Canada goose population and harvest characteristics at the Grand River Marsh Wildlife Area, 1977-1981. Report 164 [1994]

Wheeler, William E.; Hunt, Richard A. (Richard Allen), 1926-
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WISCONSIN DEPARTMENT OF NATURAL RESOURCES

RESEARCH REPORT 164

June 1994

Canada Goose Population and Harvest Characteristics at the Grand River Marsh Wildlife Area, 1977-1981

by William E. Wheeler and Richard A. Hunt
Bureau of Research, Horicon

Abstract

Grand River Marsh Wildlife Area (GRMWA) is one of the major state-owned goose management areas (6,958 acres) for the Mississippi Valley Population of Canada geese in Wisconsin. In the mid-1970s, high popularity of the area for goose hunting resulted in hunter crowding and excessive crippling losses. Goose harvest statistics were collected at GRMWA from 1977-81 to understand the forces influencing overcrowding and crippling for future management purposes. In this study of goose harvests we evaluated: (1) hunting pressure throughout the season, (2) hunter success rates, (3) harvest estimates with various daily bag limits and tags issued, and (4) crippling losses due to shooting. Data was collected by interviewing hunters in GRMWA parking lots and making observations.

The number of waterfowl hunters using GRMWA was heavily influenced by the abundance of geese. An average of 85% of the waterfowl hunters possessed goose tags and indicated they were actively hunting geese. The number of hunting trips made to GRMWA was directly influenced by the annual bag limit, decreasing by 60% when the bag limit was reduced from 4 to 1. Hunters traveled as far as 250 miles to hunt geese at GRMWA, traveling from 54 of the 72 Wisconsin counties. Fifty-three percent of the goose hunter trips originated from Milwaukee, Waukesha, Rock, and Dane counties, with 24% of all trips originating from the City of Milwaukee and its suburbs. Hunters favored early morning or late afternoon hours, and only 10% hunted all day. Hunting pressure was concentrated on opening days and weekends, the highest concentrations occurring on second openings following closures of split waterfowl seasons. Hunter success rates were low during the first week of the season, but increased as goose populations increased in mid-October, averaging 0.33 geese/trip. Crippling rates averaged 23% annually during 1977-81.

Since this study was completed, goose population peaks and goose use-days at GRMWA have tripled. In addition, zoning changes have made a larger number of hunters eligible to hunt the area. Consequently, the amount of hunting pressure, harvest, and hunter density has continued to increase.

The accuracy of current goose population estimates needs to be determined so that management decisions based on goose use-day goals can be made more precisely.

Elimination of "firing line" areas, controlling the number of hunters, or total managed hunts on goose management areas such as GRMWA are predicted to reduce hunter crowding and crippling losses.

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Errata for Research Report 164, "Canada Goose Population and Harvest Characteristics at the Grand River Marsh Wildlife Area, 1977-1981" by William E. Wheeler and Richard A. Hunt

1. Page 8, second column, second paragraph, third sentence should read as follows:

   Only in 1979 were the age ratios from bag checks at GRMWA the same as the USFWS tail fan surveys ($P > 0.05$).

2. Page 12, Figure 3.

   Ozaukee county should have a value of 1.
   Milwaukee county should have a value of 24.

3. Page 16, first column, second full paragraph, second sentence should read as follows:

   Lower ($P < 0.05$) crippling rates were reported by hunters using steel shot (14%) than those using lead shot (22%) (Wheeler et al. 1984).

Introduction

Grand River Marsh Wildlife Area (GRMWA) is one of several state wildlife areas developed to provide refuge and hunting opportunities for Canada geese (*Branta canadensis*) in Wisconsin. Early efforts at GRMWA were directed at attracting geese of the Mississippi Valley Population (MVP) away from the Horicon Marsh area in an effort to redistribute geese to a wider area using "satellite" refuges. These redistribution efforts came as a result of crop depredation problems in the area surrounding Horicon Marsh, which developed in the late 1960s (Reeves et al. 1968, Hunt and Bell 1973), as well as increased concerns about possible disease losses in concentration areas, such as occurred at the Horicon National Wildlife Refuge (HNWR) when over 225,000 geese concentrated there in the early 1970s (Klepinger and Ellis 1975; Miller and Miller, in press). Redistribution efforts coupled with increased goose numbers were so successful that by the late 1970s approximately 50% of the total number of geese in central Wisconsin were outside the Horicon Marsh area. By 1980, 65% of the population were outside the Horicon Marsh area with 100,000-150,000 geese present at GRMWA (W. Wheeler, Wis. Dep. Nat. Resour., unpubl. data).

The GRMWA is located just west of the Village of Kingston at the confluence of Spring Creek, Belle Fountain Creek, and the Grand River (Fig. 1). Land purchases for the GRMWA began in February 1958. As of August 1969, 6,958 acres were acquired in fee title, creating a 3,000-acre waterfowl refuge with the remaining lands developed for public hunting. During 1968-76, approximately 250 acres of uplands were maintained in corn (*Zea mays*), rye (*Secale cereale*), alfalfa (*Medicago satavia*), and buckwheat (*Fagopyrum esculentum*) strips to provide goose feeding and loafing areas.

Canada geese traditionally used the Grand River Valley in wet falls during the 1960s (J.R. March, Wis. Dep. Nat. Resour., pers. comm.). Increasing numbers of Canada geese began using the GRMWA very early in its establishment. In 1968, even before the main flowage was created, 1,000 geese were seen using the river area within the newly acquired lands. Three months after the low-lands were flooded in 1969, 7,000 Canada geese were using the flowage. During 1972-75, the entire MVP was fairly stable while the number of geese at GRMWA increased to 15,000 (Table 1). Hunting pressure had reached over 500 cars/day on the GRMWA and annual goose kills were estimated at approximately 2,500 during 1974-76 (T. Hansen, Wis. Dep. Nat. Resour., unpubl. data). Goose use-days at GRMWA doubled in 1976 (553,700) over the previous 4-year average (297,693). The GRMWA Master Plan annual goose use-day objective was 900,000 and the peak population objective was 30,000 (Hansen et al. 1982). In 1977 the total MVP peaked at over 575,000 and the number of geese at GRMWA increased to 56,000 as hazing was being conducted at HNWR to redistribute the MVP flock further south in the flyway (Klepinger and Ellis 1975).

Beginning in 1976 geese were discouraged from using the GRMWA as part of this same strategy designed to move geese more quickly through east-central Wisconsin. Food plots were eliminated and propane exploders were used to reduce goose concentrations on GRMWA. During 1977-81, upland food strips and green browse areas previously established for geese were replanted to grass nesting cover for ducks, emphasizing management for duck production (Hansen et al. 1982).

Prior to 1977 GRMWA was outside restricted tag zones and hunters were allowed one goose per day. GRMWA became part of the East-Central Zone in 1977, which was renamed the Central Goose Zone in 1979 (Fig. 2). During 1977-81 hunters were restricted to a seasonal bag limit of 1-4 geese by issuing tags to each permit holder.

This study was designed to gain information on the effects of increased hunting pressure on the harvest, hunter success rate, hunter behavior, and crippling rate of geese in a newly created goose management area such as GRMWA. Identification of these major characteristics of the goose harvest and hunter activity on a state wildlife area of primary importance to Canada geese in central Wisconsin provides historical data to aid in management strategies to stabilize the goose population and reduce overcrowding of hunters.

