

RESEARCH ARTICLE



'We secured the tussac': Accounts of ecological discovery, exploitation and renewal in the Falkland Islands

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Abstract

1. Sheep farms dominate the Falkland Islands landscape and have for over a century. The introduction of sheep, and several other species, has significantly transformed the ecology of this archipelago—the near elimination of tussac grass being one of the most notable changes.
2. Tracing back to early accounts of tussac grass in the 'Falklands', this paper captures its discovery, exploitation and current stage of renewal, including a closer look at the connections between tussac and livestock farming, as well as parallel trends in other countries.
3. We narrate changing relations between people and tussac grass using a combination of interview data, historical accounts and scientific literature.
4. Tussac is presented as a historical bellwether of shifting trends in local farm and environmental management in this isolated archipelago. Shifts in land ownership, grazing management methods and conservation efforts are bringing momentum to a period of renewal across the Falklands.

KEYWORDS

British Overseas Territories, Charles Darwin, climate, grazing, Islas Malvinas, land use, rotational grazing

I can remember in the seventies, this Point here was a massive cormorant colony, and was tussac, too. But the fence went, came down there, and [now] that's completely eaten out. Tussac was semi-fenced, but when we went in 1999, we found sheep running in the tussac, and there's nothing you can do with sheep that have got the taste of tussac. You have to shoot them. So, we shot them all. I mean, [they] weren't vast numbers, but we secured the tussac.

(Falkland Farmer. November, 2016)

1 | INTRODUCTION

The epigraph illustrates the transition that has occurred regarding the management of tussac¹ grass in the Falkland Islands—from a focus on its value as livestock feed to an increased interest in its preservation, including a wider appreciation of its role as an umbrella species in coastal ecosystems. The title phrase *we secured the tussac* captures the current state of play regarding this plant and sets the tone for this exploration of the turbulent history of tussac and current period of its renewal in the Falklands. Overall, there

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is widespread interest in securing the future of tussac across the Falklands for its use as high quality livestock feed, wildlife habitat and a means to combat coastal erosion. By unravelling the histories, perspectives and social contexts regarding the changing management of tussac, we reveal important insights regarding past, present and future human interactions with this plant, the ecology of the Falklands as a whole, and similar interactions in comparable environments like New Zealand.

The Falklands are a small treeless archipelago British Overseas Territory nearly 500 km east of Patagonia, consisting of two large islands, East and West Falkland, and hundreds of smaller islands. The Falklands resemble the commodity and cultural contexts of New Zealand and Scotland, but have a novel history, ecology and set of challenges. Once described as one of the most interesting plants of the Falkland Islands (Dallimore, 1919), the tussock-type grass simply referred to as 'tussac' (*Poa flabellata*) is a perennial plant that grows in tall bunches along the coastline. Tussac is endemic to the South Atlantic, found only in southern South America (Tierra del Fuego), the Falklands, South Georgia and other nearby islands (Groff, 2018; Hoppé & McAdam, 1992; Wace, 1960). Witnessed with wonderment by some of the earliest visitors to the Falklands, as it grows to dramatic heights (i.e. 2 m), tussac is an integral part of a symbiotic coastal ecosystem. Similar large, tussock-type species can be found in New Zealand (e.g. *Poa foliosa*) and the Kerguelen Islands (e.g. *Poa cooki*; see Cheeseman, 1906; Cockayne, 2011; Wace, 1960). Away from the coast much of the mainland interior is dominated by whitegrass (*Cortaderia pilosa*) and diddle-dee (*Empetrum rubrum*) that comprise an oceanic heath formation (Summers & McAdam, 1993). Beneath this heath is a largely shallow peat overlying clay (McAdam, 2014), save occasional rocky outcrops and seams of 'stone runs' (Figure 1).

Tussac is well adapted to its coastal environment, tolerating extreme salt stress and photosynthesizing in temperatures below zero degree Celsius (Armstrong, 1994). It also provides cover and habitat to a variety of birds and marine mammals, while also benefiting from the guano deposited by birds and the soil aeration provided by penguin burrows (Armstrong, 1994). Many of the bird species breeding in the tussac are endemic to the Falklands (Hoppé & McAdam, 1992). Tussac grasslands are also capable of storing considerable amounts of carbon over decades, with equivalent densities of living and above ground carbon as broadleaf deciduous and boreal forests in temperate or cold climates (Smith & Karlsson, 2017). An added challenge to tussac is the increased aridity being experienced across the Falklands (Rendell, 2011). Shifts to drier and warmer summers and milder winters may put additional pressure on supplementary feeds like tussac when pastures cease to produce, but also increase the frequency and severity of a plant disease called stripe rust that can negatively affect tussac grass communities (Upson, McAdam, & Clubbe, 2016).

While its fundamental role within the coastal ecosystem is well established, tussac is probably best known in the Falklands as a high-quality feed for livestock. As Hoppé and McAdam write, tussac grass 'is potentially the most important terrestrial ecological niche in the



FIGURE 1 Aerial photograph of stone runs in the Falkland Islands

Falkland Islands and is the most productive and nutritious native grass' (Hoppé & McAdam, 1992). This dual characteristic of ecological significance and value for livestock production has contributed to its current state of degradation and localized extirpation. Livestock feed aggressively on tussac and as half a million sheep currently graze across the whole of the Falklands, tussac restoration is at odds with dominant land use practices, which includes productive use of coasts. For instance, the marginal farmland and harsh weather conditions in the Falklands mean that lamb survival and sheep health is greatly improved with access to coastal greens, which are enriched with penguin guano, and supplemental vitamins from seaweed (Tourangeau & Sherren, unpublished manuscript). Additionally, the sheer size of Falkland properties makes fencing a significant challenge in terms of both cost and available labour. Efficacy is also an issue: irregular coastlines are challenging to fence effectively, and storms, tides, kelp and sandy soils present additional challenges to keeping fencing intact and sheep where they are intended. After two centuries of human impacts, such as the introduction of livestock and the burning of tussac, the majority of tussac grass communities have been destroyed, particularly on the main islands of East and West Falkland. Several of the uninhabited islands that have been free of livestock grazing are completely covered in tussac communities along the coastlines (to the point that the common name for them are 'tussac islands'), showcasing the pre-settlement ecology of the Falklands (Figure 2).

