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A win–win between farmers and an apex predator: investigating the relationship between bald eagles and dairy farms

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Abstract

Human–wildlife conflicts on farms and ranches are common and well-documented, particularly with apex predators. Predation of livestock, for example, can result in serious economic burdens for farmers and can become threats to wildlife populations as farmers take action to eliminate or displace populations. Among apex predators, bald eagles (*Haliaeetus leucocephalus*) have received increased media attention in recent years due to conflicts with farmers across the United States. This raises challenges for both farmers and wildlife managers as eagle abundance continues to increase and natural prey resources decline. Interestingly, a recent study in northwestern Washington State reported high eagle activity on dairy farms in response to declines in salmon carcass availability, an important resource for wintering eagles across western North America. Despite the potential for human–wildlife conflict in these areas, little is known of the relationship between eagles and dairy farms. In this study, we investigated the extent of eagle activity on dairy farms and the relationship between eagles and dairy farmers using semistructured interviews with dairy farmers. We found that (1) eagles were attracted to dairy farms to feed primarily on cow afterbirth and calf carcasses, (2) responding farmers had no issue with the presence of eagles on their farms, and (3) many dairy farmers felt that eagles provided services to their farms. Of these services, the most recognized were scavenging of dairy farm byproducts and removal or deterrence of unwanted pest species. Increased eagle abundance on dairy farms and the subsidy of anthropogenic resources may also influence the ecological role of eagles as top predators in agroecosystems. Ultimately, farmers' decisions to provide anthropogenic resources have apparently mitigated human–eagle conflict while potentially reducing top–down pressures on other wild prey species. Farmers and wildlife managers may each benefit through cooperation in continuing to understand the intricacies of dairy farm–eagle relationships.

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KEYWORDS
agroecosystem, anthropogenic resources, bald eagle, carcasses, chum salmon, dairy farm, ecosystem services, human–wildlife conflict, pest management, scavenging

INTRODUCTION

Human–wildlife conflicts on farms are common and well-documented, particularly with apex predators (Margalida et al., 2014; Pooley et al., 2017; Torres et al., 2018). Predation on livestock such as cattle (Duriez et al., 2019; Santiago-Avila et al., 2018; Steele et al., 2013), sheep (Drouilly et al., 2018; Knowlton et al., 1999; Novaro et al., 2004), and poultry (Amador-Alcalá et al., 2013; Bechtel, 2018; Weladji & Tchamba, 2003) can lead to serious economic burdens for farmers across the globe (Rust & Marker, 2014). Destruction of feed and infrastructure (Anderson et al., 2016; Carlson et al., 2018) and spreading of pathogens and antimicrobial-resistant genes by wildlife are also well known (LeJeune et al., 2008; Swirski et al., 2014; Wang et al., 2017; Warnick et al., 2001). European starlings and other birds have specifically been documented to cause millions of dollars in damage to dairy farms in North America (Adams-Progar et al., 2020; Elser et al., 2018, 2019; Shwiff et al., 2012).

In some cases, however, farmer's negative perceptions of wildlife activity are exaggerated or unfounded, leading to unnecessary conflicts (Duriez et al., 2019; Nattrass & Conradie, 2018). This can be induced by misunderstandings of wildlife activity, or by emotional factors, such as perceived risk, influenced by an animal's physical attributes, behavior, or portrayal in human culture (Castillo-Huitrón et al., 2020; Jacobs, 2012). In either case, conflicts can become large threats to wildlife populations as farmers take action to eliminate or displace populations. Understanding the extent of human–wildlife conflicts on farms can greatly inform management decisions and conflict mitigation strategies, including education and communication outreach tools (Dickman, 2010; Raymond et al., 2010).

