California Fish and Game 95(4): 175-187; 2009

THE USE OF EASTERN SACRAMENTO VALLEY VERNAL POOL HABITATS BY GEESE AND SWANS

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ABSTRACT

We studied the fall-winter use of Sacramento Valley high-terrace vernal pools and associated grassland habitats by geese and swans from November 1999 through March 2003.

During each of nine diurnal and six nocturnal (1999-2000 field season only) surveys, we recorded the presence or absence of each species and subspecies, as well as flock sizes, habitats used, and activity patterns. Although all goose and swan species and most subspecies that winter in the Central Valley were observed using study area habitats, lesser Canada/ Taverner's cackling geese, *Branta canadensis parvipes/Branta hutchinsii taverneri*, Ridgway's cackling geese, *B. h. minima*, and western Canada geese, *B. c. moffitti*, were observed most regularly and in the greatest numbers. In general, Canada and cackling geese (hereafter white-cheeked geese) used study area habitats from November through March, with regular use by large flocks of small and mid-sized subspecies in December and January. Smaller numbers of western Canada geese used study area habitats from December through the end of March, with the largest flocks occurring from late December through February. Monthly occurrence and maximum flock size values for lesser Canada/Taverner's cackling geese differed significantly throughout this 4-year study, although changes in these variables in successive months did not. Monthly changes in these variables for all other white-cheeked geese were insignificant. Following their arrival in November and early December, white-cheeked geese used artificial stock ponds as nocturnal roost sites and then departed for disjunct foraging habitats during the day. Small and mid-sized subspecies roosted primarily on vernal pools, beginning in late December or January, following the onset of ponding; most roosting western Canada geese continued to use stock ponds through the end of March.

With the growth of herbaceous vegetation beginning in late December or January, small and mid-sized white-cheeked geese shifted to a general pattern of day-long grazing activities on study area pastures. This regular and predictable shift suggests a pattern of long-term traditional use. We believe, therefore, that the protection of these remnant high-terrace vernal pool landscapes may be critical to the maintenance of California's small and mid-sized white-cheeked goose populations throughout the winter, during spring migration, and also to their success during the subsequent nesting season.

INTRODUCTION

The loss of North American wetland habitats since the 1800's due to agricultural expansion and urbanization resulted in long-term continental population declines in waterfowl (Anatidae) (Baldassare and Bolen 1994). A series of droughts throughtout the prairies of the United States and Canada beginning in the 1970's along with changing agricultural practices led to further declines in many duck populations (e.g., northern pintails) (Miller and Duncan 1999, Fleskes and Gilmer 2004). However, since the development and implementation of the North American Waterfowl Management Plan in 1986, most waterfowl populations have recovered dramatically.

Up to 60% of the waterfowl migrating down the Pacific Flyway during the fall use Central Valley (CV) wetlands (Heitmeyer et al. 1989), with the majority of these migrants wintering in the Sacramento Valley. Only 5% of California's historic wetlands still exist (Heitmeyer et al. 1989, Holland 1998), and of these wetlands, high-terrace and alkali vernal pools are among the rarest and least studied (Bogiatto and Karnegis 2006, Silveira 2000). The use of Sacramento Valley vernal pools by waterfowl and other waterbirds has been well documented (Grinnell et al.1930, Baker et al. 1992, The Nature Conservancy 1994, Silveira 1998, Silveira 2000), although only a single study focuses on the use of high-terrace pools by ducks (Bogiatto and Karnegis 2006), and none document the use of these habitats by geese and swans.

The objectives of our study were to (1) describe the goose and swan community using eastern Sacramento Valley high-terrace vernal pools and associated uplands during the fall and winter, (2) determine seasonal patterns of occurrence and flock sizes for each taxon, (3) describe the daily activity patterns of each taxon, and (4) describe the specific habitat types used by each taxon.

