

CHANGING PATTERNS OF GOOSE HARVEST ON CALIFORNIA PUBLIC HUNTING AREAS

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We summarized hunter visits, success, and the magnitude and species-subspecies composition of the goose harvest recorded on California public hunting areas (PHAs) during 1950-89. Of six geographic regions, the Northeast accounted for the largest portion of the PHA harvest (55%); most of the remainder occurred in the Sacramento (30%) and Imperial (10%) Valley regions. Harvest, hunter visits, and success were low during the 1950s, but increased during the 1960s as new PHAs were added and data from Tule Lake and Lower Klamath National Wildlife Refuges (NWRs), where about half of California's PHA goose harvest occurs, became available. Success and harvest reflected declining goose abundance during the 1970s; however, hunter visits remained high on most PHAs because ducks were abundant. During the 1980s, declining populations of greater white-fronted geese, *Anser albifrons frontalis*, and cackling Canada geese, *Branta canadensis minima*, prompted restrictive regulations resulting in low harvest and success. Hunter visits were further reduced because of declining duck abundance and overall declines in hunter numbers. White-fronted geese were most prominent in the Northeast and Suisun Marsh harvest, but the lesser snow goose, *Chen caerulescens caerulescens*, was more important in other regions. Overall, the cackling Canada goose was the third most common goose harvested. The harvest of most geese peaked during 1965-74, coinciding with a peak in hunter visits, and then declined. However, the harvest of Canada geese (includes unknown proportions of western, *B. c. moffitti*, Taverner's, *B. c. taverneri*, and lesser, *B. c. parvipes*) and Ross' geese, *Chen rossii*, increased slightly throughout the study period. PHA harvest averaged 9-15% of the total state goose harvest during 1960-89. Success on PHAs was greater than statewide success until the 1980's, when restrictive regulations were imposed in zones encompassing many Sacramento Valley and San Joaquin Basin PHAs. White-fronted geese comprised a larger portion of the PHA bag than state-wide, and their decline reduced hunting opportunity for PHA

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hunters. The status of Pacific Flyway geese has improved in recent years, but intensive population management and monitoring should continue.

INTRODUCTION

More geese winter in California than in any other Pacific Flyway state, but many of these populations have suffered marked declines since the early 1950s (Fig. 1, Pacific Flyway Study Committee 1951-84, U.S. Fish and Wildlife Service unpubl. data). At least 13 different populations of geese winter in California, including the entire continental populations of Aleutian Canada geese, *B. c. leucopareia*, and tule white-fronted geese, ("tule geese"), *A. a. gambelli*, and most Ross' geese (U.S. Fish and Wildlife Service 1978, Gilmer et al. 1982). Populations nesting on the Yukon-Kuskokwim Delta of western Alaska (cackling Canada geese, ["cacklers"], and greater white-fronted geese), and on Wrangel Island, Russia (lesser snow geese, ["snow geese"]), have declined drastically in recent decades (Pacific Flyway Study Committee 1951-84; Raveling 1984, Subcommittee on White Geese 1992). Also, many Taverner's Canada geese, *B. c. taverneri*, lesser Canada geese, *B. c. parvipes*, and cacklers that once wintered in California now winter in Oregon (Johnson et al. 1979, Raveling and Zezulak 1992). In contrast, populations of snow geese from the western and central Arctic, Ross' geese and western Canada geese, have remained stable or increased (Dzubin 1979, McLandress 1979, Krohn and Bizeau 1980, Rienecker 1987). Separate management plans with specific population goals have

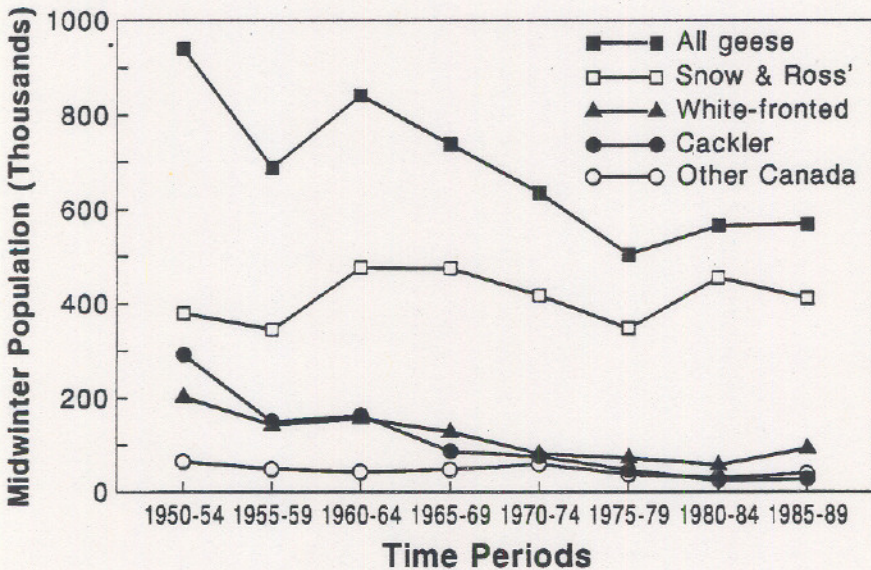


Figure 1. Average annual midwinter goose abundance in California by 5-year periods from 1950-89 (Pacific Flyway Study Committee 1951-84, U.S. Fish and Wildlife Service unpubl. data).

been developed for almost all goose populations that winter in California (U.S. Dept. of Interior and Environment Canada 1986, Childress and Rothe 1990).