Among apex predators, birds of prey have become a prominent subject of human–wildlife conflicts (Salom et al., 2021). Scavenging birds, such as vultures, are frequently (and falsely) blamed for economic losses due to livestock predation on farms (Lowney, 1999; Margalida et al., 2014). These frustrations have led to deliberate poisoning and deterrence efforts, affecting several wildlife species (Margalida et al., 2014; Ogada et al., 2012; Pauli et al., 2018; Pfeiffer et al., 2015; Plaza & Lambertucci, 2019). Other predatory birds, such as eagles, have also been subject to such techniques globally (Avery & Cummings, 2004; Phillips & Blom, 1988; Sarasola et al., 2010), driven predominantly by accusations of livestock predation. While some depredation reports have proven false or inflated (Marr et al., 1995; Sarasola et al., 2010), increasing reports on the economic burden of eagles for farmers have appeared in popular media. For example, in 2018, a pasture-based poultry farmer in Georgia won a $2.2 million legal battle for the restitution of roughly 160,000 chickens lost to bald eagle attacks (Bechtel, 2018). In addition, many media outlets have reported the increased killing of lambs by eagles in parts of the western United States, leading to economic losses for farmers (Sieve-Hicks, 2019). Such conflicts between eagles and farmers may become increasingly common, as bald eagle abundance has increased dramatically over the last three decades in the United States (USFWS, 2020).

Reductions in natural prey may also force eagles to shift their attention to anthropogenic resources provisioned by farms, as is observed with many apex predators (Parsons et al., 2022). A recent study from northwestern Washington State, USA, found that a substantial proportion of wintering eagles use nearby agricultural areas in response to declines in salmon carcass availability in riparian areas (Duvall, 2022). Most notably, eagles were observed congregating near dairy farms, foraging on calf carcasses, composted remains, and cow afterbirth produced by the facilities. Despite reports of high eagle activity in these human-dominated areas, knowledge of farmer–eagle relationships on dairy farms is not well-documented. In theory, a shift by eagles from natural prey to anthropogenic subsidies may lead to increased human–wildlife conflicts through resource competition (e.g., livestock predation) or the perceived risk of such interactions (Parsons et al., 2022). However, if resources are not in competition (e.g., eagles feeding on dairy industry discards), conflicts may be mitigated or extinguished through diversionary feeding (Dickman, 2010). Understanding the extent of human–eagle interactions on dairy farms may offer insight into the management of eagles in agricultural areas, particularly as eagle populations continue to increase, and natural prey resources decline (Rubenstein et al., 2019). Incorporating farmers' perspectives on human–wildlife relationships may also offer broader support for conflict mitigation strategies to support wildlife conservation efforts while meeting farmers' needs (Dickman, 2010).

In this study, we investigated the extent of human–eagle interactions on dairy farms and gathered

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basic insights into farmers' perspectives on eagles in this particular agricultural setting. We conducted semistructured interviews with dairy farmers in northwestern Washington State, USA, to better understand (1) eagle activity on dairy farms and drivers of eagle movement to agricultural areas, (2) whether increased eagle abundance in agricultural areas has led to heightened human–wildlife conflicts, and (3) the potential implications of increased eagle activity on dairy farms for humans and wildlife.

METHODS

Our study took place in Whatcom County, Washington, USA (Figure 1). This area was chosen for its prevalence of dairy farms and previously reported eagle activity in these areas (Duvall, 2022). Bald eagles are particularly abundant during the winter in this region, migrating from across northwestern North America to feed on spawned-out chum salmon carcasses in local rivers. Whatcom County contains approximately 40,470 ha of agricultural land (NASS, 2017) with 78 registered dairy farms as of February 2021 (Washington State Dairy Federation, personal communications with author Karen Steensma, 2021). Small dairy farms (29 total) ranged up to 199 dairy cows, medium farms (31 total) ranged from 200 to 699 dairy cows, and large farms (18 total) ranged from 700 or more dairy cows, as defined by the USDA.