STUDY AREA

Our study area included the vernal pools and grasslands on the original 619-ha parcel of The Nature Conservancy's (TNC) Vina Plains Preserve (VPP), located east of State Highway 99, and south of Lassen Road, 21 km north of Chico in southern Tehama County, California (122:03:10W 39:55:59N) (Fig. 1). This vernal pool complex lies on a terrace between the foothills of the Cascade Range and the floodplain of the Sacramento River. A subterranean durapan, formed from the consolidation of eroded sediments from the Tuscan Basalt Formation, prevents water percolation and causes rapid accumulation of water in the heavy clay loam or silt-lined pool basins (TNC 1994). This parcel of the preserve consists of four fenced pastures, each containing numerous pools surrounded by an upland community dominated by native and exotic grasses and forbs. All pastures are grazed by cattle on a rotational basis, beginning in late fall, and historically, TNC has used prescribed burns to control exotic grasses such as medusa head, *Taeniatherum caput-medusae*. Our study area also included the two southern-most pastures (472 ha) of the Earl Foor Ranch Conservation Area (EFRCA), located directly north of Lassen Road which forms the northern border of the VPP (Fig. 1). These pastures also contain numerous vernal pools as well as several artificial stock ponds for cattle. EFRCA stock ponds generally contain water by October, well in advance of vernal pool ponding (Table 1). Like the VPP, EFRCA pastures, also dominated by exotic and native grasses and forbs, are rotationally grazed by cattle.

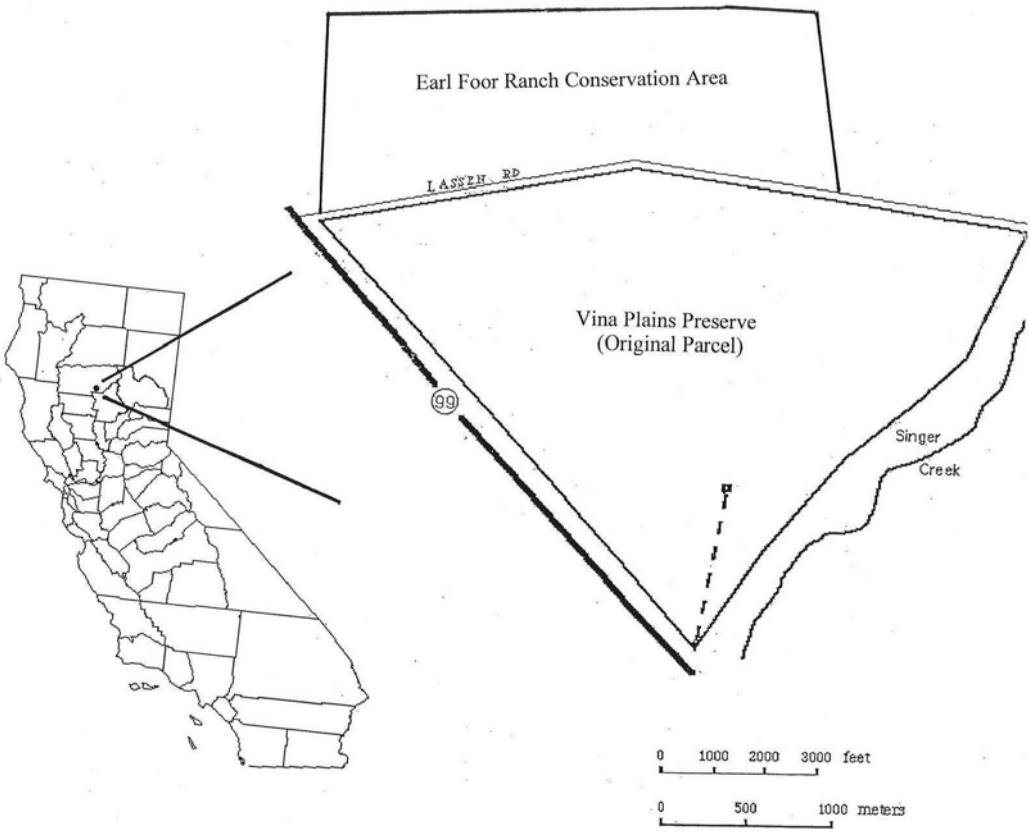

Figure 1. Location of the Vina Plains Study Area in Tehama County, California.