Hunting regulations have been implemented and revised as each population's range was delineated and its status evaluated (Calif. Dept. Fish and Game, unpubl. data). Regulations often have been more restrictive on PHAs than elsewhere in California. For instance, hunting on PHAs typically has been restricted to 2-3 days a week. Goose hunting seasons in California were relatively liberal and stable through the 1980s in the Northeast and in other regions through the 1960s. Season variations were mostly due to split seasons and to delayed hunting on Sacramento Valley PHAs and Merced NWR to prevent crop depredation. In 1975, hunting on Tule Lake and Lower Klamath NWRs was closed after 1 P.M. Modifications to season length became commonplace in the late 1960s when restrictions were placed on the Canada goose season in the Imperial Valley to reduce harvest of Rocky Mountain population western Canada geese. After 1974, Canada goose seasons were reduced in hunting zones that included all San Joaquin Basin and most Sacramento Valley PHAs to protect the endangered (federally listed) Aleutian Canada goose. During 1985-89, Canada goose season was closed entirely and white-fronted goose season reduced on most PHAs in the Sacramento Valley. Bag limits on geese also became more restrictive. Concerns for the status of snow geese, white-fronts, and cacklers resulted in restricted bag limits starting in the 1980s. A notable exception to this trend was the lifting of the ban on the hunting of Ross' geese in 1964 and further liberalization in 1980 due to recognition of the greater number of Ross' geese in the Sacramento Valley than thought previously (McLanress 1979).

In this paper, we summarize regional differences in species (and subspecies) composition of goose harvest and document trends in the participation and success of goose hunters on PHAs in California from 1950-89. These summaries will serve as a historical record of the harvest on PHAs and to compare harvest on public lands versus the total state harvest.

METHODS

Harvest Areas

Goose harvest data were obtained from the records of 28 PHAs on which managers operated check stations or conducted routine bag checks (Table 1, Fig. 2). PHAs included NWRs, state Wildlife Areas (WAs), and cooperative areas (Co-ops) leased by the California Department of Fish and Game (CDFG). We grouped the PHAs into 6 geographic regions: Northeast, Sacramento Valley, Suisun Marsh, San Joaquin Basin, Tulare Basin, and Imperial Valley. Harvest data were available for Tule Lake and Klamath NWRs only after 1962 and no harvest data were available for coastal PHAs. Opportunities to hunt geese on PHAs fluctuated annually because hunting on some PHAs was closed and potential hunter capacity within individual PHAs varied with habitat conditions and allowable hunting methods (e.g., blinds, free roaming).

Table 1. Years goose harvest data were collected from individual public hunting areas in California, 1950-90¹. WA = Wildlife Area, NWR = National Wildlife Refuge.

Region/Area	1950	1960	1970	1980	1990
NORTHEAST					
Honey Lake WA	_____	_____	_____	_____	_____
Madeline Plains WA	_____				
Tule Lake NWR		_____	_____	_____	_____
Lower Klamath NWR		_____	_____	_____	_____
Modoc NWR			_____	_____	_____
Butte Valley WA				_____	_____
Ash Creek WA					_____
SACRAMENTO VALLEY					
Colusa NWR	_____	_____	_____	_____	_____
Gray Lodge WA	_____	_____	_____	_____	_____
Sutter NWR	_____	_____	_____	_____	_____
Welch Co-op	-				
Grace Co-op	-				
Maxwell Co-op	-				
Delevan NWR		_____	_____	_____	_____
Sacramento NWR		_____	_____	_____	_____
SUISUN MARSH					
Grizzly Island WA	_____	_____	_____	_____	_____
Joice Island WA ²	_____	_____	_____	_____	_____
SAN JOAQUIN BASIN					
Merced NWR	_____	_____	_____	_____	_____
Volta WA	_____	_____	_____	_____	_____
Los Banos WA	_____	_____	_____	_____	_____
San Luis NWR			_____	_____	_____
Kesterson NWR			_____	_____	_____
TULARE BASIN					
Mendota WA		_____	_____	_____	_____
Kern NWR				_____	_____
Tulare Lake Drain. Dist.				_____	_____
IMPERIAL VALLEY					
Imperial WA	_____	_____	_____	_____	_____
Perris WA				_____	_____
San Jacinto WA					_____

¹Hunting programs were in operation on Honey Lake, Madeline Plains, and Imperial WAs and Klamath Basin NWRs before 1950 (Kozlik 1955, Gilmer et al. 1986).

²Combined with Grizzly Island in 1983.

Data Collection

Gilmer et al. (1989) describe data collection methods. Goose abundance was estimated by coordinated midwinter surveys (Pacific Flyway Study Committee 1951-84, U.S. Fish and Wildlife Service, unpubl. data). Cacklers were separated from other

subspecies of Canada geese ("Canada geese" or "other Canada geese"). Tule and greater white-fronted geese were not recorded separately in any surveys except during the last two years of the study when tule geese comprised about five percent of the total PHA white-front harvest (J. G. Mensik, pers. comm.). Thus, survey data for tule and greater white-fronted geese are combined as "white-front" data in this paper. Ross' geese were completely protected during 1931-62 and were not listed in PHA harvest surveys until 1963; some were undoubtedly shot and included in the snow goose total or listed as "others" so we included the 1,122 "other geese" harvested in the Ross' goose harvest totals. Ross' and snow geese were counted together in midwinter surveys and statewide harvest surveys as "white geese." Black brant, *Branta bernicla nigricans*, were rarely harvested on the PHAs we surveyed and are not discussed here. We used paired *t*-tests with 2-sided *P*-values (Huntsberger and Billingsley 1973:187)

