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From Biocultural Homogenization to Biocultural Conservation

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Chapter 14
Fur Trade and the Biotic Homogenization of Subpolar Ecosystems

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Abstract At the southern end of the Americas exist one of the last pristine ecosystems in the world, the sub-Antarctic Magellanic forests ecoregion, protected by the Cape Horn Biosphere Reserve (CHBR). Despite its remote location, the CHBR has been subject to the growing influences of globalization, a process that has driven cultural, biotic, and economic transformations in the region since the mid-twentieth century. One of the most important threats to these unique ecosystems is the increase of biological invasions. Motivated by the expanding fur industry that responded to the globalization process, American beavers (*Castor canadensis*), muskrats (*Ondatra zibethicus*), and American minks (*Neovison vison*) were introduced, independently, to the southern tip of South America. Research has shown that these three North American species have reassembled their native interactions to affect negatively the invaded ecosystems of the CHBR. Beavers affect river flow and

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native vegetation, changing forests into wetlands, creating suitable habitats for muskrats. Muskrats, in turn, are the main prey of inland mink populations. The latter has major impacts by preying opportunistically on the native biota, especially native birds and small rodents. In this chapter, we explore this multi-species invasive system as an example of biotic homogenization, in which the introduction of these species and their subsequent reassembling of their interactions, together with the ecosystem impacts, offer a novel example of complex processes of biotic homogenization involving both biological and sociocultural dimensions.

Keywords Cape Horn Biosphere Reserve · Biocultural homogenization · Invasive meltdown · Invasive species

14.1 Introduction

South American temperate forests represent a unique biome with extremely high endemism. Close to 90% of the woody plants, about 60% of the bryophytes, 50% of fish, 80% of amphibian, 36% of reptile, 30% of land bird, and 33% of mammal species are endemic to the forest biome (Armesto et al. 1998; Rozzi et al. 2008). This high endemism is associated with the isolation of the austral South American forest biome from the nearest tropical forests by 1500–2000 km (Armesto et al. 1998). Topographic and climatic barriers include the high Andes along with the vast dry steppe of Argentina, the hyper-arid Atacama Desert, and the southern Pacific Ocean. The biome extends for approximately 3000 km along southwestern South America from central Chile (35°S) to the southern tip of the continent in Cape Horn (56°S). At its southern end, the temperate forest biome includes the sub-Antarctic Magellanic forests ecoregion, which is dominated by trees of the genus *Nothofagus* (southern beech), one evergreen, *N. betuloides*, and two deciduous, *N. pumilio* and *N. antarctica*. The forest is embedded in the Magellanic moorland complex, composed of a matrix of peatlands, bogs, and meadows (Rozzi et al. 2006). Given its remote location, low human density, large geographical extent, and high percentage of remaining non-fragmented native forests, this area has been identified as 1 of the last 24 wildernesses areas of the world (Mittermeier et al. 2003). To protect these remote and unique ecosystems together with their cultural heritage, in 2005 a team of scientists, the local community, and the Chilean government successfully proposed to UNESCO the creation of the Cape Horn Biosphere Reserve (CHBR) (Rozzi et al. 2006).

Despite being isolated and located in a remote region, the CHBR has been subject to the growing influences of globalization, a process that has driven cultural, biotic, and economic transformations in the area since the mid-twentieth century (Rozzi et al. 2006, 2012; Berghöfer et al. 2008). One of the salient agents of change within this reserve is the introduction of invasive mammalian species, particularly those associated with the fur trade. This process has involved the relocation of species from North to South America and provides an exemplar case of human-mediated translocation of species that contributes to a pervasive phenomenon known as biotic homogenization (McKinney and Lockwood 1999), in which distant ecosystems end up dominated by similar groups of plants and animals (Simberloff 2013).

The process of biotic homogenization often involves parallel and interrelated processes of cultural homogenization. To characterize the feedback between these two processes, Rozzi (2012) coined the term "biocultural homogenization." The habitats and biotas as well as the life habits (customs and worldviews) of local people are replaced by those of global culture, a process that has been intensified during the Great Acceleration since the mid-twentieth century (Rozzi 2015).

