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Economic Impacts of Wintering Geese to Agricultural Operations in the Sacramento Valley of California

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ABSTRACT: Over 2.2 million geese rely on California's Central Valley for critical wintering habitat during the non-breeding season, with 80% over-wintering in the Sacramento Valley region. The wintering goose population has nearly doubled compared to estimates reported in 2006; notably, lesser snow geese (*Anser caerulescens caerulescens*) make up over half of all wintering geese. Despite changes to hunting regulations, lesser snow goose populations remain consistently high and have resulted in human-wildlife conflicts with farming and livestock operations. Damage by geese to pastures and planted winter crops is not a new phenomenon in the Sacramento Valley, but many farmers and ranchers report that the problem has dramatically increased since 2018, with damages in 2023 the worst they have experienced. To quantify the financial impact that occurred in 2023 in Yolo, Solano, and Sacramento counties, we partnered with county Agricultural Commissioners to survey farmers and ranchers about their losses and other costs due to geese. A total of 34 people responded to the surveys, reporting impacts at 54 unique sites. The total value of reported direct losses was $8.043 million, with an additional $281,900 in abatement and crop reseeding costs. A variety of crops were impacted, including alfalfa, wheat, grass hay, and triticale, although pastures received the highest amount of monetary damages due to the large number of acres that were impacted. The combination of drought impacts followed by extensive flooding in the winter of 2022-2023 likely contributed to a severe decline in typical food resources for wintering geese in the Sacramento Valley, increasing their impact on pasture and crop fields. The extent and severity of this human-wildlife conflict signals the need for coordinated and broad-based programs that address both the populations of wintering geese and financial relief programs for affected agricultural operations.

KEY WORDS: bird abatement, bird damage, crop loss, goose damage, human-wildlife conflict, lesser snow goose, pasture loss

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INTRODUCTION

California's Central Valley is critical habitat to one of the world's largest assemblages of wintering waterfowl, comprised of nearly 1.5 billion ducks, geese, and swans (CVJV 2020). The Sacramento Valley (the northern portion of the Central Valley) supports 80% of the 2.2 million wintering geese in the region (CVJV 2020). Many of these species, including lesser snow geese (*Anser caerulescens caerulescens*), Ross's geese (*A. rossii*), greater white-fronted geese (*A. albifrons*), and Aleutian cackling geese (*Branta hutchinsii leucopareia*), are long distance migrants that depart after the breeding season from as far north as the Arctic Circle to take advantage of more favorable winter climates in California (Billerman et al. 2022). Despite the significant amount of land conversion from native habitats to farmlands and cities in the Central Valley, waterfowl find suitable habitat on managed farms and marshes during the winter months (Reid et al. 2018). However, changes in agricultural practices, increasing wintering waterfowl populations, and climate change may interact and lead to increasing human-wildlife conflict between waterfowl and agricultural producers in this region (Matchett and Fleskes 2017).

In the Sacramento Valley, wintering waterfowl and farmers have strong ties to each other. Wintering geese rely on managed seasonal wetlands for roosting but consume seeds and green forage within agricultural lands where they rely heavily on waste agricultural grains from post-harvest rice and corn fields (Miller et al. 2010, Skalos 2012, Cunningham et al. 2021). It is estimated that 95% of the total food energy for one of the most abundant geese species, the lesser snow goose, is provided by post-harvest rice fields (Petrie et al. 2016). Water availability in a given year influences rice production and the ability to practice other beneficial management actions, such as winter flood-up of harvested rice fields (Petrie et al. 2016). The flooding in post-harvest rice fields is an important farm management tool that attracts waterfowl and significantly increases the foraging value (Fleskes et al. 2012). The flooding of post-harvest rice fields is also beneficial to farmers, as the presence of waterfowl aids in the decomposition of post-harvest stubble (Bird et al. 2000) and because of financial incentive programs (i.e., the Winter Rice Habitat Incentive Program of the California Ricelands Waterbird Foundation).

