaugurated (federal and state)
1963	Wisconsin	Goose registration system established (state)
1963	Wisconsin	Calculation of goose harvest by tail fan and registration compliance checks (federal)
1965	Horicon National Wildlife Refuge, Wisconsin	Massive feeding program (federal and state)
1965	Horicon area, Wisconsin	Early season opening in advance of regular statewide goose hunting season (federal and state)
1965	Wisconsin	Law enacted for payment of crop damages resulting from waterfowl (state)
1965	Horicon area, Wisconsin	Alternate day shooting initiated in effort to reduce rate of kill (state)
1966	Horicon Marsh, Wisconsin	Population dispersal attempt by hazing

TABLE 68. Continued

Year	Location	Practice
1967	Portion of Horicon National Wildlife Refuge, Wisconsin	Closed to state-managed goose hunting
1967	Wisconsin	Statewide goose tagging system inaugurated (federal and state)

*Also, see Nelson, 1962 and Hunt, Bell and Jahn, 1962.

5. Compliance with the state's goose registration system was poor; it deteriorated further as the season progressed.

6. There was some evidence that the hazing broke up some family groups, making them more vulnerable to shooting.

7. Nearby state-owned areas failed to attract significant numbers of geese. The Thornton Area, under private control, doubled its usual population. On October 3, an estimated 15,000 geese were present on the 19-acre pond that is the nucleus of the management area.

Information from the goose tail-fan collection survey, plus registration complicance records, indicated that the statewide kill approximated 31,000 geese, more than twice the desired number.

The events of 1966 re-emphasized the need for cooperative federal-state management, oriented to the welfare of the goose resource and the public who is privileged to use it.

Estimating Canada Goose Kills

In 1963, a mandatory system of registration was initiated in Wisconsin. Goose hunters were required to fill out cards showing their name and address, species of goose killed, date and location of kill and the license number of the motor vehicle used during the hunt. This system was continued through 1966. Registration cards were made available at manned and unmanned checking stations. Registration cards were gathered and tallied daily which provided a crude estimate of the kill.

Compliance with the regulation requiring goose registration was checked by observing from a distance geese being loaded into automobiles. The

auto license number was later checked against goose registration cards to see if the geese loaded into the car had actually been registered. The results of this comparison provided an index to compliance with the regulation requiring registration.

In order to better determine the statewide Wisconsin kill, the parts collection survey carried on by the Migratory Bird Populations Station was enlarged and improved. In this survey, a sample of waterfowl hunters are supplied with franked, addressed envelopes prior to the season. They are asked to insert into the envelopes tail feathers from each goose they killed during the season. On the face of the envelope, they entered their name, address, and location, date and time of kill. Envelopes were mailed to a central location.

The survey indicated that a significant portion of the total number of geese so reported were being killed outside the registration zone (Geis, Carney, and Hunt, 1965). It substantiated the fact that some geese being killed in the zone were not being registered. Results of the surveys revealed a total statewide kill well above the desired level of harvest (Geis and Carney, 1966):

Year	Quota for Horicon Zone	Calculated Statewide Kill
1963	12,000	20,300
1964	11,000	25,400
1965	11,000	31,800

These figures would be larger if associated crippling loss were included.

The tail-fan-registration systems analysis was intensified in 1966 to permit daily processing of all records (Carney and Geis, 1966). This enabled the Bureau to terminate, with justification, the season in the 7-county area after 2½ days of shooting, even though only 9,617 geese had been registered, and the quota for the state was 14,000. By 1966, field observations indicated that hunter compliance with goose registration had declined to about 59 percent. Clearly, another method of controlling the Wisconsin kill was urgently needed.

In 1966, preliminary examinations of the Illinois kill by R. C. Hanson and H. M. Reeves through the tail-fan collection survey and band recovery analysis suggested that the statewide Illinois quota was also being exceeded but not to the extent occurring in Wisconsin. In 1967, the Illinois quota was converted from the 4-county area to a statewide basis; 10 percent of the kill has been allotted to the portion of Illinois outside the 4-county area. Probably, the deduction should be larger.

Tagging System

Many western states have used tagging as a management technique to distribute harvest of big game by time, distribution, and extent. Game managers in Colorado, Utah, and Wyoming have used tags on Canada geese to curtail excessive harvests by individual hunters. The Federal government first used tags to control harvest of migratory waterfowl in 1962 to limit the harvest of whistling swans in Utah.

Jahn (1953) suggested the use of tags at Horicon in his penetrating analysis of the Canada goose problem there. He suggested issuing 4 tags to each hunter and thereby limit their individual bag. The advantage here would be to improve the distribution of the harvest among hunters, discourage land leasing, and possibly eliminate the need for expensive public hunting areas. He recognized that this action probably would not improve the quality of the hunt because landowners would continue to attract as many hunters to their property as possible. Jahn also questioned whether a tag system could be enforced. He did not propose the issuance of a predetermined number of tags to limit the total number of geese taken.

A special meeting of the Mississippi Flyway Council was held in St. Louis, Missouri, in February, 1967, to develop management plans for the Mississippi Valley Population of Canada geese. At this meeting, the Wisconsin Conservation Department proposed a tagging system for their state. Although having much merit, the plan met with considerable opposition from landowners near Horicon and enabling legislation was not passed. Since the tagging system could not be implemented under state auspices, the Bureau of Sport Fisheries and Wildlife, acting for the Federal government, executed the Wisconsin plan with slight modifications, through a private electronic data processing firm. Major points in the plan were:

1. Only persons possessing permits and tags could hunt Canada geese.
2. Applications for the free permits were submitted during a specific time period.
3. Permits and tags were nontransferrable.
4. Three-fourths of the state's quota was allocated to the Horicon Zone. A 90 percent success rate was anticipated, so an additional 10 percent of the number of permits were allowed. Thus, 16,500 permits and tags were issued for the Horicon Zone.
5. "Party" applications for 2 hunters were authorized to encourage father and son hunting.
6. Permits for the Horicon Zone were randomly selected by computers.
7. Persons requesting permits outside the Horicon Zone would receive 2 tags valid for the entire season.
8. If they so requested, unsuccessful applicants for Horicon Zone permits would receive permits valid outside the zone.
9. Persons killing Canada geese were required to immediately lock the tag on the leg of the bird before transporting it in any way.
10. All persons issued permits were required to report tag use or nonuse in franked envelopes provided them. Successful hunters were required to report within 12 hours after killing a goose, and unsuccessful hunters were required to report within 12 hours after the close of their hunting period.
11. Each nonrespondent to the reporting requirement would receive one reminder. Following this, persons still not responding would be investigated

by law enforcement officers. If warranted, prosecutions would be made.

Permits were issued in the Horicon Zone in 6 periods. Opening weekend was considered period 1. Each of the remaining periods were 7 days in length. In Period 1, 1,650 tags were issued; 2,970 tags were issued for each of the remaining periods.

The tagging system has not yet been completely evaluated, but indications are that it has achieved the desired objectives of controlling the magnitude of the kill and distributing the harvest among the maximum number of persons over an acceptable time span. It has opened to hunting lands formerly closed to the general public by lease or other arrangements, and has markedly improved the quality of the hunting experience. But it has not been well received by some local landowners, or lessees of hunting rights who have been restricted to a single goose per season.

Unusually heavy crop depredations in October and early November 1967, triggered by an extremely wet fall which delayed the harvest, has been blamed by some farmers on the light hunting pressure resulting from the tagging system. To alleviate this criticism and perhaps reduce the problem, some rearrangement in the distribution of tags may be in order, concentrating more of the hunting pressure during the time when crops are most vulnerable to depredations.

* * * *

This has been a case history, and as such, does not require conclusions. However, one seems obvious: the final chapter in this story has yet to be written even though most of the problems in goose management have been encountered. Surely, much has been gained from these experiences and a sound management program is that much closer to realization.

Summary

WE ARE in a period of significant change in the management of the Canada goose. Our environment is changing. We now have a good basic system of refuges with which to operate. Our constituents are changing. Birdwatchers are growing in number, hunters relatively in the decline. So our traditions are changing. We seek quality human recreation in many forms as well as geese in quantity for the gun. Our level of confidence is growing. Where once some might have felt that honkers were on the way to becoming endangered, today we generally recognize with Grieb that geese offer a great potential for "doing something" with waterfowl. Our concepts are changing. We believe that Canada geese lend themselves to management by taxonomic, ecological, or geographic units rather than in the mass. Techniques are changing. The modern manager has a kit bag of tested tools with which to measure and manipulate hunters and hunted. In short, we are in an era of transition from general to intensive management of geese and goose harvests. An abiding concern for the resource has become tempered by a growing belief in our ability to maintain, restore, and increase Canada goose populations on a man-dominated continent. Our confidence in turn is tempered by a recognition that we need better research, stronger leadership, cooperative and coordinated efforts, and more money.

Jahn offers a number of key "impressions of actions required for resolving problems and improving programs" in Canada goose management today:

1. We need more and better research, particularly into the special characteristics of distinct subspecies, and into the dynamics and distribution of discrete populations.

2. The Canada goose must be universally recognized as an international bird. He does not "belong" to any state or province, much less to any area. Management efforts must be guided by overall plans to prevent competitive practices.

3. Something more than gross flyway or even statewide regulations are required. We must apply the "goose harvest management unit" concept.