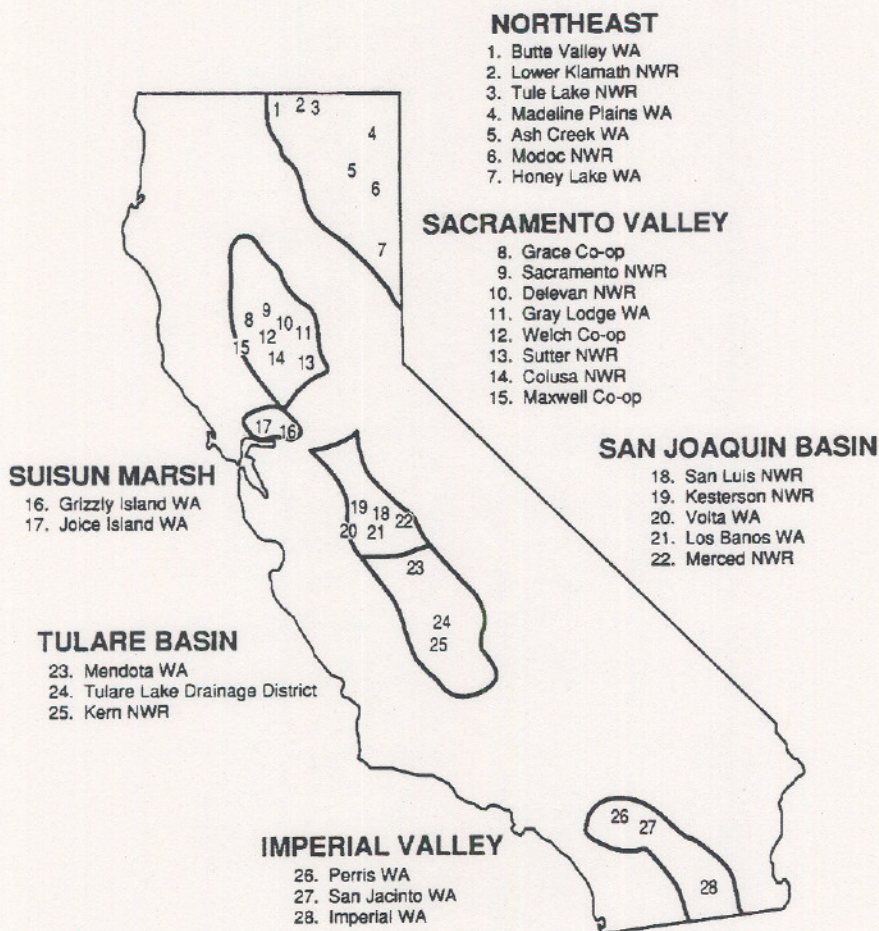


Figure 2. Location of geographic regions with public hunting areas in California.

to compare annual hunter success on PHAs (geese per hunter visit) versus state-wide success (geese per hunter day) estimated by USFWS waterfowl harvest surveys (J. C. Bartonek, pers. comm.).

RESULTS

Statewide Harvest on Public Hunting Areas

From 1950 through 1989, an average of 17,828 (range 558 to 46,404) geese were harvested each year on PHAs during 95,039 (range 9,657 to 166,646) hunter visits for an average success of 0.17 (range 0.05 to 0.38) goose per hunter visit. Overall composition of the harvest was: snow geese 38%, white-fronted geese 36%, cacklers 14%, other Canada geese 10%, and Ross' geese 2%.

Characteristics of the harvest on PHAs changed in relation to abundance of geese, harvest regulations, and number of hunters visiting PHAs. These changes are described by summarizing each of the four decades from 1950-1989.

1950s--Harvest, hunter success, and hunter visits were low during the 1950s (Fig. 3). Geese were abundant (Fig. 1) and harvest regulations were liberal, but hunter visits were low because many areas had not yet been established or opened to public hunting. In addition, harvest data were not collected at Tule Lake and Lower Klamath NWRs, where about half of California's PHA goose harvest occurs. Composition of the PHA harvest (Fig. 4) reflected wintering populations (Fig. 1), except white-front harvest increased (Fig. 5) while their abundance gradually declined.

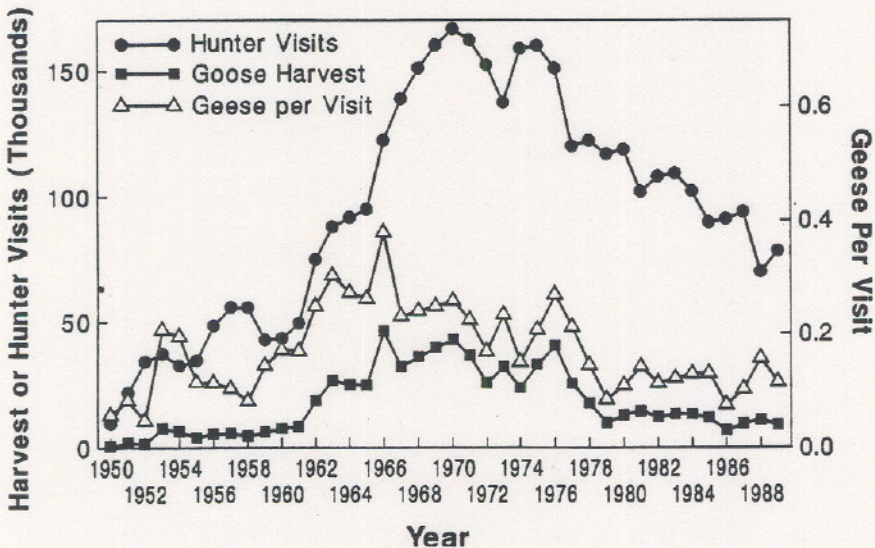


Figure 3. Annual number of hunter visits, geese harvested and hunter success (geese per visit) on public hunting areas in California from 1950-89.

1960s--Harvest, hunter success, and hunter visits increased dramatically during the 1960s (Fig. 3) as new PHAs were established and data from Tule Lake and Lower Klamath NWRs became available. White-front and cackler abundance was about half that during the 1950s, but white geese increased so overall goose abundance was similar to the 1950s (Fig. 1). Harvest regulations remained relatively liberal. The highest annual harvest (46,404 geese) and success (0.38 goose per visit) occurred during the 1966-67 season, when more geese were counted during the midwinter survey than any year of our analysis except 1951. White-fronts were the primary species harvested (Fig. 4) even though white geese were more abundant.