Exceptional and extreme drought conditions in the winters of 2020-2021 and 2021-2022, respectively, reduced water availability and resulted in an overall reduction in the amount of rice produced in 2022 and the amount of rice fields that practiced winter flooding (Petrie et al 2016). Additionally, increased harvesting efficiency has reduced the amount of waste grain left after harvest (Fleskes et al. 2012), ultimately reducing the total food energy available for geese. Estimates report grain food supplies that geese

rely on in the Sacramento Valley are commonly depleted by early February or March, at which time geese may switch to green forage (Skalos et al. 2021). These food sources are often readily available in newly planted grain crop and irrigated pasture fields. Under a scenario of continued reduction of rice production and other threats to waterfowl foraging habitats, traditional goose food resources are predicted to be depleted as early as January in future years, increasing the likelihood of geese searching elsewhere for food which may lead to increased crop and pasture losses for local agricultural producers (Skalos 2012).

Currently, the overall goose population in the Central Valley has nearly doubled compared to population estimates reported in 2006 (CVJV 2020). Most species of North American geese have surpassed conservation population objectives, most notably lesser snow geese, which make up over half of all wintering geese that utilize the Sacramento Valley (CVJV 2020). The rapid population growth of lesser snow geese can be attributed to several factors related to climate change, such as warmer temperatures on the Arctic breeding grounds and the expansion of northern farms that provide ample food resources in proximity to breeding colonies (Mowbray et al. 2020). In response to the large population size and a higher number of human-wildlife conflicts with lesser snow geese, California hunting limits have been set to 20 white geese per day per licensed hunter, and a late season has been established that permits the hunting of lesser snow geese after the traditional closing of the waterfowl hunting season in late January (California Fish and Game Code §502). Despite changes in hunting regulations, wintering lesser snow geese populations remain consistently high in the region (CVJV 2020).

Human-wildlife conflicts between agricultural producers and wintering geese typically occur when large aggregations of geese forage and loaf in irrigated pastures and newly planted crop fields. This can occur from late December through March in the southern Sacramento Valley, but can last until mid-April, before birds embark on migration back to their breeding grounds. Geese can cause damage by trampling young plants, consuming seedlings, consuming large volumes of forage, and leaving large amounts of droppings. Once large aggregations of geese form in fields, strategies to deter geese can be challenging and costly with low efficacy. In response to complaints from landowners of damage from large aggregations of geese in the 2022-2023 winter, our objectives were to document the geographic scope, economic damage, types of crops impacted, and perceived effectiveness of different hazing strategies for wintering geese in the southern Sacramento Valley, California.

METHODS

Our study takes place in the southern portion of the Sacramento Valley, California, in Yolo, Solano, and Sacramento counties, representing gross production values of agricultural commodities of $693,548,000, $460,391,000, and $602,751,000, respectively (Yolo County Crop Report 2023, Solano County Crop Report 2023, Sacramento County Crop Report 2023). The predominant non-urban land-use in this three-county area is diversified farming, dryland and irrigated pasture, wildlife habitat and combinations of wildlife habitat and agricultural operations. Primary cultivated crops in this region include rice, wild rice, wheat and other small grains, processing tomatoes, alfalfa, cereal forage crops (for silage and hay), corn, sunflowers, wine grapes, almonds, and walnuts (Yolo County Crop Report 2023, Solano County Crop Report 2023, Sacramento County Crop Report 2023). Crops that are vulnerable to damage by geese include newly planted small grain and annual forage crops, and perennial forage crops such as alfalfa. Permanently established irrigated pastures are also vulnerable to damage by geese regardless of the presence of livestock. Irrigated pastures in the region are a valuable feed resource as livestock operations depend on the pastures for year-round or seasonal grazing by cattle and/or sheep. Irrigated pastures that are not grazed year-round will be seasonally grazed from May through November with the livestock being transported to annual rangelands where they graze November through April. Seasonally-grazed irrigated pastures are often harvested for hay once in the spring before animals arrive in May.