In his call for placing goose harvests in different areas under varying intensities of management, dictated by goose population status and local hunting demand, Jahn is careful to point out that such a development will require aggressive leadership by wildlife managers and policy makers, and strong support from hunters and other interested citizens. His words are an echo of Gabrielson, saying that "the most uncertain factor in wildlife management is not management of game itself but public support for a suitable and effective program." It is probably true that the future of Canada goose management in America hinges as much on "the engineering of public consent" for sound harvesting regulations as on the engineering of more goose habitat.

4. Where hunting pressure is light, we can count on bag, possession, and season limits to provide sufficient protection; but where hunting pressure is intense, more sophisticated hunter controls will be required to hold harvests within allowable limits and to preserve some semblance of a quality recreational experience.

5. Establishing harvest management units for Canada geese will resolve numerous complex problems, but periodic excessive goose numbers and their attendant threats of crop depredation, recreational degradation, and over-shooting will remain a constant challenge to wildlife managers.

6. Improved approaches are needed to encourage more Canada geese to use southern states.

In substance, if we can muster enough facts, funds, and effective teamwork, Jahn believes "the future of the Canada goose in North America looks very bright." At least it seems the geese will meet us half way.

SUMMARY: REQUIREMENTS AND OPPORTUNITIES FOR MANAGING CANADA GEESE

Laurence R. Jahn

THIS MEETING HAS focused attention on requirements and opportunities for managing Canada geese more intensively in North America. All 15 speakers contributed important historical experiences. My purpose is to use that excellent background to emphasize the present status and future needs of research and management required to maintain, restore, and increase Canada goose populations in a man-dominated environment.

Five authorities described in depth the status of Canada geese in North America. With the exception of the Aleutian Canada goose which is an endangered species, all known subspecies are at reasonably safe population levels in the 1960's. But some local populations are stable or declining. Hansen cited the unfavorable age structure and stable population of dusky Canada geese. Sherwood reported low or declining numbers of the giant Canada goose in certain localities in the north central states. In these cases, and very likely in many others less well documented, excessive hunting mortality is a major factor limiting flock size.

Management would be aided by researchers identifying all races and populations of Canada geese and providing refined designations of their breeding, migration, and wintering areas. More specific information is required by investigators and resource managers to enlarge the firm framework of knowledge needed for managing goose subspecies and populations more effectively. Identified subspecies and populations are the crucial units to be managed intensively. The sum of geese in each race or population equals the total number of Canada geese on the continent, an interesting figure, but unmanageable. A single, thorough description of all subspecies and populations of North American Canada geese awaits preparation. Filling this void will be no simple task, as the number of usable goose study skins for ages and sexes of many races in all North American museums are believed inadequate. Existing banding data are also incomplete. As Crissey stressed, many wintering concentrations of Canada geese must be banded.

Although taxonomic relationships of some subspecies and populations remain to be established, other goose flocks are delineated sufficiently well to permit intensive management of them. Grieb described excellent progress in establishing the numerical status of wide-ranging Central Flyway Canada goose populations through coordinated interagency teamwork. Similar efforts by flyway councils and their technical sections, working cooperatively with the Bureau of Sport Fisheries and Wildlife and the Canadian Wildlife Service, have contributed much knowledge and many refinements to the management of individual goose populations since the flyway organizations were initiated in 1952. More such partnership surveys and investigations will be required to obtain periodic population estimates of other subspecies and populations. Individual investigators, wildlife managers, conservation enforcement officers, and goose hunters must pool their findings and experiences from many local areas to cover the broad geographic range used by the birds annually

While individual races, populations, or both may become mixed on molting and migration areas, as breeding and wintering birds they usually are

believed to be separate, except where races intergrade when ranges overlap. MacInnes' report illustrates the need to have broad vision when attempting to scribe boundaries of breeding grounds and understand variation within individual groups of Canada geese. Nevertheless, additional taxonomic studies are best applied on breeding areas to yield maximum information on ecological relationships between the geese and their range. Similarly, discrete wintering populations deserve special research efforts. Crissey energetically advocates investigating each wintering population.

Gulden's report on the Rochester, Minnesota wintering flock illustrates the adaptive behavior of Canada geese. They use man-made lakes, roost on thermally conditioned water in winter, and feed on private lands. These distinct winter flocks, even small ones, have unique distributional and behavioral characteristics that require local recognition and management to encourage the nuclei to expand. Herein lies the promise for a bright future for Canada goose populations, if managers will capitalize on all known discrete populations and those identified or restored in the future. With proper management these populations can increase to fill breeding ranges believed to be used lightly or not at all.

Assessing the annual population status of Canada goose races and populations is no simple matter. Many available techniques have severe limitations when applied to geese. Aerial transects over the remote, widespread breeding grounds are costly, offer sampling problems not yet resolved, and are of limited value in areas of frequent adverse weather, such as described by Hansen for the Aleutian Islands. Crissey believes broad breeding ground censuses will not provide adequate information on the status of the numerous Canada goose wintering populations, especially small concentrations.

Based on pioneering studies with color- and radio-marked Canada geese, Raveling found that pre-hunting season group counts, made only at the moment flying geese alight, may prove valuable in appraising annual production of the Mississippi Valley Canada goose population. Research is continuing to determine if the technique can become operational. Further study is warranted since the approach could provide information on the goose population status quickly and economically. But for many flocks, group counts will not be meaningful. Therefore, a practical technique remains to be developed for establishing precisely the age structure and reproductive success of Canada goose populations. Crissey feels a well-executed pre-hunting-season banding program could provide much of the vital information.

Banding now provides the most useful information on goose population characteristics, but the data must be used with great care. Age ratios from trapped samples are biased by differential feeding behavior of immature and adult geese and, therefore, do not yield unbiased estimates of population structure. In spite of this limitation, banding yields the best information on distribution, mortality, and survival of goose populations. But recoveries of banded geese also must be interpreted carefully. Hunters report varying percentages of banded geese in different periods of years. Banders do not necessarily identify the race of each goose banded. A bander now classifies to subspecies each goose caught for banding on the basis of physical characteristics. But where a mixture of subspecies and populations occur, classifying all individual geese becomes impossible for the average bander.

Research effort is needed to improve the quality of banding information. A new trapping technique that would insure capturing large numbers of geese and yield an unbiased estimate of the sex and age structure of a population would be extremely helpful. Possibly new drugs can be used to capture many geese easily. A new technique is also needed to aid banders in identifying precisely individual geese of different subspecies. Interdisciplinary research is required to explore possibilities of using blood, feathers, or specific tissues in classifying geese to subspecies. Interpretation and usefulness of band recoveries could be improved if a practical identification aid was made available to banders and people checking bagged Canada geese. Likewise, if fieldmen improved their capabilities to identify Canada goose subspecies, their precise observations could contribute much information to the pool of knowledge required by management.

Numerical estimates of geese made in early fall and again in January, especially at designated concentration sites in Canada and the United States, now offer the best approach for establishing the overall status of individual populations. A well coordinated effort by trained census takers is required to complete the inventory at proper times and places, thereby avoiding mixed populations as much as possible. Grieb described a single, coordinated fall census used successfully to inventory the Tall Grass Prairie geese when they were spread from Canada to Texas. Dill reported using January estimates to follow trends of the Mississippi Valley Canada geese. Goose census figures combined with data from harvest surveys, age ratios, and banding are used for estimating fall flights. Crissey described the need for these investigations and for better quality control to insure reliability of the estimates.

The entire discussion on goose harvests and distributions left me with six impressions of actions required for resolving problems and improving management programs.

Impression I

Canada geese must be recognized by more people as a common property resource.

Tradition holds that all citizens should have equal rights to enjoy the recreational privileges provided by such resources. This tradition was spawned and became a part of our culture in an era of low human populations and light hunting demand. Today hunting demands are high, and would grow if more opportunities were available to go afield. Each goose hunter is in competition with others to get his share of geese. It is unreasonable to expect most individual hunters to restrain their own hunting efforts. Any goose one hunter passes up, potentially will be taken by another. With this competitive attitude, increasing demand for hunting

privileges, and without adequate controls, it is inevitable that Canada geese will be overharvested, except where proper regulations prevent it.

Impression II

Something more than simple, uniform, flyway-, province-, and state-wide regulations are required to regulate goose harvests effectively.

Hunter demand now exceeds goose supply. Early openings, long seasons, and late closings, as permitted by the overall framework of federal waterfowl regulations, in some cases, are too liberal and have contributed to excessive harvests of goose populations throughout North America.

Needed are specific regulations tailored to the characteristics of individual goose populations. Regulations for designated locations and times must be designated, first, to promote the welfare of geese without causing severe conflicts with private crops, and secondarily, to provide recreational opportunities for people.

Fortunately, states and provinces are beginning to use regulations to protect individual flocks within their boundaries. Sherwood described such progressive actions taken by several north central states. Through interstate cooperative agreements and arrangements wide-ranging flocks can be protected in other states as well. Hansen described how California and Arizona closed a wintering area to hunting along the Colorado River to restore flocks of Great Basin Canada geese breeding in Wyoming and Idaho. This action demonstrates that interstate agreement can be reached and can work effectively to protect highly mobile goose flocks.