Tracing back to early historical accounts of tussac in the Falklands, this paper captures the discovery, exploitation and



FIGURE 2 The Great Island group was purchased and destocked by the Poole family in the late 1980s, including 'tussac islands' High Tyssen and Peat Tyssen (foreground). [Correction added after online publication on 17 October 2019: figure legend corrected from 'High Tyssen and Peat Tyssen (lower right and mid-left) are ungrazed tussac islands, whereas Sandbar Island (middle) is grazed, as is the mainland behind'.].

renewal of this important plant. According to van Goethem and van Zandem (2019), there is a need for more historical approaches to studying biodiversity decline, including interdisciplinary historical examinations of socio-economic causes and human-nature relations. Further, Smith and Karlsson (2017) argue coastal peat-forming plant communities characterised by large tussock-forming grass, such as tussac, are significantly understudied. Tussac is arguably the most important native plant in the Falklands and is both ecologically and historically significant. We set out to better understand the dramatic decline of tussac in the Falklands, as well as efforts to restore this plant to its former place in the ecosystem. Using a combination of historical documents and primary data, we explore experiences and interactions with tussac during the brief history of human impact—this includes examining tussac's roles as both livestock feed and an umbrella species in coastal ecosystems.

2 | METHODS AND DATA

Interviews used in this paper were collected during two visits to the Falklands to do research on the various aspects of sheep grazing, focusing on new efforts of adaptation in this marginal climate. The first visit was in January 2015, when KS was invited as one of a dozen researchers, but the only social scientist, to the first Pan-American Science Symposium hosted by the South Atlantic Environmental Research Institute. During that week the group was immersed in research and resource management issues around the Falklands through talks with government officials and visits to penguin colonies. It was seeing sheep grazing among penguins that inspired the second trip of a month during November and December of 2016 (Figure 3).

Interview-based methods rarely capture a significant share of a land-base, but thanks to the small number of large farms on



FIGURE 3 Sheep grazing among penguins

the Falklands, on that second trip KS and MD conducted 22 interviews with farm owners and/or managers representing 30% of the Falklands' farms by number and area and spanning the full range of scale and management regime. Sampled farms represented East and West Falkland equally, as well as one of the farmed outer islands, with interviews mostly undertaken during farm visits. Semi-structured interviews explored perspectives on change in the Falklands landscape—as well as associated social, economic, environmental and political changes—and changing management as a result. Discussions were also held with local MLAs (Members of the Legislative Assembly), Department of Agriculture employees, newspaper journalists (*Penguin News*), Falklands Conservation officers, wool industry representatives, and two local historians. They watched shearing in action at several sheds and spoke with shearing teams, met rural schoolchildren boarding in Stanley along with their house parent, had four extensive tours to visit revegetation efforts and view the impacts of different grazing intensities as well as wildfire, and attended a farm field day about a growing invasive plant threat, calafate. Throughout, KS journaled and took photographs with consent. Those journal entries returned again and again to tussac as an important fulcrum for the human–environment relationship in the Falklands.

WT completed a targeted analysis of the transcribed interviews using the qualitative data analysis software *ATLAS.ti*, mining systematically for mentions of tussac to interrogate some of those field observations. Additionally, WT performed an extensive search through digital and print materials (books, ship logs and journals, news articles, reports, scientific papers and so forth) on sightings and experiences with tussac in the Falklands. Resulting codes and patterns of interview data are integrated with reviewed historical materials to build this account of tussac grass in the Falkland Islands since the first human impacts.

3 | THE FALKLAND ISLANDS

Today, the Falklands are populated with only a few thousand residents, and while most Falklanders live in Stanley, the capital, there are a few hundred people occupying the rural areas of East and West Falkland and some of the smaller outer islands. Living among the Falklanders, predominantly at a military base situated 36 miles from

Stanley, is a 1,500-strong garrison provided by the United Kingdom (UK). This base is intended as deterrence to Argentina, which invaded and occupied the Falklands in 1982, before surrendering to the British after 10 weeks. Argentina continues to claim sovereignty over the Falklands, which it calls *Islas Malvinas*. Falklanders voiced their wish to remain British in a referendum held in 2013; voters overwhelmingly expressed their desire for the Falkland Islands to remain an Overseas Territory of the UK (Dodds & Pinkerton, 2013). Today agriculture remains the largest employer, but it only contributes 2% to GDP, compared to around 40% from fishing licenses (FIG Policy Unit, 2016). Commercial fishing and more recent developments in oil and gas exploration and tourism growth, have led to great prosperity for the Falklands (Marroquín, 2014). The primary economic role of rural Falklands, known simply as 'Camp' (short for *campo*, the Spanish word for countryside), is wool production. That wool economy, however, did not develop for nearly the first two centuries of human involvement with these islands.

3.1 | Formation of a wool economy

The first claimed sightings of the Falklands occurred in the late 16th century and the first known landing was in 1690 by Captain John Strong, who named the islands after Viscount Falkland who was, at the time, Treasurer of Britain's Navy. There was no indigenous population. There are several recorded visits to the Falklands during the eighteenth and nineteenth centuries; during this time, however, its future was in question as a viable economy and a suitable place to live. Early accounts of the Falklands describe a vast and unappealing landscape with little economic opportunity. Sealing (and other types of hunting and fishing) was a common purpose for early visits; populations of fur seals, elephant seals, sea lions and penguins were all impacted (Armstrong, 1994). It was not until the late 1850s and 1860s that a clear economic role was established—that of repairing and supplying the ships that were sailing around the southern tip of South America. By 1870 the ship repair trade had reached its peak, but during the same period sheep farming on the islands had been proven to be viable, transforming the Falklands into a wool economy (Royle, 1985). These developments in livestock agriculture were largely borne out of the investments of English merchant Samuel Fisher Lafone, who helped establish the UK-based Falkland Islands Company (FIC) in 1851 (The Falkland Islands Company, 2018). The development of the Falklands has been closely linked to the FIC—at one point the farmland owned by the FIC accounted for 47% of the total land area (Wright, 2006).

It was not until after the 1982 Falklands Conflict that local farmers were given the opportunity to buy farmland rather than only working for absentee landowners as they had for the previous century and more. A 1982 post-war report (an update to a 1976 report) to the British government by Lord Shackleton—who was Chairman of the Economic Survey of the Falkland Islands—recommended, among other things, economic development of the Falklands through local land ownership (Shackleton, 1982). This report highlights the need 'to widen the ownership of farms in order

to create opportunities for independent Falkland Islanders to have a stake in the Islands' (Shackleton, 1982, p. 5). Significant land reform followed, shifting farms from overseas companies to local ownership, and breaking them up into family-sized units. Before 1980 the Falklands comprised 36 farms, 23 of which were owned by 14 overseas companies with 96% of the sheep; the FIC being the most significant owner. By 1988 there were approximately 83 distinct farms, mostly owned by Falklanders and only nine remaining in overseas ownership (Summers & McAdam, 1993; Taylor, 2003). Yet the FIC remained the largest single landowner until 1991, when it sold its few remaining farms to the Falkland Islands Government (FIG), which operates three large farms under the Falklands Landholdings Corporation (Department of Agriculture, 2017a; Reference Services Central Office of Information, 1993). Even subdivided, farms in the Falklands are very large, averaging 14,072 Ha with 6,051 sheep and 42 cattle (Department of Agriculture, 2017b).