We created separate surveys for crop and livestock producers to quantify damage that resulted from geese from December 2022 through April 2023. We partnered with county Agricultural Commissioners to distribute surveys to producers through existing email lists. Additional email lists and contacts of the local University of California Cooperative Extension offices were utilized to distribute the surveys. We also advertised the ability to participate in the surveys with county Farm Bureaus. We released the livestock survey in spring, whereas we released the crop survey later in mid-summer once the vulnerable crops were harvested and the full value of losses was known to producers.

The surveys gathered information on location, crop or pasture type, market price, total acres impacted, expected vs. actual yields, abatement strategies used, perceived effectiveness of abatement strategies, and receipt of disbursements from crop insurance to cover the financial damage. We calculated total loss as the sum of reported direct value of crop loss, reseeding costs (if applicable), and abatement costs.

Livestock producers were able to use one of two calculation methods to estimate their pasture losses. The first method was based on the estimated reduction in livestock weight gains per acre for the number of days that pastures were impacted by geese. The value of lost livestock weight gains was estimated using the market beef prices at local auction yards at the time of the loss. The second method was based on the difference in livestock carrying capacity of impacted pastures during the time geese were present on the pastures compared to the same time period during a normal year. The livestock carrying capacity was calculated as Animal Unit Months which was converted to tons of feed. The value of forage losses was calculated using the market hay price for replacement grass hay at the time of the loss, plus the value of hay that was purchased, and the associated cost in labor and fuel to feed the hay. Livestock producers were not asked about the monetary impact of abatement costs, as this question was added after the initial release of the survey.