More research and use of existing knowledge are needed to spell out where and when similar action should be taken to increase other goose populations and encourage them to use available, suitable breeding range. Support of landowners, hunters, other interested citizens, conservation commissions, and state, provincial, and national legislatures is essential to apply information aimed at increasing goose populations and providing more recreational opportunities.

Impression III

Where hunting pressure is light, shortening seasons, reducing daily bag and possession limits, or employing a season bag limit may provide sufficient protection for goose populations.

According to Hansen, short seasons and reduced limits are helping some goose populations in certain lightly populated western states. Vaught and Crissey reported that goose populations benefited when waterfowl hunting pressure was low during years of very restrictive duck seasons.

Nagel emphasized that a season bag limit on geese without tags and based only on voluntary compliance should be avoided. It penalizes honest hunters. A season limit of 6 to 8, enforced with nonreusable tags, reduced the harvest of Great Basin Canada geese in some western states. This is possible where hunting pressure is light and a small percentage of hunters take a large percentage of the total goose harvest. This occurs when hunting privileges are leased on a seasonal rather than a daily basis. But where large goose harvests are taken by many hunters, most bagging only a few geese a year, a season limit alone will not reduce the total kill. In areas of heavy hunting pressure, both hunting effort and goose harvest must be managed, if prescribed harvests are to be taken in reasonably long hunting seasons.

Impression IV

Where hunting pressure is high, harvest management units and zones should be established to avoid excessive hunting pressure and to hold harvests of individual goose populations within allowable limits set by reproductive gains and quotas.

While many approaches to curtail goose harvests have been made, short of managing hunting privileges, they have provided only partial solutions in areas of high hunting pressure. A daily bag limit of one, short seasons, and quotas using voluntary or mandatory registration of the kill are all inadequate to protect Canada geese effectively. In fact, an effective pattern of restrictive regulations can increase the goose harvest, as was done historically in Wisconsin and is currently being done in North Dakota.

Experiences with the Mississippi Valley goose population in Illinois and Wisconsin during the past third of a century emphasize that something more than customary hunting regulations is required to improve management of the goose harvest. Variations in weather conditions, food availability on refuges and private lands, degree of land management for geese on private lands, behavior of geese, and hunting pressure influence the size of harvest in any year and make its advanced prediction impossible.

In 1967 Wisconsin was divided into two harvest management units in the first attempt to manage both hunting privileges and the Canada goose harvest through a statewide computerized tagging system. This pioneering effort is very similar to the management unit system used so successfully in managing herds of big game.

Harvest management unit one consisted of a 1,560-square-mile area surrounding the Horicon National Wildlife Refuge. Within this area an average of 75 percent of Wisconsin's Canada goose kill occurs. A season's limit of one Canada goose per hunter prevailed in 1967. Harvest management unit two was the state and a season's limit of 2 Canada geese applied.

Zones within harvest management unit one suggest future regulatory patterns around major goose refuges or management areas to avoid excessive

hunting pressure and help insure quality hunting experiences.

Zone 1 is the refuge itself. Hunting may be permitted on part of the area or be prohibited, as was done at the Horicon Refuge in 1967.

Zone 2 is the adjacent management zone, in this case subdivided into two parts.

2a is a 50-square-mile block immediately around the refuge in which blind spacing regulations are applied to provide space to maintain reasonable quality in goose hunting. Occupied blinds must be at least 75 yards from the refuge boundary, 100 yards from a property line, and 200 yards apart.

2b is the 1,560-square-mile block scribed by road boundaries and encompassing zones 1 and 2a. Waterfowl hunting is prohibited from roads, railroads, and their respective rights-of-way to avoid mass concentrations of hunters. This is the area of high goose use, high hunting pressure, and high goose kill.

The Wisconsin intensive goose harvest management system featuring a statewide tagging system achieved its goals of distributing hunting privileges, helping to maintain quality hunting conditions, avoiding an excessive goose harvest, and providing a more accurate tally of the bag during the hunting season. First-year experiences demonstrated soundness of principles of the system. Minor adjustments remain to be incorporated to make it more satisfactory. Potentially a tagging system, where needed, should help maintain the Canada goose as a trophy game bird.

Band recoveries show that high percentages of the harvest from several North American Canada goose populations occur in the vicinity of specific management areas. This harvest pattern clearly suggests that management units and zones established around these goose concentration areas could be effective in managing hunting pressure and goose harvest on a sustained yield basis. Size of each local management unit and specific regulations applied within zones of each unit would be dictated by the goose population status and relative demand for goose hunting privileges.

Application of the goose management unit concept, where needed throughout the range of a population, could help insure distribution of the harvest among and within provinces and states. This would be extension of the interstate quota arrangement now used by Wisconsin and Illinois. Grieb's description of the harvest pattern for the Short Grass Prairie Canada geese suggests consideration of international quotas may be needed soon in the central part of North America. Addy recommends consideration of such quotas for the eastern part of the continent now. Well-coordinated harvest management is required to avoid competitive management aimed merely at "getting our fair share". Landowners in the vicinity of goose concentration areas should welcome a stable management program from which they can benefit. Issuing a fixed number of tags for designated zones will prevent excessive commercialization of goose hunting.

We are now in an era of transition from general to intensive management of goose harvests. Due to massive changes in land use, other environmental features, and the human population, many established traditions now are being challenged and changed. New traditions are called for in some locations and are being established. This involves progressive management required to manage effectively millions of Canada geese in an environment dominated by man.

Actually placing goose harvests in different areas on varying intensities of management, dictated by goose population status and local hunting demand, will require aggressive leadership by wildlife managers and policy makers, with strong support from hunters and other interested citizens.

Impression V

Establishing harvest management units for Canada geese will resolve many complex problems, but excessive goose numbers and crop depredations will remain as challenging threats requiring continuing attention of wildlife managers.

Based on testimony of our 15 speakers, excessive numbers of Canada geese are currently of major concern with only two populations in North America. Grieb described the unexpected effectiveness of superimposing protection on existing habitat and attracting and holding thousands of migrant Canada geese in northern Colorado during the winter. Reduced wintering populations in New Mexico prompted Colorado to refrain from establishing any more new areas closed to goose hunting in the region and to consider opening closed areas to push geese south with hunting pressure. This fine, cooperative, good neighbor policy is aimed at insuring New Mexico with access to the geese.

Dill described the excessive numbers of fall migrant Canada geese which exceed the carrying capacity of Wisconsin's Horicon National Wildlife Refuge. Plentiful water, abundant food within and surrounding the management area, and a 21,600-acre refuge offering protection from disturbance have in two decades encouraged increasing numbers of geese to build traditions for using the area. All efforts to induce early fall southward migration of the settled geese have failed. The protection, food, and water continue to attract and hold the tradition-bound geese until freeze-up. Then they go south to winter in southern Illinois and the immediate vicinity. This situation of more geese than can be accommodated on an area was reached over two decades ago in Illinois. After unsuccessful efforts to push the geese south, Illinois acquired more land to accommodate the excess Canada geese.

These experiences in Colorado, Illinois, and Wisconsin suggest two alternative methods for handling excessive local goose concentrations.

Method 1. Acquire more management areas to provide protection, food and water for the geese.

Arthur's vivid description of investments for land and farming operations made by Illinois

remind us that initial cost for using this method is high, but in the long run it provides substantial benefits. Vaught recommended providing more land specifically for geese. But adding more goose management areas will influence the overall distribution pattern of the population. Great care must be taken in selecting sites for new areas and in planning the amount of protection and types of food provided to avoid concentrating geese ever northward and closer to their breeding grounds. Addy suggested providing only aquatic plants and green crops, not corn, at northern latitudes. To further help insure southward migration of Canada geese, consideration should be given to locating northern management areas where freeze-up normally occurs early. Leases and agreements, rather than fee title purchase of lands, may be more realistic for holding geese temporarily in fall. Overall patterning of management areas within the entire range of each Canada goose population deserves more attention than it has received to date.

Method 2. Remove the protection from a management area to encourage geese to migrate by exposing them to human disturbance, including hunting.

Effects of such actions are known to me from only two cases involving relatively small flocks of Canada geese in Wisconsin and North Dakota. It was successful in both cases, but involved a substantial goose kill for a few days in North Dakota. To avoid excessive kills hunting pressure should be managed, as through a tagging system, if protection is ever removed from a large flock having established traditions for using a local area. Without control of hunting pressure, a goose slaughter can be anticipated at some areas, at least for the initial few days of hunting.

Deciding whether land is acquired, protection is removed, or a combination of methods is applied to handle excess geese in a given situation is no easy task. Possibly land acquisition is most appropriate for wintering areas having climatic conditions suitable for geese. Decreasing or removing protection may be best applied carefully to migration areas. Information resulting from evaluating the total pattern of existing and proposed management areas for individual Canada goose populations should help in formulating crucial decisions through coordinated and cooperative international and interagency teamwork.

Crop depredations by Canada geese now are a major problem only in certain autumns in the vicinity of Wisconsin's Horicon National Wildlife Refuge, although the potential for crop losses occur in other localities. Damage may be important one year and nonexistent the next. It is most severe when wet weather delays normal crop harvesting schedules.