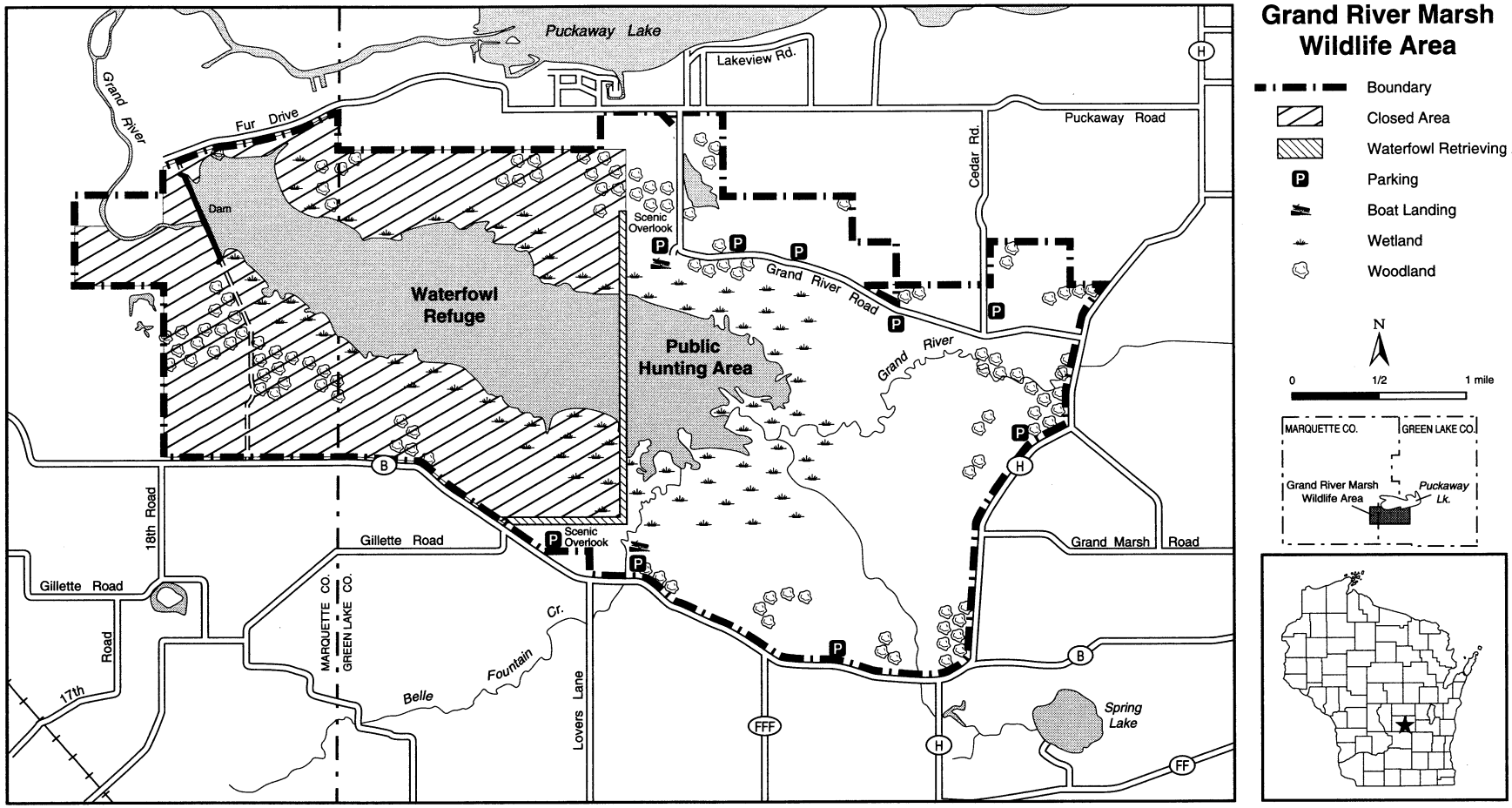


Figure 1. *Location of Grand River Marsh Wildlife Area and the general distribution of refuge areas and public hunting areas.*

Table 1. *Canada goose population trends for Grand River Marsh and east-central Wisconsin, 1972-81.*

Year	Grand River Marsh			Horicon NWR	
	Peak Aerial Census[a]	Peak Ground Counts[b]	Goose Use-Days[c]	Goose Use-Days	Mid-December[d] Surveys (MVP)
1972	5,600	6,000	185,750	10,594,000	295,800
1973	8,200	15,000	445,050	11,379,000	277,700
1974	9,800	11,000	311,950	10,775,000	304,300
1975	13,200	10,000	248,025	10,535,000	305,900
1976[e]	12,400	23,500	553,700	7,242,000	478,500
1977[f]	47,000	56,600	1,720,250	6,405,000	575,000
1978[g]	40,000	42,000	1,093,550	2,076,000	434,500
1979[h]	14,600	22,000	650,515	3,686,000	394,900
1980	15,000	36,270	1,081,477	4,441,000	367,400
1981	18,900	40,460	933,475	4,842,000	250,900
1977-81 Mean	27,100	39,466	1,095,853	4,290,000	404,640

[a] J. Winship, USFWS, unpubl. data.

[b] T. Hansen, DNR, unpubl. data.

[c] R. A. Hunt, DNR, unpubl. data. Goose use-days are defined as estimated number of geese per day x number of days geese observed.

[d] K. E. Gamble, 1981.

[e] HNWR: hazing by helicopter, airboats, exploders; water level draw down, food crops removed from refuge. Grand River Marsh: last year grain planted for geese.

[f] HNWR: only exploders and airboats used in hazing.

[g] HNWR: hazing by exploders and airboats, botulism outbreak and helicopter/airboats sanitation and hazing, statewide quota new high 50,000, kill estimate 224,800 MVP (Rusch et. al. 1985).

[h] HNWR: survey results affected by airboat hazing, cholera outbreaks and sanitation clean-ups by airboats/helicopter. Grand River Marsh: survey results affected by cholera outbreak and boat sanitation disturbances in refuge.

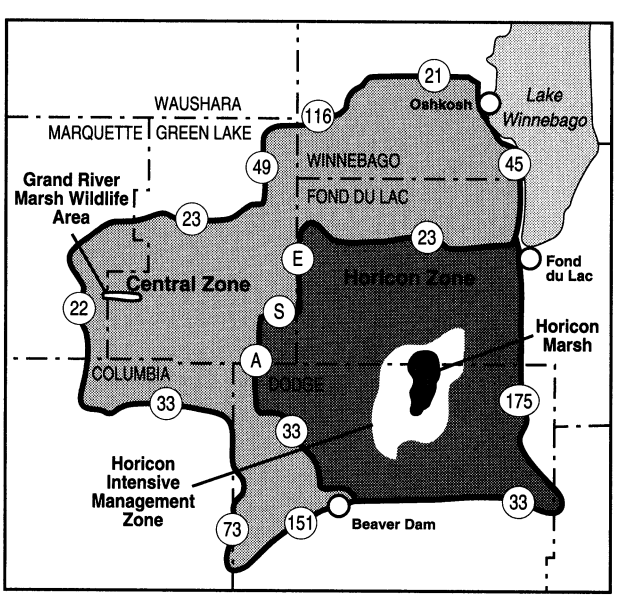


Figure 2. *Grand River marsh Wildlife Area relative to the Central Zone, 1979.*

Methods

Population Indices

Weekly Goose Surveys

An index of goose numbers at GRMWA was estimated each week by counting geese leaving the area to feed in the adjacent uplands. For use in this study, data were obtained from ground observers who counted geese in assigned zones of flight from prominent overlooks (T. Hansen, Wis. Dep. Nat. Resour., unpubl. data). Aerial surveys using a Cessna 337 and 2 experienced observers were also conducted weekly (J. Winship, U.S. Fish and Wildl. Serv., unpubl. data). The highest weekly count was considered the peak count during the fall. Total annual goose use-days for an area were estimated by averaging the number of geese present on 2 adjacent weekly counts, multiplied by the number of days between counts, and summing the use-days between counts for all counts during the fall.

