

SHEEP FARMERS AND TURKEY VULTURES (*CATHARTES AURA*) IN THE  
FALKLAND ISLANDS: FROM CONFLICT TO COEXISTENCE

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## **Dedication**

This thesis is dedicated to those humans and wildlife that suffer as a result of human-wildlife conflict.

## Abstract

Human-wildlife conflict harms humans, wildlife, and wildlife conservation globally. I investigated a perceived conflict regarding the lethal control of turkey vultures *Cathartes aura* by sheep farmers in the Falkland Islands. The conflict escalated after the passage of a government policy limiting the traditional method of vulture management (i.e., shooting). I interviewed half of the sheep farmers on the islands, gathered questionnaires from half of the farmers and the majority of conservationists, and estimated vulture damage to sheep during my observations of vulture-sheep interactions during the 2008 lambing season (Sept. – Nov.). Half of farmers queried considered vultures a major threat to lambs, birthing ewes, and sheep that lie or fall down and are unable to get up (i.e., cast sheep). One of the forty-one farmers interviewed had personally witnessed turkey vulture predation on a lamb, the first account of its kind. I did not observe vultures attack sheep or lambs during 184 hours of field observation, although I did see vultures feeding on cast and still alive ewes twice. I estimated turkey vultures feed on 0.0 – 3.7% of ewes during the lambing season while the ewes are cast, and I concluded vulture predation on lambs is rare. Results suggest potential to mitigate this conflict exists through a policy modification that authorises limited control of “problem” vultures. I believe this change will result in more satisfied farmers, fewer turkey vultures killed, and ultimately greater success for wildlife conservation in the Falkland Islands.

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## Introduction

Human-wildlife conflict (HWC) occurs when humans and wildlife compete for the same resource. Such conflicts can be destructive to humans and wildlife, as well as to wildlife conservation. Worldwide each year HWC leads to hundreds or thousands of human fatalities (Thirgood et al., 2005), costs billions of U.S. dollars (Conover, 2002), results in the deaths of millions of wild animals (USDA, 2009), and threatens dozens of species with extirpation or extinction (Woodroffe et al., 2005b; Inskip & Zimmerman, 2009).

Managing a HWC requires knowledge of the levels and causes of wildlife damage and stakeholder dissatisfaction, as well as the effectiveness and feasibility of interventions to reduce wildlife damage and increase stakeholder satisfaction. Case studies of HWCs can produce knowledge and applied insights that aid HWC management practices. I present a HWC that concerns the lethal control of turkey vultures *Cathartes aura* by sheep farmers in the Falkland Islands [Islas Malvinas].

Livestock depredation is a leading cause of HWC (Woodroffe et al., 2005b). Bears, canids, and big cats commit most livestock depredations worldwide, but some birds, including species of vultures, also kill stock. Black vultures *Coragyps atratus* occasionally depredate livestock, predominantly new-borns, throughout the south-eastern United States (Buckley, 1999; Lowney, 1999; Humphrey et al., 2004). Eurasian griffons *Gyps fulvus* and Cape griffons *Gyps coprotheres* have been reported to kill vulnerable sheep and lambs (Cardenal, 1995; Scott, 1997).

Turkey vultures can kill live prey, but do so rarely, and are not known to kill livestock (Kirk & Mossman, 1998). Hamilton (1941) reported turkey vulture predation on new-

born pigs in Florida, but this case most likely involved misidentified black vultures. Confirmed turkey vulture prey are vulnerable animals, such as ruffed grouse *Bonasa umbellus* chicks (Titus & Mosher, 1980); captive, juvenile ringed turtle doves *Streptopelia risoria* (Smith, 1982); and juvenile cotton rats *Sigmodon hispidus* (Platt & Rainwater, 2009).

Livestock producers commonly kill wildlife perceived as threatening livestock (Woodroffe et al., 2005b). Turkey vultures will scavenge recently dead livestock and may be perceived mistakenly as the cause of death. In North America, ranchers killed tens of thousands of turkey vultures in the past century (Parmalee, 1954) although evidence these birds damage livestock is lacking.

Lethal control can be an appropriate technique for managing wildlife when it is socially acceptable and effective in reducing wildlife damage. Lethal control is unlikely to be effective, however, when the individual animal taken did not cause the damage or will be quickly replaced through immigration (Conover, 2002; Treves & Naughton-Treves, 2005). Non-lethal control is generally preferable to lethal control when viable options exist (e.g., Reiter et al., 1999). Animal husbandry practices can sometimes be altered to decrease wildlife damage (Ogada et al., 2003, Gusset et al., 2009). For example, farmers who remove carrion from livestock areas suffer less wildlife damage than landowners who leave carcasses on their property (Robel et al., 1981; Treves & Karanth, 2003).

Disagreements among stakeholder groups over what constitutes appropriate use of lethal control factor into many HWCs. Livestock producers can become upset when legislation outlaws a traditional, lethal method for dealing with problem wildlife

(Naughton-Treves, 1997; Hill, 2004). In some cases, farmers may retaliate against government officials by killing wildlife illegally (Gottelli & Sillero-Zubiri, 1992; Kellert et al., 1996). Re-writing controversial policies to better incorporate farmer concerns may be one option to reduce conflict and the illegal destruction of wildlife (Hatcher & Gordon, 2005; Keane et al., 2008).

In an attempt to understand the farmer-vulture conflict in the Falkland Islands, I ask (1) what human-dimension factors contribute to the conflict and (2) what percentages of lambs and adult sheep are harmed by turkey vultures during the lambing season. To address these questions, I interviewed farmers, distributed questionnaires to farmers and local conservationists, and estimated vulture damage to sheep using observations of vulture-sheep interactions during the 2008 lambing season. I close with recommendations on managing this conflict.

### **Study Area and Background**

The Falkland Islands is a self-governing British overseas territory in the South Atlantic, 450 km from mainland Argentina. The Islands are sparsely populated (0.2 individuals per sq. km) with a total human population near 3,000. The archipelago contains two main islands, East and West Falkland, and hundreds of smaller islands of which only about a dozen are inhabited. The landscape is treeless, with primarily a mixture of grasses, heath, and bare rock on flat to hilly terrain. Winds are strong and persistent, and the climate is cool-temperate oceanic. Light precipitation falls on many days, with average annual precipitation around 60cm.