METHODS

We studied the use of vernal pool and associated uplands by geese and swans during the fall and winter months, from November 1999 through March 2003. During the 1999-2000 field season, we conducted 12 - 15 3-hr field surveys each month. Survey time periods were as follows: 1-hr post-sunset – 4-hr post-sunset; 4-hr pre-sunrise – 1-hr pre-sunrise; 1-hr pre-sunrise – 2-hr post-sunrise; 3-hr post-sunrise – 6-hr post-sunrise; and 2-hr pre-sunset – 1-hr post-sunset. We attempted to cover all survey periods equally with three surveys each per month, and with a maximum of one survey per day.

Diurnal and nocturnal (auditory) surveys were conducted along Hwy. 99 and Lassen Road by vehicle, whereas remote portions of the study area were surveyed on foot. During field surveys, we used binoculars, two 20-60X Kowa spotting scopes, head lamps, and topographic maps of the study area.

Data collected during field surveys included species and subspecies identification, flock location, the number of individuals per flock, flock arrival and departure times, the most common flock behavior within each habitat, and the presence or absence of cattle by pasture.

Table 1. Ponding chronology for the vernal pools on the Vina Plains, Tehama County, California, Fall 1999 – Winter 2003.

Field season	Initial ponding[1]	Desiccation[2]
1999-2000	19-21 Jan. 2000	8-10 Apr. 2000
2000-2001	10-12 Jan. 2001	19 Mar. – 4 Apr. 2001
2001-2002	23-25 Nov. 2001	Still ponded – 15 Apr. 2002
2002-2003	13-14 Dec. 2002	Still ponded – 16 Apr. 2003

[1] Most large vernal pools (surface area ≥ 15,000 m^2) ponded

[2] Most large vernal pools desiccated

We present maximum flock sizes and percent occurrence values by month, with percent occurrence defined as the percentage of survey-days per month in which each taxon was present, and with maximum flock size defined as the maximum number of individuals from each taxon observed during a 3-hr survey. We determined flock sizes through complete counts or collaborative estimates by members of the survey crew.

Numbers of geese in flocks detected during nocturnal surveys were quantified during return visits to the study area at sunrise.

We tested for significant patterns of change in monthly occurrence and maximum flock size for each white-cheeked goose subspecies using the Friedman Two-Way Analysis of Variance by Ranks test, the null hypothesis being that monthly values throughout this 4-yr study were the same. When monthly patterns of change were significant, we used the Wilcoxon-Mann-Whitney test to compare values in successive months (e.g., November vs December, December vs January, etc.), the null hypothesis being that percent occurrence and maximum flock size values in successive months were the same.

We eliminated nocturnal surveys from our protocol beginning in Fall 2000, because our data from 1999-2000 suggested that nocturnal use of the Vina Plains was limited to roosting activity on vernal pools and stock ponds. As a result, to control for survey time periods among years, we used only data collected during the three diurnal sampling periods for our statistical analyses.

RESULTS

Goose and Swan Taxa Observed

Except for the Aleutian cackling goose, *Branta hutchinsii leucopareia*, and the tule white-fronted goose, *Anser albifrons elgasi*, all goose and swan taxa which regularly winter in the Sacramento Valley were observed using habitats on the Vina Plains (Table 2). However, two Canada goose subspecies, *Branta canadensis parvipes*, the lesser Canada goose, and *B. c. moffitti*, the western Canada goose, as well as Ridgway's race (Mlodinow 2008) of the cackling goose, *B. h. minima*, were the most frequently observed and abundant goose taxa throughout this study (Tables 2 and 3, Fig. 2). Also, flocks of lesser Canada geese often

Table 2. Percent occurrence values for geese and swans on the Vina Plains, Tehama County, California, November 1999 - March 2003.