1970s--Declining goose abundance (Fig. 1) reduced harvest and hunter success during the 1970s despite high hunter visits (Fig. 3) and relatively liberal harvest regulations. By the 1978-79 season, goose abundance was the lowest ever recorded and harvest dropped to 17,707 with an average success rate of 0.14 goose per visit. White geese regained prominence in PHA harvest as white-fronts and cacklers declined. Harvest of Canada geese and Ross' geese remained relatively stable compared to other species (Fig. 4).

1980s--Restrictive hunting regulations and declining hunter visits resulted in relatively low harvest and hunter success during the 1980s (Fig. 3). For example, the lowest PHA harvest (6,882) and success (0.07 goose per visit) since the 1950s (when data from few PHAs were available) occurred during 1986-87. White geese were abundant but wintering white-front and cackler populations remained low (Fig. 1). Regulations were especially restrictive for dark geese (white-fronts, cacklers and

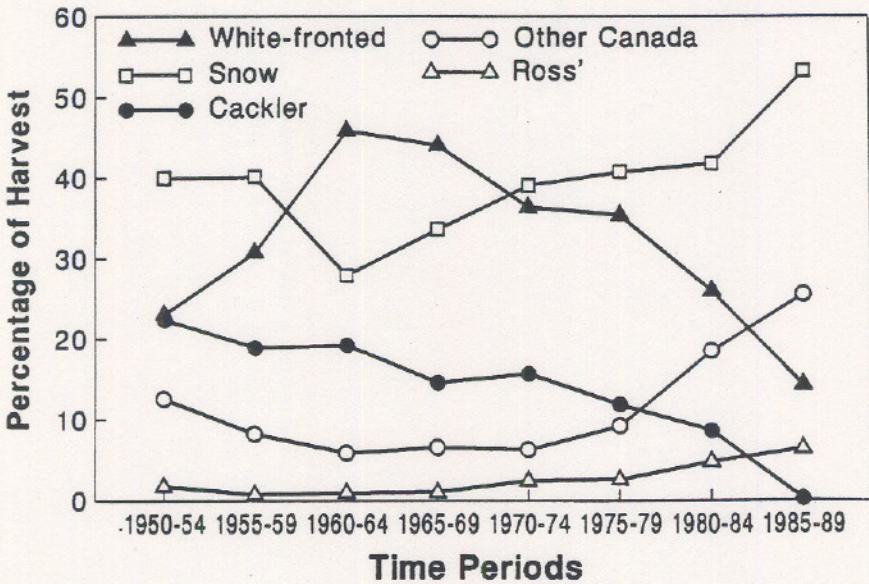


Figure 4. Average annual species composition of goose harvest on public hunting areas in California by 5-year periods from 1950-89.

other Canada geese) after 1984, resulting in white geese becoming dominant in the harvest (Fig. 4). The importance of Canada geese in the harvest increased with the decline of other dark geese (i.e., cacklers and white-fronts) and the addition of Butte Valley and Ash Creek WAs, both important Canada goose harvest areas.

Regional Harvest

The distribution of wintering geese, hunters, and PHAs in California are distinctly regional. This has had a major influence on the characteristics of the harvest.

Northeast--About 26% of all hunter visits and 55% of the total PHA harvest occurred in the Northeast region. Most PHA harvest of white-fronts, cacklers and Canada geese occurred in this region (Fig. 6). Tule Lake and Lower Klamath NWRs accounted for 91% of the region's PHA goose harvest. Hunter visits declined drastically in the region after 1974 and total harvest declined after 1969 (Fig. 7). Hunter success was highest of all regions (0.34 goose/visit), but success during the 1980s was only half that during the 1970s. White-fronts dominated the harvest until the 1980s (Fig. 8). Despite declining abundance, cacklers comprised about 15-20% of the regional harvest until 1985 when the season was closed. The importance of Canada geese increased dramatically during the 1980s as white-front and cackler abundance declined and hunting restrictions were imposed on white-fronts and cacklers. Canada geese comprised about half of the regional PHA goose harvest during 1985-89.

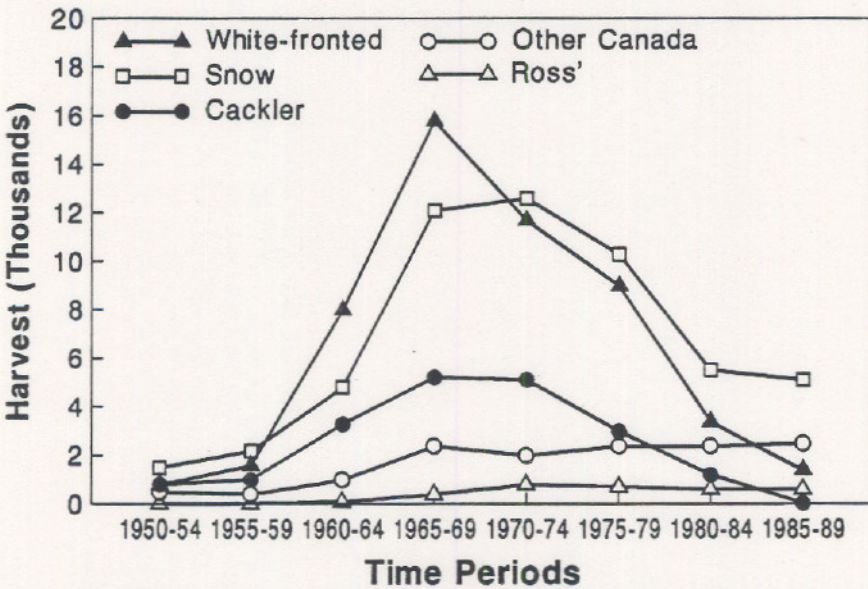


Figure 5. Average annual number of each goose species harvested on public hunting areas in California by 5-year periods from 1950-89.