Among the kit of tools to discourage crop losses, scaring devices provide an immediate solution in many cases to discourage geese from using a particular field. Since 1965 Wisconsin has had a law authorizing payment of crop damages caused by waterfowl. But effectiveness of the new law remains to be evaluated. Dill suggested that more tags may be used in future years to focus hunting pressure during the period crops are most vulnerable to geese. In emergency cases, killing permits can be issued in both Canada and the United States under prescribed conditions and for specific times and places to help farmers solve unusual depredation situations. Which one or combination of these techniques is used to resolve a particular case must be based on local field evaluation.

A more intensive effort seems needed to provide farmers in the vicinity of large goose concentrations with information useful in discouraging Canada geese from using unharvested cropfields. Extension specialists in the fields of wildlife and agriculture could provide a valuable service in such an effort. The necessary first step is to have wildlife managers, soil and crop specialists, farmers, and extension people meet to draft a set of practical recommendations that can be provided all farmers and work unit conservationalists within the area of depredation threat. In view of the high demand for geese, both by hunters and nonhunters, and the stimulus of geese to local economies, this approach seems realistic as part of a total program to manage geese without their causing serious conflicts with private crops.

Impression VI

Improved approaches are required to encourage more Canada geese to use southern states.

Knowledge of historical distributions of Canada geese remains clouded, largely because no one knows which subspecies or populations formerly occupied the deep south. Identification of some existing populations and flocks remain questionable or unknown. A combination of overharvest, less attractive habitat in the south, and more attractive habitat in the north are believed responsible for bringing about changes in goose distribution patterns.

Wintering population and banding records for the past 30 years demonstrate a major shift of some Canada goose populations from deep south to midcontinent in states east of the Mississippi River. But growth of the flock using South Carolina's Santee National Wildlife Refuge from 10 geese in 1943 to 40,000 in 1964 should remind us to look at characteristics of individual goose populations, and not merely gross shifts in goose numbers for broad geographic areas. Improved knowledge of the Santee Refuge flock's population dynamics and behavior during fall migration would help us understand growth of this flock, at the same time other deep south flocks declined.

A scattering of remnant groups of Canada geese having unique behavioral patterns adapted to local wintering areas remains in the south. Hope rides with these remnants for increasing Canada geese in the south, rather than by transplanting more migrant or wintering geese from midcontinent to the south. Hankla described the general lack of success with goose transplantation projects.

Recommendations are needed to show how to protect and increase each remnant flock. Providing the facts required to formulate the recommendations

is a top priority research task recommended by Crissey. Successful application of knowledge could help satisfy the objective of increasing wintering goose flocks throughout the south.

This entire session developed broad perspectives essential for viewing management of Canada geese properly. It leads to one conclusion. Capitalizing on the available golden opportunities to intensively manage Canada geese will require stronger leadership, continuing cooperative and coordinated efforts by all organizations and individuals involved, and improved funding.

More funds than those available now are needed to improve goose management and research efforts. Taxonomic studies, especially in the remote northern Canadian breeding grounds, are costly. Administering a tagging system to distribute hunting privileges and avoid excessive goose harvests will take additional money. Vaught emphasized that prices of lands required for goose management areas are escalating. Possibly hunters would endorse a nominal fee for goose hunting applications or tags used to place management of geese on an elevating sustained yield basis. The alternatives would be to seek general funds to advance the entire program. Regardless of source of funds, spending those funds in goose investigations, management areas, and harvest management could provide immediate and long-term benefits.

With the vast breeding grounds not disturbed adversely by man and numerous wintering grounds capable of accommodating more Canada geese, intensive harvest and habitat management hold promise for encouraging individual populations to expand and utilize available breeding and wintering habitat. Larger goose populations would provide increased hunting privileges and other recreational opportunities. This is a unique opportunity for wildlife managers to demonstrate the dividends which can be realized from more intensive management of a wide-ranging international resource. But management efforts must be guided by overall plans to prevent competitive management. With continuing effective teamwork the future of Canada geese in North America looks very bright.

Discussion

ONE THING this book has called for is goose hunting of high quality. It is easier to count geese than it is to measure the quality of recreation. Quality is intangible. Its measurement involves subjective judgments. As William Webb has said, "There is no ruler or scale of absolutes to support our uncertain judgments of what is high quality in recreation." It is often easier to analyze an experience of low quality. In this respect quality is like another abstract concept: justice. We may not be able to define justice, but most of us would agree that we can identify an injustice. Yet each human being does have his own private feelings about quality. Each individual seeks out experiences which he intuitively feels are quality experiences. It is difficult to put into words why a particular experience is of high quality because such a statement involves an attempt to quantify an aesthetic emotional experience. If we are to manage for quality hunting as well as for quantity geese, however, we must make some attempt to describe and delineate as tangibly as possible what it is we seek as well as what we seek to avoid:

For example, shooting geese in a poorly-managed situation approaches slaughter, not sport. There is no suspense, no challenge. The birds are tame, the shooters wild. You are almost as sure of bringing home a gander as if you were to visit your local meatmarket—provided you can run faster than the fellow in the next blind. Goose hunting in such a setting bears more resemblance to a spectator sport like football than to bona fide hunting—a football game between the Green Bay Packers and Gopher Prairie High!

Rightly done, on the other hand, goose hunting is far from a simple, one-time game. It is a year-round ritual, as complete with secret incantations, special garments, secluded chapels, and sacred scriptures as the most elaborate rites of an exclusive fraternity.

The uninitiated hunter may actually regard shoulder-to-shoulder shooting as fun, of course. He may relish the race to claim a cripple, the exchange of cusswords, or even simply his seat in a government-owned stadium. The real question is, should goose managers participate in degrading a great recreational resource in such a manner? The answer surely is "No!" To provide guidelines to quality goose hunting, we have to begin to "tell it like it is."

* * * *

Capturing the spirit of the sport is not easy. There are many forms of quality goose hunting. There is field shooting—locating the feeding geese one day, digging a pit in the dark of the night, and at dawn the distant gaggles of geese which you try to call in to your decoys. There is the hunt on a sand bar—with the voice of the river in your ears like an organ. And there is the mixed hunt on a duck marsh where geese are more or less an unexpected bonus that makes the morning extra-special. Whatever the setting, certain ingredients are essential.

Wherever he hunts, the principal amulet of the true goose hunter is the decoy, which you fashion in your basement workshop during the dog days of winter. While you may lace your set with some manufactured jobs of styrofoam, you place your real faith in the silhouettes or blocks you route out by hand, and paint and repaint with all the devotion of a Michelangelo.

An early fall sacrament of the goose hunter is known as "fixing up the blind." No matter how sturdily you may build your marsh hideout in the first place, the amount of annual maintenance is considerable. As you work, you make your distinctive preseason signal, a series of dull thuds accomplished by engaging the butt end of a tamarack post with a heavy mall. Sometimes this basic call is accompanied by a low muttering, not unlike an oath.

After shoring up the framework with due ceremony, you turn to the ritual of cutting, bundling, and tieing on a new covering of camouflage. Securing rushes to the snow-fence sides of a blind is an art known only to waterfowlers. No woman arranging living-room draperies exercises

such sophisticated care. From the perspective of every possible on-coming bird, the outline of the blind and its inhabitants must be perfectly concealed. To double-check your artwork, you row out to take a look before you tie on the last batch of bundles, as if you were arranging the exact trappings of a communion altar.

At this time of year you will also frequent your marsh shack, replacing the anchor cords on your decoys or painting your boat that shade of ineffable beauty, "dead grass tan." Being a true goose hunter, you are characterized by glassy eyes set in a head perpetually cocked to left or right, as you listen constantly for the sibillant sound of waterfowl wings. That is not a cigar you have in your mouth. It is a reed on which you continuously practice the cry of the Canada.

The crescendo of the goose hunting ceremony opens at 6:05 of a late fall evening, with the TV weatherman tracing on his map the course of a big "front" moving down from the north, preceded by rain and followed by falling temperatures. At 6:10 your phone rings. It is the High Priest of the Hunt—the friend who has a private marsh. "Did you see the forecast?" he asks. This is the password. You give the counter-sign. "I sure did." The High Priest utters the magic words, "Let's leave at 8!"

That is the signal for collecting by the numbers the biggest stockpile of combat gear this side of Vietnam. Stationwagon loaded, you flee the suburbs in frantic haste, like a couple of refugees deserting a doomed city. The rain beats a tatoo on the windshield, and the wind sends cascades of sodden leaves across the glistening road. You don't talk much, because idle conversation might break the spell of the ceremony. You turn off the highway onto a county trunk, then onto a town road, and finally onto a slippery lane. In a patch of woods you cache the car and head down through the swamp, your flashlights making only a feeble dent in the blackness as you slosh along in knee-deep muck. The rain has stopped now, but the wind keeps up its high-pitched litany in the tamaracks, punctuated once by the gabble of snow geese waving unseen overhead.

After a tortuous half-mile hike you stumble up to a quonset hut. The stubborn padlock finally yields to a special curse, and you enter the mystic domain of the goose hunter—the shack. Lamps are lit, stove stoked, alarmclock set, all according to a routine as immutable as a baptism. You sleep only fitfully, disturbed by visions, and you are up making breakfast before the alarm goes off. You have to crack a film of ice on the water bucket. It will be "a good day for ducks." You paddle out to your blind early, well before the sun is up, because there is a special magic about a pre dawn pothole. To the accompaniment of the mysterious noises of the night, you place the blocks—a tight knot of puddlers here, a string of divers there, and in between a gaggle of geese. To toss out the decoys you have assumed a kneeling position. This attitude of prayer is a vital part of the goose hunter's ritual. As if in answer to your supplication, a brace of bluebill bursts by.