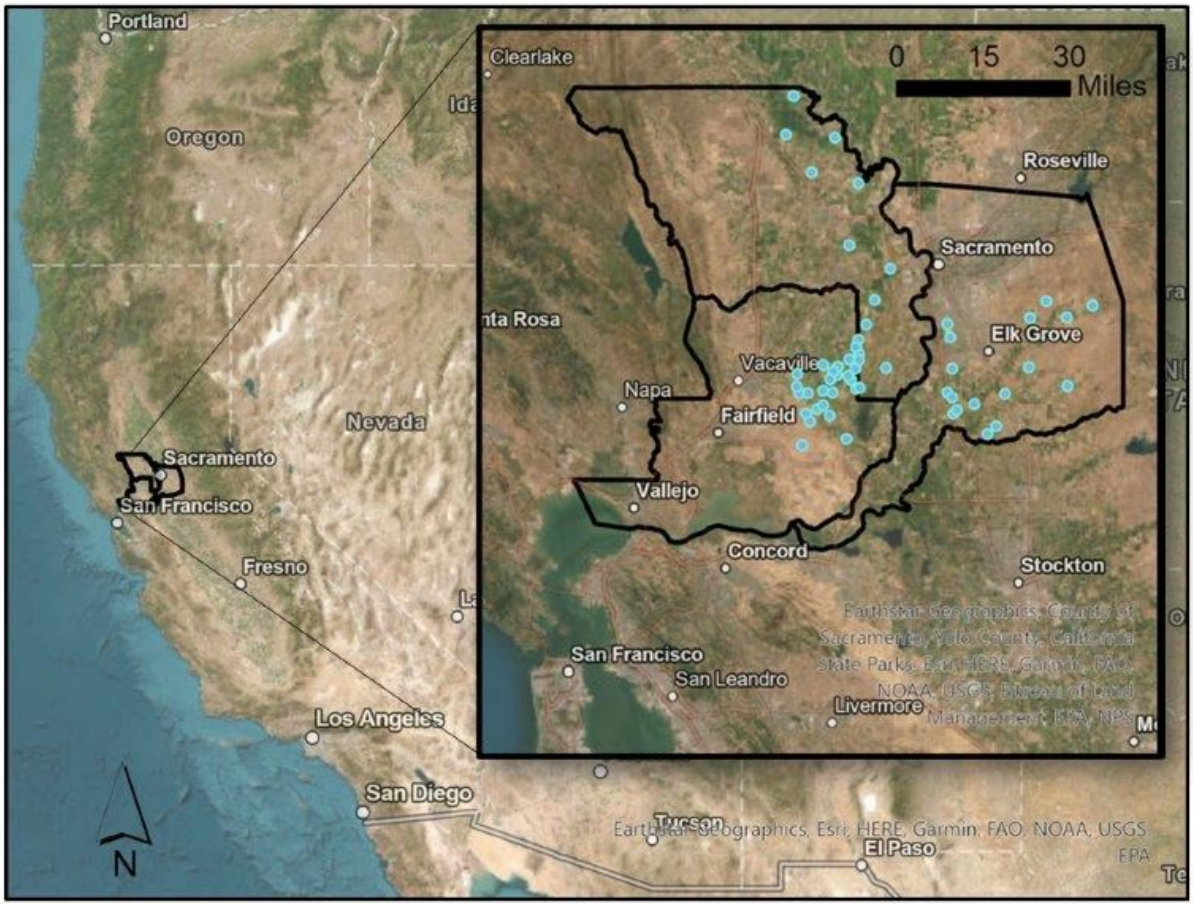


Figure 1. Locations of geese pasture or crop loss (blue dots) reported in the winter of 2022-2023 in Yolo (top left), Solano (bottom left), and Sacramento (right) counties.

RESULTS

Impacts from wintering geese were reported at 54 unique sites in Yolo, Solano, and Sacramento counties (Figure 1). A total of 34 agricultural producers responded to the surveys, comprised of 19 crop producers and 15 livestock producers. The types of crops where damage was reported included alfalfa, wheat grain, grass hay, silage, canola, triticale grain, wild rice, and cover crops, while pasture sites included dryland and irrigated pastures (Table 1). The cumulative area of damage reported was 58,939 acres (area reported in acres to remain consistent with how producers measure land). Reports included 34 crop and 20 pasture sites totaling 6,514 and 52,425 acres, respectively. Of the impacted sites, 24 were in Yolo County (18 crop; 6 pasture; 5,758 acres), 18 in Sacramento County (12 crop; 6 pasture; 8,298 acres), and 12 in Solano County (4 crop; 8 pasture; 44,883 acres). Of the total impacted acres reported across the three-county area, Solano County had the largest proportion of acres impacted (76.4%), followed by Sacramento (14.1%) and Yolo (9.5%) counties. The total reported impacted acreage was highest for pastures (55,425 acres), followed by grass hay (2,427 acres), wheat (1,442 acres), alfalfa (1,070 acres), silage (1,200 acres), canola (145 acres), wild rice (80 acres), triticale (75 acres), and cover crops (75 acres; Table 1).

The total value of direct losses reported was $8.043 million, with an additional $281,900 in abatement and crop reseeding costs (abatement: $104,950; reseeding: $176,950). The total value of losses was highest on pastures ($4.522 million), followed by alfalfa ($1.073 million), wheat ($880k), grass hay ($811k), silage ($467k), canola ($152k), wild rice ($126k) and triticale ($13k; Table 1). The largest financial impact was experienced in Solano County with $3.541 million in losses, followed by Sacramento County at $2.767 million, and Yolo County at $1.608 million (Figure 2).

Of the 34 crop sites impacted by geese, direct crop losses on only seven sites were covered by crop insurance, although the total number of crop producers that possessed insurance or were insured but were denied claims is unknown. Crop insurance regulations limit the type of crops covered (i.e., pasture lands do not qualify) and, in some cases, could not apply to such a localized event. In some circumstances, crop producers had the ability to re-seed where crop damage had occurred. Of the 24 crop sites represented in the survey, 5 sites were able to be re-seeded. Other producers reported not re-seeding for one or more of the following reasons: the soil being too wet, the timing being too late, the lack of seed availability, the lack of

Table 1. Summary of reported crop acreage and monetary loss by county in Sacramento, Solano, and Yolo in the winter of 2022-2023.