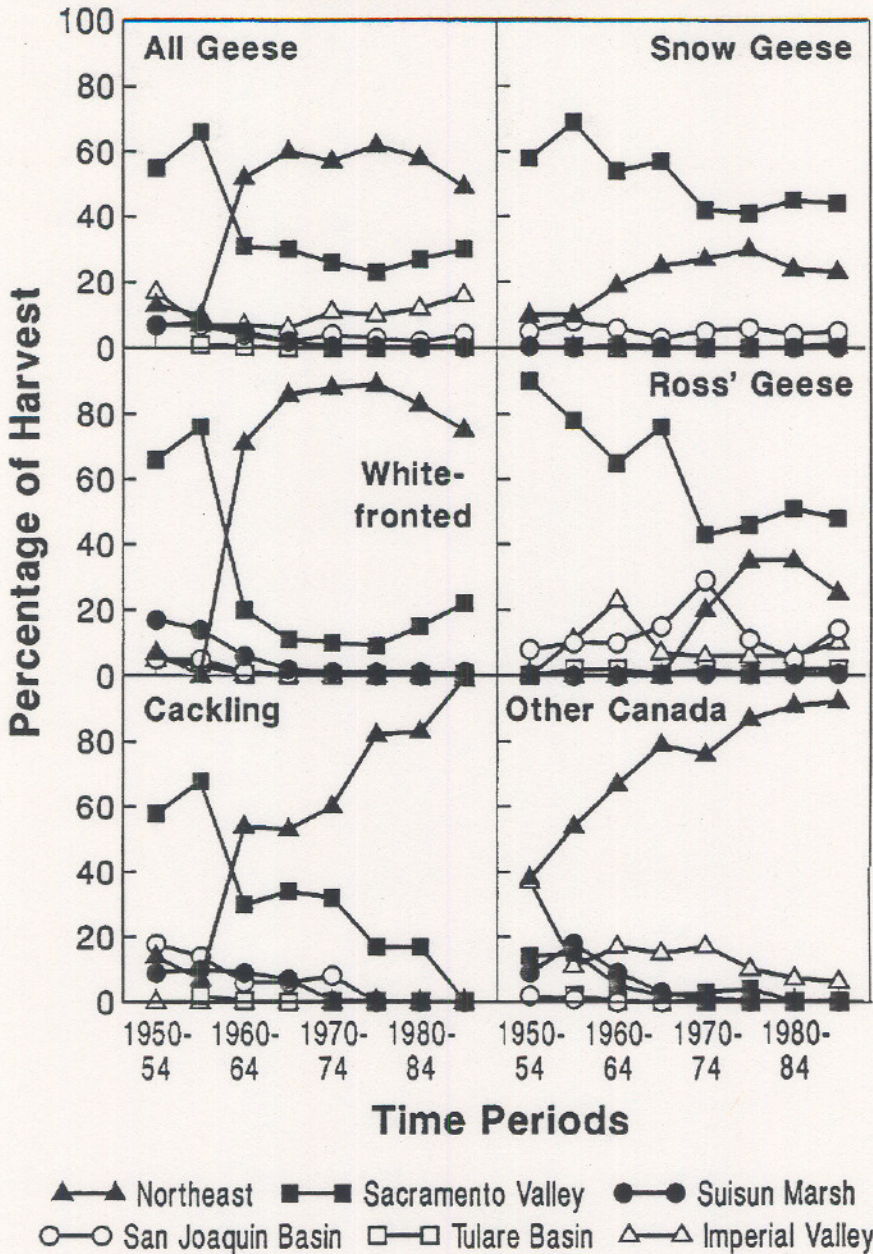


Figure 6. Percent of total California public hunting area harvest of each species occurring in each region by 5-year periods from 1950-89.

Sacramento Valley--About 27% of all visits and 30% of the total harvest on PHAs occurred in the Sacramento Valley. Most snow and Ross' geese were taken in this region (Fig. 6). About 30% of the PHA cackler harvest occurred in the region during 1960-74, but this dropped to 15% after Aleutian Canada goose protection zones were established in 1975 (Fig. 6). Sacramento and Delevan NWRs accounted for 60% of the regional PHA harvest. The addition of these sites to the PHA program during 1960-69 resulted in the increased hunter visits and total harvest (Fig. 7). Harvest