TAXA	% Occurrence (Frequency) Nov	Dec	Jan	Feb	Mar
Tundra Swan *(Cygnus columbianus)*	0 (0)	3.2 (1)	9.7 (3)	10.7 (3)	6.5 (2)
Greater White-fronted Goose *(Pacific subspecies) (Anser albifrons frontalis)*	0 (0)	12.9 (4)	9.7 (3)	7.1 (2)	9.7 (3)
Snow Goose *(Chen caerulescens)*	0 (0)	0 (0)	0 (0)	0 (0)	6.5 (2)
Ross' Goose *(Chen rossii)*	13.6 (3)	3.2 (1)	3.2 (1)	0 (0)	0 (0)
Western Canada Goose *(Branta canadensis moffitti)*	4.5 (1)	19.4 (6)	51.6 (16)	75.0 (21)	74.2 (23)
Lesser Canada Goose *(B.c. parvipes)* / Taverner's Cackling Goose (Branta hutchinsii taverneri)[1]	50.0 (11)	71.0 (22)	71.0 (22)	10.7 (3)	0 (0)
Ridgeway's Cackling Goose *(B.h. minima)*	18.2 (4)	35.5 (11)	25.8 (8)	10.7 (3)	3.2 (1)
Cackling Goose *(B.h. taverneri ?) X* Greater White-fronted Goose	0 (0)	9.7 (3)	0 (0)	0 (0)	0 (0)

[1] The 4-yr pattern of monthly change in % occurrence is significant ($X^2_r = 10.105$, df = 4, p = .041).); results of month-to-month comparisons were not significant (all p-values > .05).

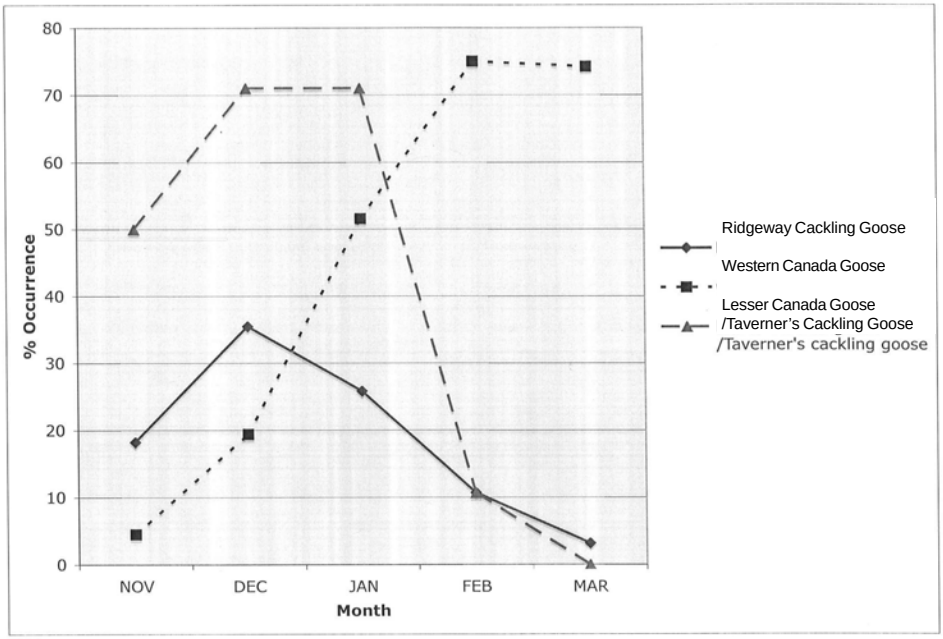

Figure 2. Seasonal occurrence of Canada and cackling geese on the Vina Plains, Tehama County, California, Fall 1999 – Spring 2003.

included individuals which were morphologically consistent with Taverner's cackling geese, *B. h. taverneri*, which tend to be somewhat smaller and darker than lesser Canadas (Yocom 1972, Johnson et al. 1979, Bellrose 1980).

Nevertheless, although genetically distinct (Shields and Wilson 1987a, b, Van Wagner and Baker 1990, and others), the lack of distinct morphological features makes the separation of these two geese all but impossible in the field (pers. comm., J. S. Sedinger, University of Alaska, Fairbanks, pers. comm., P. F. Springer, retired, Cooperative Research Unit, Humboldt State University, Arcata). Therefore, because of this taxonomic ambiguity, we combined data for lesser Canada and Taverner's cackling geese, and will refer to them collectively.

Our definitive identification of the lesser Canada goose was made possible through the tracing of a neck-banded bird observed in January 2001 (blue collar with the alphanumeric code MF6). This particular goose, a 3.5-year-old female, was banded near Anchorage, Alaska in 1998 (pers. comm., T. Rothe, Waterfowl Coordinator, Alaska Department of Fish and Game, Anchorage).