You hunker down in your blind and watch the dawn wrestle with the dark. A mallard hen becomes audibly enthusiastic back in the rice beds, but you cannot make out what she is talking to. You hear a flock of sprig, pitching pondward, tear the dark silk of the night in one long rending nose-dive, but there is still nothing to see except stars. Then with an unbelievable rush the dark is gone and you are revealed to be suspended in time and space—a pair of goose hunters eye-deep in the marsh like so many muskrats, clinging to the strand of cattails that separates tamarack from tossing waters. A sense of history lies heavy on such a place. Yearly since the ice age it has awakened each fall morning to the clangor of Canada geese and the beating pinions of pintails. In the incredible sweep of millennia which underlies the affairs of nature, your hunt is only a momentary intrusion.

Far to the northeast, winding the oxbows of the river, an arrow of waterfowl cleaves the dawn sky. They appear to be geese. Are they moving steadfastly south or are they looking for a place to sit down? Can they hear you? These are the immemorial questions that lend almost unbearable suspense to the world of the waterfowler. You give them a tentative toot on your goose call. They seem to answer. You go to work in earnest. They turn your way, giving tongue to a few querulous honks. You crouch down in the boat and hold your breath. Majestically the flock swings high over you, stepping up its conversation.

Do they like what they see? After an agonizing pass to the west they

come pumping back. In a pandemonium of trumpets, croaks, and cries they set their wings and glide down, black landing-gear lowered and rumps white against the far hills. Out in the middle of the pond they come to rest with a great honking and splashing, long necks and beady eyes surveying the scene with the caution that has brought them safely to this spot from Hudson Bay.

This is the climax of the goose hunter's ceremony. No matter how many times you have been initiated, it is always a breathtaking experience. No other outdoor event is so fraught with primeval drama. For one awful second there is nothing in time but you, a little stretch of windswept pothole, and a huddle of wild waterfowl. For a magic moment you look right into the eye of nature. What you see displayed before you, as Leopold wrote, is no mere bird. The Canada goose is the symbol of our untamable past, a cymbal in the orchestra of evolution. His annual pilgrimage is the ticking of the geologic clock. Upon the hunters he visits he bestows a sort of blessing, and upon the place of his alighting he confers a peculiar distinction. Amid the antiseptic surroundings of civilization, a goose pond holds a paleontological patent of nobility. The sadness discernible in some subdivisions arises, perhaps, from their once having harbored geese. Now they stand humbled, cut off forever from the flow of nature.

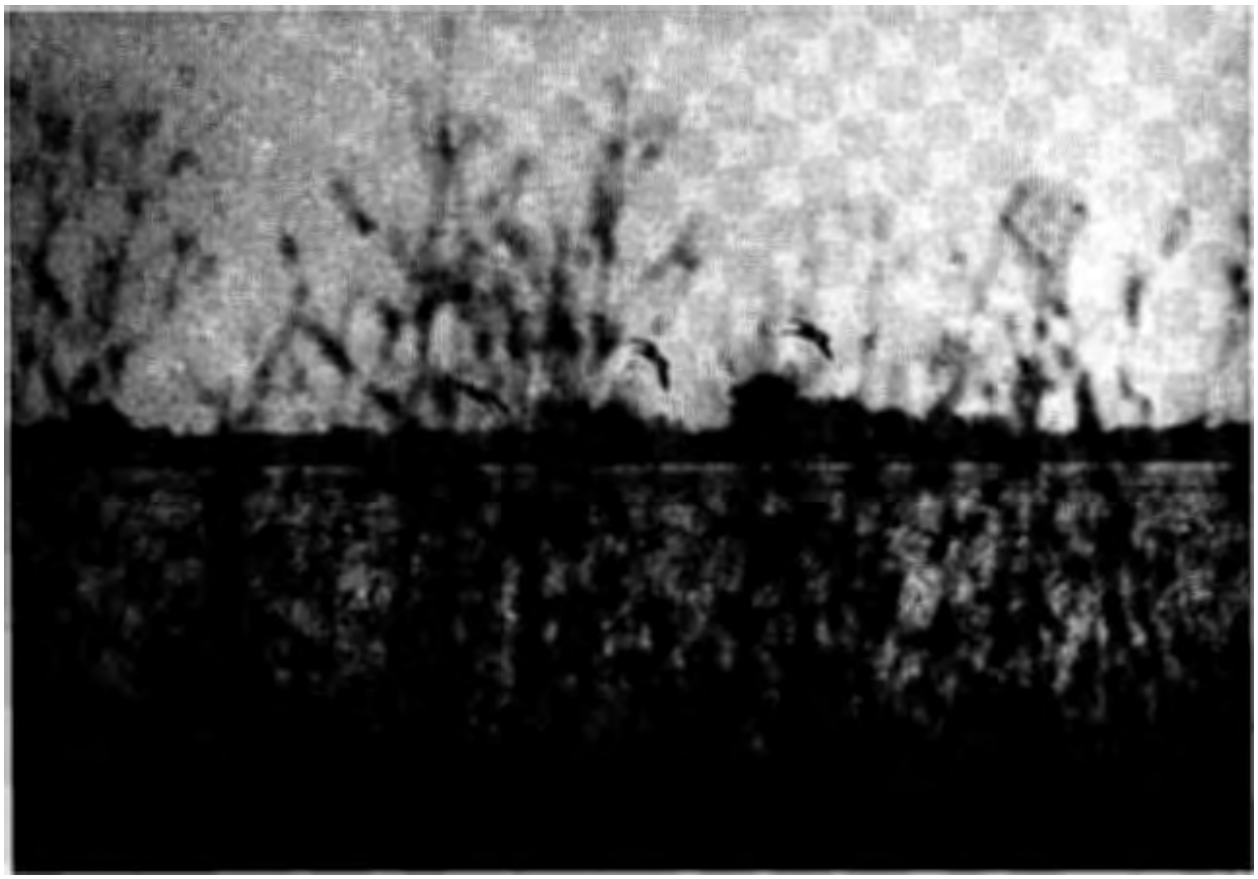
The geese are not with you long. For a moment they conduct a loud debate over the relative merits of staying or of heading south. The urge to travel wins. With a surge of flapping and gabbling they take off. Their angle of ascent and the direction of the wind are such that they present you with a target as they gain altitude—16 huge honkers spread out in the sky right in front of your blind. The firing of your gun is strictly anticlimactic. Almost reluctantly you throw three quick shots at the milling mass of birds.

One gander collapses with that clean abandon that makes the deed seem preordained. The rest continue on their way without so much as breaking formation, to become once again nothing but a distant "V" on the southern horizon. The geese have fought a good fight, and you have kept the faith.

How your priesthood has developed, anthropologists aren't sure. One theory holds the goose hunter to be a throwback to a race of amphibians that never totally made the transition from water to land. Goose hunters themselves claim they represent the acme in man's evolution, because of their manifest kinship with the sky as well as with the ground. Once the true goose hunter was quite common. Today, even in the presence of more geese, he is becoming increasingly rare. Circumscribed by restrictions on his gun, his hours, and his bag; harassed by pseudo sportsmen on "managed" hunting grounds, driven from his marshes by drainage projects, housing developments, and power boats; plagued by the vagaries of the weather; ridiculed by his business associates and ostracized by his family —all in all it could be that the true goose hunter, and not the goose, will go the way of the passenger pigeon, and in another generation will be found only behind glass in a museum. Indeed, maybe the government has been going about things all wrong. Instead of collecting $3 a year from every waterfowler for the protection of waterfowl, perhaps Washington ought to collect $3 from everybody else for the care and preservation of pure goose hunters. Certainly it would be an evil day for America were a certain dawn in autumn not to signal the assemblage of avid goose hunters in isolated swamps, their storied tenacity testifying to something special in the human spirit.

What do these vignettes of low and high quality goose hunting suggest as management guidelines? Webb proposes an "Index of Congestion" as a crucial consideration in judging quality. Platoons of people hunting shoulder to shoulder are not engaged in quality recreation. Regulation of intensity of use of land and water for goose hunting becomes, then, an essential management goal. Too many hunters in one spot can end quality goose hunting more swiftly than too few geese in the same spot. In the words of a Mississippi Flyway position paper: "This is not a recreation for the masses. If it is to possess quality, there must be appropriate restrictions on hunter numbers as well as on how they utilize this limited resource."

In this day and age, of course, some compromises with quality are



probably unavoidable, Hawkins points out. The plain fact is that most flocks of geese have become associated with a relatively few concentration points, many of them man-made. Concentrations of hunters follow, many of them deliberately arranged. How can we avoid this curse of the concentric ring?

In some places we cannot. We are too committed. Yet even here we can at least insist on enough room between shooting pits that the birds can respond to decoys and calls without being skybusted. In other places we may not be so committed that we cannot reverse the trend—by spreading more geese among satellite areas, and by extending the diameters of the "demilitarized zones." There is always bound to be a periphery somewhere, but it should be far enough away from the inner core to minimize the undesirable features of a truncated boundary. In still other places we can set up quality standards from scratch, rather than recapitulate the management practices that have created as many problems as they have solved by contributing directly or indirectly to the degradation of quality recreation.