One of the industries that expanded with the globalization process during the twentieth century was the fur industry. Humans have historically used hides as clothes for protection from the environment, including the Native American cultures that inhabited the hostile climates of subpolar regions of the Americas. Hides were an essential component of the clothing of Koyukon, Inuit, Algonquian, and Iroquois people inhabiting the temperate and sub-Arctic zones of North America and the Fuegian people inhabiting terrestrial and coastal ecosystems in the sub-Antarctic region of South America (Martin 1982; McEwan et al. 2014). However, during the nineteenth and twentieth centuries, the fur industry prospered as a response to more than just using clothes for protection. It was a response to an increasingly profitable clothing industry motivated by western ideas of aesthetics and fashion in the United States and Europe, which started to expand in the twentieth century with the growing free market and global economic system (Skov 2005; IFTF 2017). The fur industry settled at the south end of South America between the 1930s and 1950s.

Among the 12 documented non-native mammals introduced into the CHBR, 3 are furbearing species brought as a response to the promotion of fur industry by the Argentinean National Direction of Wildlife (Lizarralde 1993). These are the American beaver (*Castor canadensis*), the muskrat (*Ondatra zibethicus*), and the American mink (*Neovison vison*). These three species that interact in their native range in North America (Viljugrein et al. 2001; Shier and Boyce 2009; Mott et al. 2013) have reassembled those native interactions in the non-native ecosystems of the CHBR (Fig. 14.1; Crego et al. 2016). In this chapter, we explore the reassemblage of these three North American species and potential ecological impacts on the ecosystems of the sub-Antarctic Magellanic ecoregion, which represents a unique example of biotic homogenization between two subpolar ecosystems.

14.2 The Trio and a Trans-Hemispheric Journey

Beavers are important components of North American ecosystems as keystone and ecosystem engineer species (Baker and Hill 2003). With their dam- and den-building activities, together with foraging, they can alter the hydrology, geomorphology, and chemistry of freshwater ecosystems, having large effects on plant and animal species composition, density, and distribution (Baker and Hill 2003; Rosell et al. 2005). There is one species that benefits from beaver behavior, the muskrat, which frequently occurs in habitat associated with beaver dams and dens (Mott et al. 2013). Muskrats are also known to affect invertebrate and plant abundance and nutrient flows of aquatic habitats (Connors et al. 2000; de Szalay and Cassidy 2001). Additionally, a third North American mammal can benefit from the presence of muskrats: the mink.