Sheep ranching is the dominant land use, and there are approximately 500,000 sheep on 86 farms, nearly all of which breed sheep (Falkland Islands Government Department of Agriculture, 2009). Historically, wildlife species believed to be destructive to sheep production were exterminated, resulting in the extinction of the native fox-like warrah *Dusicyon australis*, extirpation of cinereous harrier *Circus cinereus*, and regional extirpation of the striated caracara *Phalacrocorax australis*. Hundreds of thousands of other birds also have been killed, including geese and turkey vultures, and other raptors (Falkland Islands Government Archives, 1922, 1924; Woods & Woods, 2006). Recently, commercial fisheries and tourism have surpassed the sheep industry in economic importance, and societal interests have shifted in the direction of greater appreciation of wildlife. In 1999, legislators passed the Conservation of Wildlife and Nature Ordinance, which conferred protection on all native bird species (except the upland goose *Chloephaga picta*) under penalty of fine.

Some farmers voiced their displeasure with the new legislation due to concerns about possible threats to sheep posed by turkey vultures. Turkey vultures are scavenging raptors that kill only rarely (Kirk & Mossman, 1998), and are not known to impact domestic livestock in other regions of the world where the species and livestock co-occur (Bellati & von Thungen, 1990; Humphrey et al., 2004).

Farmer concerns, however, could not be dismissed because the Falkland Islands represents a unique ecology and the understudied resident population of turkey vultures may have expanded their niche (c.f. Thiollay, 1998) to include occasional predation.

In response to pressure from some farmers, Falkland Islands Government initiated a permit application process in 2005 allowing applicants to cull as many as 20 turkey

vultures per year from a population of an estimated 4,170 to 6,050 birds (Breen & Bildstein, 2007). From 2005 through 2009, permit-holding farmers reported killing 24 to 73 turkey vultures annually (Falkland Islands Government Environmental Planning Department, 2010). Uncertainty on a number of fronts (e.g. extent of farmer dissatisfaction, impact of vultures on sheep) compromises the ability of the Falkland Islands Government to manage this conflict efficiently.

## **Methods**

### ***Interviews and Questionnaires***

From May-July 2007, I pilot tested interview questions and procedures with 16 farmers to identify key aspects of the farmer-vulture conflict in the Falklands. The results of these interviews guided the development of a more intensive study and modification of the survey and interview guides.

In August-September 2008 I attempted to meet many of the farmers who breed sheep (n=81; flock size range: 67 to 79,714; mean flock size: 6,353; FIG Department of Agriculture, 2009) by travelling door-to-door around the mainland islands of East and West Falkland. I phoned farmers several days in advance of my presence in their region to explain the research and ask permission to visit for an interview. I did not attempt to visit the eleven farmers living on off-shore islands due to travel limitations, but I did interview three when they made trips to the mainland. I attempted to contact approximately 55 out of the 70 mainland farmers based on available time. I succeeded in reaching 42 mainland farmers via phone, and 38 agreed to meet me, two were not interested in meeting, and two were unavailable to meet during my time in their area. I

mailed questionnaires to those farmers I could not meet in person. In total, I collected interview and questionnaire data from 35 farmers, only interview data from 6 farmers, and only questionnaire data from 10 farmers.

I distributed modified questionnaires to nine staff or full-time volunteers at Falklands Conservation, BirdLife partner on the islands, during September-November 2008, and an additional three questionnaires to new staff in 2009. All individuals returned questionnaires for a total of 12 questionnaires from “conservationists.”

In interviews I asked farmers nine open-ended and closed questions, which addressed their observations of turkey vulture behaviour, willingness to engage in illegal shooting of vultures, attitudes towards government policy on vultures, and any additional thoughts about vulture behaviour and policies (Appendix I). I took notes on farmer responses and entered these into an Excel spread sheet within 48 hours. I analysed these qualitative data by coding each question for themes, then analysed the data for frequencies and percentages of responses.

Immediately following the interview, I asked the farmer to complete a questionnaire (Appendix II). The questionnaire contained 41 statements with a scaled response of “strongly agree,” “agree,” “neutral,” “disagree,” and “strongly disagree” on the topics of predator control, attitudes and beliefs about turkey vultures, perceptions of stakeholder groups, and vulture policy. Additional questions asked respondents to classify bird species and other perceived threats (e.g., weather) to lambs or adult sheep as “no threat,” “minor threat,” or “major threat”; classify the turkey vulture threat to lambs (i.e., from birth until weaning), hoggets (i.e., from weaning until first shearing), birthing ewes, adult sheep, and cast sheep (i.e., sheep that lie down, are unable to get up, and are

likely to die in a few days unless assisted by a farmer) as “no threat,” “minor threat,” or “major threat”; record the number of sheep they would tolerate losing to predators before taking action; and record the number of their sheep, annually, they believed would live were it not for turkey vulture behaviour. I created a conservationist questionnaire by removing farmer-specific material from the farmer questionnaire. This questionnaire contained only 26 statements with the same scaled response from “strongly agree” to “strongly disagree” on the topics of predator control, attitudes and beliefs about turkey vultures, perceptions of stakeholder groups, and vulture policy (Appendix III).

I tabulated and analysed questionnaire responses using descriptive statistics (frequencies and percentages). For my analyses of response data to questionnaire statements I created three categorical responses: (1) “strongly agree” and “agree,” (2) “neutral,” and (3) “disagree” and “strongly disagree.” I compared farmer and conservationist responses to questionnaire statements using Fisher’s exact test and program R (R Development Core Team, 2010). Farmer and conservationist responses to select questionnaire statements are presented in the manuscript while the complete responses are available in Appendix IV.

### ***Lambing Observations***

During the 2008 lambing season (September-November), I visited five farms to observe vulture-sheep interactions. I visited farms during “peak” lambing based on consultations with farm owners, and I selected farms based on possible differences in sheep-predation risk. I classified two farms as “high risk” based on farmer complaints about turkey vultures together with data indicating high vulture densities on these farms.