To investigate human–eagle relationships on dairy farms, we conducted in-person interviews with dairy farm owners and employees during the winter of 2020–2021. We followed a semistructured questionnaire format where one individual asked questions while another recorded responses. The questionnaire contained 12 core questions related to eagle abundance, behavior, phenology, and the perception of eagles by farmers (Appendix S1: Table S1). Interviews began with an explanation that this was an independent research project by university students, with no affiliation with government agencies, and that all answers would be treated anonymously. We prioritized

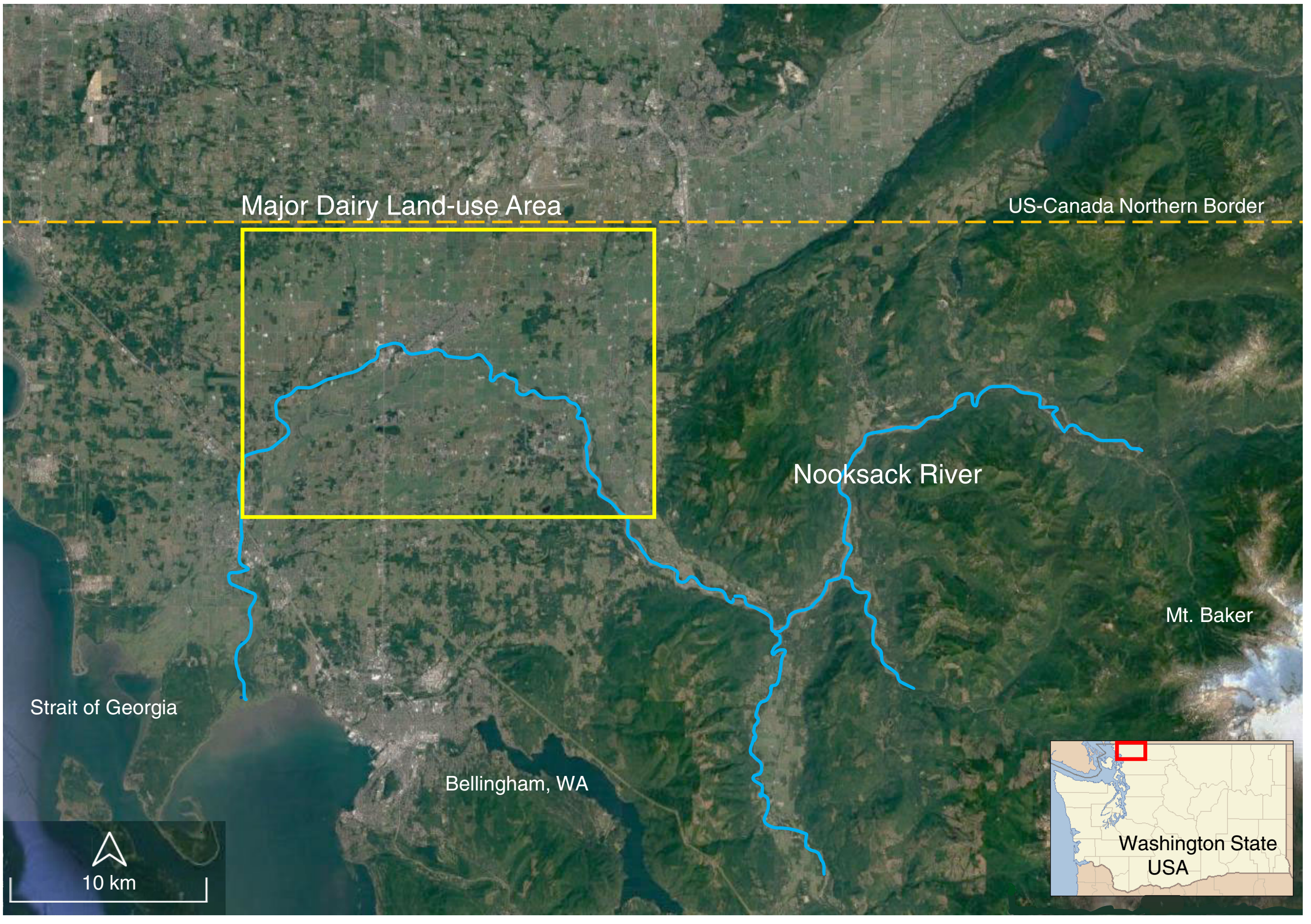

FIGURE 1 Map of the study area showing the location of dairy farms relative to the Nooksack River, WA, USA (48.975340, −122.304852). Satellite imagery sourced from Copernicus Sentinel data. Retrieved from USGS EarthExplorer, 17 November 2020, processed by European Space Agency.