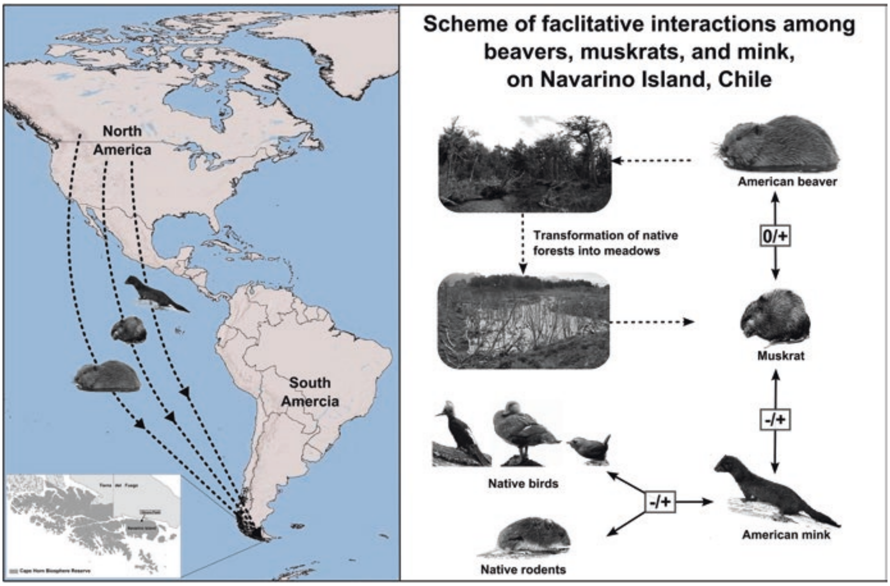

Fig. 14.1 This figure represents on the left the long-distance translocation of American beavers, muskrats, and American mink led by the fur industry from northern areas of North America to the southern regions of South America within the Cape Horn Biosphere Reserve, which promoted the biotic homogenization of both regions. On the right, the facilitative interactions among the three invasive species that were described by Crego et al. (2016) for Navarino Island are represented. American beavers modify native forests along fast water streams into meadows with calm water, favoring the establishment of muskrats (0/+ interaction type). Muskrats are the main prey of mink that inhabit in the forests and meadows of the island, facilitating mink survival, especially during the winters (−/+ interaction type). In turn, mink affect native species of rodents and birds through predation (−/+ interaction type). These interactions resulted in the reassemblage of the interactions that take place in the native habitats of North America

In many areas of their native range, muskrats are the preferred prey of the mink, a carnivore mustelid of semi-aquatic habits (Larivière 1999). Correlated population fluctuations in a predator-prey interaction between mink and muskrats have been documented in Canada indicating a tight ecological linkage between the two (Viljugrein et al. 2001; Shier and Boyce 2009). These three mammalian species form an assemblage that coevolved in a variety of habitats in North America.

In the mid-twentieth century, this trio of North American furbearing mammals was introduced in southern South America (Fig. 14.1). In 1946, 20 beavers were brought from Canada and released in the Fagnano Lake in the Argentinean side of Tierra del Fuego Island (Jaksic et al. 2002). At a similar time and in a similar location, several muskrats were also released in Tierra del Fuego freshwater systems (Jaksic et al. 2002). Since the introduction, beavers and muskrats have colonized almost every environment on the island of Tierra del Fuego and have dispersed onto other islands and the mainland of the South American continent (Jaksic et al. 2002; Graells et al. 2015). Beavers, particularly, have impacted large areas of native ecosystems, altering stream nutrient cycles (Ulloa et al. 2012), stream food webs

(Anderson and Rosemond 2007), and changing large areas from closed *Nothofagus* forest to grass and rush-dominated meadows (Lizarralde et al. 2004; Anderson et al. 2006a). These habitat alterations are landscape-wide and long-lasting (Henn et al. 2016).

The American mink was introduced from fur farms. The first mink individuals were brought from North America to farms installed in Punta Arenas, Chile, during the years 1934 and 1936 (Rozzi and Sherrifs 2003). Additionally, fur farms began operations in southern Argentina in the 1930s (Jaksic et al. 2002). By 1959 there were more than 60 mink breeding centers in southern Argentina, including Tierra del Fuego (Rozzi and Sherriffs 2003). They ultimately led to the establishment of wild populations due to escapes and intentional releases (Lizarralde and Escobar 2000). After 1990, sightings of mink have become more common in several areas of Tierra del Fuego Island (Lizarralde and Escobar 2000), and approximately at the end of that decade, mink crossed the Beagle Channel reaching Navarino Island, in southern Chile (Rozzi and Sherriffs 2003). Since then, mink have quickly dispersed throughout the CHBR (Anderson et al. 2006b; Valenzuela et al. 2014; Crego et al. 2015). Today, the populations of mink represent a major threat for native mammals, birds, and fishes that are part of the mink's diet in the CHBR (Schüttler et al. 2008, 2009; Ibarra et al. 2009).

14.3 Biotic Homogenization of Two Poles in the Americas

The CHBR is composed of many different islands. Navarino Island, located south of Tierra del Fuego, is where the town of Puerto Williams and the Omora Ethnobotanical Park are situated. This location is the scientific center of the CHBR where the majority of the studies on the reserve take place. A recent study suggests that the ecological interactions that occur among American beavers, muskrats, and mink in the sub-Arctic region of North America have been reassembled on Navarino Island in the sub-Antarctic region of South America (Crego et al. 2016).

Beavers and muskrats crossed the Beagle Channel from Tierra del Fuego into Navarino Island around 1962 (Jaksic et al. 2002). The mink was first detected on this island more recently, in 2001 (Rozzi and Sherriffs 2003), where it became the top terrestrial predator. In contrast with Tierra del Fuego and Hoste Islands where the native Culpeo fox (*Lycalopex culpaeus*) is the top predator (Sielfeld 1977), Navarino Island had no mammalian terrestrial predators. Additionally, on Navarino Island freshwater ecosystems are mainly formed on steep mountain slopes with rivers having narrow beds and high water velocities (running waters). These are not the habitat conditions that muskrats prefer; they inhabit water systems that present low variations in water levels, found in calm waters such as ponds, and with abundant aquatic vegetation (Artimo 1960).