Mid-winter Surveys

Aerial surveys were conducted annually on or near December by the U.S. Fish and Wildlife Service (USFWS) and biologists from the MVP states in the Mississippi Flyway.

Age and Sex Ratios

An index of the ratio of young to mature and male to female geese in the population at GRMWA was obtained by live-trapping geese using the cannon net method for banding during each year of the study (Dill and Thornsberry 1950). Geese possessed by hunters at exit interviews were also sexed according to cloacal characteristics and aged according to cloacal and tail-feather criteria (Giles 1971).

Harvest Characteristics

Hunter numbers were determined each day during the waterfowl season as an index of hunting pressure. Counts of hunters' cars in parking lots on GRMWA were performed 1.5 hours after the start and 1.5 hours before the closing of shooting hours, respectively. Car counts were timed to coincide with the morning and evening goose flights to and from the marsh when, presumably, the maximum number of hunters were present. The total number of cars counted daily was adjusted downward for all-day hunters as determined by interviewing hunters upon departure. Adjusted counts were then expanded by the average number of hunters per car to estimate the daily number of hunters at GRMWA. This is a minimum estimate; some cars may have left before 8:00 a.m. or arrived after 4:00 p.m.

Hunters were interviewed by clerks at the 4 major parking lots throughout the day as they returned to their cars. Information was taken on hometown location (1981 only), number of hunters in the party, birds crippled or knocked down but not retrieved as reported by the hunter, gun gauge, and shot type.

During 1977-81, bag checks were conducted daily on waterfowl hunters as they came off the marsh (Wheeler et al. 1984). The data provide an in-depth look at goose hunting statistics for the GRMWA. All geese possessed by hunters were checked for leg bands and neck collars and the number killed per hunter was recorded. Daily goose kill was calculated by expanding the kill recorded during hunter interviews by the total number of hunters estimated from car counts.

Statistical Analysis

Chi-square tests (Steel and Torrie 1960) were used to compare yearly and periodic hunter success rates, crippling rates, age ratios, and sex ratios.

Results and Discussion

Population Indices

Goose Counts

Canada goose population indices on GRMWA were collected throughout the fall, utilizing both aerial and ground counts during 1972-81 (Table 1). Only population trends were compared between the 2 counts, because the ground count was assumed to be a complete count while the aerial count was not corrected for geese present but not seen. Differences between the 2 methods were evident when ground counts varied 30-60% higher over the period than aerial counts for peak goose numbers. Both counts indicated a building population at GRMWA from 1972 through 1978. A peak count of 56,600 geese was recorded in October 1977 with peaks in the range of 14,000 to 20,000 recorded during 1979-81.

In 1977 and 1978, goose use increased to 4-6 times the 1972-75 average. These increases occurred even though all land in goose food crops had been converted to grass nesting cover for ducks. Midwinter surveys indicated the MVP declined during 1978-81, suggesting that the high flyway-wide MVP harvests of 184,000 in 1977 and 225,000 in 1978 (Rusch at al. 1985) reduced the number of geese available in fall flights to GRMWA and HNWR in 1979.

By 1980 aerial and ground counts as well as total goose use-days indicated an increasing population at GRMWA once again, and numbers

DNR PHOTO

Sexing and aging a Canada goose.

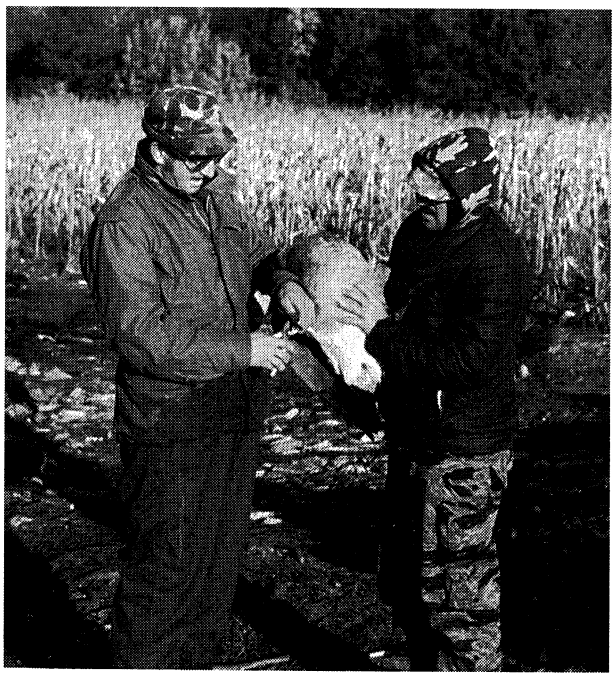
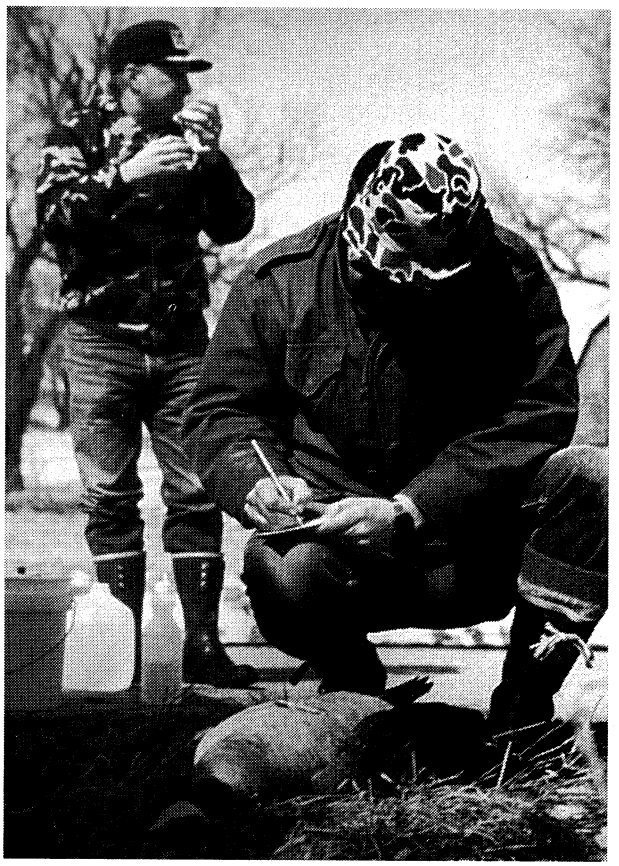


PHOTO: CHRISTIAN

Goose-banding.

Recording goose data.



DNR PHOTO

PHOTO: WHEELER

Bag-checking goose hunters in a Grand River Marsh parking lot.

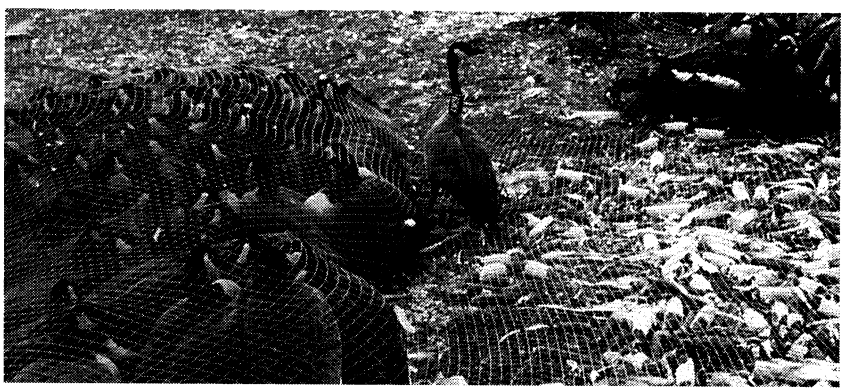


PHOTO: WHEELER

Geese captured by cannon net.

were much higher than those during 1972-75. Even with a decrease in the MVP and without a goose food program at GRMWA, goose use remained high during 1977-81. Peak numbers of geese on GRMWA continued to grow after the study (1987-91) to over 100,000 (W. Wheeler, Wis. Dep. Nat. Resour., unpubl. data).