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speaking with dairy farm owners but would interview employees if designated by the owner. The interviewers self-identified as White early-career researchers (graduate and undergraduate students), one male and one female, with an educational focus on wildlife ecology.

We used a two-way ANOVA to examine the relationship between farm size (small, medium, and large) and average and peak eagle abundance reported by farmers. However, due to limited sample size and unstandardized survey methods, our questions and analyses related to eagle abundance and phenology are meant to provide context to the responses of farmers rather than accurate estimates or statistically meaningful results. All interview responses were compiled and reported as a percentage of total responses. We performed all analyses using R (version 3.4.0; R Core Team, 2017).

RESULTS

Of the 78 dairy farms in Whatcom County, 27 were approached for an interview. These farms were chosen based on proximity to previously conducted eagle–farm surveys in Whatcom County (fig. 1 in Duvall, 2022). Twenty farmers were willing to be interviewed, representing 74% of farms approached, and 25.6% of all the dairy farms in Whatcom County. Those not able to interview were either busy or otherwise unavailable. Of the farmers who agreed to be interviewed, 4 owned small dairy farms, 12 owned medium dairy farms, and 4 owned large dairy farms.

Of the 20 farmers interviewed, 100% stated that bald eagles frequented their farm. Seventy percent of farmers stated that these visits were year-round, 25% of farmers stated that eagles only frequented during the winter, and one farmer could not provide an answer to that question. According to 65% of farmers, bald eagles were present daily or every other day during the winter; 15% stated that eagles visited weekly and 20% were uncertain about precise frequency. On average, farmers estimated a daily average of 2.65 ± 0.86 eagles on their farms; however, the peak number of eagles reported by farmers was much more variable, ranging from 3 to 50 with an average of 20 ± 13 per farm. There was no significant statistical relationship between farm size and reported peak and average eagle abundance ($p < 0.05$).

When farmers were asked about reasons why eagles were present on their farms, 45% of farmers reported scavenging of cow afterbirth, 40% reported scavenging on the carcasses of dead dairy calves, 25% reported scavenging of compost piles, 25% reported the predation of wild animals (e.g., waterfowl, rabbits, mice), and 10% reported the predation of domestic poultry (Figure 2). In addition, 30% of farmers made some mention of eagles killing barn cats and other small pets.