This wave of new local land ownership coincided with significant changes in the wool market. Prices for wool (in both categories of fine and coarse wool) peaked in 1989, and then entered a period of decline starting in 1990 (New Zealand long term data series (LTDS), n.d.; Statistics New Zealand, 2012). This is partly explained by events in Australia during this time; as the global leader in wool production, fluctuations in their market can have global impacts (Bardsley, 1994). Put briefly, Australia introduced price stabilization measures in the 1970s through the Wool Reserve Price Scheme, which set a minimum floor price for wool. This led to overproduction of wool in the 1980s and a stockpile of wool worth billions of dollars. The 1991 suspension of the reserve price scheme effectively collapsed the wool market, for which recovery was slowed by the subsequent sale of the stockpile (see Bardsley, 1994; Massy, 2016; Richardson, 2001). Other reasons for the wool price decline of the 1990s include the dissolution of the Soviet Union in 1991 (which was a major wool importer), as well as a falling demand for formal outerwear made from wool and increased competition from other fibres, including synthetics (Richardson, 2001; Statistics New Zealand, 2012). Despite some support from the Falkland's government in reaction to falling wool prices, many new landowners were immediately compelled to overstock their properties to meet their new mortgages. Stocking numbers rose, surpassing 700,000 sheep throughout much of the nineties (Falkland Islands Government, 2019). One Falkland farmer suggested that overstocking has resulted in the encroachment of unwanted diddle-dee. Over the subsequent decade to 2010, as wool prices recovered (Department of Agriculture, 2017a), sheep numbers dropped by one-third (Falkland Islands Government, 2019). The new carrying capacity of half-a million sheep, roughly level since 2010, may have been caused by eroded natural capital, likely including tussac degradation, following this period of increased economic and thus ecological pressure.

In addition to new financial considerations, local ownership has empowered modifications in farm management, including increased attention to land condition and grass growth. This transition, however, also came with a learning curve. One Falkland farmer explained that there is an important difference between handling stock and

managing land, and that subdivision resulted in shepherds becoming land managers virtually overnight and needing to learn how to take on this different role. In order to regenerate pastures, and adapt to new challenges like climate change, there has been a move towards rotational grazing methods among several farmers, with some converting to Holistic Management (HM; Tourangeau & Sherren, unpublished manuscript). HM is a whole-system approach to managing all aspects of the farm and involves extensive planning and monitoring to rotate livestock through pastures with enough rest time to regenerate grasses (Savory & Butterfield, 2016). Sometimes trained holistic planners are hired to visit farms to help develop their annual plans. This is a shift away from the traditional ranching approach found in the Falklands; the increased attention on management and monitoring, and the use of fenced paddocks, may offer a potential complement to tussac restoration. Although, as there are no grazing animals that are native to the Falklands—though Upland geese feed on grasses and have been known to eat young tussac shoots (Summers & McAdam, 1993)—the presence of livestock will always run counter to its pre-settlement ecology.

3.2 | Tussac as a singular ecosystem

In the absence of information on the pre-settlement ecology of tussac grass communities in the Falklands, more recent research on tussac (particularly on the outer islands less affected by human impacts) provides a proxy for understanding its role in South Atlantic coastal ecosystems. This includes its critical role as a habitat for local wildlife. There are over 220 species of birds in the Falklands, including five species of penguins (Falkland Islands Tourist Board, n.d.). Among the many species of birds, there are 15 of global conservation concern that regularly occur in the Falklands, including nine threatened species (Woods, Ingham, & Brown, 2009). Early descriptions of birds in the Falklands, such as the personal observations of Captain C.C. Abbott from 1858–1860, include several references to their use of tussac grass—for habitat, breeding and nest construction. Abbott even discovered some nests of the Johnny Rook (striated caracara) combined tussac grass and sheep's wool (Abbott, 1861). The relationship between tussac and birds in the Falklands is significant and well established, illustrating the critical ecological role of this once abundant coastal grass.

In 1926 A.G. Bennett writes that the Tussock-Bird (blackish cinclodes) is 'a common inhabitant of tussock islands, where it breeds. This bird is so tame that it will perch on a man' (Bennett, 1926). Several decades later, Eleanor Rice Pettingill wrote of her time in the Falklands with ornithologist Olin Sewall Pettingill, Jr.—the two were a naturalist-cinematographer team hired by Walt Disney Productions to film for the nature series *True-Life Adventures* (Ghez, 2012). In her 1960 book, Pettingill wrote of the birds among the tussac:

For all our unpleasant memories of the place, landing on the beach that beautiful morning was like coming home. From his bed in the tussock the old sea lion placidly watched us unloading. Logger ducks and their

broods paddled about in the shallow water. Jackass penguins crossing the beach paused momentarily before disappearing into the tussock. There were house wrens, robins, and tussock birds everywhere. (Pettingill, 1960)

This quote exemplifies the many recorded accounts of wildlife interactions with tussac. Subsequent research has been conducted on the birds of the Falklands, and the critical importance of tussac communities.

In 1970, R.W. Woods published research from multiple field visits studying bird species on Kidney Island—one of the smaller islands in the Falklands that remain covered in tussac communities. Lying off the coast of East Falkland, Kidney Island is a National Nature Reserve abundant in tussac and free of rats and mice, allowing wildlife to thrive (Falklands Conservation, 2016). During his visits, Woods carefully profiled a range of bird species, including population numbers, diet and the specific use of tussac grass by each species (Woods, 1970). Specifically, 18 different bird species are described as using tussac for nest building, feeding on seeds and occupying one of the several minor habitats that are found in the different parts of tussac. Many of these birds also feed on insects living among the tussac. Among the species and habitats described, the Black-chinned Siskin builds nests in the new grass at the very top of the tussac on the new leaves, and feeds on its seeds (Figure 4); below the new leaves is a 'skirt' of dead stems where the Grey-backed Storm Petrel carves out a nest-hollow about one foot deep; below the skirt is a fibrous pedestal in which the Tussock-bird and Cobb's Wren² seek out holes and cracks for suitable habitat; at the ground-level the Rockhopper Penguin, Kelp Goose and others form nests; and below ground, burrowed deep into thick layers of tussac peat, live the Magellanic Penguin and Sooty Shearwaters (Woods, 1970). This collection of symbiotic species (some of which are endemic to the Falklands, such as the Cobb's wren) is unique to the tussac ecosystems of the Falklands; however, similar descriptions have been made on New Zealand, where different species of birds make use of tussock grasslands (Holtmeier, 2015).