* * * *

Besides goose hunting of sustained quality, this book has called for goose populations of higher quantity. What's the point of this computerized concern for Canada geese in a day of circling satellites? We can give you hard-nosed answers, couched in dollars and cents, if you want it that way. Because North American waterfowling is a multi-million dollar business. But we have other answers, too. For one thing, goose research is important simply because the world of research is all of one piece. As we study waterfowl we are participating surely in that broad sifting and winnowing for knowledge that can lead miraculously from inland marsh to outer space. Goose conservation is important because conservation, too, is all of one piece. Ignore any phase of outdoor husbandry like goose management and you jeopardize all our natural resources. More significantly, the American way itself is all of one piece. Stem the pursuit of happiness and you stem life and liberty. For millions of Americans the pursuit of happiness is linked inextricably with the sights and sounds of wild geese.

Almost any fall or spring night you can hear the voice of "the good life"—the querulous, clarion call of migrating Canadas. At first it may be so faint and indistinct as to be mistaken for the background static on a distant radio. Then, as the long, unseen line whip-saws high overhead, a wild chorus from a hundred straining throats proclaims the turn of the seasons in a song as old as time, yet ever new. Winging steadily in flying wedges and wavering lines, the leaders calling the tired stragglers on, their eerie chant ringing across the breadth of wilderness and metropolis alike, the Canadas call to us. Listening in the dark we mark these Nomads of the night as they journey down the trackless sky trail. Our minds are moved by the old riddle of bird migration; our hearts are stirred by a compelling intimation of our kinship with nature.

The Canada goose, like perhaps no other outdoor creature, has had the power to inspire a concern for outdoor husbandry in human breasts. A generation ago one of our most colorful conservation leaders got on the stump at an early meeting of the infant Izaak Walton League to make a dramatic plea for the restoration of a great refuge. First he painted a picture of the marsh of yore—"the greatest paradise for game and fish in the northwest, 6 miles wide, and 16 miles long, picturesque and beautiful in the extreme, with its peninsulas, islands, and numberless bays and coves, abounding with ducks and geese." Then, his voice quavering, he described the marsh after the ditchers and drainers had wreaked their havoc: "Not a drop of water in all this great territory, the river as dry as a floor, miles and miles of cattails, weeds, and Canada thistles." His conclusion had all the impact of a trumpet: "There is an awakening call in the breezes. Our marsh is the hope of the future. Let us fight for the old heritage, the sights our fathers saw. Restore them for posterity is my plea, for the tomorrow of our boys and girls."

The call was heard, by plain people and by politicians, from Weyewauga to Washington. The restoration of that marsh slowly became a reality. And the geese came back. The masses of big birds milling today over Horicon represent more surely than a missile a triumph of man. For one species to protect another is really a new thing under the sun, as Leopold observed. The Cro-Magnon who slew the last mammoth thought only of steaks. The hunter who shot the last passenger pigeon thought only of his prowess. But we have saved geese. In that fact rather than in Colonel Carpenter's rocket lies objective evidence of our superiority over the beasts.

As Jahn emphasizes, if we are to continue to save Canada geese in quantity and Canada goose hunting of quality, the concept of harvest management units is "crucial" to placing the husbanding of the birds on a sounder foundation and to advancing a pattern of sounder hunting regulations. The harvest management unit concept is based on our growing recognition that Canada geese are not so many peas in a pod. They can be approached meaningfully in terms of there being discrete ecological groupings, each with its particular habits and requirements. Gross continental and even flyway data can therefore give way to "more definitive information on subspecies, populations, and flocks; something more than simple, uniform flyway and even statewide regulations" can follow.

We need information on the location, extent, and nature of breeding grounds, migration routes and areas, and wintering grounds. Reproductive characteristics and patterns of mortality, especially that resulting from hunting, must be determined for each location within the entire range of a manageable population or flock. Such studies will call for a high level of teamwork among researchers and managers at international, federal, flyway, regional, state, and local levels. Once we begin to acquire and evaluate results from refined researches, we can establish "special hunting regulations for individual manageable flocks of Canada geese."

It may be instructive to review briefly one set of such regulations now in effect in association with the National Wildlife Refuge at Horicon, Wisconsin, which harbors each fall a very large increment of the Mississippi Valley Population of Todd's Canadas:

At the outset, a Wisconsin–Illinois annual harvest ceiling is set. The development and application of such an interstate goose-kill quota system "is recognized as one of the important recent advances in the history of waterfowl regulations." Within Wisconsin, a computerized state-

wide tagging system, similar to that used on big game, is in effect to reduce and distribute excessive hunting pressure. The system employs three management zones.

An "inner management zone" is Horicon itself, where no hunting is permitted. An "adjacent management zone" has a season limit of 1 Canada goose per hunter possessing a special goose hunting permit; various other controls are applied to distribute hunting pressure in time and place as a means of attaining a reasonable goose-hunting experience. An "outer management zone," the balance of the state, has a season limit of 2 birds per hunter. Season length is a function of the size of the state's quota.

While such regulatory procedures may seem "drastic," they have been deemed essential "to bring goose hunting demands in line with goose supply" in the Mississippi Valley. Similar harvest management unit practices may hold promise for helping insure Canada geese in quantity and Canada goose hunting of quality wherever hunters and hunted present problems in distribution, Jahn believes. Whatever the approach, "complete planning is a must," focused on the premise that "space among hunters is the crucial element absolutely essential for providing opportunities for quality goose hunting."

* * * *

It may well be, however, that the ultimate purpose of Canada goose management is really much more than a concern for geese in quantity and goose hunting of quality per se. Is not rather our whole philosophy, our weltanschauung, at stake? In our relationships with geese is tested in no small way the totality of our relationships with men and land. If we botch up goose management we establish a subtle pattern that can progressively degrade our very nature. When we accomplish wise goose management we reinforce the emergence of an ecological conscience.

Tradition has it that geese in the Temple of Juno once saved the city of Rome. In 390 B.C. the Gauls attacked and drove the Romans to a steep, rocky hill known as the Capitol, which was used as a fort. One night the counsel Manilus was awakened by the cackling of the sacred geese. Rushing to the wall, he saw that the Gauls had almost climbed it. His shouts and the noise of the geese alerted other defenders, and Rome was saved.

The sights and sounds of Canada geese in the skies over America likewise alert us of the 20th century. There is a profound message in the music of migrating Canadas. It says, as Secretary of Interior Udall has written, that "our conservation challenge today is one of quality—purity of surroundings, an opportunity to stretch, a chance for solitude, for quiet reflection." The message of the geese reminds us as well that Henry Thoreau's decision to "live deliberately"—to absorb the natural world around him, not merely through the senses into his physical being but into his deepest thoughts, to scorn artificiality and find richness in simplicity—this is the nutrient of a great culture and a more peaceful world order.

So as we save the geese the geese save us.

Appendix

CONSOLIDATED BIBLIOGRAPHY

ALLEN, W. R.
1967. Development and Management of the Blythe Ferry Goose Management Area, Meigs County, Tennessee. Tenn. Game and Fish Comm. Rep. 15 p.

AMERICAN ORNITHOLOGISTS' UNION, COMMITTEE
1957. Check-list of North American Birds. 5th Ed. Port City Press, Baltimore. 691 p.

ARTHUR, GEORGE
1963. Minutes of the meeting of the Technical Section of the Mississippi Flyway Council. Newsletter 46:10.

BALHAM, R. W.
1954. The behavior of the Canada goose (Branta canadensis) in Manitoba. PhD Thesis. Univ. Missouri. 244 p.

BELLROSE, FRANK
1968. Waterfowl migration corridors. Ill. Nat. Hist. Surv., Biol. Notes No. 61.

BENT, ARTHUR CLEVELAND
1925. Life Histories of North American Wildfowl. U. S. National Museum Bull. 130.

BLAIR, W. FRANK, ALBERT P. BLAIR, PIERCE BRODKORB, FRED R. CAGLE, and GEORGE A. MOORE
1957. Vertebrates of the United States. McGraw-Hill Book Co., Inc., New York. 819 p.

BOYD, H.
1953. On encounters between wild white-fronted geese in winter flocks. Behavior 2:85-129.

BRADSHAW, JUDITH E. and D. O. TRAINER
1966. Some infectious diseases of waterfowl in the Mississippi Flyway. J. Wildl. Mgmt. 30:570-576.

BRAKHAGE, GEORGE K.
1965. Biology and behavior of tub-nesting Canada Geese. J. Wildl. Mgmt. 29: 751-771.

BRAZDA, A. R. and GERALD POSPICHAL
1966. Coordinated inventory of "small" Canada geese. Bur. Sport Fish. and Wildl. Rep. 7 p.

BRAZDA, A. R. and JOHN W. WINSHIP
1962. Coordinated inventory of "small" Canada geese Central and Mississippi Flyways. Bur. Sport Fish. and Wildl. Rep. 18 p.

BURT, WILLIAM H.
1964. A Field Guide to the Mammals. 2nd Ed. Houghton Mifflin Co., Boston. 284 p.