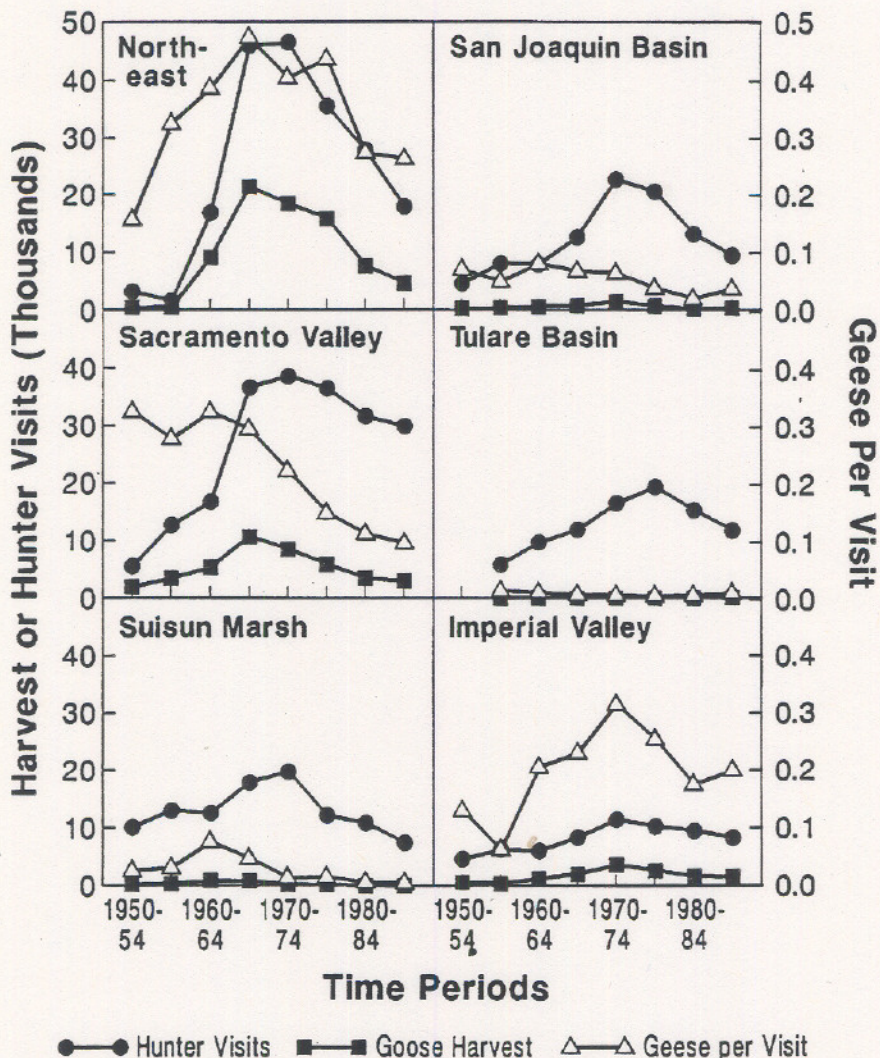


Figure 7. Average annual hunter visits, geese harvested and hunter success (geese per visit) on public hunting areas in six geographic regions of California by 5-year periods from 1950-89.

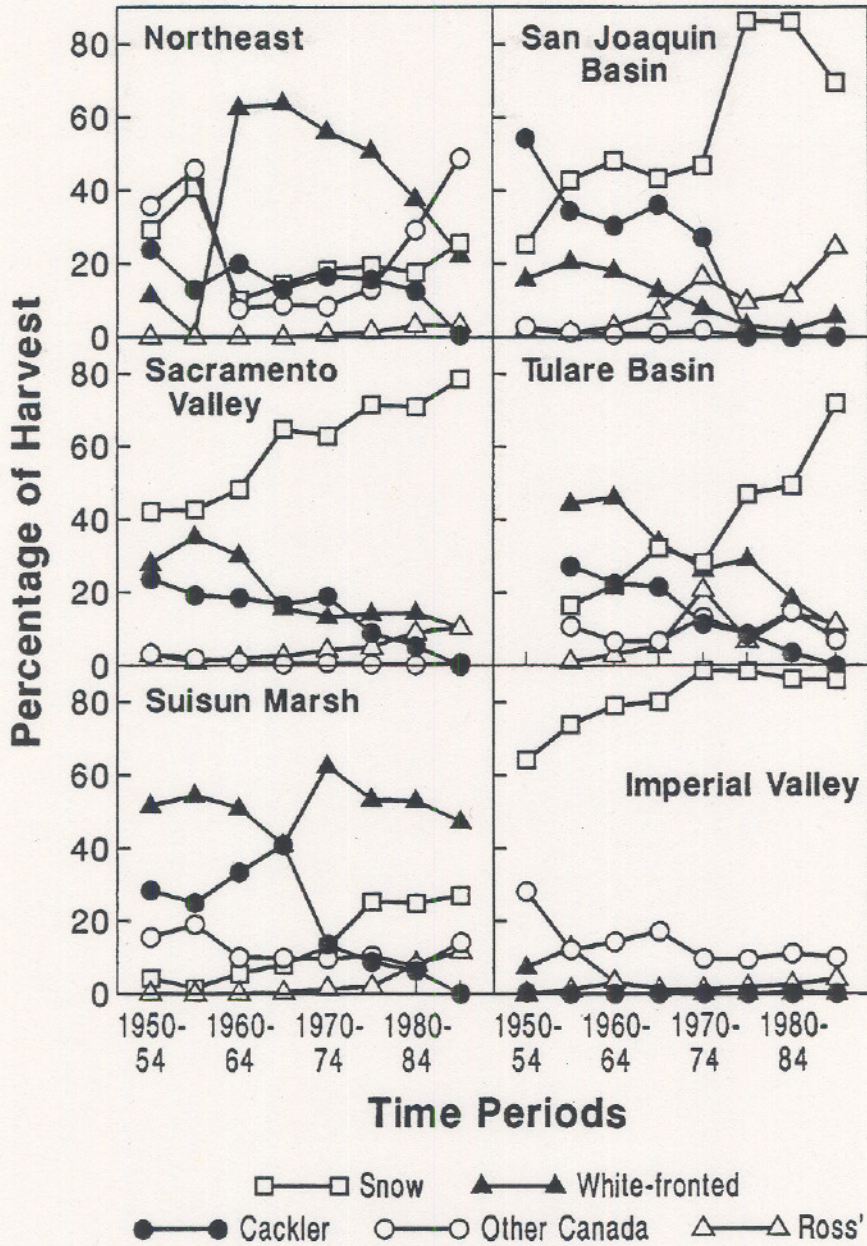


Figure 8. Average species composition of the goose harvest on public hunting areas in six geographic regions of California by 5-year periods from 1950-89.

declined after 1969 and hunter visits declined gradually after a peak in the early 1970s. Hunter success (0.22 goose/visit) was second only to the Northeast, but declined steadily after 1964. Snow geese dominated the harvest and the importance of snow and Ross' geese increased as white-fronts and cacklers declined (Fig. 8). Combined, white-fronts and cacklers comprised about half of the Sacramento Valley harvest during 1950-64, but only 10-30% thereafter. Few Canada geese were harvested on Sacramento Valley PHAs, even before Aleutian Canada goose protection zones were established.