FIGURE 4 New leaves and seed heads of a tussac plant

Birds and other wildlife had a place among the tussac long before any human presence in the Falklands, yet some birds have also been variously served by sheep farming. Predatory birds such as raptors and gulls (e.g. Kelp Gull, Turkey Vulture, etc.), some of which have been known to utilize tussac in nest construction, also benefit greatly from livestock in the Falklands, as they feed on weak and dead sheep, as well as afterbirth and other carrion (Bingham, 2002; Woods, 1970). By contrast, declines in tussac have also meant the destruction of a primary source of food and habitat for birds like the Cobb's Wren, which is further threatened by the presence of rats, and invasive species found across many parts of the Falklands. Overall, it is largely a history of livestock grazing and deliberate burning that has led to the currently denuded state of tussac in the Falklands. In the sections that follow, we capture key accounts of the brief history of human interactions with this unique coastal ecosystem. These accounts cover tussac's *discovery* and initial appraisal, its subsequent decline due to *exploitation*, and finally the ongoing *renewal* efforts aimed at re-establishing tussac in areas it was lost, as well as conserving the areas not yet destroyed.

4 | DISCOVERY: TUSSAC AS A NOVEL RESOURCE

In 1764, the first settlement was established in Port Louis, East Falkland by French explorer Louis-Antoine de Bougainville. Among his initial observations, Bougainville writes: 'a country lifeless for want of inhabitants; neither pasturelands nor forests for the encouragement of those who are destined to become the first colonists; a vast silence, broken only by the occasional cry of a sea-monster; everywhere a weird and melancholy uniformity' (Gough, 1992). In 1766, Bougainville described what can be assumed to be tussac grass lining the coasts of the islands. From the translated accounts of his voyage, Bougainville writes,

We were surprised, when we landed, to see that what we took for woods as we sailed along the coast, was nothing but bushes of a tall rush, standing very close together. The bottom of stalks being dried, got the colour of a dead leaf to the height of about five feet; and from thence springs a tuft of rushes, which crown this stalk; so that at a distance these stalks together have the appearance of a wood of middling height. These rushes only grow near the sea side, and on little isles; the mountains on the main land are, in some parts, covered all over with heath, which are easily mistaken for bushes (Bougainville 1772).

This is likely one of the first recorded notes on tussac in the Falklands, remarking on its height that appeared as trees from a distance.

Charles Darwin, during his 1833 voyages aboard *the Beagle*, referred to the treeless landscape as 'desolate looking' and having 'a

miserable appearance' (Burkhardt, 2008). Darwin made two visits to the Falklands (1833, 1834), cataloguing a wide range of geological and ecological observations on fossils and various wildlife; he compared the tameness of the birds in the Falklands with those of the Galapagos (Armstrong, 2004). Darwin observed the Magellanic (Jackass) penguin during his second visit to the Falklands in 1834, writing (using an old scientific name): 'I was much amused by watching a Demersa, having got between the water and it. It continually rolls its head from side to side [...] Stands quite upright: can run very fast with its head stretched out & crawls among the tussocks by aid of its little wings so as to extraordinarily resemble a quadruped; throws its head back & makes a noise very like a Jackass, hence its name' (Armstrong, 2004). Darwin does not appear to have written any detailed notes on tussac, focusing instead on other phenomena.

One decade later, in the 1843 publication *Notes on the Botany of H. M. Discovery Ships, Erebus and Terror in the Antarctic Voyage*, English Botanist William Jackson Hooker, then Director of the Royal Botanic Gardens of Kew, wrote of the tussac grass in the Falklands in much greater detail. His observations are derived from information collected by his son, Joseph Dalton Hooker, who was Assistant Surgeon aboard the *Erebus*. In these *Notes*, W.J. Hooker also included excerpts from Bougainville's notes, who along with naturalist Antoine-Joseph Pernety, made some of the first observations of collected plants in the Falklands. Hooker writes of the pair:

Bougainville's own notice of the plant is far more correct [than Pernety, who misidentified the tussac]: "All the sea-coast and islands are covered with a plant, which has been erroneously termed a Cornflag; it is, however, a species of grass, of the most beautiful green colour, and growing to a height of 6 feet. It forms a hiding place for the sea-lions and sea-wolves,³ and served as a shelter to ourselves during our wanderings. A house may be formed of it in a very short space of time; the inclined stems, when fastened together, serving as a roof, while the dried straw makes a tolerably good bed. With this plant we also thatched our dwellings. The root is sweet and nutritious and preferred by beasts to any other food" (Hooker, 1843).

Bougainville's note of animal preferences for tussac is of importance, showing the early discovery of its value for animals as a habitat and for humans as livestock feed (Figure 5).

Also included in Hooker's *Notes* on the botany of the Falklands is an excerpt from the September 15, 1842 issue of the *Guernsey Star* newspaper, which declares: 'The splendid *Tussack Grass* is the gold and the glory of the Falklands [...]. Every animal here devours this grass with avidity, and fattens upon it, in a short time. [...] Indeed, so fond of it are both horses and cows, that they will devour dry *Tussack* thatch from the roofs of the cottages, in preference to good grass' (Hooker, 1843). Tussac is described as eaten so aggressively, especially by pigs, that it would be preferable to reap and bundle the plant for feeding elsewhere to avoid damage by grazing. Hooker's



FIGURE 5 Sea lions sheltering among the tussac

Notes also include accounts of penguins building nests in the shade of the tussac to hatch their young (Hooker, 1843).

In response to Hooker's *Notes* on the Falklands, tussac grass was subsequently written about with great excitement in an 1845 issue of the British publication *The Penny Magazine*,

A serious deficiency in the productions of these islands is the total absence of trees, and even of shrubs larger than our common furze. This necessarily gives them a blank and dreary aspect, and may account for the unfavourable opinion of early voyagers. But in compensation for many deficiencies, these islands have been gifted with an extraordinary kind of vegetation, covering the greatest part of their coasts, and flourishing abundantly on a soil which, in that climate, would otherwise be totally unproductive. This is the tussac grass, described by Dr. Joseph Hooker as constituting a remarkable feature of the landscape from its peculiar mode of growth. (Charles Knight & Co., 1845, p. 226)

The article is focused on tussac's many positive aspects as described by Hooker, and ends with the following passage: 'Should the tussac grass be eventually introduced to this country, and be found to thrive in similar situations to those which it occupies in the Falkland Islands, it will not only add a novel feature to English scenery, but will be of the highest value in affording rich pasturage on a description of soil hitherto considered as nearly useless' (Charles Knight & Co., 1845).