Greater white-fronted geese (Pacific race), *Anser albifrons frontalis*, snow geese, *Chen caerulescens*, Ross's geese, *C. rossii*, and tundra swans, *Cygnus columbianus*, occurred infrequently throughout this study (Tables 2 and 3). Individuals or small numbers of these goose taxa were generally observed within flocks of grazing or roosting white-cheeked geese, and except for one swan observed loafing on an EFRCA stock pond, all swan observations were of single or small numbers of birds foraging or loafing on VPP vernal pools.

We also observed two hybrid geese which appeared to be crosses between greater white-fronted and cackling geese (Tables 2 and 3). The hybrids, which shared morphological

Table 3. Maximum flock size for geese and swans on the Vina Plains, Tehama County, California, November 1999 - March 2003.

TAXA	Maximum Flock Size				
	Nov	Dec	Jan	Feb	Mar
Tundra Swan *(Cygnus columbianus)*	0	12	42	26	7
Greater White-fronted Goose *(Pacific subspecies) (Anser albifrons frontalis)*	0	1	11	6	9
Snow Goose *(Chen caerulescens)*	0	0	0	0	10
Ross' Goose *(Chen rossii)*	20	1	0	0	0
Western Canada Goose *(Branta canadensis moffitti)*	1	102	69	51	14
Lesser Canada Goose *(B.c. parvipes)* / Taverner's Cackling Goose (Branta hutchinsii taverneri)[1]	330	1200	1300	25	0
Ridgeway's Cackling Goose *(B.h. minima)*	230	475	475	12	2
Cackling Goose *(B.h. taverneri ?) X* Greater White-fronted Goose	0	2	0	0	0

[1] The 4-yr pattern of monthly change in maximum flock size is significant ($X^2_r = 12.05$, df = 4, p = .019); results of month-to-month comparisons were not significant (all p-values > .05).

features with both species, were observed during three surveys in December 2002, and always in close association with two other geese, one adult white-fronted goose and another bird that was morphologically consistent with Taverner's cackling goose.

Our focus thoughout the remainder of this paper will be on white-cheeked geese, as they were the most regularly occurring taxa on the Vina Plains.

Chronology, Percent Occurrence, and Flock Size

Lesser Canada/Taverner's cackling geese were the most abundant and among the most regularly occurring taxa using study area habitats during the fall and winter (Tables 2 and 3, Fig. 2). These mid-sized white-cheeked geese were observed from November through February, although they occurred most regularly in late December and January. Although the 4-yr pattern of change in monthly occurrence for these geese was significant ($p = .041$), differences in values from successive months were not (all p-values > .05). Monthly maximum flock sizes, which ranged from 0 – 1300 geese, also showed a significant pattern of change ($p = .019$), although month-to-month comparisons did not (all p-values > .05).

Western Canada geese were observed on the Vina Plains from November through March, although they occurred most regularly from January through the end of our field season in late March (Table 2, Fig. 2). The 4-yr pattern of monthly changes in occurrence and maximum flock size were not significant. Maximum flock sizes ranged from 0 – 102 geese, although flocks of 100 or more birds were observed only in December 2001 (Table 3).

Ridgway's cackling geese, the smallest of the white-cheeked geese, used Vina Plains habitats from November though March, although we observed them most regularly in late