Age Ratios

Age ratios of young to adult from harvested and fall live-trapped geese have been traditionally used as indices of the reproductive success of spring populations. These age ratios continue to be used even though they have been shown to be highly biased because of behavioral characteristics of geese (Nass 1964, Raveling 1966, Higgins et al. 1969) and hunting methods (Hanson and Smith 1950, Higgins et al. 1969). Because these ratios are biased toward a younger population, they do not accurately reflect reproductive success. Juvenile geese are more vulnerable to the hunter than adults. Hanson and Smith (1950) calculated that juveniles were over 8 times more vulnerable than adults at Horseshoe Lake in 1943 where decoy shooting was heavily practiced. Vaught and Kirsch (1966) reported young geese at Swan Lake, Missouri, were twice as vulnerable to shooting as adults. Rusch (1983) reported immature geese banded at HNWR (1960-80) were recovered at 2.72 times the adult recovery rate in the year of banding. Most geese were killed by pass shooting at both HNWR and GRMWA, whereas early Illinois hunting was mostly decoy hunting. In the absence of landing group counts (Raveling and Lumsden 1977), age ratios from cannon net samples were the best indicators of trends in the proportions of young in the population at GRMWA (Table 2).

The same general trends in age ratios were found by cannon net samples, bag checks and tail fan surveys from 1977 to 1981. The only exception was the low age ratio in the cannon net sample at GRMWA in 1979 when compared with statewide net samples. The 1979 cannon sample was the result of 2 large (over 120 geese) catches whereas in all other years catches only averaged 44-75 geese/catch. Raveling (1966) found that large catches are dominated by adults because they are more able to compete in the large groups and can defend feeding areas for young in family groups. Samples in the succeeding 2 years were from 8-9 net catches/year and may have been more representative of cannon catch age ratios in general.

The USFWS tail fan survey indicated consistently higher proportions of young in the sample that included geese from both pass and decoy shooting than either the GRMWA or Wisconsin cannon samples. This would be expected if young are considerably more vulnerable to the gun. Only in 1977 were the age ratios from bag checks at GRMWA the same as the USFWS tail fan surveys ($P < 0.05$). In the first 2 years of the study, the tail fan ratios were higher than bag checks while during the last 2 years the ratios were lower. Because the tail fan survey contains a high percentage of birds associated with HNWR, it was not expected to reflect age ratios from other concentration sites in Wisconsin. Therefore, care must be used when attempting to identify trends in production derived from age ratios in cannon-net catches.

In 1979 cannon samples from GRMWA indicated lower production when compared to cannon samples from all of Wisconsin, bag checks,

Table 2. *Age ratio (young to adult) of Canada geese from Wisconsin (sample size in parentheses), 1977-81.*

	Grand River Marsh WA*		Wisconsin	
Year	Cannon Net Sample	Bag Checks	Cannon Net Sample**	USFWS Tail Fan Survey***
1977	0.5(97)	0.9(1229)	0.3(546)	1.3(309)
1978	0.2(300)[a]	0.7(1532)	0.2(709)[a]	0.9(250)
1979	0.2(255)	1.3(536)[b]	0.4(325)	1.4(325)[b]
1980	1.1(393)[c]	2.0(760)	0.9(623)[c]	1.7(310)
1981	0.3(466)[d]	0.9(609)	0.4(732)[d,e]	0.5(195)[e]

* This study.

** GRMWA, Collins Marsh, Eldorado, Pine Island.

*** USFWS Admin. Rep.

[a-e] Values with same superscripts are not significantly different ($P > 0.05$).

and tail fan surveys (Table 2). Therefore, age ratio information from a single site must be used with caution in determining trends in production for the MVP.

In general, 1978 and 1981 were years with low proportions of young geese in the flocks of GRMWA and throughout Wisconsin. Hunter success rates however, were not proportionally lower in these years of fewer young (Table 3) as might be expected. Pass shooting appears to be more random and therefore less likely to select for young geese. In contrast, 1981 surveys at Horseshoe Lake (Thornburg and Estel 1983) in southern Illinois, indicated samples from the same population had 2.6 young/adult or a ratio 60% above the 1965-81 Horseshoe Lake average. In 1981 Wisconsin tail fans also revealed 0.5 young/adult or a ratio 60% below the 1965-81 Wisconsin average.

Generalizations about goose production from age ratios obtained from just one harvest area, cannon trap sample area, or even state totals for tail fan surveys may not be representative of a goose population. Even trends in total MVP tail fan age ratios is suspect due to probable differences in young vulnerability, yearly changes in goose use of harvest areas, quota shifts, weather, and disturbance to refuge areas.

Sex Ratios

Ratios of male to female geese harvested and live-trapped at GRMWA, live-trapped elsewhere in Wisconsin, and a sample of geese picked up during a lead-poisoning outbreak in 1981 are compared in Table 4. A majority of the cannon samples show a slight preponderance of males, although there were no statistical differences between ratios at sites in specific years. The ratios do suggest that females were shot more heavily at GRMWA in 1977.

Also of interest, the lead-poisoning outbreak in 1981 apparently affected males to a much higher degree than females. Males were disproportionately affected by lead, but we are not aware of any evidence to support differences in lead availability or susceptibility to poisoning between males and females.

Table 3. *Average daily goose hunter success rates at Grand River Marsh (sample size in parentheses), 1977-81.*

Year	First Day	Opening Day-11 October	12 October-31 October	1 November-20 November	All Season
1977	0.13(39)[a]	0.21(1,068)[a]	0.42(3,017)[b]	0.41(1,605)[b]	0.37(5,690)
1978*	0.03(199)	0.12(1,145)	0.38(2,337)	0.46(1,425)	0.36(4,907)[ij]
1979*	0.33(57)[cde]	0.40(501)[c]	0.31(1,041)[df]	0.25(445)[ef]	0.30(1,987)[ijk]
1980	0.12(121)	0.23(302)	0.32(1,353)[g]	0.30(993)[g]	0.30(2,648)[k]
1981	0.04(149)	0.27(622)[h]	0.27(942)[h]	0.40(774)	0.33(2,338)[jkl]
Mean	0.13	0.25	0.34	0.36	0.33

* Two birds daily bag limit, other years one per day.

[a-l] Values with the same superscripts are not significantly different ($P > 0.05$). Values are compared from period to period in each year except the percent for all season which is compared between years only.

Table 4. *Wisconsin Canada goose sex ratios of males to females (sample size in parentheses), 1977-81.*

	Grand River Marsh WA		Wisconsin		
Year	Cannon Net	Bag Check	State Nets*	HNWR Nets**	Lead Poisoning***
1977	1.1(97)	0.6(1,229)	1.2(435)	1.2(2,509)	
1978	0.9(300)	0.9(1,532)	1.1(616)	1.2(1,552)	
1979	1.1(255)	0.9(536)	1.0(445)	1.4(2,079)	
1980	0.8(393)	1.0(760)	0.9(623)	1.2(1,584)	
1981	1.1(466)[e]	1.2(609)[f]	1.1(732)[g]	1.0(1,009)[h]	2.6(882)[efgh]

* GRMWA, Collins Marsh, Eldorado Marsh, Pine Island.

** From Rusch et. al. 1985.

***L. Puckaway, L. Maria, GRMWA (R. A. Hunt, DNR files).

[a-e] Values with the same superscripts are different at $P < 0.05$; all values within years were tested.