Discovery of tussac in the Falklands—while tied to anthropocentric aims that eventually led to significant ecological impacts—marks an important period of captivation and awe. Notably, Royal Navy officer Edward Gennys Fanshawe—then-commander of H.M.S. *Daphne*—kept a journal of his time in the Falklands in 1849. He wrote of how tussac is the best food for cattle, and described the plant in detail, remarking on the large tufts of grass growing atop tall mounds of dead vegetable matter, earth and fibre (Fanshawe, 1904). In addition to a naval Commander, Fanshawe was an artist, painting and drawing the various landscapes he encountered during his voyages. Among the group of

three drawings he completed in the Falklands in May of 1849 is *Tussac Grass, Falkland Islands*—a watercolour of the tall grasses engulfing a cloaked figure on horseback (Fanshawe, 1849). It is clear from his descriptions and painting that Fanshawe was fascinated by the tussac grass, just as it held the attention of Hooker and Bougainville in years prior.

5 | EXPLOITATION: BURNING AND OVERGRAZING TUSSAC

The earliest decades of human settlement in the Falklands demonstrate a typically 'extractive' colonial view of the natural landscape, introducing non-native species with little regard to their potential ecological impact and eradicating native ones that interfered with production goals (Feyrer & Sacerdote, 2017). Parallels of this productivist treatment of nature can be found in transformations to vast grasslands in New Zealand; their dominant sheep industry triggered changes in the landscape via overstocking, overgrazing and burning to manage the land (Brooking & Pawson, 2011). Early instances of intentional burning in the Falklands were by visiting sealers in the early 1800s (Woods et al., 2009), and also by French settler Bougainville, who—in addition to introducing pigs, cattle and sheep to the Falklands—considered tussac useless and burned it to clear the land or aid hunting (Armstrong, 1994). These settlers also exterminated the only endemic mammal—the native, fox-like warrah—for fur, entertainment, or to protect their stock. This extinction was predicted by Darwin during his 1834 visit to the Falklands because of their tameness: the last one was killed in 1876 (Armstrong, 1994). The ecological footprint of these early residents and visitors was substantial, early settlers left behind livestock like cattle that eventually grew feral and overgrazed tussac and other grasses. The intentional burning of tussac, and unmanaged grazing by introduced animals, are two of the most significant contributors to the exploitation and destruction of tussac grass communities in the Falklands.

Wild cattle bred naturally to 60,000 by 1846, diminishing the tussac grass around the coast, causing the cattle to venture inland. Eventually the cattle were systematically exploited for export as well as local consumption. While some efforts were made to limit their slaughter, cattle populations were effectively destroyed after an 1864 UK Privy Council decision legally defined the cattle population as *ferae naturae*—feral animals whose ownership is determined by their capture (Armstrong, 1994). This decision was in response to appeals from the FIC, who wanted the right to hunt and capture the cattle on the lands they were leasing from the UK government (Law Times, 1865). The damage to tussac caused by early cattle (and other livestock) had long-term impacts for the young colony: without a ready supply of tussac, beef cattle could not be adequately fattened. Among the farmers who have diversified into cattle in recent years, some find they must grow crops to feed them, including a need for significant inputs such as tilling, seeding and fertilizing.

Other introductions, though sometimes short-lived, also had implications for tussac cover. Pigs, which were introduced to several smaller islands by sealers, also thrived on the tussac grass; what is more, the sealers would set fire to the tussac to drive the pigs onto the shore during hunting. While they once numbered in the thousands, wild pigs have not been sighted in the Falklands for over half a century. Guanacos were introduced twice, and after the second time in the early 1930s the population grew rapidly to a herd of several hundred, causing additional damage to tussac grass communities (Armstrong, 1994). Endemic to South America, they are now known to only inhabit one island in the Falklands. Additionally, nearby South Georgia has a history of livestock introduction that is connected to experiences in the Falklands. Reindeer were introduced to South Georgia as a food source for Norwegian whalers on three occasions between 1909 and 1925, resulting in significant overgrazing of tussac (among other things) and its replacement by other grasses more tolerant to grazing by reindeer (Christie, 2010). Eradication projects took place on South Georgia in 2013–2014; a combination of herding and corralling and ground shooting were used to eradicate thousands of reindeer, with some of the meat recovered for the cruise ship industry and the Falklands (Government of South Georgia & the South Sandwich Islands, 2018). In an effort to establish a commercial reindeer herd as well as preserve the genetics of this population, a total of 59 reindeer calves were translocated from South Georgia to the Falkland Islands (Bell & Dieterich, 2010); also, a second herd was privately established on Beaver Island, located southwest of West Falkland (Christie, 2010). The ecological impact of reindeer on tussac and other plants in the Falklands is largely unknown (Upson, 2012).

Several species have also been *unintentionally* introduced to the Falklands. Rats are an invasive species in the Falklands, likely introduced by accident from the ships that anchored there throughout history. The introduction of rats (as well as cats, house mice and rabbits) by humans are worth noting, as their presence is also tied to tussac vis-à-vis the prevalence and distribution of certain bird populations (Brown, 2013; Hall, Woods, Brooke, & Hilton, 2002). Hall, Woods, Brooke and Hilton (2002) conducted research on factors affecting the distribution of the endemic Cobb's Wren (and other passerines) in the Falklands and identified a strong negative association with the presence of rats. In areas where tussac remains or is restored, the presence of rats prohibits the survival of the Cobb's wren (Woods et al., 2009). Further, Tabak et al. suggest that conservation efforts involving eradication of rats may not be sufficient to protect all species of conservation concern; ovenbirds like the tussock-bird are better able to re-establish populations on eradicated islands than other bird species, such as the Cobb's wren (Tabak, Poncet, Passfield, Goheen, & Martinez del Rio, 2015). Rat eradication efforts are also linked to a host of other species interactions, such as the inadvertent poisoning of raptors like the striated caracara (Brown, 2013), known locally as the Johnny Rook.

As the resource value of tussac became realized, the lack of colonial concern for local ecosystems or long-term sustainability extended to targeting species that threatened tussac. In the early 20th century, for instance, the Falklands Government permitted

the killing of southern sea lions because they were destroying large quantities of tussac, making it unfit to feed horses. Also, a Falklands farmer wrote to the Government during this time, requesting permission to kill the Magellanic penguins that were causing him great distress, explaining that by pulling up the young tussac plants and burrowing underground, the penguins make the land less suitable for livestock (Bernhardson, 1988).

Wool proved to be a reliable commodity in the marginal landscapes that remained in the Falklands after the above trajectory. Falklanders found sheep (at least certain breeds) could survive the climate, and that the climatic conditions produced a wool with favourable properties (Jones, 1924). Sheep numbers rose quickly. Systematic wool production efforts began in the 1840s, and by 1898 the population reached the historical peak of 807,211 (Armstrong, 1994; Moore, 1863–5). In a 1924 issue of the *Geographical Review*, Clarence F. Jones points out the role of remaining tussac in that trajectory:

When the sheep industry in 1867 was established on a permanent footing, tussock grass, excellent for grazing purposes, grew on all the islands. To this grass was due, in part, the great increase in the number of sheep—35,000 in 1867, 283,000 in 1877, 563,000 in 1887. In 1896, a record of 801,000 was reached. Since then the numbers have been on a fluctuating decline. At present the total head of sheep is about 668,000. The tussock grass, originally a valuable food, has been almost eradicated from all the larger islands by overgrazing. The cool, peaty soil now supports only a poor growth of tawny grass, which has little nutriment for cattle, but on which sheep do fairly well. The ranges are now stocked to capacity. (Jones, 1924)

From this account, it seems the significant and lasting damage to tussac communities occurred largely between 1867 and 1924 as a result of the burgeoning sheep industry, but early cattle and other introduced species also played a role.