	County			
	Sacramento	**Solano**	**Yolo**	**Totals by Crop**
Pasture				
Acres	6,011	43,083	3,331	**52,425**
Loss	$1,275,574	$2,828,329	$417,646	**$4,521,549**
Alfalfa				
Acres	450	150	470	**1,070**
Loss	$847,500	$38,813	$186,300	**$1,072,613**
Wheat grain				
Acres	100	345	997	**1,442**
Loss	$18,875	$217,350	$643,490	**$879,715**
Grass hay				
Acres	537	1,160	730	**2,427**
Loss	$158,850	$304,500	$348,000	**$811,350**
Silage				
Acres	1,200			**1,200**
Loss	$466,500			**$466,500**
Canola				
Acres		145		**145**
Loss		$152,250		**$152,250**
Triticale grain				
Acres			730	**75**
Loss			$348,000	**$13,050**
Wild Rice				
Acres			80	**80**
Loss			$126,000	**$126,000**
Cover Crop				
Acres			75	**75**
Loss			n/a	**n/a**
Total acreage by county	**8,298**	**44,883**	**5,758**	**58,939**
Total loss by county	**$2,767,299**	**$3,541,242**	**$1,734,486**	**$8,043,027**

equipment, permanent/perennial crops that cannot be re-seeded, and/or concern of future damage by geese.

Among the 34 respondents, there were 70 reports of abatement strategies being employed to deter or remove geese from an area. Strategies included hunting, chasing, visual scaring devices (scarecrows, balloons, reflective tape, helium balloons), audio scaring devices (propane cannons, gunshots), dogs, increased livestock and human presence, and lasers (Table 2). Chasing the geese, typically on 4-wheeler vehicles, was the most common abatement strategy followed by hunting and noise devices. People often reported, both in the survey and through personal communications, that the abatement strategies only temporarily moved the geese to an adjacent field. Of the reported abatement strategies, hunting was the only strategy reported to be very effective by one respondent, although 9 respondents ranked hunting as only moderately or slightly effective, and 8 others indicated it was not effective.

DISCUSSION

The impacts of geese on agricultural operations have ranged from a nuisance to threatening the viability of agricultural ventures. Agricultural producers surveyed in Yolo, Solano, and Sacramento counties reported $8.043 million in direct crop losses at 54 sites in the 2022-2023 winter from geese, with the greatest loss reported in irrigated pastures in Solano County. Abatement strategies were generally not reported to be effective at deterring geese and often incurred significant costs to producers. Some producers were able to reseed their crop after damage, although this not always a viable solution and depended on the type of crop damaged in relation to other environmental factors. While damage by geese to winter crops is not a new phenomenon in this three-county region of the Sacramento Valley, many farmers and ranchers report that the problem has dramatically increased since 2018, with damages in the 2022-2023 winter and spring the worst they have experienced.

Exposure to damages from geese may be influenced by climatic conditions that impact available food on the landscape and the extent of crops deemed favorable by geese (Petrie et al. 2016). Prolonged extreme and exceptional drought conditions in Northern California from 2020 through 2022 (Tinker 2023) severely limited or completely eliminated irrigation water allocations in many regions of the Sacramento Valley during the summer of 2022. As a result, rice production in 2022 was greatly reduced as many fields were left fallow. The combination of drought impacts followed by extensive flooding in the winter of 2022-2023 likely contributed to a severe decline in typical food resources for wintering waterfowl in the Sacramento