For example, point count data from April-August 2007 indicated these two farms had 1.76 and 0.91 vultures/km<sup>2</sup> compared to a mean of 0.33 vultures/km<sup>2</sup> on ten other farms (data from Breen & Bildstein, 2007). I classified the other three farms I visited “low risk.” I believe the great majority of farms belong in the “low risk” category based on my own observations of vulture densities throughout the islands as well as vulture-survey data (Breen & Bildstein, 2007).

In the field I watched at any one time between 50 and 400 ewes plus their lambs from a high vantage point located 100 – 1000 m away. I logged hours in the field, used 8x44 binoculars to observe vulture-sheep interactions, and recorded all turkey vulture-sheep interactions. I changed observation sites several times daily to watch different flocks and investigate feeding turkey vultures to record information on the carcass species and carcass age class (i.e., sheep or lamb).

I estimated  $p$ , the percentage of breeding ewes that turkey vultures harm during the lambing season, for “high” and “low risk” farms using the equation,

$$p = ( a / ( b * 0.75 * 0.98 * c ) ) * d$$

where  $a$  is the number of vulture-sheep interactions I observed in which ewes were harmed,  $b$  is the average number of breeding ewes I observed at one time,  $0.75$  is the proportion of ewes that give birth during the peak lambing season and  $0.98$  is the ewe conception rate (I assumed vultures only harm ewes in the act of birthing),  $c$  is the number of hours I spent in the field, and  $d$  is number of daylight hours in the peak lambing season (I assumed sheep and vultures interact only during daylight hours). I calculated  $d$  to be 294 hours (21 days [the first cycle of the ewe] \* 14 hours of sunlight



per day). Farmers and Falkland Island Government employees at Department of Agriculture informed my model parameters on lambing.

## **Results**

### ***Human Dimensions of Conflict***

One out of four farmer respondents reported being satisfied with the current Falkland Islands Government policy on turkey vultures (Table 1, #17). Also, most comments by farmers on turkey vulture policy were criticisms, with many farmers arguing that the policy was unnecessary using words like, “I can’t see the reason for the policy,” and “[the policy] should never have come around” (Table 2).

When farmers were asked if the vulture population had been decreasing, stable, or increasing recently, 79% of respondents said it was increasing or possibly increasing, 21% said stable, and no one said it was decreasing (n=34).

Farmer respondents in general were intolerant of low levels of predation (Table 3). Sixty per-cent of farmer respondents (n=35) estimated losses to vultures that exceeded their tolerance even though most farmer respondents estimated < 0.5% of their sheep (i.e., <1 out of every 200 sheep) were lost to turkey vultures annually.

In attempts to protect their sheep, farmer respondents shot turkey vultures infrequently whether doing so was legal or not. Sixty-one percent of farmer respondents (n=31) said they would shoot a vulture seen “harassing” sheep, and 68% of these (n=19) did not possess a permit to do so at the time of questioning. Eighty-six per cent of farmer respondents who specified conditions when they would shoot turkey vultures (n=14) said when a vulture behaved as a “problem,” saying they would shoot the vulture that, “acted

like a pest,” or that “took my [sheep’s] eyes and intestines.” A majority of farmer respondents believed shooting turkey vultures was effective (Table 1, #16) and their only viable option for protecting sheep from vulture damage (Table 1, #7). Also, a majority of farmer respondents believed only those vultures seen in the act of predating sheep should be shot (Table 1, #15).

Half the farmers did not recognize vultures as providing benefits to the health of the farm environment (Table 1, #5), and in fact reported on negative experiences with vultures. Farmer respondents who encountered cast sheep that had been fed upon by turkey vultures or other birds (e.g., missing eyes, tongue) found the experience unpleasant; twenty-four per cent of farmer respondents (n=41) brought up the subject during interviews, using phrases such as “pretty awful,” “sickens you a bit,” and “it’s tough on you.”

Farmer and conservationist respondents exhibited many areas of common ground in their assessment of several environmental topics and stakeholder roles and responsibilities. Nearly all respondents agreed that great environmental damage can occur without human protection of the environment, that the complete removal of predators from a region is unacceptable, that policy-makers should make better efforts to understand farmer viewpoints, that farmers have responsibilities as stewards of wildlife, and that many conservationists do not understand the realities on the farm (Table 1, #1-2, 10-12). That said, the two groups disagreed regarding when the lethal control of wildlife is acceptable (Table 1, #3-4) and expressed neutral or negative perceptions of each other (Table 1, #8-9, 12-14).

### ***Turkey Vulture Impact on Sheep***

Farmer respondents estimated that turkey vultures represent one of four avian threats to sheep (Fig. 1a-b), and are most damaging to birthing ewes, cast sheep, and lambs (Fig. 1c). Forty-two per cent of farmers surveyed believed if no action were taken then sheep farming would suffer as a consequence of turkey-vulture damage (Table 1, No. 6). Surveyed farmers estimated from none to 2.5% (mean=0.7%, median=0.4%) of their sheep and lambs die each year for reasons attributable to turkey vultures (n=33).

I did not see turkey vultures attack mobile sheep or lambs during 25 days and 184 hours observing vulture-sheep interactions during the peak lambing period, even though unsupervised lambs were seen several times in areas with vultures. I observed vultures feeding primarily on dead sheep and lambs, but I twice witnessed vultures feeding on cast and still-living ewes (Table 4). The first time, I noticed 4-6 turkey vultures < 5m away from a cast and still-living ewe and her dead lamb. I arrived to see that the ewe's right eye had been removed, and exposed muscle on her back had been recently fed on. The ewe was weak and apparently unable to stand. On the second occasion, a single turkey vulture and 3-4 southern giant petrels *Macronectes giganteus* stood next to a cast, birthing ewe. I witnessed the turkey vulture feed from the backside of the still-living ewe. I estimated 0.0% and 1.8 - 3.5% of breeding ewes on "low" and "high risk" farms are fed on by turkey vultures when cast (Table 5).

One farmer respondent offered a first-hand account of vulture predation on a mobile lamb. The farmer said the incident lasted half an hour when three vultures on the ground separated a lamb from its ewe. Once the lamb had been separated by about 20 m one turkey vulture began pecking at the lamb's head until the lamb collapsed and died.