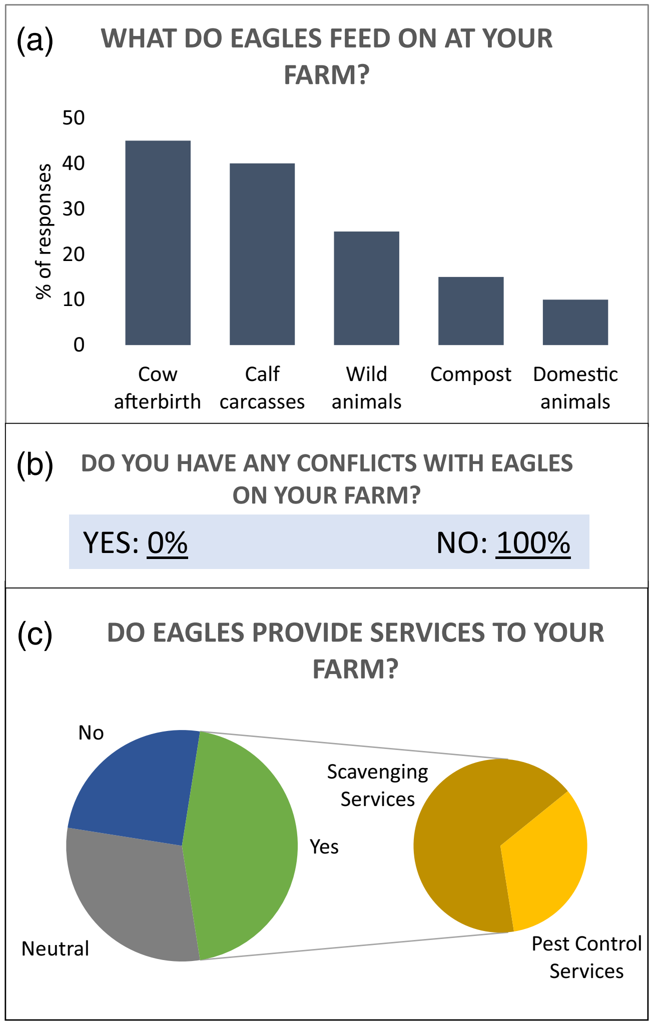

FIGURE 2 Summary of dairy farmer answers to three key questions: (a) What do eagles feed on at your farm? (b) Do you have any conflicts with eagles on your farm? (c) Do eagles provide services to your farm?

When asked about conflicts with eagles, 100% of the farmers interviewed stated they had no conflict with the eagles on their farms. Additionally, 100% of responding farmers stated that they did not want eagles off their farms and that they did not foresee future issues with eagles on their farms. Furthermore, 45% of responding farmers stated that eagles provided services to their farms, while 30% and 25% stated that they were neutral or did not provide services, respectively. Of the services reported, 65% included the scavenging of carcasses and compost and 35% included the predation or frightening of other "pest" species (e.g., starlings, geese, pigeons, rodents) (Figure 2).

The scavenging of cow placentas and calf carcasses by eagles was described in many ways. During the winter, many farmers stated they dispose of carcasses in compost piles, or on remote areas of their properties, as allowed by Washington State law (WSDA, 2014). Some farmers

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stated they regularly dispose of carcasses in farm fields and adjacent forests in order to allow natural decomposition to take place and nutrients to be returned to soils. In the summer, pastured cows are free to range, and their afterbirth is naturally accessible in open fields; however, since fully pastured dairy cows represent a small fraction (<5%) of dairy cows in Washington (Washington State Dairy Federation, personal communications with author Karen Steensma, 2021), most placentas do not become naturally accessible to eagles. One farmer reported that "eagles have no access to afterbirth because cows give birth inside the barn." According to the interviews, medium dairy farms may host ~1–3 cow births per week while large dairy farms may have approximately one birth or more per day. A few farmers stated that eagles would flock to afterbirth when available, as it can decompose within a matter of days.

While some farmers stated that eagles were not effective at scaring away pests such as starlings and pigeons, others stated that eagles were influential in reducing these species on their farms. One farmer stated that discarding cow placentas near dairy feed piles, such as open commodity sheds and bunkers containing grains, ensiled corn, or grass, reduced destruction of feed by starlings due to more frequent presence of eagles. Another farmer stated that berry acreage adjacent to the dairy farm experienced reduced fruit damage from starlings and pigeons. Other farmers mentioned issues with seasonal waterfowl such as ducks, geese, and swans, destroying cover crops during the winter, also thereby increasing soil erosion and runoff to streams. Such farmers see placenta and carcass placement in fields as serving the double purpose of natural disposal while attracting eagles, which may be quite effective in keeping waterfowl numbers down. One farmer, however, stated that other farmers might avoid placing carcasses or placenta into fields in order not to upset neighbors. The legal description of natural decomposition of carcasses requires placement a minimum of 0.40 km from property lines, residences, public roads, or watercourses (WSDA, 2014). Thus, this method of carcass disposal is not suited for small parcels of land.

Lastly, the majority of farmers seemed to enjoy the scenic value of eagles on their farms. Many displayed pride in their ability to support eagles on their farms.

DISCUSSION

We report that dairy farmers and eagles are able to coexist and can even benefit from each other's presence. This stands in contrast to the prevalent notion of conflict between humans and apex predators (Pooley et al., 2017), including many historical conflicts between farmers and eagles. Based on farmer accounts, three main observations arise: (1) eagles are clearly attracted to dairy farms to feed primarily on cow afterbirth and calf carcasses, (2) farmers consenting to be interviewed had no issue with the presence of eagles on their farms, and (3) many dairy farmers feel they benefit from the presence of eagles on their farms, reflecting a rare win–win between farmers and an apex predator (Figure 3).