The traditional method of sheep grazing in the Falklands is 'set-stocking', which is the continuous grazing of livestock across a large area for the entire year (or grazing season). This method allows for minimal management effort, and if done carefully with the appropriate stocking densities, it can sustain the native plants. However, set stocking also provides less control over the animals' impacts on the land (i.e. overgrazing preferred plants, leaving other plants to thrive). As one farmer described it, 'we were set stocked at the start, and I could see it was, you know, our land was getting worse and worse and worse. [...] It's traditional. It's just the traditional way that people did it in The Falklands. You have a few hundred sheep in this camp, 500 sheep in this camp, for 365 days of the year.' A lack of control over sheep grazing has effectively cleared much of the tussac on East and West Falkland.

Another farming practice linked to tussac, and the health of pastures in the Falklands more generally, is the deliberate burning

of pastures. Intentional burning is distinct from spontaneous fires, likely ignited by occasional lightning strikes, that have contributed to how tussac (and other Falklands ecosystems) evolved by depending on fire to kill off fungus and other pathogens, thereby fostering the health and long-term stability of these grass communities (Armstrong, 1994). Deliberate burning (particularly of whitegrass and diddle-dee) has been practiced as a method of pasture improvement meant to rejuvenate grass quality by removing dead grass and thereby boosting productivity; however, some of these fires, burning into the peat, are known to have smouldered for years (Armstrong, 1994; Summers & McAdam, 1993). Importantly, as burning seldom improved native pasture production (McAdam & Burton, 2015a), and risks fires getting out of control and damaging the fragile peatland ecosystem, this practice is no longer encouraged (McAdam, 2014). An added risk to this practice is the possibility of fire spreading to coastal vegetation communities containing tussac, which overlies dry peaty soil, and has been known to be quite combustible (Armstrong, 1994; Wilson, Clark, McAdam, & Cooper, 1993). Further, the practice of burning has also raised concerns regarding the biodiversity and carbon storage potential of the Falklands peatlands, particularly in the face of climate change predictions (McAdam & Burton, 2015b). Today intentional burning is generally limited to relatively small re-seeded areas, though some risk remains due to the drying climate.

Humans have additional direct impacts to tussac (and the local ecosystem in general) via tourism. Wildlife tourism, as well as military tourism, has emerged as an integral part of the Falklands economy and now occupies a considerable portion of human activity in the Falklands. Falklanders maintain fleets of vehicles equipped to drive tourists to penguin rookeries and other sites, and some farmers maintain former shepherd cottages for tourists to stay overnight. Popular destinations like Gypsy Cove (a penguin rookery) near the capital of Stanley on East Falkland have led to damaged penguin burrows due to trampling by tourists sometimes numbering 1,000 per day in the high season. In 2004, one incident involving habitat destruction occurred on Green Island where a private yacht party accidentally set fire to the tussac grass and peat soil during a barbecue picnic (Royle, 2006). The fire reportedly killed or injured many southern sea lions that often breed among tussac; the Island is home to the second largest sea lion breeding colony in the Falklands (Otley, 2008; Otley, Munro, Clausen, & Ingham, 2008). Tourism, introduced species, and intentional burning represent key human impacts that have significantly changed the landscape of the Falklands; this exploitative trajectory, however, is in the process of changing.

6 | RENEWAL: TUSSAC RESTORATION, MANAGEMENT AND CONSERVATION

The extractive approach to tussac did not proceed without exception—evidence of tussac preservation and restoration efforts date back to the second half of the 19th century ('Finding Cobb: Restoring Bleaker's tussac, 2018). Richard Clement Moody, the first Governor of the Falkland Islands, reported on how best to cultivate tussac in 1842

(Walton, 1985). In 1879, A.E. Felton initiated successful restoration of tussac on West Point Island (located in the northwest corner of the Falklands), efforts which have been continued by successive generations. As well, Arthur Cobb, ornithologist and one-time FIC manager, led tussac restoration efforts on Bleaker Island in 1916 ('Finding Cobb: Restoring Bleaker's tussac, 2018). More recently, in the decades since subdivision and local ownership, restoration efforts have gained momentum; tussac is now commonly viewed as invaluable to the coastal ecosystem and long-term viability of the Camp livelihood and lifestyle.

Tussac is connected to soil health, erosion control, carbon storage, bird habitats, and a range of other ecosystem roles which form a symbiotic relationship that has historically been disrupted by the introduction of humans and their livestock. Current accounts of tussac grass in the Falklands are, in general, more focused on its ecosystem value than in the past. More than any other plant species in the Falklands, many farmers view tussac as a precious resource that needs to be protected and restored. Knowledge of its multiple purposes has led to widespread efforts to restore tussac along the coasts, which includes seed collecting and tussac planting projects. Tussac restoration is one of the projects being conducted by Falklands Conservation, a local environmental NGO that also shares updates and pictures of their efforts over social media using the tag line '#TussacTuesday' (Falklands Conservation, 2018).

This shift in practices and perspectives resembles shifts taking place in New Zealand, where productivist logics are being challenged and emphasis is shifting towards more sustainable land use practices (Pawson & The Biological Economies Team, 2018). If tussac restoration and conservation campaigns are going to be successful on land areas used as rangelands for sheep and cattle, such shifts in logic are needed. While conservationists and farmers alike are working to restore tussac in select areas, the prevalence of sheep and cattle grazing means that restoration goals are varied, and at times, conflicting. A range of tussac habitats will be needed to balance all its associated benefits across the Falklands. Preserving undisturbed, rodent-free tussac islands is important because benefits to wildlife are best realized when tussac is left ungrazed. In other areas, parallel efforts can focus on restoring tussac grass for grazing and other anthropocentric purposes like erosion control.

The establishment of nature reserves helps to preserve islands still blanketed by tussac grass communities. One example of this is approach is the two small islands in the Falklands, named 'Top' and 'Bottom', which remain covered in tussac grass and are being considered for inclusion as a National Nature Reserve due to the presence of White-chinned Petrels and Sooty Shearwaters. Efforts to increase the numbers of these two bird populations have seen success since the local eradication of Brown Rats (Agreement on the Conservation of Albatrosses and Petrels (ACAP), 2018). Also, in the Falklands, Kidney Island and Cochon Island are likewise covered by tussac; they are considered an Important Bird Area by BirdLife International and have been designated Nature Reserves since the 1960s (Woods, 1970; Woods et al., 2009). Such designations are invaluable to ongoing efforts to protect and revive the abundant bird species in the Falklands and preserving extant tussac communities as a result.