The farmer said the ewe appeared to “give up.” Other farmer respondents said they had witnessed vulture predation on mallard ducklings *Anas platyrhynchos*, a goose on a nest *Chloephaga spp.*, a long-tailed meadowlark *Sturnella loyca*, and “shorebird” fledglings.

I observed 17 new-born lambs during or within 30 min of birth (i.e., lambs with dangling umbilical cord or wet with birth fluid). Turkey vultures did not intervene during any births or harass any new-borns. In one instance, a ewe was cleaning her new-born lamb when eight vultures landed nearby within 10 sec of each other and began feeding on and fighting over the placenta. The ewe postured toward the vultures for about a minute, and then walked off with the lamb.

## **Discussion**

My study of the perceived conflict over the lethal control of turkey vultures by sheep farmers in the Falkland Islands reveals that some conflict indeed exists. I believe that much of the conflict stems from farmer reactions to the Falkland Island Government’s Conservation of Wildlife and Nature Ordinance of 1999. This policy restricted the primary method (i.e., shooting) many farmers considered effective for reducing the perceived vulture threat to sheep during a time period when most farmers believed the vulture population was increasing. Also, the policy did not sufficiently incorporate farmer viewpoints; many farmers felt government oversight of vulture control was unnecessary because few vultures were shot each year (<80, plus undocumented illegal shooting), and farmers believed they culled wildlife responsibly (Table 2). The Falklands case reinforces previous findings that imposing costs on people (in this case costs to farmers from real and perceived vulture damage due to policy restrictions)

without addressing their concerns can lead to conflict (Starr, 1969; Naughton-Treves, 1997; Madden, 2004; Hill, 2004).

Based on my findings turkey vultures appear to cause little damage to sheep overall. What harm they do cause occurs primarily when vultures feed on and hasten the deaths of cast but still living sheep. However, it is likely only a fraction of these losses can be attributed to turkey vultures because those cast sheep that are not already terminally ill are unlikely to be found and set upright before they die, given the area farmers have to manage in the extensive sheep farming of the Falkland Islands.

Turkey vulture predation on lambs is rare, according to my interviews and observational data. Only one of the 41 farmers I interviewed, a group with collectively several hundred years of farming experience, offered a first-hand account of vulture predation on a lamb. Additionally, I did not observe predatory behaviour by vultures during our 184 hours observing vulture-sheep interactions although seemingly unsupervised and vulnerable lambs were present on several occasions. My findings support previous research on this topic; investigators did not report turkey vulture predation on livestock during 60 and 100 hrs of observations of bird-livestock interactions in cow pastures in Florida (Humphrey et al., 2004) and sheep ranches in Patagonia (Bellati & von Thungen, 1990), respectively.

While turkey vultures can cause some damage they also provide benefits to the farm environment. My vulture feeding observations (Table 4) indicate that sheep carrion is a large proportion of vulture diet in lambing paddocks. Together with the abundance of turkey vultures in the Falklands (Woods & Woods, 2006; Breen & Bildstein, 2007) this insight suggests that vultures provide a service to farmers by removing a large amount of

carrion that could otherwise putrefy and cause environmental pollution (Markandya et al., 2008) or support large populations of other meat-eating birds that are more harmful to sheep farming than turkey vultures (e.g., striated caracara). In summary, my results agree with other studies that found the turkey vulture to be a beneficial scavenger that can kill live prey, but does so only rarely in relation to vulnerable animals (Kirk & Mossman, 1998).

In anticipation of a way forward, I identified additional factors that may aid or impede conflict management. Farmers and conservationists disagreed on when lethal control of wildlife was acceptable, and thus progress on this topic will require compromise. Also, farmers' and conservationists' ambivalent or negative perceptions of each other may be obstacles to conflict management because people tend to interpret the words and behaviours of distrusted individuals more negatively (Susskind et al., 2000). Building social capital, the elements of social organizations that facilitate cooperation for mutual benefit (Putnam, 1993), can aid in conflict resolution (van Kooten et al., 2006). For instance, good relations between agriculturalists and conservation authorities contributed to a satisfactory policy on predator control in South Africa (Lagendijk & Gusset, 2008). My findings suggest that farmers and conservationists do agree on many topics (Table 1, #1-2, 10-12), and recognizing these areas of common ground could increase social capital and improve conflict management capacity.

Several lines of evidence suggest the turkey-vulture policy of the Falkland Islands Government should be revisited. Only one quarter of farmer respondents were satisfied with the policy. Several farmers suggested the policy actually increased the number of vultures shot (Table 2). Also, the willingness of farmers to illegally remove vultures casts

doubt on the effectiveness of the policy and accuracy of records on vulture control. Furthermore, the effectiveness of limited, unselective culling of turkey vultures to reduce damage to sheep and lambs is in doubt. Culled vultures are likely to be quickly replaced through local movements (Conover, 2002; Treves & Naughton-Treves, 2005) because culling occurs over a small area (i.e., a single farm) and vultures are capable of travelling tens of km per day in the Falklands (K. Bildstein, unpubl. data). Additionally, turkey vultures that predate lambs or feed on birthing ewes would likely possess specialized learning (Linnell, 1999) and thus selective culling of these individuals, rather than the Falkland population as a whole, appears more likely to reduce damage.

### **Management Recommendations**

I recognize considerable potential to manage the local human-wildlife conflict in the Falkland Islands by modifying the permit system, adapting farming practices, and engaging in educational interventions.

I recommend the current Falkland Island Government's turkey-vulture policy (i.e., up to 20 turkey vultures per farm per year culled with a government-issued permit) be changed to allow each farm to remove as many as ten turkey vultures *seen in the act of threatening viable sheep* per year without obtaining a permit; on the condition that farmers list all such removals annually when reporting stock numbers and movements to the Department of Agriculture. Restoring farmer ability to remove "problem" vultures and streamlining policy to reduce paperwork burdens would alleviate at least some farmer concerns. These policy modifications are designed to incorporate more farmer input into the policy, increase the likelihood that lethal vulture control results in reduced

vulture damage to sheep, and improve tracking of incidences of “problem” vultures to allow an eventual assessment of whether selective lethal control decreases future incidents. This policy change would likely reduce the number of vultures killed, increase farmer tolerance of vulture damage, and improve farmer-regulator efforts to jointly manage vulture damage.