Indeed, many farmers stated their appreciation for the scavenging services provided by eagles. Eagles' ability to speed disposal of discarded cow placenta and calf carcasses, produced as byproducts on dairy farms, seemingly benefits eagles while reducing cost and labor for farmers. For example, disposal of cow carcasses through commercial means can cost farmers between $50 and $250 per carcass (Tri-County Dead Stock Removal, personal communications with author Karen Steensma, 2021). Removal of carcasses is also important for preventing the spread of diseases and protects air, water, and soil quality, a service acknowledged by scavenging birds globally (DeVault et al., 2016). While negative perceptions of avian scavengers, such as vultures, are still prevalent (Duriez et al., 2019; Plaza & Lambertucci, 2019), an appreciation by farmers for scavenging services provided by wildlife has been observed in other agricultural settings (Craig et al., 2018; Henriques et al., 2018; Phuyal et al., 2016).

The potential for eagles to kill or deter unwanted species (e.g., starlings, pigeons, waterfowl, mice) was also recognized and appreciated by many farmers. Such "pest control" services have been realized by other predator birds in agricultural areas, for example, the predation of mice and other crop field pests by wild falcons, hawks, and owls (Kross et al., 2016, 2018; Tschumi et al., 2018) has been promoted through the placement of nest boxes, habitat restoration (Labuschagne et al., 2016), or reducing exposure to toxic chemicals (Tassin de Montaigu & Goulson, 2020). Similarly, by subsidizing eagles on dairy farms, farmers can benefit when eagles indirectly scare off unwanted species, or directly remove them through predation. This reflects an important instance of apex predators becoming more prevalent in agroecosystems in response to natural prey decline, whereby increased predation is directed at unwanted species rather than valued species (e.g., livestock) resulting in a positive feedback for farmers rather than a negative feedback (Parsons et al., 2022).

Though some farmers were neutral or unconvinced of any benefits eagles provided to their farms, either due to true lack of a benefit or lack of acknowledgment of ecosystem services provided, all responding farmers clearly supported having eagles on their farms. Bald eagles are generally revered in the United States for their charisma

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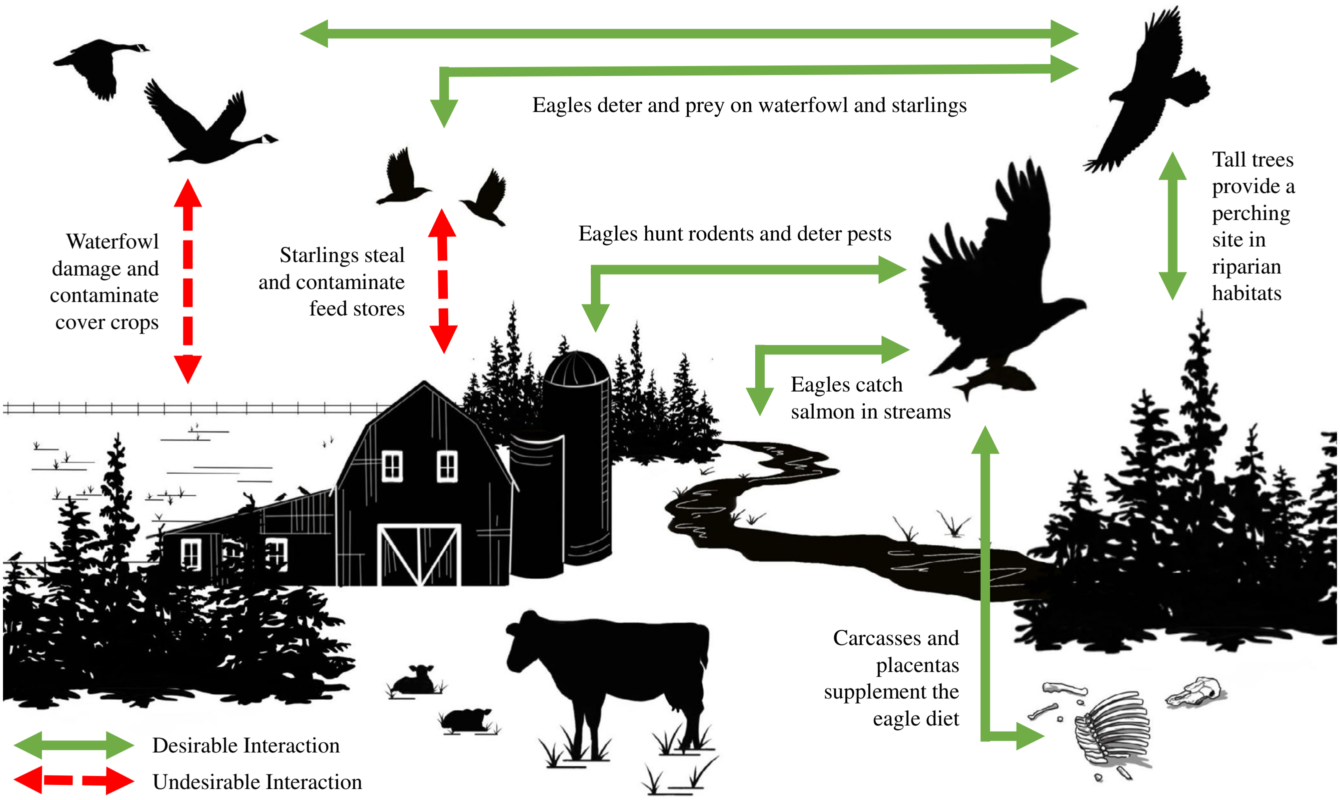