Harvest Characteristics

Hunting Trips

High goose numbers were a major factor for the continued heavy hunting pressure on GRMWA during the study period. Goose hunter trips to GRMWA (6,958 acres) averaged 9,392/year (1977-81), ranging from 15,272 in 1978 to 5,980 in 1981 and were highly correlated ($r = 0.9482$) with the number of tags issued in the Central Zone, which included GRMWA (Table 5). By comparison, only 11,815 hunter trips were made in 1981 to all public hunting areas in the Illinois Quota Zone (58,100 acres) where hunter numbers were also regulated (Horseshoe Lake, 7,900 acres; Union County, 6,200 acres; and Crab Orchard NWR, 44,000 acres).

Proportion of Waterfowl Hunters Pursuing Geese

An average of 85% of the waterfowl hunters at GRMWA had goose permits and tags during the study period and indicated in interviews that they were actively hunting geese. The proportion of waterfowl hunters hunting geese fluctuated (73-96%) in direct relation to the number of yearly tags issued per person (Table 5). When only a single permit was issued for each hunter during 1980-81, the percent of waterfowl hunters actively pursuing geese declined substantially to 73-75%.

Hunting Patterns

Goose hunters were well aware of the morning and evening flight patterns of geese in and out of the GRMWA refuge, and concentrated their hunting efforts during periods of heavy goose movement. While most hunters hunted in either the early morning or late afternoon, few hunted both. On average, only 10% of hunters spent the entire day goose hunting (Table 5). The number of goose hunters spending all day doubled from 1979 to 1980, the first year with an annual bag limit of one. This may have been the result of increasing gasoline prices, fewer trips per hunter, or a decline in crowding on the areas immediately surrounding the refuge. Hunters at GRMWA paralleled those hunting in Wisconsin's Central Zone in making fewer trips during 1980-81 (3.2-3.3) as compared with 1979 (4.1) (Rusch et al. 1983*a*, 1983*b*; Rusch and Wetzel 1983). The total number of trips decreased by half from 1978 to 1979 when the annual bag limit was changed from 4 to 2.

Hunter Origin

GRMWA was a major area drawing goose hunters from around the state. Bag check interviews indicated that 24% of the total goose hunter trips to GRMWA originated from Milwaukee and its suburbs (Table 6). During a managed hunt on HNWR with a reservation system (1957-61), 30% of the trips originated from Milwaukee (Hunt et al. 1962). The increased mileage involved in making a trip to GRMWA rather than Horicon (+50 miles) appeared to have little effect. Thirty-nine percent of all trips to GRMWA originated from 17 cities other than Milwaukee (Table 6). Less than 5% of

Table 5. *Canada goose hunting statistics, Grand River Marsh, and East-Central* Canada goose hunting zone permit, quota and kill estimates, 1977-81.*

Year	Authorized Permits	No. Annual Tags	Daily Limit	No. Hunters w/Permits	Proportion of Hunters Hunting Geese	No. of Trips	% Hunted All Day	Estimated Goose Kill			
								GRMWA Harvest	GRMWA Unretrieved	East-Central Quota	East-Central Estimated Kill
1977	Unlimited	3	1	23,263	93	13,340	6	4,593	1,087	12,000**	16,000
1978	Unlimited	4	2	22,285	96	15,272	6	5,084	1,515	18,000**	17,250
1979	Unlimited	2	2	22,300	90	6,140	7	2,046	720	12,000	11,846
1980	Unlimited	1	1	30,300	73	6,228	15	1,960	521	10,000	8,619
1981	19,200	1	1	19,200	75	5,980	14	1,796	641	5,000	5,704
Mean					85	9,392	10	3,096	897		

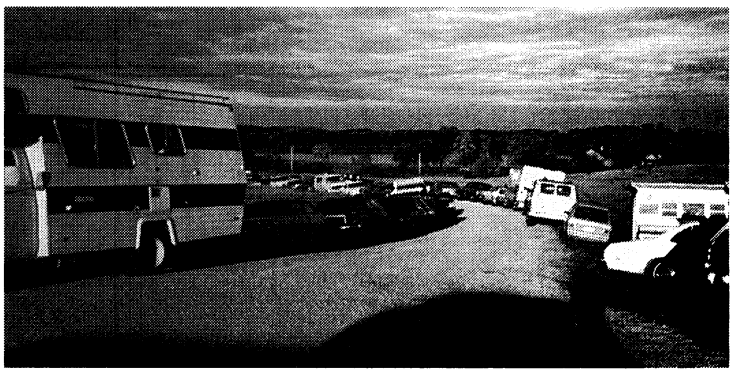
* Known as the East-Central Quota Zone 1977-78, Central Zone 1979-81.

** 1977 and 1978 Quotas included Central Zone plus the rest of the state not included in quota zones.

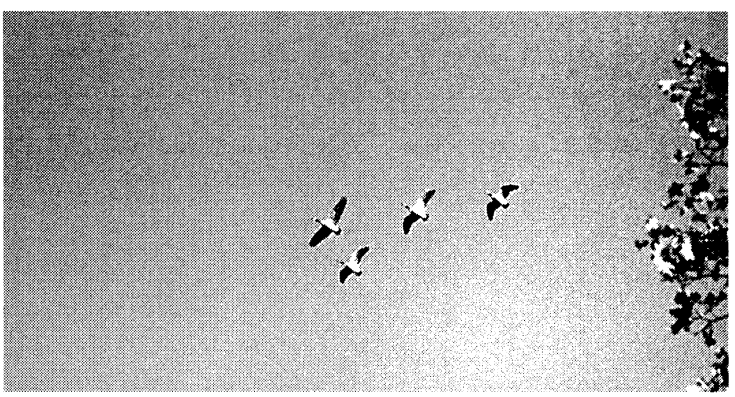
the hunter trips originated from local cities or villages within 25 miles of the marsh. Hunters were willing to drive long distances to hunt at GRMWA with some traveling over 250 miles for a chance to harvest only a single goose (Fig. 3). Fifty-three percent of all goose hunter trips originated from Milwaukee, Waukesha, Rock, and Dane counties.

Hunting Pressure.

As expected, hunting pressure was concentrated on opening days and weekends with the highest hunting pressure on Saturdays during 1977-81 (Table 7). Opening days falling on Mondays had somewhat lower hunting pressure than weekend openings. A midweek opening would probably have reduced hunting pressure even further. Numbers of goose hunters were highly correlated ($r = 0.960$) with the number of geese observed at GRMWA on opening day. Heavy hunting pressure on the second opening following the 5-day closure in the split seasons was believed related to hunters concentrating on duck hunting in the early part of the season,



Typical crowded parking conditions, 1976.



Typical range of geese at the "firing line."

PHOTOS: WHEELER

Table 6. *Origin* of goose hunter trips (2,214) to Grand River Marsh Wildlife Area, 1981.*

	Major Cities of Origin**		Local Cities and Villages Within 25 Miles		
Area	**No. of Trips**	**% of Total Trips**	**Area**	**No. of Trips**	**% of Total Trips**
Milwaukee or suburbs	528	24	Montello	22	1.0
Madison	156	7	Princeton	21	1.0
Janesville	94	4	Pardeeville	18	1.0
Stevens Point	87	4	Markesan	7	0.3
Beloit	86	4	Randolph	6	0.3
Racine	75	3	Kingston	4	0.2
Waukesha	56	3	Dalton	4	0.2
Kenosha	54	2	Marquette	1	0.1
Wisconsin Rapids	42	2	Manchester	1	0.1
Sun Prairie	35	2	Green Lake	1	0.1
Chicago and suburbs	29	1	Fox Lake	1	0.1
Portage	29	1	Cambria	1	0.1
Edgerton	28	1			
Wautoma	24	1			
DeForest	23	1			
Montello	22	1			
Princeton	21	1			
Pardeeville	18	1			
Total	1,346	63		87	4.5

* Mailing address.