In addition, farming practices can be modified to reduce the probability of vulture damage. I recommend that farmers who are concerned about vulture damage regularly patrol flocks of sheep containing individuals at high risk of becoming cast (e.g., first-time breeding ewes). Regular patrols will increase opportunities to rescue cast sheep or ewes experiencing birthing complications, as well as position farmers to remove “problem” vultures. Also, farmers who move carcasses from lambing paddocks to other locations can lure turkey vultures away from lambs and birthing ewes. In Kansas, USA, Robel and colleagues (1981) found farmers who removed sheep carcasses had lower predation rates from coyotes *Canis latrans*. Finally, improving the condition of ewes prior to the lambing season has potential to lower the incidence of cast ewes, and thus potential for turkey vulture damage. The above livestock husbandry practices could reduce the likelihood of vultures developing the habit of feeding on live sheep and therefore provide long-term protection for sheep.

Finally, sharing study results with conservationists, policy makers, and farmers could inform stakeholders in this conflict and add to on-going communication about the issues. Conservationists should be made aware that turkey vultures can damage sheep and limited selective lethal control of “problem” turkey vultures has the potential to reduce vulture damage to sheep and increase farmer tolerance of vultures. In general, improved



understanding and relations with farmers, the major land owners, would likely benefit conservation programs Islands-wide. I also recommend that government authorities make an effort to incorporate farmers' viewpoints into policies that impose costs on farmers. Finally, farmer tolerance of vultures and vulture protection could be enhanced by sharing information on the low level of vulture damage in the Falkland Islands, the benefits of vultures to the farm environment, and the role of law in preventing indiscriminate shooting of turkey vultures.

Table 1. Farmer and conservationist responses to selected questionnaire statements regarding ecology, predator management, turkey vultures, stakeholders, and policy, Falkland Islands, 2008.

No.	Statement	Farmer responses n=40-45			Conservationist responses n=11-12			p-value
		Agree (%)	Neutral (%)	Disagree (%)	Agree (%)	Neutral (%)	Disagree (%)	
<b>Ecology</b>								
1	The environment has its limits, and without human protection great damage to the environment can occur	84	7	9	92	0	8	1.000
<b>Predator Management</b>								
2	It is unacceptable when regions completely remove predators	84	9	7	100	0	0	0.615
3	When a native species is common, permission to shoot this species should be granted easily if it is said to be a nuisance	77	9	14	18	0	82	<0.001
4	When there is uncertainty in the degree of harm caused by a species, it is still necessary for farmers to act to protect their stock	55	27	18	25	8	67	0.007
<b>Turkey Vultures</b>								
5	Turkey vultures provide services that benefit the health of the farm environment	49	24	27	64	36	0	0.155
6	If no action is taken against vultures, sheep farming will likely suffer in the future	42	31	27				
7	Without the ability to shoot vultures, farmers have no power to protect their livestock	67	13	20				
<b>Perceptions About Stakeholders</b>								
8	Farmers act favourably toward the health of the environment in the Falklands	77	14	9	9	64	18	<0.001

9	Falkland farmers would not kill a native species unless this species posed a significant threat	75	14	11	9	18	64	<0.001
10	Policy makers should make a better effort to understand farmer viewpoints	91	7	2	91	0	9	0.430
11	Farmers have a responsibility to act as stewards for the wildlife on their land	95	2	2	91	0	9	0.495
12	Many urban conservationists do not understand the realities on the farm	91	9	0	91	9	0	1.000
13	Many conservationists act “high and mighty” regarding conservation	70	21	9	36	27	36	0.035
14	Conservationists in Stanley make the Falkland Islands a better place	33	43	24	82	18	0	0.012
<b>Government Turkey Vulture Policy</b>								
15	Farmers should <i>only</i> be allowed to shoot vultures caught in the act of predating sheep	58	14	28	55	36	9	0.195
16	Shooting vultures is an effective way to protect sheep	58	21	21				
17	I am satisfied with current policy	23	28	49				

Table 2. Recurring themes in farmer responses to, “What is your opinion on the current vulture policy,” Falkland Islands, 2008 (n=41)

	Frequency
<b>Responses critical of policy</b>	
Farmers are busy and few vultures are shot: regulation unnecessary	16
Farmers are sensible enough to manage vultures without regulation	12
Regulation will encourage more shooting or resentment	8
Regulation is a hassle	7
Farmers should be able to cull if vultures are numerous	5
More flexibility is needed in regulation	5
<b>Responses supportive of vulture protection</b>	
Vultures are not a problem if sheep are strong	10
Vulture protection is necessary to prevent indiscriminate shooting	7
Vultures provide benefits by cleaning up environment	7

Table 3. Degree of farmer intolerance of predation, Falkland Islands, 2008. (n=38)

Sheep lost	% Farmers who find degree of damage intolerable
1 out of 1000	39
1 out of 100	63
1 out of 10	84

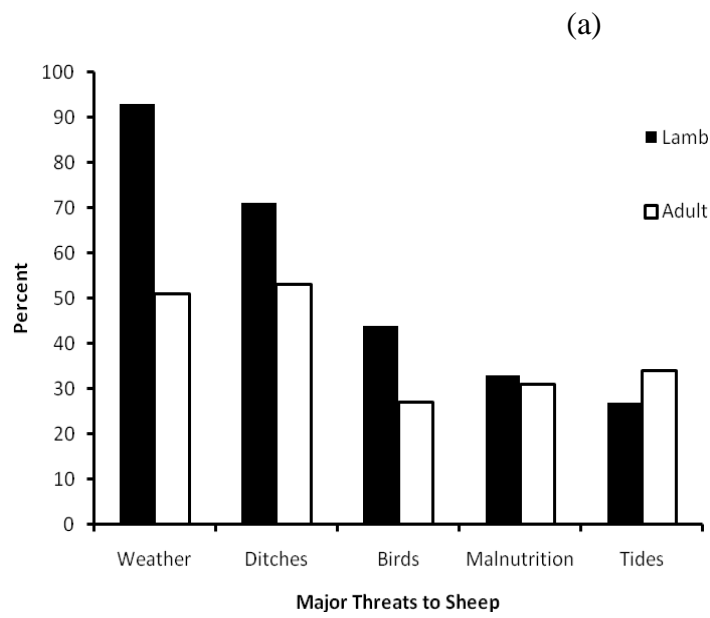
Table 4. Vulture feeding events observed over 25 days, 184 hours total of observation on five farms during the 2008 lambing season, Falkland Islands.