Tussac planting campaigns are bringing tussac back to areas where it was lost to overgrazing and burning. It involves significant experimentation to establish planting and restoration protocols in such a novel ecosystem. This research has been led by farmers and Falklands Conservation, assisted by Kew Botanical Gardens. Falklands Conservation, first established in 1979, engages in a variety of efforts to conserve biodiversity and protect the surrounding environment. Falklands Conservation has considered the dramatic loss of tussac communities on East and West Falklands a key issue since (at least) 1988 when it released a publication detailing the 80% drop in mainland tussac over time (Strange, Parry, Parry, & Woods, 1988; Otley, Munro, Clausen, & Ingham, 2008). This organization's main contributions to tussac restoration include tussac planting work supported by the John Ellerman Foundation as well as a replanting program on Elephant Beach in East Falkland, which began in 2005 with support from Falkland Conservation's Small Grant Scheme. Regeneration at Elephant Beach has produced a tussac grass community strong enough to support some grazing by cattle (Falklands Conservation, 2015). Additionally, between 2014 and 2016, Falkland Conservation received funding from the UK through the Darwin Plus Initiative for the planting of tussac tillers⁴ through community events, which focuses on the use of native plants to combat erosion through habitat restoration (Falklands Conservation, 2012).

While the planting of tussac tillers has seen success in habitat restoration on peat and sandy soils, it is not without its challenges. Tussac planting demands a significant amount of labour and financial investment, and involves considerable uncertainty, with new tillers sometimes failing after being in the ground for years. Recent research on revegetating different eroded soil types in the Falklands found success using native tussac seeds (though adequate amounts are hard to come by) supported with treatments such as sheep manure and sheep dags/locks—the extra, often dirty, off-cut wool from fleeces. Additionally, Smith and colleagues have found that,

sowing our successful native species could be integrated with alternative grazing practices that are increasingly being adopted across the islands. For example, seeds and treatments could be applied within rotational livestock grazing management, during the period of 'rest' when a paddock is ungrazed. Nevertheless, for our approach to be adopted and gain widespread traction across the islands requires better integration of sowing native seeds with livestock grazing." (Smith et al., 2018)

Relatedly, Falklands Conservation has carried out small trials using the planned movement of animals to distribute sheep manure, instead of spreading it manually over the tussac seeds, but results have been mixed (Personal Communication, 2015). This method is essentially already being used by some farmers who graze cattle on tussac—the cattle spread manure and distribute seeds.

Farmers pioneered early tussac restoration efforts in the Falklands, and some are now coordinating their efforts with groups like Falklands Conservation to restore tussac on production land, as

well as protecting existing tussac stands in order to provide ready sources for seed and tillers. The Falkland Islands Government, through the Department of Agriculture, supports (among other things) fencing and planting for tussac restoration via funding through their Farm Improvement Programme (Department of Agriculture, 2018). Rather than being recipients of this new conservationist outlook on tussac, farmers are at the forefront of building it. When asked about goals and plans over the next decade, one farmer remarked: 'Well, I'd like to get all my coastline back to tussac grass, and I've fenced off all round this edge of this creek and up to the boundary to get that back to tussac grass'.

Restoration on farmlands involves significant investments in fencing and careful planning regarding what animals (if any) have access to the regenerating tussac. A complication is that there are many benefits from giving sheep access to the coast, because of rich coastal greens fertilized by penguin guano, and access to seaweed or kelp for supplemental vitamins. As one farming expert explained: 'we're very lucky because we have a huge amount of coastline, and then, of course the animals get onto the beach and eat kelp and seaweed and other bits, too, so they get some form of supplementation by that'. There is also evidence outside of the Falklands of algae/seaweed used as livestock feed; in fact, in North Ronaldsay, the most northern of the Orkney islands (Scotland), the diet of sheep is comprised entirely of seaweed (Hansen, Hector, & Feldmann, 2003; Makkar et al., 2016). Seaweed can also be used as a fertilizer, tested in trials for regeneration of tussac grass in the Falklands but evidencing only minimal improvements in growth (McAdam, 1989). In addition to replanting tussac along the coastlines where it once grew, some farmers choose to plant tussac in chicken coops to provide shelter to the chickens and protect the tussac from grazing (Figure 6).

On farms where tussac remains, or is being restored, it is still being used as occasional livestock feed. In recognizing its range of ecological benefits, it is being grazed in a more careful manner. As one farmer put it, 'Yeah, well, I mean, tussac's a fantastic wildlife habitat. Its awesome cattle finishing feed, and it stops erosion, so it's the gem, isn't it?' And another farmer remarked:

We can't grow crops on [this property] because we don't have the soil depth and we don't have the rain, don't have enough rainfall. It's really quite arid [...]. So, we utilize the tussac, which we have, again, sub-divided.



FIGURE 6 Planted tussac in chicken coop, East Falkland

So, we use one section one winter, and then it rests for a winter or two winters, and then we use another section. So, that's how we put our cattle, and especially our younger calves and so on, go into the tussac in the winter, just to stop them losing weight.

KS: Sure, and you find the tussac recovers all right?

Amazing; yeah. It's really very, very, very, very strong. As long as you take them [the cattle] out before September, or by September when the -- Tussac really starts to grow in September-October time. It's strongly influenced by the salt water, and, you know, the environment it's in. Then, it puts a seed-head up before Christmas, so you've got to just get it right. But lots of people have used tussac in that way in the Falklands, and we just talked to older people about it. I mean, I'm old, but those are even older people than me. (laughs) And I wouldn't put them in tussac at all, initially; I was so precious about it when we first bought [the property]. But I was encouraged by older people about how good cattle can be if managed properly; how they trample new tussac tillers into the ground, and how it helps it to grow more vigorously.

This quote illustrates a renewed appreciation for tussac that has enabled more sustainable uses, as well as conservation and restoration efforts. Another farmer, when asked how it is possible to utilize tussac as livestock feed while working to restore the presence of the plant, remarked: 'Yeah, I only graze it with cattle at the moment, because cattle actually complement tussac grass, because they will actually pull tillers out of the bogs and re-tread them in. And just from their manure and that, you see the seed popping up in it'. While cattle may provide regeneration benefits by treading seeds and shoots into the ground, potential costs associated with grazing tussac include trampling bird burrows and reducing the carbon capture of the grass community.