**Cities from which 1% or more of the hunter trips originated.

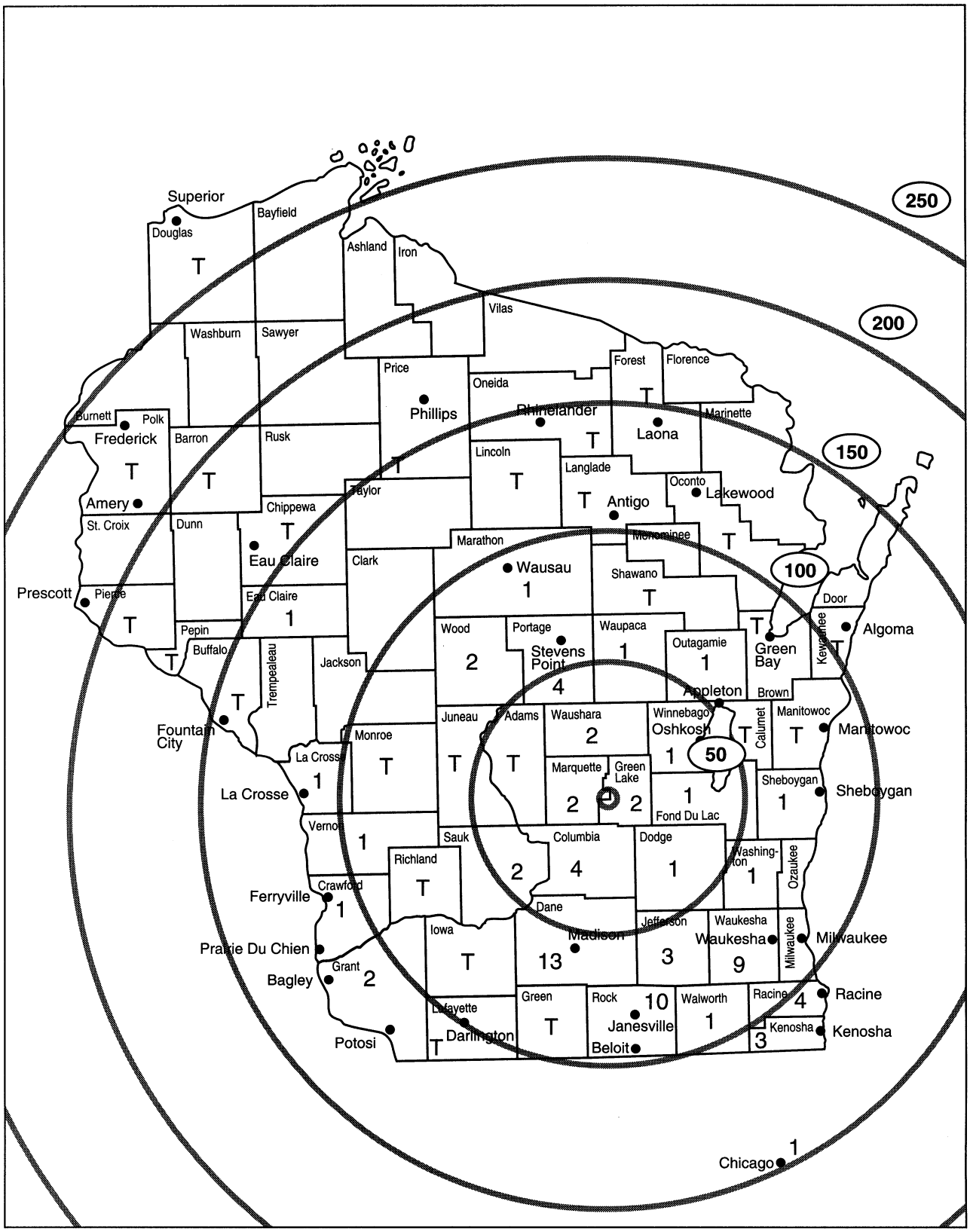


Figure 3. *Percent of hunter trips to Grand River Marsh Wildlife Area to hunt Canada geese in 1981, by county of origin. Less than 1% indicated by "T". Circled numbers show distance (miles) to Grand River Marsh.*

then shifting to goose hunting as duck numbers declined; a peak in goose numbers on GRMWA near the second opening; and the expectation of good hunting associated with opening days (Wheeler et al. 1984). When hunters were questioned in 1978 at GRMWA, 68% felt moderately to not-at-all crowded and 32% felt extremely crowded (Heberlein et al. 1978).

Shooting Efficiency

A high concentration of hunters on refuge boundaries (i.e., "firing lines") during weekends in 1977 and 1978 led to increased competition among hunters and "sky busting." The number of shots/goose were tallied from an observation point on the south refuge boundary at GRMWA during several Sunday mornings in 1977 (Table 8). The mean number of shots/goose downed was 23, nearly a box of ammunition. Many crippled geese sailed into refuge areas where they could not legally be retrieved. We do not know how many of these geese were retrieved or brought to bag. If only geese killed outright are considered, the number of shots fired per clean kill ranged from a low of 16 to a high of 87 shots/kill.

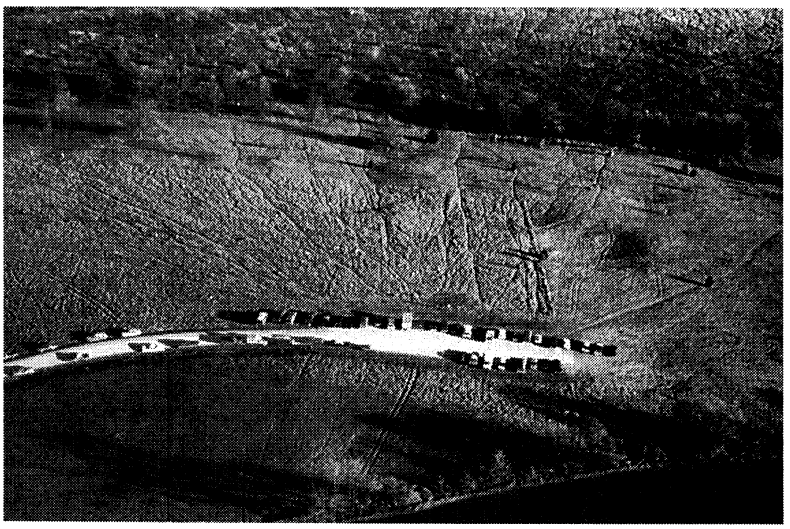


PHOTO: WHEELER

Grand River "firing line". Note trails to shooting area.

Table 7. *Distribution of Hunting Pressure During the Goose Season at Grand River Marsh, 1977-81.*

	No. of Goose Hunters					
Day/Period	**1977**	**1978**	**1979**	**1980**	**1981**	**Mean**
Opening day	142(Sat)	519(Sun)	85(Mon)	146(Mon)	326(Sun)	244
Opening weekend	694	–	–	–	–	384
Second opening day after split in season	742(Sat)	845(Sat)	331(Sat)	–	367(Sat)	571*
Second opening weekend	1,251	1,558	658	–	617	511*
Saturday (mean)	491	680	241	310	263	400
Sunday (mean)	425	521	247	210	247	352
All weekend days (mean)	497	595	244	258	254	375
Weekday	213	251	107	89	89	148

*Excludes 1980 when no split in waterfowl season occurred.

Table 8. *Shooting intensity on weekends on the refuge boundary at Grand River Marsh Wildlife Area, 1977.**

Date	**No. Shots Fired**	**No. Geese Killed**	**No. Geese Crippled**	**No. Shots/Goose Dropped**
30 October	96	3	5	12
2 November	373	23	2	14
6 November	524	6	5	48
Total	993	32	12	23

*Sunday mornings in 1977 represent the most crowded conditions experienced by hunters on the firing line.