Food item	Frequency
Sheep carcass	45
Lamb carcass	42
Bird carcass	9
Sheep afterbirth	5
Unknown	2
Cast sheep	2
Ruddy-headed goose	1
<i>Chloephaga rubidiceps</i> eggs	

Table 5. Estimated vulture adverse effects on breeding ewes during the lambing season on “high” and “low risk” farms, Falkland Islands, 2008.

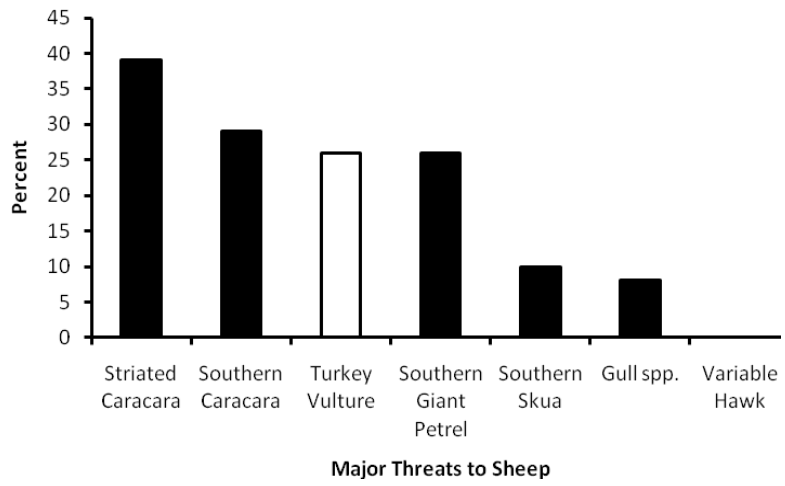
Farm category	Hours in field	Farms visited	Adverse events	No. sheep observed per hour (estimate)	Breeding ewes adversely effected (%)
High Risk	109	2	2	200	3.7
				300	2.4
				400	1.8
Low Risk	75	3	0	200	0.0
				300	0.0
				400	0.0

Fig. 1. Percentage of farmer respondents who perceived various threats to sheep as major threats: (a) all threats, (b) threats from birds, and (c) types of sheep for which turkey vultures are thought to be a major threat, Falkland Islands, 2008. Note: disease is not thought to be a significant threat to sheep in the Falklands. (n = 38-44 for each bar, variation in n due to missing responses)

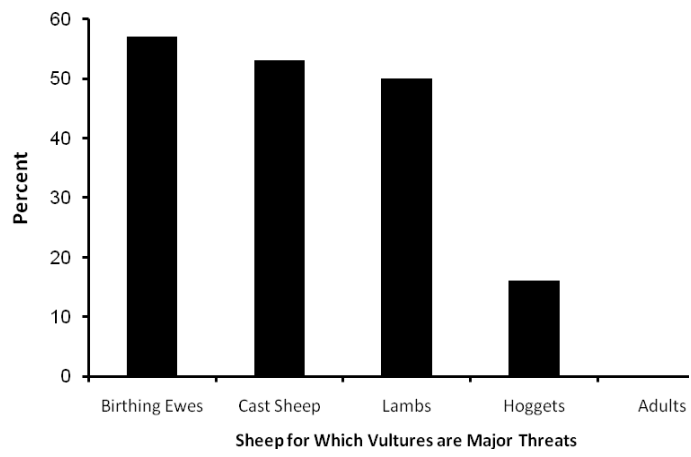




(b)



(c)



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## **Appendix I. Farmer interview questions**

1. Are there regions on your farm where turkey vultures are numerous? If so, where and approximately how many vultures have you seen in these locations?
2. Which paddocks or pastures do you use for lambing?
3. Do you use any advanced technology (e.g. artificial insemination, embryo transport) when breeding your sheep?
4. Has the vulture population increased, remained stable or decreased recently?
5. Do you believe vultures (or other birds) are a threat to your sheep?
6. Have you seen predation, or threatening behaviour, by vultures (or other birds) on your sheep? Please detail.
7. Would you destroy a turkey vulture you saw harassing your sheep?
8. What is your opinion about current government policy on turkey vultures? Are there aspects of the policy you like and/or dislike?
9. Do you have any further comments regarding turkey vultures?

## Appendix II. Farmer Questionnaire

### Section 1: Multiple Choice Questions

Please answer the following questions according to the following scale:

strongly disagree	disagree	neutral	agree	strongly agree
1	2	3	4	5

<b>Worldview</b>	Strongly Disagree				Strongly Agree
The environment has its limits, and without human protection great damage to the environment can occur.	1	2	3	4	5
The wildlife on my farm is important to my quality of life.	1	2	3	4	5
I would like to learn additional ways to make my farm more suitable for wildlife.	1	2	3	4	5
The way in which vultures are controlled on <i>other</i> farms does not matter to me.	1	2	3	4	5

#### **Worldview and Predation**

It is unacceptable when regions completely remove predators	1	2	3	4	5
Even if I lose a few sheep, I like seeing predators on my land	1	2	3	4	5
There is no room for predators in a landscape with livestock.	1	2	3	4	5
I can live with a low level of predation occurring on my livestock.	1	2	3	4	5

#### **Worldview and Predator Control**

When a native species is common, permission to shoot this species should be granted easily if it is said to be a nuisance.	1	2	3	4	5
Strong evidence that a native species causes economic harm should be required before permission to shoot this species is granted.	1	2	3	4	5



Farmers should be allowed to use any means they choose to protect their livestock. 1 2 3 4 5

When there is uncertainty in the degree of harm caused by a species, it is still necessary for farmers to act to protect their stock. 1 2 3 4 5

Killing native species to protect livestock should be a last resort 1 2 3 4 5

It would be upsetting if many vultures that did not kill livestock were shot. 1 2 3 4 5