CARNEY, S. M. and A. D. GEIS
1966. A preliminary estimate of the Canada goose kill during the first three days of the 1966 Wisconsin goose season. U. S. Fish and Wildl. Service, Admin. Rep. No. 124. 3 p.

CHAPMAN, J. A.
1967. Population characteristics, hunter kill, and productivity of dusky Canada geese. M. S. Thesis. Oregon State Univ. 82 p.

COOCH, F. G.
1958. The breeding biology and management of the blue goose (Chen caerulescens). PhD. Thesis. Cornell Univ. 235 p.

COOK, R. S. and D. O. TRAINER
1966. Experimental lead poisoning of Canada geese. J. Wildl. Mgmt. 30:1-8.

COPELIN, FARRELL F., EARL CRAVEN, CHARLES O. GILLIAM, and JIM ADCOCK
1964. Waterfowl hunting activities and harvest in the Tishomingo National Wildlife Refuge, Oklahoma 1960-1963. Southeastern Assoc. Game and Fish Commissioners Conf. 18:79-90.

CRAIGHEAD, FRANK C., JR. and JOHN J. CRAIGHEAD
1949. Nesting Canada Geese on the Upper Snake River. J. Wildl. Mgmt. 13:51-64.

CRIDER, E. DALE
1967. Canada goose interceptions in the Southeastern United States with special reference to the Florida flock. Paper presented at 21st Annu. Conf. of the Southeastern Assoc. of Game and Fish Comm. 26 p.

DAVIS, F. H.
1954. The Horseshoe Lake flock of Canada geese and some of its management prob-

lems. Rep. filed U. S. Fish and Wildl. Service, Minneapolis, Minn. 9 p.

DAY, ALBERT M.
1949. North American Waterfowl. Stackpole and Heck, New York. 329 p.

DELACOUR, JEAN T.
1954. The waterfowl of the world, Vol. I. Country Life Ltd., London.

DEY, NORMAN H.
1966. Canada goose production and population stability, Ogden Bay Waterfowl Management Area, Utah. Utah State Dept. Fish and Game. Pub. No. 66-7 (Federal Aid Project W-29-R). 38 p.

DINGELL, J. D.
1967. Eighteen million hunters contribute to the welfare of this nation. Congr. Rec., March.

DUNKESON, ROBERT L.
1965. Ten shell limit at Swan Lake. Mo. Conservationist 26 (11):14-15.

EAST, BEN
1954. The truth about Cairo. Outdoor Life 113(3):33-35, 118-122.

ELDER, WILLIAM H.
1953. Fluroscopic measures of shooting pressure on pink-footed and grey lag geese, p. 123-126. In The Wildfowl Trust, 7th Ann. Rep.

1950. X-ray measurement of hunting pressure. Trans. N. Amer. Wildl. Conf. 15:490-503.

1946. Implications of a goose concentration. Trans. N. Amer. Wildl. Conf. 11:441-446.

ELDER, WILLIAM H. and NINA ELDER
1949. The role of the family in the formation of goose flocks. Wilson Bull. 61(3):132-140.

FALLIS, A. MURRAY and DANIEL O. TRAINER, JR.
1964. Blood parasites, p. 343-348. In Joseph P. Linduska [Ed.], Waterfowl tomorrow. U. S. Dept. Int., Washington, D. C.

FASSETT, NORMAN C.
1957. A Manual of Aquatic Plants. Revised ed. Univ. of Wis. Press, Madison. 405 p.

FUNK, HOWARD D. and JACK R. GRIEB
1965. Baited cannon-net sampling as an indicator of Canada goose population characteristics. J. Wildl. Mgmt. 29:253-260.

GABRIELSON, IRA N.
1943. Wildlife Refuges. MacMillan, New York. 257 p.

GEIS, AELRED D. and S. M. CARNEY
1966. Effectiveness of the quota system in controlling the harvest of the Mississippi Valley Canada goose flock. U. S. Fish and Wildl. Service, Admin. Rep. No. 123. 5 p.

GEIS, AELRED D., S. M. CARNEY and RICHARD A. HUNT
1965. Distribution and degree of registration of the Canada goose kill in Wisconsin and Illinois, 1963 and 1964. U. S. Fish and Wildl. Service, Admin. Rep. No. 76. 9 p.

GEIS, AELRED D. and RICHARD D. TABER
1963. Measuring hunting and other mortality, p. 284-298. In Henry S. Mosby (Ed.), Wildlife Investigational Techniques, 2nd ed. The Wildlife Society.

GLEASON, HENRY A. and ARTHUR CRONQUIST
1963. Manual of Vascular Plants of the Northeastern United States and Adjacent Canada. Van Nostrand Co., Princeton. 810 p.

GREEN, W. E., HARVEY K. NELSON and CHARLES W. LEMKE
1963. Methods for determining cumulative goose kill on special areas. U. S. Dept. Int., Spec. Sci. Rep. Wildl. 72. 43 p.

HALLADAY, ORLYNN J.
1965. History and development of Seney National Wildlife Refuge, Rep. filed at Seney Wildlife Refuge, Seney, Mich.

HAMMOND, M. C. and G. E. MANN
1956. Waterfowl nesting islands. J. Wildl. Mgmt. 20:345-352.

HANKLA, D. J. and R. R. RUDOLPH
1967. Changes in the migration and wintering habits of Canada geese in the lower portion of the Atlantic and Mississippi Flyways with special reference to National Wildlife Refuges. Paper presented at 21st Ann. Conf. Southeastern Assoc. of Game and Fish Comm. 25. p.

HANSEN, HENRY A.
1962. Canada geese of coastal Alaska. Trans. N. Amer. Wildl. and Nat. Resources Conf. 27:301-320.

HANSEN, HENRY A. and HARVEY K. NELSON
1964. Honkers large and small. p. 109-124. In Joseph P. Linduska [Ed.], Waterfowl Tomorrow. U. S. Dept. Int. Washington D. C.

HANSON, HAROLD C.
1965. The Giant Canada Goose. So. Ill. Univ. Press, Carbondale. 226 p.

1962. Characters of age, sex and sexual maturity in Canada geese. Ill. Nat. History Survey, Biol. Notes 49.

1959. The incubation patch of wild geese: its recognition and significance. Arctic 12 (3):139-150.

HANSON, HAROLD C. and CAMPBELL CURRIE
1957. The kill of wild geese by the natives of the Hudson-James Bay Region. Arctic 10(4):211-229.

HANSON, HAROLD C. and ROBERT H. SMITH
1950. Canada geese of the Mississippi Flyway with special reference to an Illinois flock. Bull. Ill. Nat. History Survey 25(3):67-210.

HENDERSON, U. P.
1963. An economic analysis of the waterfowl resource of the Swan Lake National Wildlife Refuge and the impact upon the rural community. PhD. Thesis. Univ. Missouri. 157 p.

HENNY, C. J.
1967. Population characteristics of the dusky Canada goose as determined from banding data. M. S. Thesis. Oregon State Univ. 98 p.

HEWITT, OLIVER H.
1950. Recent studies of blue and lesser snow goose populations in James Bay. Trans. N. Amer. Wildl. Conf. 15:304-309.

HUNT, RICHARD A.
1964. Hunting Horicon honkers, Wis. Conserv. Bull. 29(5):15-16.

HUNT, RICHARD A. and LAURENCE R. JAHN
1966. Canada goose breeding populations in Wisconsin. Wis. Conserv. Dept., Tech. Bull. No. 38. 67 p.

HUNT, RICHARD A., J. G. BELL and L. R. JAHN
1962. Managed goose hunting at Horicon Marsh. Trans. Amer. Wildl. and Nat. Resources Conf. 27:91-106.

HUNT, RICHARD A., D. R. THOMPSON, A. J. RUSCH and G. F. MARTZ
1963. Some results of goose hunting regulations at Horicon Marsh, Wisconsin in 1963. Paper presented at the 25th Midwest Wildl. Conf. 7 p.

JAHN, LAURENCE R.
1968. The place of planning in waterfowl refuge management. Wildlife Mgmt. Inst. Rep.

1953. Aspects of a Canada goose management plan for Wisconsin, Part I. Wis. Conserv. Dept. 19 p.

JOHNSON, C. S.
1947. Canada goose management, Seney National Wildlife Refuge. J. Wildl. Mgmt. 11:21-24.

JONES, ROBERT D., JR.
1963. Buldir Island, site of a remnant breeding population of Aleutian Canada geese, p. 80-84. In The Wildfowl Trust, 14th Ann. Rep.

KACZYNSKI, C. F. and E. B. CHAMBERLAIN
1966. Canada goose surveys in Eastern Canada. Progress Rep. 1956, 1962-1965. Bur. of Sport Fish. and Wildl. Admin. Rep. 105. 16 p.

KEITH, LLOYD B.
1964. Some social and economic values of the recreational use of Horicon Marsh, Wisconsin. Univ. Wis., Research Bull. 264. 16 p.

KLOPMAN, ROBERT B.
1958. The nesting of the Canada goose at Dog Lake, Manitoba. Wilson Bull. 70(2): 168-183.

KRUTILLA, JOHN V.
1967. Conservation reconsidered. American Economic Review. Sept., 1967.

KUYT, E.
1966. Further observations on large Canada geese moulting on the Thelon River, Northwest Territories. Can. Field Naturalist 80(2):63-69.