Managed Hunts

Managed hunts eliminate competition by separating hunters in isolated blinds. In a managed hunt at GRMWA, Heberlein et al. (1978) reported that 17% of hunters in blinds in the refuge with no competition still fired one or more boxes of shells (25) per hunt. In comparison, 9% of those on the public firing line fired one box of shells or more. During the managed goose hunts at HNWR (1953-61) the number of shots per goose bagged reported by hunters ranged from 15 to 40 (Hunt et al. 1962). Hunt (1968) also reported that spy-blind observations (1963-64) indicated hunters reported 9-10% fewer shots taken than they were observed to fire. Managed hunts did not reduce the number of shots fired to bag a goose or eliminate poor shooting that was most likely due to shooting at geese out of range.

The experimental managed hunt at GRMWA was more successful than other managed hunts on public lands in the Mississippi Flyway. In 1978, a managed hunt was operated on GRMWA, during which hunters could hunt from blinds on the upland portion of the refuge area. The success rate of hunters during this hunt was 0.68 (Hansen 1979). Success rates of similarly managed hunts on Horseshoe Lake and Union County state areas in Illinois averaged 0.39 and 0.58 (Thornburg and Estel 1983). In comparison, goose-hunter success rates from Minnesota's Lac qui Parle area averaged only 0.17 during 1976-78 (Anderson et al. 1979).

Ammunition Type

Goose hunters on GRMWA refuge boundary firing lines used 61 different shotgun loads in 1977 (Table 9). These ranged from size 8 shot to #0 buckshot and included 24 illegal types of loads. All 12-gauge hunters were limited to the use of steel shot in 1977, yet we observed 23 different illegal 12-gauge lead loads being used by goose hunters. Apparently, hunters depleted their legal goose loads and then continued shooting illegal loads, regardless of shot size or type requirements. The use of illegal loads ranged from 1 or 2 rounds/hunting location to full boxes of obviously illegal lead loads/hunting site.

Hunter Success

Success rates of goose hunters at GRMWA averaged 0.33 geese/trip from 1977 to 1981 (Table 3). The success ratio in 1977 was higher ($P \geq 0.05$) than in all of the 4 succeeding years. These rates are somewhat lower than the 0.44 average success rates reported by hunters in the entire Central Zone (Rusch et al. 1983*a*, 1983*b*; Rusch and Wetzel 1983) during 1979-81. Success rates at GRMWA were analogous to the 0.25-0.33 success rates experienced by hunters in "free permit" areas (all hunting other than licensed clubs) in southern Illinois during 1981 (Thornburg and Estel 1983). Hunter success rates at GRMWA were generally low on opening day and throughout the first week of the season, but improved during mid- to late October as goose populations increased (Table 3). The lowest (0.03) and highest (0.46) success rates were recorded in 1978 for opening day and the period 1-20 November, respectively.

Harvest Statistics

The goose harvest (retrieved geese only) on the GRMWA averaged 3,096 birds during 1977-81 (Table 5). Harvest was the highest during 1977 (4,593) and 1978 (5,084). The harvest was highly correlated with both the increasing number of tags issued ($r = 0.955$) and high annual goose populations ($r = 0.949$) at GRMWA (Fig. 4). The 5-year mean annual harvest on the GRMWA of approximately 3,000 geese accounts for 17-31% of the Central Zone harvest of 6,000-12,000 geese (Rusch et al. 1983*a*, 1983*b*).

Unretrieved kill. Hunter-reported unretrieved kill averaged 1,114 geese/year at GRMWA or approximately 23% of the total kill annually (Table 10).

Bag checks. During 1978 and 1979, hunters at GRMWA were allowed a daily bag of 2 Canada geese. Bag checks, however, indicated that only

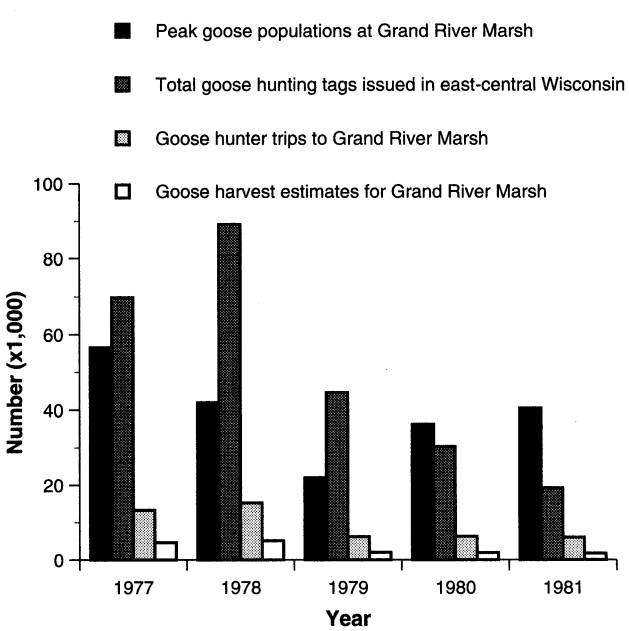


Figure 4. *Goose populations and harvest characteristics at Grand River Marsh, 1977-81.*

Table 9. *Range of shot types used to hunt geese at Grand River Marsh during 12-gauge mandatory steel shot season, 1977.**

Gauge of Gun	Shot Type	No. of Different Loads	Shot Sizes
10	Lead	5	2,4
12	Steel	10	1,2,4
12	Lead (all illegal)	23	0 buck, 4 buck, BB, 2,4,5,6,8, copper coated 2,4.
16	Lead	5	2,4,8
20	Lead	18	2,4,5,6,8, copper coated 2,
Total		61	10

*Hunters with 12-gauge shotguns were required to use steel shot in 1977.

Table 10. *Daily mean Canada goose crippling rates reported by hunters at Grand River Marsh (number of geese crippled in parentheses), 1977-81.*

Year	First Day	First Day-11 October	12-31 October	1-20 November	All Season
1977	0.38(5)	0.31(197)[ab]	0.19(1,161)[ac]	0.13(605)[bc]	0.18(1,963)[1,5,6]
1978	0.00(6)	0.24(105)	0.24(816)	0.21(597)	0.23(1,518)[1,2,7]
1979	0.21(19)	0.28(199)	0.24(291)	0.28(120)	0.26(610)[2,3,5]
1980	0.21(15)	0.18(133)	0.18(382)[d]	0.26(287)[d]	0.21(802)[3,4]
1981	0.14(6)	0.21(159)	0.28(238)	0.27(279)	0.26(676)[4,6,7]
Mean	0.19(10)	0.24(159)[e]	0.23(578)	0.23(378)[e]	0.23(1,114)

[a-e] Values with the same superscript letter are significantly different at $P < 0.05$; all values tested between the 4 periods within the same years.

[1-2] Values with the same superscript number are significantly different at $P < 0.05$; annual rates tested among years.

Table 11. *Success rates of hunters at Grand River Marsh Wildlife Area, 1977-81.*

Year	Number of Hunters Checked	Hunters Shooting Geese*				Percent of Successful Hunters with 2 Geese
		1 Goose		2 Geese		
		No.	%	No.	%	
1977	5,690	1,963	34	–		–
1978	4,906	1,039	21	239	5	19
1979	1,987	434	22	88	4	17
1980	2,648	802	30	–		–
1981	2,310	676	29	–		–
Mean	3,508	983	27	163	5	18

*Daily bag limit of 2 was allowed only in 1978 and 1979, all other years daily bag limit was 1.