Suisun Marsh--Grizzly Island and Joice Island WAs (combined in 1983) were the only PHAs in this region, and accounted for 14% of hunter visits and 2% of the total PHA goose harvest. Hunter visits peaked in 1970-74, but by then success was so low that goose harvest remained low (Fig. 7). Total harvest reflected hunter success (0.03 geese/visit); both peaked earlier than in most other regions. White-fronts were the most common goose shot, comprising about half of the regional PHA harvest (Fig. 8). Cackler harvest declined in the Suisun Marsh earlier than in other regions. Nearly 10% of the cacklers harvested statewide on PHAs were taken at Suisun Marsh during 1950-1969, but <1% thereafter (Fig. 6). Snow and Ross' geese increased proportionately in the harvest as cacklers declined.

San Joaquin Basin--About 13% of the hunter visits and 3% of the goose harvest occurred in this region. Most geese in the region were shot at Los Banos WA (36%), Merced NWR (29%), and San Luis NWR (16%). Hunter visits followed patterns similar to other regions (Fig. 7). Hunter success was low (0.05 goose/visit) and declined after 1964. Snow geese and cacklers each comprised about 40% of the region's harvest during 1950-74 (Fig. 8). About 10% of the PHA harvest of cacklers occurred in the San Joaquin Basin region (Fig. 6) until 1975, when harvest restrictions designed to protect Aleutian Canada geese virtually eliminated cackler harvest in the region. The importance of white-fronts also declined while Ross' geese became more common at hunter check stations. During the 1980's, hunters' bags consisted mostly of white geese (Fig. 8). Hunters harvested few Canada geese (other than cacklers) even before Aleutian Canada goose protection zones were established.

Tulare Basin--This region accounted for 12% of the total visits but only 0.4% of the total goose harvest on PHAs; most of the harvest (96%) occurred at Mendota WA. Hunter visits peaked later (1975-79) than in other regions (Fig. 7), probably because Kern NWR was added to the PHA program in 1973. Hunter success was lowest of all regions (0.01 goose/visit) with no consistent trend. Species composition of the bag was mixed and trends were similar to other regions (Fig. 8).

Imperial Valley--About 8% of the hunter visits and 10% of the total harvest on PHAs occurred in this region. Imperial WA accounted for 99.9% of the regional harvest. Harvest and success peaked later than in most other regions (Fig. 7). Hunter success (0.20 goose/visit) was higher than other southern regions. Snow geese comprised 60-90% of the annual harvest (Fig. 8), and about 25% of the total PHA snow goose harvest occurred in this region (Fig. 6). Canada and Ross' geese were the only other species commonly harvested (Fig. 8).

DISCUSSION

Public Hunting Area Harvest

Hunter Visits and Harvest-- As new areas were added to the PHA system, hunter visits and harvest increased. The opening of Sacramento and Delevan NWRs to hunting during the early 1960s increased PHA harvest, especially for white geese. Similarly, the opening of Modoc NWR in 1974 and Butte Valley and Ash Creek WAs in the 1980s increased PHA harvest of Canada Geese.

Our estimates of PHA hunter visits and harvest are low and species composition biased for the 1950s because harvest and hunting activity records were not maintained at Tule Lake and Lower Klamath NWRs even though these important goose areas were open to public hunting. Thus, differences between the 1950s and the 1960s were undoubtedly less than the available data reflect in harvest magnitude and composition, hunter success, and hunter visits. White-fronts were the most common goose harvested at Tule Lake and Lower Klamath NWRs during 1936-41 (Gilmer et al. 1986) and 1960-79, indicating that white-fronts probably dominated PHA harvest throughout the 1950s.

Waterfowl abundance influenced the number of hunters afield and affected harvest. Hunter visits to most PHAs appeared to more closely respond to duck abundance (Gilmer et al. 1989) than goose abundance, suggesting that hunters traveled to most PHAs primarily to hunt ducks; geese were harvested opportunistically. For example, hunter visits to PHAs remained high during the 1970s when goose populations were low but ducks were numerous (Gilmer et al. 1989). During the 1980s, goose populations increased but duck abundance was the lowest on record and hunter visits remained low. Exceptions to this occurred in the Northeast and Imperial Valley, where most PHAs have special goose hunting fields and hunters travel great distances to hunt in these areas (Gilmer et al. 1986). Hunter visits to the Northeast declined more abruptly than in other regions when goose abundance and goose hunting success declined. Likewise, hunter visits to the Imperial Valley did not decline as drastically as in other regions when duck populations plummeted and goose populations did not.

The effect of changing duck populations on hunter visits was most apparent on the white goose harvest which increased between 1965-69 and 1970-74 even though white goose abundance and the average white goose harvest per hunter visit declined. When duck abundance increased during 1970-74, more people hunted and the white goose harvest increased even though their abundance declined. Most white goose harvest on PHAs occurred in the Sacramento Valley.

Hunter visits to PHAs dropped after the 1970s. Although we attribute much of the decline to a decrease in waterfowl abundance other factors such as increasing recreational costs, complicated regulations, changing hunter demographics, competing recreational opportunities, and contaminant concerns undoubtedly contributed to reduced hunting interest (Pacific Flyway Study Committee 1988, Gilmer et al. 1989). Hunter visits to PHAs located far from major urban areas may be differentially

reduced because hunters are probably less likely to travel long distances when the probability of success is low.

Goose Abundance and Harvest--Abundance and harvest trends differed among goose populations. The harvest of Ross' geese increased after the 1960s, especially in the two northern regions, probably because of increasing populations (McLandress 1979) as well as an increase in the daily bag limit from one to three. In contrast, the abundance and harvest of geese migrating from western Alaska (e.g., white-fronts and cacklers) declined (Raveling 1984).

Abundance of geese differed greatly among regions, and hunter success and harvest reflected a distinct north to south gradient. Most geese that winter in the Sacramento Valley migrate through northeastern California (Rienecker 1965, Bellrose 1976, Pacific Flyway Study Committee 1951-84, U.S. Fish and Wildlife Service, unpubl. data). Higher hunting success in the Northeast may have been due to juvenile and unwary geese, earlier seasons, and higher goose densities. Populations of many geese that winter in the Imperial Valley take a migration path east of the Sierra Nevada mountains (Rienecker 1965, Bellrose 1976) and the availability of these geese probably boosted harvest opportunities above that of other southern regions. Also, Canada goose closures were not needed in the Imperial Valley because Aleutians and cacklers were rarely observed there (Nelson and Hansen 1959, Woolington et al. 1979).