While it is widely understood that managed cattle grazing can be sustained on tussac, the view expressed in the epigraph that sheep are lethal for tussac is not ubiquitous. Falklands Conservation considers grazing sheep on tussac sustainable, under certain circumstances. They offer advice on where, when, and how to integrate grazing in the processes of tussac planting and restoration. Their recommendations include winter planting in deep peaty soils that are free from any grazing while the young plants are being established, likely requiring fencing, suggesting that after about three years of reasonable growth, tussac can endure managed (as opposed to continuous and unmonitored) grazing, ideally in early winter (May–July; Falklands Conservation, n.d.). Tips are also provided on the extent to which tussac can be grazed without damaging the plant, as well as stocking guidelines for different sheep types—for example, hoggets (young sheep between weaning and one year of age or first shearing) stocked at 4–5 per hectare. This indicates some of the remaining differences of opinion regarding marrying livestock production and tussac restoration.

Grazing management has begun to shift towards more sustainable land-use practices, such as rotational grazing, including farm management methods with prescribed monitoring, use of fencing, and the planned movement of livestock (Tourangeau & Sherren, unpublished manuscript). These changes may complement ongoing efforts to restore tussac grass on Falkland farms (Department of Agriculture, 2010; McShane, 2016; Ross, Short, Short, & Poncet, 2016). What is more, a growing market interest in the remote origin, low-input production, and overall 'story' of Falkland wool products works to further encourage sustainable farming practices (Falkland wool buyer, personal Communication, November 2016, Falkland Islands.). This shift to making new value from the land and relying less on the quantities and scale of production mirrors trends in New Zealand, and what Pawson & The Biological Economies Team. (2018) call the *new biological economy*. Sheep farming in the Falklands is changing; while farmers are adapting their sheep management practices to help prevent overgrazing, diversification has also become part of this period of renewal as farmers become less inclined to depend solely on a wool income (Tourangeau & Sherren, Unpublished manuscript).

Since the 2003 introduction of an abattoir on East Falkland for both domestic and export markets, farmers have focused more attention on raising 'dual-purpose' sheep (producing both wool and meat) and cattle in order to diversify into meat production. One of the farmers involved in tussac restoration commented on the value-added aspects of grazing cattle on tussac, suggesting that the abattoir could be offering a premium price for tussac-fed beef since it is arguably more natural compared to the cattle being fattened on non-native crops. Additional means of diversification for farmers in the Falklands include working in Stanley (the capital), as well as driving and/or hosting tourists that come to witness the Falklands wildlife. The Falklands has a growing wildlife tourism industry that relies on the presence of penguins and many other species, and therefore encourages coastal stewardship, including the preservation of tussac communities (Hoppé & McAdam, 1992). As with many experiences in the Falklands, this mirrors that of New Zealand, where diversification into meat production occurred over a century ago, and tourism and value-added marketing have already taken hold (Pawson & Perkins, 2013; Pawson & The Biological Economies Team, 2018). New Zealand's experiences represent a shift towards a new 'biological economy' that places less emphasis on the linear/narrow frame of agri-business and productivism, focusing instead on the complex connections between agriculture and other dynamics, such as tourism, recreation, fishing, conservation and so forth (Campbell et al., 2009; Pawson & The Biological Economies Team, 2018). Framing and understanding the shifts in the Falklands in terms of a shifting biological economy may help to explain the new ways in which agriculture is becoming interwoven with other means for creating value from the land.

7 | CONCLUSIONS

Long before Bougainville's settlement or Darwin's visits, the Falklands have been home to hundreds of species of plants and

animals, evolving together in this island ecosystem. Isolated in the southern Atlantic Ocean for millennia, human contact is a relatively new phenomenon. For two centuries starting in the 1600s, ecological exploitation was the colonial project of visitors and settlers; all available resources were utilized with little to no consideration of long-term ecological impacts. A fringe of giant tussac grasses was one of the first things to be noted about this singular ecosystem by humans first approaching its coast and was soon recognized and exploited as a novel resource. Sheep—as well as cattle, pigs, horses, guanacos, and reindeer—were all introduced to the Falklands to establish first a food source and then an economic commodity (wool), in part enabled by tussac. As the natural capital of tussac eroded, knowledge grew of its ecological importance as habitat for native species, and later of the benefits that humans—not least the farmers—gain from sustaining the tussac. Falkland Islanders are increasingly determined to reverse the simplification of their landscape towards plant life that can withstand grazing pressure.

Farmers, conservationists and the local government, are working to restore tussac in the Falklands; current efforts underway include the designation of nature reserves, campaigns for tussac seed collecting and planting, and the rise of sustainable grazing practices. For areas that remain rich in tussac, reserve designations and selective exclusion from grazing and invasive species are essential. For those areas already denuded of tussac, planting campaigns have been deployed. Changes to sustainable grazing practices are important for tussac restoration efforts but are also relevant to ecological restoration efforts in the Falklands more generally; some farmers are using techniques like rotational grazing to improve the condition of their pastures. As the production of wool remains synonymous with farming in the Falklands, a continued shift is needed towards practices that help farmers work with the natural ecosystem in which they are situated.

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CONFLICT OF INTEREST

The authors declare that they have no conflict of interest.

AUTHORS' CONTRIBUTIONS

K.S. and W.T. conceived the ideas and designed methodology; K.S. and M.D. collected the data; K.S. and W.T. analysed the data; W.T. led the writing of the manuscript. All authors contributed critically to the drafts and gave final approval for publication.

DATA AVAILABILITY STATEMENT

Due to the size and nature of the community under investigation it is not possible to make the data publicly available. Additionally, the ethics application for the study assured participants that data would be kept confidential.

COMPLIANCE WITH ETHICAL STANDARDS

This study received approval through the Dalhousie University Research Ethics Board (approval #2016-3971). Informed consent to participate in the study was obtained from all human subjects.

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ENDNOTES

- ¹ The species *Poa flabellata* is generally referred to as tussac grass, or simply tussac. Historical references to this plant also use the less common spelling 'tussack', as well as 'tussock'—the more generic term for bunch grasses that belong to the genus *Poa*, and the Poaceae family.
- ² Wood's (1970) description of the Southern House Wren is assumed to be the Cobb's Wren, based on updated lists of birds in the Falklands.
- ³ It is unclear which particular species is being referred to here. Southern sea lions (or South American sea lions), scientific name *Otaria flavescens*, are found on the Falklands (and throughout South America), and they are commonly referred to as 'sea lion' and 'sea wolf' ScienceDirect (2019). While several other species of sea mammals frequent the Falklands, there appears to be no other with this nomenclature.
- ⁴ A tiller is an individual shoot of tussac that grow in dense clusters. Individual tillers can be extracted from a mature tussac plant, and if planted when the soil is wet can establish roots and initiate a new tussac clump.

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SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section.

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