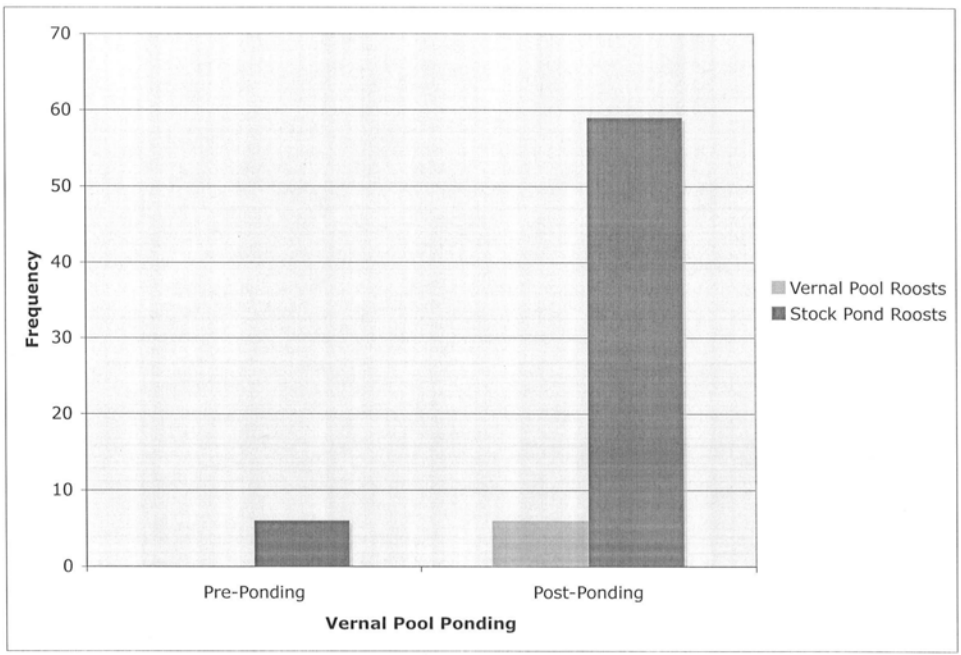

Figure 3. Use of Vina Plains vernal pools and artificial stock ponds as roost sites by western Canada geese, Fall 1999-Spring 2003.

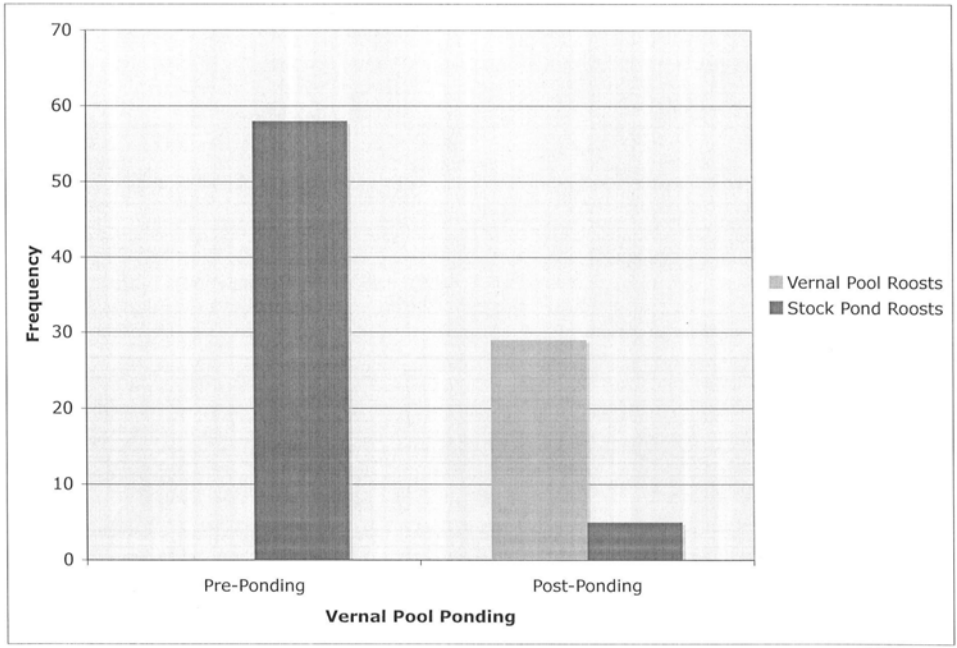

Figure 4. Use of Vina Plains vernal pools and artificial stock ponds as roost sites by Ridgway's cackling geese and lesser Canada/Taverner's cackling geese, Fall 1999 – Spring 2003.

December and January (Table 2, Fig. 2). Maximum flock sizes ranged from 0 – 475 birds, although flocks of over 100 birds were observed only in November and December 2002, and January 2003 (Table 3). The 4-yr pattern of monthly changes in percent occurrence and maximum flock size were not significant.