Cackler harvest declined earlier in the Suisun Marsh than in other regions and the reason is unclear. Regulations were similar to adjacent regions when the decline occurred, and harvest trends in the Suisun Marsh for other geese were similar to other regions. Cackler abundance may have been affected by the same habitat changes within and outside Suisun Marsh that are thought to have reduced use of the marsh by northern pintail, *Anas acuta*, (Michny 1979, Crapuchettes and Lewis 1989). Alternatively, cacklers wintering in Suisun Marsh may have been a separate subpopulation that was eliminated because of lower survival or productivity.

Regulations and Harvest--Regulations were an important factor controlling goose harvest and were effective during the late 1980s in reducing the harvest of populations in decline. For example, seasons and daily bag limits for white-fronts were reduced after 1979 and harvest declined dramatically (Fig. 5).

Harvest regulations for one population often affected harvest of other geese. Restrictions to protect Aleutian Canada geese in the Central Valley reduced harvest of all Canada geese there, especially cacklers. Conversely, when the hunting season for cacklers was closed in the Northeast and the harvest of white-fronts severely restricted, harvest of other Canada geese increased in that region. Rienecker (1985, 1987) expressed concern that overhunting had reduced the subpopulation of Canada geese that were resident in the vicinity of Tule Lake and Lower Klamath NWRs.

Public Hunting Areas versus the Entire State

Harvest Magnitude--Harvest on PHAs comprised a small portion of the total state harvest. During 1962-89, an average of 23,310 geese were harvested annually on

PHAs compared to estimates for the entire state of 159,578 determined by the USFWS waterfowl harvest survey (J. C. Bartonek, pers. comm.) and 244,984 determined by the CDFG mail questionnaire (California Department of Fish and Game, unpubl. data).

Hunter Success--Hunter success for geese averaged 24% greater (range +14% to +39%) on PHAs than for the state overall during the 1960s (PHA minus statewide success mean annual difference = 0.06, $t_{7df} = 8.48$, $P < 0.0001$) and 14% greater (range -22% to +28%) during the 1970s (PHA minus statewide success mean annual difference = 0.03, $t_{9df} = 2.74$, $P = 0.02$). However, hunting restrictions that were imposed to protect cacklers, Aleutians and white-fronts caused success to decline more precipitously on PHAs than for the state overall, so that during the 1980s, PHA success averaged 4% less (range -31% to +21%) than statewide success (PHA minus statewide success mean annual difference = -0.01, $t_{9df} = 0.02$, $P = 0.98$). For instance, statewide success was greater than PHA success for only two years during 1962-82 but for all but one year since 1982. The steep decline in goose hunting success on PHAs that began in the late 1970s occurred because white-fronts declined, which were especially important to PHA hunters, and restrictive regulations (e.g., Canada goose season reductions, closure zones, and white-front season reductions) impacted most PHAs but a smaller portion of non-PHA lands. In contrast, duck hunting regulations on and off PHAs were more similar and during years of low abundance of one important species, the northern pintail, PHA duck hunters were able to successfully harvest other species that concentrate on PHAs. Thus, unlike goose hunting success, duck hunting success on PHAs during the 1980s remained relatively constant while state-wide success declined (Gilmer et al. 1989).

Species Composition--The composition of harvest during 1962-89 on PHAs differed from the state as a whole (J. C. Bartonek, pers. comm.). Although the importance of snow and Ross' geese in the harvest on PHAs and the state were similar, Canada geese and cacklers, combined, were less prevalent (25% vs 38%) and white-fronted geese were more prevalent (34% vs 21%) in PHA harvest. Closure zones for Canada geese reduced hunter opportunity on most PHAs but left much of the state less restricted. The absence of public hunting opportunities in key locations, like coastal areas and the Sierra foothill reservoirs, reduced the importance of Canada geese in the PHA harvest. Most PHAs are situated at areas traditionally used by white-fronts for staging and wintering.

CONCLUSIONS

Public Hunting Areas have provided goose hunting opportunity to thousands of hunters in California. Although populations of some geese are recovering from critically low levels, hundreds of thousands of geese congregate on some PHAs. Recent regulations have effectively reduced harvest for most geese. Restrictive regulations combined with low goose and duck abundance, and other factors (Pacific Flyway Study Committee 1988, Gilmer et al. 1989) have also reduced numbers of hunters. Although declines in hunter numbers, duck abundance and duck harvest are

nationwide trends, the decline of goose abundance and harvest is unique to the Pacific Flyway (Bellrose 1976, J. C. Bartonek, pers. comm.). During the 1960s, 30% of the geese harvested in the United States were taken in the Pacific Flyway, but since 1974 fewer geese have been killed in the Pacific Flyway than in any other flyway. Much of the Flyway's goose population is derived from breeding grounds in western Alaska where native subsistence hunting adds substantially to other mortality factors (Raveling 1984). Progress towards solving subsistence and other goose management problems is being made (Pamplin 1986) and populations are responding (J. C. Bartonek, pers. comm.).

The outlook for the recovery of goose populations in the Pacific Flyway is improving. Efforts to sustain and increase habitats, delineate subpopulations, and refine management strategies should be continued to maintain this recovery. Future goose hunting opportunities on PHAs will depend not only upon the status of goose populations, but also on social and economic factors.

Waterfowl check stations in California provide an important opportunity to closely examine characteristics of the state harvest such as the regional distribution of harvest, subspecies composition and physiological condition of birds. We believe that a comprehensive program to collect accurate waterfowl harvest data at carefully selected check stations will provide resource managers with an effective tool in the conservation of the waterfowl resource.

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