I would prefer to manage predators on my farm using non-lethal techniques so long as these were effective. 1 2 3 4 5

### **Attitudes toward Turkey Vultures**

Turkey Vultures are dirty, disgusting animals 1 2 3 4 5

It would please me if there were fewer vultures on my farm 1 2 3 4 5

The Turkey Vulture is beautiful to watch in flight 1 2 3 4 5

I like having Turkey Vultures present on my farm 1 2 3 4 5

### **Beliefs about Turkey Vultures**

Turkey Vultures kill healthy sheep/lambs on my farm 1 2 3 4 5

Turkey Vultures provide services that benefit the health of the farm environment 1 2 3 4 5

If no action is taken against vultures, sheep farming will likely suffer in the future 1 2 3 4 5

There is a significant number of sheep/lambs on my farm that would survive were it not for Turkey Vultures 1 2 3 4 5

Without the ability to shoot vultures, farmers have no power to protect their livestock. 1 2 3 4 5

### **Perceptions of the People Involved**

Farmers act favourably towards the health of the environment in the Falklands. 1 2 3 4 5

Falkland farmers would not kill a native species unless this species posed a significant threat	1	2	3	4	5
Policy makers should make a better effort to understand farmer viewpoints.	1	2	3	4	5
Farmers have a responsibility to act as stewards for the wildlife and plant life on their land.	1	2	3	4	5
Farmers should make a better effort to communicate their concerns to policy makers.	1	2	3	4	5
Falkland farmers take pride in the health of the environment on their farms.	1	2	3	4	5
Many urban conservationists do not understand the realities on the farm.	1	2	3	4	5
Many conservationists act ‘high and mighty’ regarding conservation.	1	2	3	4	5
Conservationists in Stanley make the Falklands a better place	1	2	3	4	5

### **Policy**

Requiring a permit to shoot vultures is good	1	2	3	4	5
Farmers should <i>only</i> be allowed to shoot vultures caught in the act of predating livestock.	1	2	3	4	5
Permits to shoot Turkey Vultures should cover a longer period	1	2	3	4	5
It is bothersome to apply for a permit to shoot vultures	1	2	3	4	5
Shooting vultures is an effective way to protect sheep	1	2	3	4	5
Farmers should <i>not</i> shoot vultures when they are breeding	1	2	3	4	5
Permit-holders should be allowed to shoot more vultures	1	2	3	4	5
I am satisfied with current policy	1	2	3	4	5

**Section 2: Fill in the Blank, and Multiple Choice**

1. Mark an “X” for the level of threat posed to sheep on your farm by each of the following:

	<b>No Threat</b>	<b>Minor Threat</b>	<b>Major Threat</b>
Kelp Gull and Dolphin Gull ( <i>Larus dominicanus</i> and <i>Leucophaeus scoresbii</i> )	_____	_____	_____
Falkland Skua ( <i>Catharacta antarctica</i> )	_____	_____	_____
Striated Caracara ( <i>Phalacrocorax australis</i> )	_____	_____	_____
Turkey Vultures ( <i>Cathartes aura</i> )	_____	_____	_____
Southern Caracaras ( <i>Caracara plancus</i> )	_____	_____	_____
Red-backed Hawks ( <i>Buteo polyosoma</i> )	_____	_____	_____
Southern Giant Petrel ( <i>Macronectes giganteus</i> )	_____	_____	_____

2. Mark an “X” for the level of threat posed to your ADULT SHEEP (there is a separate question for lambs below) for each of the following:

	<b>No Threat</b>	<b>Minor Threat</b>	<b>Major Threat</b>
Weather	_____	_____	_____
Malnutrition	_____	_____	_____
Birds	_____	_____	_____
Ditches	_____	_____	_____
Beaches/tides	_____	_____	_____
Other _____	_____	_____	_____

3. Mark an "X" for the level of threat posed to your LAMBS for each of the following:

	No Threat	Minor Threat	Major Threat
Weather	_____	_____	_____
Malnutrition	_____	_____	_____
Birds	_____	_____	_____
Ditches	_____	_____	_____
Beaches/tides	_____	_____	_____
Other _____	_____	_____	_____

4. How many sheep/lambs lost to predation annually would you tolerate before you decided to act to control the predator?

\_\_\_\_\_ (write in a number)

5. On what do you base your belief about the level of threat posed by Turkey Vultures to your livestock? (Circle all that apply.)

your direct observations      your own hunch      opinions from other farmers  
 observations from other farmers      opinions from previous generations  
 observations from previous generations      \_\_\_\_\_ other

6. Mark an "X" for the level of threat posed by Turkey Vultures to each of the categories of sheep:

	No Threat	Minor Threat	Major Threat
Lambs <sup>1</sup>	_____	_____	_____
Birthing Ewes	_____	_____	_____
Hoggets <sup>2</sup>	_____	_____	_____
Adult sheep	_____	_____	_____
Cast sheep <sup>3</sup>	_____	_____	_____
Other _____	_____	_____	_____

<sup>1</sup>Lamb = from birth until weaning (12-14 weeks), <sup>2</sup>Hogget = from weaning until first shearing (1 year of age), <sup>3</sup>Cast sheep = sheep on ground and unable to get up

7. **How many sheep or lambs do you think turkey vultures kill on your farm annually that would otherwise have lived were it not for Turkey Vultures?**

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write in a range (example 1-20 or 50-200, or 10+)

### Appendix III. Conservationist Questionnaire.

Please answer the following questions according to the following scale:

strongly disagree	disagree	neutral	agree	strongly agree
1	2	3	4	5

#### **Worldview**

The environment has its limits, and without human protection great damage to the environment can occur. 1   2   3   4   5

Wildlife is important to my quality of life. 1   2   3   4   5

The way in which vultures are controlled in the Falklands *does not* matter to me. 1   2   3   4   5

#### **Worldview and Predation**

It is unacceptable when regions completely remove predators 1   2   3   4   5

There is no room for predators in a landscape with livestock. 1   2   3   4   5

#### **Worldview and Predator Control**

When a native species is common, permission to shoot this species should be granted easily if it is said to be a nuisance. 1   2   3   4   5