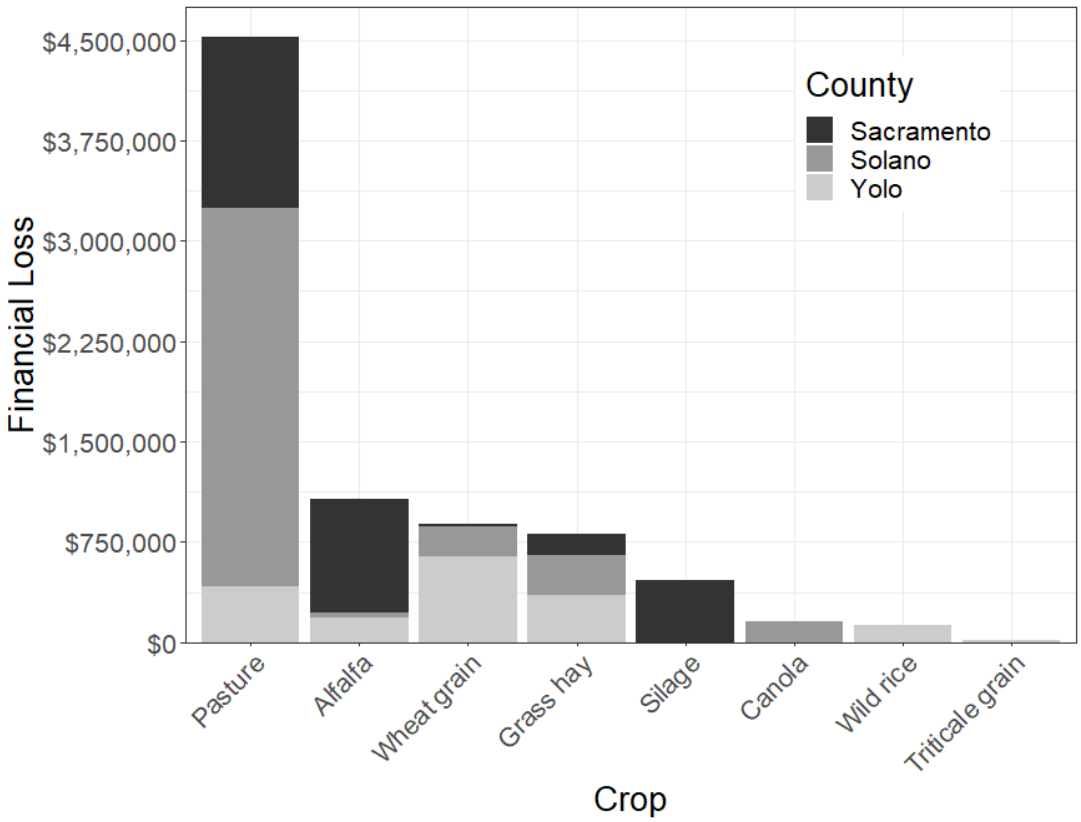


Figure 2. Reported financial losses from goose damage by crop type in Sacramento, Solano, and Yolo counties in the winter of 2022-2023.

Table 2. Summary of abatement strategies used to deter geese and their perceived effectiveness as rated by survey participants.

	Effectiveness				
	Very	**Moderately**	**Slightly**	**Not**	**Total**
Chasing		3	7	12	**22**
Hunting	1	3	6	8	**18**
Audio scaring devices		2	4	9	**15**
Visual scaring devices		2	3	4	**9**
Dogs				2	**2**
Human/livestock presence			2		**2**
Laser			2		**2**
Total	**1**	**10**	**24**	**35**	**70**

Valley, increasing the impact of geese on pasture and crop fields. Although the climatic impacts on waterfowl-agriculture conflicts are only surmised, similar climatic conditions are likely to occur in the future, especially if migratory goose populations remain at high levels. If the causation is confirmed, it would be helpful for agricultural organizations and agencies to communicate warnings to the agricultural community in years where conditions may lead to increased conflict so that pre-emptive actions can be taken, such as planting alternative crops or early seeding of vulnerable crops in impacted areas.