Habitat Use and Daily Activity Patterns

In general, the daily activity pattern of white-cheeked geese included nighttime roosting activities on artificial stock ponds and vernal pools (Figs. 3 and 4), as well as periods of morning and afternoon grazing on pastures. We also documented some use of study area ponds and pools as midday roost sites.

More specifically, geese arrived at night roost ponds from 14-48 min post-sunset, with the earliest arrival times recorded in January and February and on cloudy evenings. Morning departure times from night roosts ranged from 14 min pre-sunrise to 52 min post-sunrise, with the earliest departures recorded in November and early December.

These early morning departures and late evening arrivals in the fall are consistent with diurnal movements to disjunct foraging habitats (Raveling 1969, Raveling et al. 1972, Owen 1980). The latest morning departures were recorded from late December through January as well as on overcast mornings. Arrival and departure times were more or less consistent for all white-cheeked geese.

Following morning departures from roost ponds, white-cheeked geese grazed for brief periods of 15-45 min on study area pastures throughout November and early December, with lengthy, sometimes day-long departures to foraging habitats disjunct from the Vina Plains. We believe that geese were likely moving to agricultural areas in order to take

advantage of waste grains such as rice and corn. A shift to more extended periods of grazing on Vina Plains pastures occurred in late December or early January following the start of the growing season. In general, white-cheeked geese grazed Vina Plains pastures for 2-3 hours in the morning after leaving the night roost, and for 2-3 hours in the afternoon before returning to stock pond or vernal pool night roosts. It should be noted that 46 of 47 (97.9%) observations of foraging geese occurred on pastures previously or concurrently grazed by cattle.

The use of stock ponds or vernal pools as midday roost sites by small and mid-sized white-cheeked geese was minimal, with more consistent use by western Canada geese, which we often observed grazing near their roost ponds or in pastures located 1-2 km from roost ponds; they generally returned to their night roost pond or another nearby pond during the midday hours. These geese arrived at midday roosts from 3-3.5-hr post-sunrise, and then moved off to afternoon foraging sites from 2-2.5-hr pre-sunset. From late February through March, most of the western Canada geese spent the entire day on or adjacent to EFRCA stock ponds (Fig. 3).

Small and mid-sized white-cheeked geese did not return to their night roosts during the midday in November and early December. Beginning in late December, use of midday roost ponds by these smaller taxa was more variable, with flocks often remaining on Vina Plains pastures throughout the day. This pattern of prolonged, often day-long grazing (hyperphagia) is thought to facilitate the accumulation of endogenous body reserves necessary for migration and reproduction (McLandress and Raveling 1981).

DISCUSSION

The low numbers and irregular occurrence of tundra swans, greater white-fronted geese, snow geese, and Ross's geese on these high-terrace landscapes (Table 2) is not surprising. Large populations of these species (Scott 1972, Owen 1980) roost primarily within large Sacramento Valley wetland complexes, and feed mostly on rice and other waste grains in nearby agricultural fields throughout the fall and winter (McLandress 1979, Bellrose 1980, Owen 1980).

Prior to the onset of vernal pool ponding (Table 1), use of study area habitats by white-cheeked geese was limited to roosting activities on EFRCA stock ponds.

Small to mid-sized subspecies began using vernal pools as roost sites immediately following the beginning of ponding (Fig. 4), with a subsequent shift to diurnal grazing on Vina Plains pastures. This shift in foraging behavior is likely due to the availability of high protein and more easily digestible grasses and forbs at the onset of the growing season (Raveling 1979a, Raveling 1979b, Raveling and Zezulak 1991).

Western Canada geese used Vina Plains habitats from December through March, although their numbers were relatively low (Tables 2 and 3, Fig. 2). The largest flocks occurred from late December through February, with low numbers of what were likely local, non-migratory individuals remaining on the study area through late March.

As these large geese are more aquatic than smaller white-cheeked geese (Owen 1980), the bulk of their population tends to winter in agricultural areas of the Sacramento Valley, roosting within large managed marshlands, on lakes and reservoirs, and along rivers.