FIGURE 3 Exchange of ecosystem services between eagles and dairy farm habitats, highlighting the benefits provided by eagles to dairy farmers. These benefits are promoted through farmers' actions to supply anthropogenic subsidies and through creation of habitat.

and patriotic symbolism, which may also contribute to farmers' positive perceptions of the species. Human emotions toward wildlife are understood to have an important positive influence on species-specific tolerance (Castillo-Huitrón et al., 2020; Jacobs, 2012; Kansky et al., 2016), and the opposite social construction has been observed in rural systems where "eco-xenophobic" outlooks lead to negative perceptions of avian species (Dinat et al., 2019).

Dairy farmers in this particular region of Washington have participated in successful riparian preservation and restoration projects over the past 30 years or more, through both unpaid voluntary habitat work and through compensation by the Conservation Reserve Enhancement Program (CREP) (WCD, 2013). This in turn has likely contributed to maintenance, and in some cases improvement, in various salmon spawner trends over the years, particularly in the Bertrand, Fishtrap, and Ten Mile Creek tributaries of the Nooksack River (Nooksack Salmon Enhancement Association, personal communications with author Karen Steensma, 2021). Regardless of any potential increase in salmon carcass resources for bald eagles, mature trees in these riparian areas adjacent to dairy pasture and dairy forage land have also likely improved the availability of perching and hunting sites for eagles and other birds of prey, creating greater opportunity for raptor habitat in dairy areas.

Ultimately, our results reflect a broader theme: provision of ecosystem services through agricultural land stewardship and return of services to agriculture from species inhabiting those lands may override some of the potential conflicts between humans and apex predators. In this case, conflicts involving eagles and other species on dairy farms appear to be mitigated through the provisioning of alternative food sources generated by the dairy farm facilities. While diversionary feeding for apex predators has been effective at mitigating conflict in other settings (Dickman, 2010), we stress the importance of considering human emotions, the balance of costs and benefits, site specificity, and indirect negative effects of anthropogenic resource supply. For example, the reverence for bald eagles in the United States may increase farmers' tolerance of them in ways that differ from other apex predators or scavengers such as vultures. Additionally, if organic poultry farms were more abundant near dairy farms in our study, then a redistribution of eagles to agricultural areas could lead to indirect negative effects via increased poultry predation, making the balance between costs and benefits more complex. Theoretical frameworks for assessing human tolerance to wildlife, such as the

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Wildlife Tolerance Model (Kansky et al., 2016), may be used to explain or predict the degree of conflict between humans and apex predators in response to anthropogenic resource supply.