A condition observed by many farmers and ranchers is the preference geese have for foraging on young and tender crop shoots. This preference may explain the impact on pasture, alfalfa, wheat, and other small-grain crops, all of which are typically short and succulent when geese arrive in December and January. Un-grazed pastures and crops that were able to grow to about a 6 to 8-inch height prior to the arrival of geese were not reported to be impacted. Further observations by ranchers indicate that once a pasture of high grass was grazed to a short stature by livestock, geese were likely to forage on the pasture.

Further investigation into canopy height, livestock grazing, and goose site selection should be investigated (Mandema et al. 2014).

As a result of the geese consuming forage resources on irrigated pastures near the Yolo Basin, ranchers identified indirect impacts on grazing lands in other regions of the state. With little forage available on pastures affected by geese in the spring months, which is when many livestock are moved to valley irrigated pastures, ranchers had to leave livestock on rangeland pastures elsewhere in the state beyond desired grazing thresholds. This not only depletes the forage base ranchers depend on in fall months when livestock are moved back to rangelands, but it may also have negative impacts on rangeland ecosystems (Jones 2000).

Large aggregations of geese on irrigated pastures have the potential of wildlife-to-livestock transmission of economically important diseases, some of which are also infectious to humans. The transmission of diseases from wild fowl to livestock (cattle and small ruminants) is well documented in scientific literature (Weithoelter et al. 2015) and includes salmonellosis (diarrhea/sepsis), pasteurellosis (pneumonia), echinococcosis or cysticercosis (tapeworm cysts), leptospirosis (abortion/renal disease), toxoplasmosis (abortions), chlamydiosis (causes abortions, infected joints of lambs, and pink eye), and most recently, highly pathogenic avian influenza (Caserta et al. 2024). While there were no confirmed cases of actual transmission of such diseases from wildlife to livestock or to humans in this region in 2022-2023, it is a growing concern which calls for vigilance by livestock producers, veterinarians, health care professionals and people working in areas impacted by large populations of geese. In personal communications with several livestock producers, they reported that dead geese were commonly present in their pastures and expressed concern of potential disease transmission to their livestock and to themselves as they retrieved goose carcasses for disposal.

Despite the severity of agricultural impacts caused by geese in 2023, affected farmers and livestock producers had to absorb the totality of the losses and costs. Federal disaster programs that normally provide financial relief to farmers and ranchers impacted by weather events do not apply to crop damages and losses caused by wildlife (Personal communications with USDA Farm Service Agency county office directors). While financial relief has generally not been available for crop losses due to geese, agricultural producers may be forced to adapt some farming practices, such as switching to alternative crops that will not be impacted by geese. Producers were largely unsuccessful in deterring geese with abatement strategies, and often these strategies were costly in terms of time and labor. Future research into effective abatement of wintering geese in crop fields and pastures in this region is warranted, including the development of regional strategies needed to alleviate the issues on a larger scale than the individual producer (Bauer et al. 2018).

Proposed solutions to the problem should be multifaceted and consider research, management, and economic aspects. Further research is needed to help understand interannual patterns and ways of preventing future damage to inform regional planning and public and private land management. Expansion of federal disaster programs to cover crop losses due to wildlife damage and ensure agricultural viability will be important to alleviate the financial burden from agricultural producers while solutions are implemented. The development of programs in which farmers and ranchers are paid for feeding waterfowl and changes to waterfowl management in general could also be impactful. California is not the only state suffering severe agricultural impacts from wintering geese. Similar impacts have been observed in Washington, Pennsylvania, midwestern states, mid-Atlantic states, and northern Europe (Mason 1995, Miller 2000, Amano et al. 2007, Jensen et al. 2008, Lefebvre et al. 2017), and successful outcomes from these regions should be studied to inform next steps. The extent and severity of this human-wildlife conflict signals the need for coordinated and broad-based programs that address both populations of wintering geese and financial relief programs for affected agricultural operations in the Sacramento Valley.

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