Although they were occasionally observed on or near vernal pools, western Canada geese continued to use EFRCA stock ponds as roost sites following vernal pool ponding

(Table 1, Fig. 3), with most grazing activity occurring in pastures adjacent to these culturally maintained ponds.

Numbers of up to several hundred Ridgway's cackling geese used Vina Plains vernal pools and pastures, with the most regular use and the largest flocks occurring in late December and January (Tables 2 and 3, Fig. 2). In 1984, when their population was at an all-time low, it was estimated that up to 85% of these birds wintered in the CV (Mlodinow et al. 2008). The current figure is at 5% of an estimated 193,300 geese, with the remaining 95% wintering in the lower Columbia River Valley of Washington and Oregon, and the Willamette Valley of western Oregon (Mlodinow et al. 2008, USFWS 2008, USFWS 1999). According to Raveling (1978), these sorts of shifts often suggest changes in winter resource availability. Although reasons for this migratory "short stopping" remain unclear, it is thought that this particular shift may have been stimulated by drought conditions in California during the period from 1986-1992, as well as an increase in winter forage availability (e.g., ryegrass agriculture) in areas of Washington and Oregon (USFWS 1999). Based on this well documented shift in winter distribution, coupled with the historic loss of California's vernal pool landscapes (Holland 1978, Holland 1998), we suspect that the use of these habitats by Ridgway's cackling geese was much greater in the past.

Large flocks of up to 1300 lesser Canada/Taverner's cackling geese were present on the Vina Plains from December through January (Tables 2 and 3, Fig. 2). Most observed roosting activities of these geese as well as Ridgway's cackling geese shifted from stock ponds to vernal pools following the onset of ponding (Fig. 4). Based on current estimates, approximately 10,000 lesser Canada/Taverner's cackling geese winter in central California (Mlodinow et al. 2008). As these birds likely move into California from late October though mid November, and as their northern migratory movements have been documented in the Columbia River Basin as early as mid February, our occurrence and flock size data suggest that Sacramento Valley vernal pool habitats provide resources to a significant portion of this wintering population(s).

Traditional use of migration routes as well as wintering, staging, and breeding habitats has been well documented for geese and other waterfowl (Hochbaum 1955, Raveling 1979c, Owen 1980). We believe that the regular and predictable shift by small and mid-sized white-cheeked geese from artificial stock ponds to vernal pools following the onset of ponding, and from disjunct foraging sites to study area pastures is consistent with a pattern of long-term traditional use. Also, it is likely that usage of these habitats would have been greatest from initial pool ponding in late December or January until spring migration.

Additionally, based upon their continued use of relatively deep stock ponds throughout the winter and spring, we think it likely that historic and prehistoric use of these shallow vernal pools by western Canada geese would have been minimal.

Traditional roost sites are thought to serve as important reunification and communication centers for goose family units and subflocks (Raveling 1969, Raveling 1970). Considering that the selection of a roost site is likely based on that pond's ability to provide adequate protection from predators and harsh environmental conditions, it can be argued that maintaining the quality of traditional roosting and foraging habitats, such as those on the Vina Plains, may be critical to the maintenance of California's small and mid-sized white-cheeked goose populations during the winter, spring migration, and also to their success during the subsequent nesting season. Accordingly, we suggest that large, intact vernal pool landscapes on elevated terraces along the east side of the Sacramento Valley should be protected as part of a long-term management strategy for both small and mid-sized

white-cheeked geese. Although we did not test for the effects of cattle grazing on the selective use of upland habitats by these geese, our data suggest that traditional levels of rotational grazing on Vina Plains pastures should be maintained

ACKNOWLEDGMENTS

We would like to thank TNC for granting us access to the original parcel of the VPP, as well as for their financial support of our research efforts. In addition, we would like to thank Mr. P. Wells for his consistent support of our research, and for granting us access to the EFRCA.. Thanks also go to J. Rotnem, College of Natural Sciences, California State University, Chico, for her assistance during the grant writing phase of this project. Lastly, we are indebted to N. Carter and N. Schwertman for their assitance with our statistical analysis, and to J. Silveira and S. Kirn for their review of this manuscript.

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Received: 29 March 2009
Accepted: 21 September 2009