LAGLER, KARL F.
1956. The pike (Esox lucius) in relation to waterfowl on the Seney National Wildlife Refuge, Michigan. J. Wildl. Mgmt. 20: 114-124.

LEBRET, T.
1956. Are group size counts of wild geese an index of productivity? Ardea 44:284-288.

LEFEBVRE, EUGENE A. and DENNIS G. RAVELING
1967. Distribution of Canada geese in winter as related to heat loss at varying environmental temperatures. J. Wildl. Mgmt. 31:538-545.

LEOPOLD, ALDO
1948. A Sand County Almanac. Oxford Univ. Press, N. Y. 226 p.

LEOPOLD, STARKER, et al.
1968. The national wildlife refuge system, a report of the Advisory Board on Wildlife Management to Interior Secretary Stewart Udall, March 11, 1968.

LINDUSKA, JOSEPH P. [Ed.]
1964. Waterfowl Tomorrow. U.S. Dept. Int., Washington, D.C. 770 p.

LYNCH, JOHN J. and J. R. SINGLETON
1964. Winter appraisals of annual productivity in geese and other water birds, p. 114-126. In The Wildfowl Trust, 15th Ann. Rep.

MacINNES, CHARLES D.
1966. Population behavior of eastern Arctic Canada geese, J. Wildl. Mgmt. 30:536-553.

1963. Interaction of local units within the eastern Arctic population of small Canada geese, PhD. Thesis. Cornell Univ. 121 p.

1962. Nesting of small Canada geese near Eskimo Point, Northwest Territories. J. Wildl. Mgmt. 26:247-256.

MARQUARDT, RICHARD E.
1962. Ecology of the migrating and wintering flocks of the small white-cheeked geese within the south-central United States. PhD. Thesis. Okla. State Univ. 179 p.

MARTIN, ELWOOD M.
1967. Characteristics of waterfowl hunters: activity categories for the 1965 season. U.S. Fish ahd Wildl. Service, Admin. Rep. 126. 10 p.

MARTIN, FANT W.
1966. Behavior and survival of Canada geese in Utah. Utah State Dept. Fish and Game. Pub. No. 64-7 (Fed. Aid Proj. W-29-r). 89 p.

MARTINSON, R. K. and J. A. McCANN
1966. Proportion of recovered goose and brant bands that are reported. J. Wildl. Mgmt. 30:856-858.

MAYR, ERNST
1963. Animal Species and Evolution. Belknap Press of Harvard Univ. Press. Cambridge. 797 p.

1942. Systematics and the Origin of Species from the Viewpoint of a Zoologist. Columbia Univ. Press, New York. 334 p.

MORRISON, FRANK B.
1956. Feeds and Feeding: Handbook for the Student and Stockman. 22nd ed. Morrison Pub. Co., Ithaca, N. Y. 1165 p.

MUNRO, WILLIAM T.
1963. Quebec waterfowl kill survey. Canadian Wildl. Service Rep.

1962. Quebec waterfowl kill survey. Canadian Wildl. Service Rep.

MURIE, OLAUS J.
1959. Fauna of the Aleutian Islands and Alaska Peninsula. N. Amer. Fauna 61, U.S. Fish and Wildl. Service, Washington, D. C. 406 p.

NASS, ROGER D.
1964. Sex and age-ratio bias of cannon-netted geese. J. Wildl. Mgmt. 28:522-527.

NELSON, HARVEY K.
1962. Recent approaches to Canada geese management. U.S. Fish and Wildl. Service Spec. Sci. Rep., Wildlife 66. 25 p.

PHILLIPS, JOHN C.
1916. Two problems in the migration of waterfowl. Auk 33(1):22-27.

PIRNIE, M. D.
1935. Michigan waterfowl management. Mich. Dept. Conserv., Lansing. 328 p.

RAVELING, DENNIS G.
1966. Factors affecting age ratios of samples of Canada geese caught with cannon-nets. J. Wildl. Mgmt. 30:682-691.

RICHARDSON, E. L.
1962. Evaluation of shell limit in goose management. Mississippi Flyway Council Newsletter 44:4.

1961. An evaluation of the effect of a shell limitation on goose hunting. Ind. Fish and Game Dept., Job Completion Rep. Fed. Aid Proj. W-Z-R. 33 p.

RUTHERFORD, WILLIAM H.
1965. Description of Canada goose populations common to the Central Flyway. Central Flyway Waterfowl Council's Technical Committee Rep. 20 p.

SCHENDEL, GORDON
1954. They call it "sport". Argosy 338(1): 32-33, 73-77.

SCHOENFELD, CLAY
1968. Cabins, Conservation and Fun. A. S. Barnes and Co. 335 p.

SCHOONOVER, LYLE J.
1966. Key areas in the harvest of tall grass prairie geese. Bur. Sport Fish. and Wildl. Rep. 7 p.

SCHOONOVER, LYLE J. and H. M. REEVES
1966. Geese --more or less? N. Dakota Outdoors 29(3):6-8.

SHERWOOD, GLEN A.
1967. Behavior of family groups of Canada geese. Trans. N. Amer. Wildl. and Nat. Resources Conf. 32:340-355.

1966a. Canada geese on the Seney National Wildlife Refuge. PhD. Thesis. Utah State Univ. 300 p.

1966b. Flexible plastic collars compared to nasal discs for marking geese. J. Wildl. Mgmt. 30:853-855.

1965. Canada geese of the Seney National Wildlife Refuge. Seney Nat'l Wildl. Refuge Completion Rep., Bur. Sport Fish. and Wildl., Minneapolis. 222 p.

1961. Black Brant of the Lower Kashunuk River. Rep. filed Alaska Dept. Fish and Game, Fairbanks. 36 p.

SMITH, J. D. and F. H. DAVIS
1958. Canada Geese of the Mississippi Flyway. Naturalist 9(1):13-17.

TINBERGEN, N.
1953. Social Behavior in Animals. John Wiley and Sons, Inc., New York. 150 p.

TURNER, L. M.
1886. Contributions to the natural history of Alaska. No. 11 in Arctic Series of Publications issued in connection with the Signal Service, U. S. Army, Washington, D. C.

U. S. DEPARTMENT OF THE INTERIOR
1967. Federal regulations governing the hunting, possession, transportation, importation of waterfowl, coots, and cranes, gallinules and snipe. Washington, D. C. 16 p.

1966. The Population Challenge. Conservation Yearbook No. 2, U. S. Gov't Printing Office, Washington, D. C. 80 p.

U. S. FISH AND WILDLIFE SERVICE
1945-1966 Midwinter inventories. Reports filed at Bur. Sport Fish. and Wildl., Minneapolis, and Ill. Dept. Conserv., Springfield.

1941. The Canada goose situation in Illinois. Rep. of Ill. Dept. Conserv. and Ill. Nat. History Survey, filed at Bur. Sport Fish. and Wildl., Minneapolis. 25 p.

VAUGHT, RICHARD W. and GEORGE C. ARTHUR
1965. Migration routes and mortality rates of Canada geese banded in the Hudson Bay Lowlands. J. Wildl. Mgmt. 29:244-252.

VAUGHT, RICHARD W. and LEO M. KIRSCH
1966. Canada geese of the eastern prairie population with special reference to the Swan Lake flock. Missouri Dept. Conserv., Tech. Bull. 3. 91 p.

WALKER, HELEN M. and JOSEPH LEV
1953. Statistical Inference. Henry Holt and. Co., New York. 510 p.

WEBB, WILLIAM L.
1968. Public Use of Forest Wildlife: Quantity and Quality Considerations. J. Forestry 32:106-110.

WILLIAMS, C. S.
1967. Honker. Van Nostrand Co. Inc., Princeton. 179 p.

WILLIAMS, C. S. and WILLIAM H. MARSHALL
1938. Survival of Canada goose goslings, Bear River Refuge, Utah, 1937. J. Wildl. Mgmt. 2:17-19.

WRAKESTRAW, GEORGE F.
1961. Season bag restriction of Canada geese. Wyo. Game and Fish Comm. Rep. 7 p.

YOCOM, CHARLES F.
1962. History of the Great Basin Canada goose in the Pacific Northwest and adjacent areas. Murrelet 43(1):1-9.

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WHILE Canada Goose Management represents a unique compendium of some of the latest thinking on the subject, it makes no pretense at being a definitive treatment of the bird. A more comprehensive consideration of the Canada goose must await the publication of a forthcoming book by Dr. Harold C. Hanson of the Illinois Natural History Survey. The book will deal particularly with the taxonomy, distribution, and evolution of the races of Canada geese. Dr. Hanson will postulate that there are at least 20 subspecies--an example of evolution in action that rivals the story of Darwin's finches. Dr. Hanson has now flown over and photographed most of the northern breeding grounds on the continent. His new book will contain numerous detailed maps and hundreds of oblique photographs of representative terrains as well as large numbers of diagnostic photographs of living examples of the various races. A second section of the publication will summarize a four-year study by Hanson and Dr. Robert L. Jones on the mineralogy of the primary feathers of the

races, the use of mineral elements in tracing individual birds to their birthplace, breeding, or molting grounds, and the relation of the feather elements to the ecosystems of the areas in question.

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Linduska (1964): pages 6, 7, 11, 26, 32 and 44.

Wisconsin Department of Natural Resources: pages 2, 102, 147, 159, 163 and 165.

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