In our study, the accessibility of food resources produced by dairy farms and the resulting benefits received by eagles and farmers are largely driven by farmers' individual actions. For example, decisions to place carcasses and placentas in fields or compost piles, for natural decomposition and scavenger access, rather than using commercial dead stock removal services, may be based on perceived economic and environmental benefits. These decisions, however, also seem influenced by a number of factors, including legalities surrounding carcass disposal, an understanding of how farmers' actions impact eagles, an understanding of how farmers' actions may benefit their farms, social and community relationships, or a sense of wildlife stewardship and pride in attracting and supporting eagles on their farms.

Farmers' decisions to subsidize eagles on their farms may impact eagles or other wildlife populations in a variety of ways that are currently unknown. Anthropogenic subsidies are known to alter the diet, activity, behavior, abundance, and distribution of apex predator populations. For example, Fedriani et al. (2001) observed that coyotes in human-dominated landscapes subsidized by anthropogenic foods displayed densities eight times greater than coyotes in areas feeding on natural foods. Similarly, greater dingo group sizes occurred in areas with access to anthropogenic subsidies than in areas without (Newsome et al., 2013). To this effect, the reliability, concentration, and energetic benefits of anthropogenic subsidies produced by dairy farms may promote eagle survival and abundance near farm habitats while reducing home range and distribution.

By subsidizing eagles, dairy farms may also alter the ecological role of eagles in these areas. Bald eagles are capable of depleting populations of seabirds (Harvey et al., 2012; Hayward et al., 2010; Henson et al., 2019) terrestrial mammals (Hayward et al., 2010), waterfowl (Elliott et al., 2011; Griffin et al., 1982; Watson et al., 1991), and other prey resources. Thus, an increase in eagle densities due to provisioning of anthropogenic subsidies may also increase overall predation on natural prey in agroecosystems, particularly when dairy discards are unavailable. In Monterey Bay, CA, for example, anthropogenic subsidies from landfills have increased western gull (*Larus occidentalis*) abundance, increasing overall predation on threatened steelhead salmon (*Oncorhynchus mykiss*) populations (Osterback et al., 2015). However, anthropogenic subsidies can also decouple predator–prey interactions (Ciucci et al., 2020; Kuijper et al., 2016; Rodewald et al., 2011) and dairy discards may mitigate top–down pressure by eagles on prey species. More research is needed to understand the dynamic relationship between eagles, salmon carcass availability, habitat availability, anthropogenic resources, and natural prey populations (Figure 3).

There are 40,200 dairy farms in the United States (NASS, 2021). While this study provides basic insights into the relationship between dairy farms and eagles, our study was limited by sample size and spatial extent. Future studies could further examine the extent of services provided by eagles on dairy farms, including different strategies farmers can use to maximize the benefits of eagles on their farms. More research should also go into understanding how dairy farms and farmers' decisions influence eagle populations and surrounding ecosystems. Ultimately, we believe that farmers and wildlife managers may each benefit through cooperation in understanding the intricacies of dairy farm–eagle relationships. For example, farmers may be important allies to managers in supporting eagle populations or mitigating top–down pressures on other species in the face of climate change and other anthropogenic pressures. Wildlife managers may also benefit by promoting wildlife stewardship among farmers through discourse involving eagles and dairy farm ecosystem services. Conversely, farmers may benefit from initiatives to better understand the influence of dairy farms on eagle populations, through peer-to-peer farmer workshops and development of best management practices (BMPs) to mitigate wildlife conflict and maximize the benefits of eagles on their farms.

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CONFLICT OF INTEREST STATEMENT

The authors declare no conflict of interest.

DATA AVAILABILITY STATEMENT

Data (Duvall et al., 2023) are available from Dryad: https://doi.org/10.5061/dryad.dr7sqvb2z.

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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