Strong evidence that a native species causes economic harm should be required before permission to shoot this species is granted. 1   2   3   4   5

Farmers should be allowed to use any means they choose to protect their livestock. 1   2   3   4   5

When there is uncertainty in the degree of harm caused by a species, it is still necessary for farmers to act to protect their stock. 1   2   3   4   5

Killing native species to protect livestock should be a last resort 1   2   3   4   5

It would be upsetting if many vultures that did not kill livestock were shot. 1   2   3   4   5

#### **Attitudes toward Turkey Vultures**

Turkey Vultures are dirty, disgusting animals 1   2   3   4   5

The Turkey Vulture is beautiful to watch in flight 1   2   3   4   5

### **Beliefs about Turkey Vultures**

Turkey Vultures provide services that benefit the health of the farm environment 1 2 3 4 5

### **Perceptions of the People Involved**

Farmers act favourably towards the health of the environment in the Falklands. 1 2 3 4 5

Falkland farmers would not kill a native species unless this species posed a significant threat 1 2 3 4 5

Policy makers should make a better effort to understand farmer viewpoints. 1 2 3 4 5

Farmers have a responsibility to act as stewards for the wildlife and plant life on their land. 1 2 3 4 5

Farmers should make a better effort to communicate their concerns to policy makers. 1 2 3 4 5

Falkland farmers take pride in the health of the environment on their farms. 1 2 3 4 5

Many urban conservationists do not understand the realities on the farm. 1 2 3 4 5

Many conservationists act 'high and mighty' regarding conservation. 1 2 3 4 5

Conservationists in Stanley make the Falklands a better place 1 2 3 4 5

### **Policy**

Requiring a permit to shoot vultures is good 1 2 3 4 5

Farmers should *only* be allowed to shoot vultures caught in the act of predating livestock. 1 2 3 4 5

Farmers should *not* shoot vultures when vultures are breeding 1 2 3 4 5

**Appendix IV. Complete farmer and conservationist responses to questionnaire statements regarding ecology, predator management, turkey vultures, stakeholders, and policy, Falkland Islands, 2008.**

Statement	Farmer responses n=40-45			Conservationist responses n=11-12			p-value
	Agree (%)	Neutral (%)	Disagree (%)	Agree (%)	Neutral (%)	Disagree (%)	
<b>Worldview</b>							
The environment has its limits, and without human protection great damage to the environment can occur	84	7	9	92	0	8	1.000
Wildlife is important to my quality of life	87	7	7	100	0	0	1.000
I would like to learn additional ways to make my farm more suitable for wildlife	44	42	14				
<b>Predator Management</b>							
The way in which vultures are controlled on <i>other</i> farms does not matter to me	20	40	40	8	0	92	0.003
It is unacceptable when regions completely remove predators	84	9	7	100	0	0	0.615
Even if I lose a few sheep, I like seeing predators on my land	53	29	18				
There is no room for predators in a landscape with livestock	20	22	58	0	0	100	0.018
I can live with a low level of predation occurring on my livestock	63	21	16				
When a native species is common, permission to shoot this species should be granted easily if it is said to be a nuisance	77	9	14	18	0	82	<0.001



Strong evidence that a native species causes economic harm should be required before permission to shoot this species is granted	41	18	41	92	0	8	0.008
Farmers should be allowed to use any means they choose to protect their livestock	42	14	44	0	0	100	0.002
When there is uncertainty in the degree of harm caused by a species, it is still necessary for farmers to act to protect their stock	55	27	18	25	8	67	0.007
Killing native species to protect livestock should be a last resort	55	20	25	83	0	17	0.153
It would be upsetting if many vultures that did not kill livestock were shot	53	25	22	92	0	8	0.051
I would prefer to manage vultures on my farm using non-lethal techniques so long as these were effective	64	12	24				
<b>Turkey Vultures</b>							
Turkey vultures are dirty, disgusting animals	27	31	42	8	17	75	0.171
It would please me if there were fewer vultures on my farm	48	32	20				
The turkey vulture is beautiful to watch in flight	49	31	20	67	33	0	0.249
I like having turkey vultures present on my farm	36	35	29				
Turkey vultures kill healthy sheep/lambs on my farm	51	18	31				
Turkey vultures provide services that benefit the health of the farm environment	49	24	27	64	36	0	0.155

If no action is taken against vultures, sheep farming will likely suffer in the future	42	31	27				
There is a significant number of sheep/lambs on my farm that would survive were it not for turkey vultures	47	20	33				
Without the ability to shoot vultures, farmers have no power to protect their livestock	67	13	20				
<b>Stakeholders</b>							
Farmers act favourably toward the health of the environment in the Falklands	77	14	9	9	64	18	<0.001
Falkland farmers would not kill a native species unless this species posed a significant threat	75	14	11	9	18	64	<0.001
Policy makers should make a better effort to understand farmer viewpoints	91	7	2	91	0	9	0.430
Farmers have a responsibility to act as stewards for the wildlife on their land	95	2	2	91	0	9	0.495
Farmers should make a better effort to communicate their concerns to policy makers	77	14	9	55	36	9	0.189
Falkland farmers take pride in the health of the environment on their farms	86	7	7	18	82	0	<0.001
Many urban conservationists do not understand the realities on the farm	91	9	0	91	9	0	1.000
Many conservationists act “high and mighty” regarding conservation	70	21	9	36	27	36	0.035
Conservationists in Stanley make the Falkland Islands a better place	33	43	24	82	18	0	0.012
<b>Government Turkey Vulture Policy</b>							
Requiring a permit to shoot vultures is good	53	7	40	100	0	0	0.016

Farmers should <i>only</i> be allowed to shoot vultures caught in the act of predating sheep	58	14	28	55	36	9	0.195
Permits to shoot turkey vultures should cover a longer period	58	26	16				
It is bothersome to apply for a permit to shoot vultures	50	30	20				
Shooting vultures is an effective way to protect sheep	58	21	21				
Farmers should <i>not</i> shoot vultures when they are breeding	43	24	33	91	9	0	0.013
Permit-holders should be allowed to shoot more vultures	41	32	27				
I am satisfied with current policy	23	28	49				

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