Table 12. *The percent of hunters who reported crippling geese at Grand River Marsh (number of hunters interviewed in parentheses), 1977-81.*

Year	First Day	First Day-11 October	12-31 October	1 November to 18-20 November	All Season
1977	9(39)[*acd]	10(1,068)[ab]	10(3,017)[bc]	6(1,605)[d]	8(5,690)
1978	0(199)	4(1,145)	13(2,337)[e]	13(1,425)[e]	11(4,907)
1979	9(57)[fgh]	14(501)[fi]	10(1,041)[hj]	11(445)[gij]	11(1,987)
1980	3(121)[k]	12(302)[1]	7(1,353)[k]	10(993)[1]	8(2,648)
1981	1(149)	8(622)	13(942)[m]	14(774)[m]	12(2,338)
Mean	4(565)	10(3,638)[no]	11(8,690)[np]	11(5,242)[op]	10(17,570)

[a-p] All values with the same superscript are not significantly different ($P > 0.05$). Values are compared period to period in each year, except the percent for all season which is compared between years only.

5% of the total number of hunters were able to kill 2 geese/day (Table 11). Eighteen percent of the successful hunters were, however, able to bag a second goose.

Crippling Losses

Crippling rates of geese at GRMWA averaged 23% annually during 1977-81 (Table 10). Reported crippling losses during the Horicon managed hunt prior to shell limits ranged from 11-42% during 1953-61 (Hunt et al. 1962), and 7-10% during 6-shell limit seasons during 1963-64 (Hunt 1968). Crippling rates reported by hunters are probably minimum estimates, as hunters are known to under-report crippling by approximately 50% (Carney and Smart 1964, Hunt 1968).

In 1980, crippling rates by hunters using 12-gauge lead and steel shot were compared. Lower ($P > 0.05$) crippling rates were reported by hunters using steel shot (14%) than those using lead shot (22%) (Wheeler et al. 1984).

Crippling rates of geese and the percentages of hunters reporting such losses are recorded for various periods throughout the hunting season in Tables 10 and 12. The percentages of hunters who reported losing shot geese ranged from 0-14% and averaged 10% during 1977-81 (Table 12). Reported crippling was lower during the first day than in subsequent periods. This may have been due to lower goose numbers on opening day at GRMWA. No patterns of heavier crippling losses during opening days or during later periods were detected (Table 10).

Crippling rates of geese at GRMWA increased due to firing lines, as determined by observation, and probably exceeded other hunting situations in Wisconsin on private lands. At the time of this study, the USFWS added 13% unretrieved kill (Carney et al. 1982) to the total goose kill estimate in the Mississippi Flyway. High crippling losses at GRMWA on the upland firing lines and in the marsh were influenced by hunter crowding and competition, high shooting, thick stands of marsh vegetation, and a lack of retrieving dogs. Crippled geese often out-distanced hunters paddling after them in the open water retrieve zones and escaped into the refuge and were lost.

Summary

1. High harvest levels of the MVP flock in 1977 and 1978 probably reduced goose numbers at GRMWA in 1979. Goose numbers began increasing again in 1980 and 1981 to average about 40,000 birds.
2. Even with the high harvests during the study period (1977-81), annual goose use-days on GRMWA exceeded management objectives (900,000) by 4-91% during all years except 1979.
3. Heavy hunting pressure by goose hunters averaged 9,392 trips/year on GRMWA, ranging from 15,272 to 5,980/year during 1977-81. The total number of goose hunter trips to GRMWA was highly correlated with the total number of tags issued in the Central Zone. Therefore, the number of tags issued per hunter in the Central Zone greatly influenced hunting pressure on GRMWA.
4. The majority of goose hunters hunted early in the morning or late in the afternoon; only 10% hunted all day at GRMWA.
5. Some hunters were willing to travel up to 250 miles to hunt geese at GRMWA. Fifty-three percent of the trips to hunt geese originated in Milwaukee, Waukesha, Rock, and Dane counties, with 24% of hunters from the City of Milwaukee and its suburbs.
6. Hunting pressure was concentrated on opening days and weekends.
7. Compliance with steel shot laws was poor when only 12-gauge shooters were required to use steel shot.
8. Hunters at GRMWA averaged 0.33 geese/trip during 1977-81.
9. The goose harvest during 1977-81 ranged from 1,796 in 1981 to 5,084 in 1978 at GRMWA and the annual harvest was highly correlated with the number of tags issued in the Central Zone.
10. Only 5% of the goose hunters were able to bag 2 geese/day when the daily bag limit was increased from 1 to 2 geese during 1978-79.
11. Crippling rates of geese at GRMWA averaged 23%. In 1980, when lead and steel were legal, those using lead shot reported crippling geese at a higher rate than those using steel shot.

Management Implications

Population Estimates

Sound estimates of goose populations and use-days will continue to be a problem whether using fly-out counts or aerial surveys until the accuracy of each can be documented. New filming and video techniques have still not solved the accuracy problem due to insufficient light during early morning or late evening hours when the maximum numbers of geese are present. There is presently an urgent need for a comparison of photo and actual counts to correct current estimates. Accurate estimates are especially important if the counts are used in management decisions or evaluations.

Current goose use at GRMWA exceeds management goals. If fly-out counts were used to calculate goose use-days instead of aerial counts, estimated goose use would be much higher. This problem is magnified when trying to estimate MVP "size" to determine kill quotas throughout the flyway. Counting techniques for waterfowl have changed little in the last 50 years and improved methods are needed to improve both precision and accuracy.

Harvest

Goose hunting at GRMWA and on most other goose hunting areas in Wisconsin continues to be only "goose shooting," where geese are pass-shot and not decoyed or called into good shooting range. Firing lines promote hunter crowding and result in high crippling loss from hunters shooting at high-flying geese. Managed hunts in Wisconsin have successfully reduced crowding but have done little to reduce long-range shooting. Management must decide whether hunter satisfaction and obligations to the hunting public are provided by: (1) maximum hunting opportunity and maximum kill, (2) reduced opportunity and increased quality hunting, or (3) a combination of the desirable features of both philosophies of goose harvest.

We also need to determine the kill percentage of the tag-zone quotas on state wildlife areas. This might be accomplished by including appropriate questions on the Wisconsin Goose Hunter Questionnaire. Managing goose kill within specific areas is essential when planning future managed hunts and setting kill quotas.

Epilogue

Since this study was completed, goose population peaks at GRMWA have tripled in size (Fig. 5) with mean peak populations for 1989-93 reaching 93,600. Goose use-days have also increased on this area from approximately 1,100,000 to 3,600,000 from the time of this study to the present (W. Wheeler, Wis. Dep. Nat. Res., unpubl. data). In addition, since 1988, the Central Goose Hunting Zone (Fig. 2) became part of the Horicon Zone, making GRMWA open to Canada goose hunting by the much larger number of hunters receiving permits to hunt the new, larger Horicon Zone. As a result of the increased goose use of GRMWA and the larger number of hunters eligible to hunt there since this study, the amount of hunting pressure, geese harvested, and hunter density surely has continued to increase.

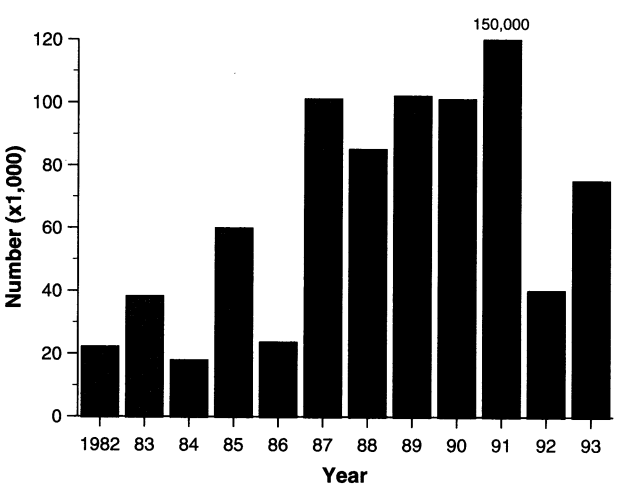


Figure 5. *Canada goose population trends for the Grand River Marsh, 1982-93.*

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