Beavers may then benefit muskrats in Navarino Island by transforming riparian forests into meadows, changing running waters into calm waters where vegetation grows. To investigate this interaction, Crego et al. (2016) sampled for muskrat signs in four different types of aquatic habitats: active beaver dams with a pond system, inactive beaver dams with a pond system, inactive beaver dams with a running water system (i.e., old beaver dams with recovered stream flow), and streams with no beaver activity. Muskrat's signs were more abundant in habitats that had been transformed by beavers into calm water systems. Moreover, muskrat's signs were almost absent from naturally occurring fast-flowing streams. These findings revealed a novel facilitative interaction between beavers and muskrats, where beavers create suitable habitat for muskrats (Fig. 14.1; Crego et al. 2016).

Crego et al. (2016) also examined the trophic interactions of mink with muskrats and beavers. They studied the mink's diet and found that mink populations inhabiting marine coastal habitats feed mainly on fish, while populations inhabiting inland forests and meadows feed mainly on muskrats. Today, in inland habitats of Navarino Island, muskrats represent over 50% of the total biomass intake of the mink. This predator-prey interaction closely resembles trophic interactions described for mink populations in their native habitats of North America (Viljugrein et al. 2001; Shier and Boyce 2009). Additionally, previous research has shown that mink consumption of muskrats is more important during harsh winters when other prey items decrease in abundance (Schüttler et al. 2008; Ibarra et al. 2009). Therefore, muskrats may play a pivotal role in allowing part of the mink population to survive winters with low prey abundance. Mink have, in turn, major impacts on the native fauna, especially after the breeding season, when their population increases. This is particularly relevant for Navarino Island because native species of small rodents and birds evolved in the absence of terrestrial mammalian predators, making them potentially naïve to mink predation risk (Crego et al. 2016). High predation rates on native species of rodents and birds (Schüttler et al. 2008, 2009; Ibarra et al. 2009; Jiménez et al. 2014) may have important consequences on population dynamics (Fig. 14.1; Crego et al. 2014).

In summary, on Navarino Island the presence of muskrat seems to be facilitated by beaver's habitat modifications, which in turn facilitate mink survival in inland habitats (Fig. 14.2). These three species appear to be synergistically interacting to invade and transform the terrestrial biotic community of the sub-Antarctic Magellanic ecoregion in the CHBR. The habitat modifications and trophic interactions among a trio of mammals that interact in the native habitats of North America offer a novel example of complex processes of biotic homogenization involving both biological and sociocultural dimensions. As a result, today the sub-Antarctic and sub-Arctic ecosystems share an assemblage of species that make these two distant regions more similar than they were a century ago.

14.4 The Homogenization Includes Eurasia

The effect on biotic homogenization driven by American beavers, muskrats, and American mink is not limited to the subpolar regions of the Americas. With the prosperity of the fur industry in the Northern Hemisphere, these species were also

Fig. 14.2 These photographs represent the interaction of American beavers, muskrats, and American mink on Navarino Island, Chile. The photograph on the left shows the habitat transformation that results from the activity of American beavers. Trees die and are replaced by grasses and rushes at the time that the river is transformed into a pond. This new habitat is preferred by muskrats. The photograph on the right shows the remains of fur (inside the circle) left by a mink after preying on a muskrat on the shore of the same beaver pond showed on the left

introduced in Europe and Asia. Currently, American beavers are restricted to Finland and northwestern Russia (Parker et al. 2012); however, muskrats and mink inhabit great extensions of Europe and Russia, with populations still expanding (Andow et al. 1990; Bonesi and Palazon 2007; Iordan et al. 2012). In these vast territories, American beavers and American mink have a direct effect on the native Eurasian beaver (*C. fiber*) and European mink (*Mustela lutreola*), respectively, by direct competition (Andow et al. 1990; Bonesi and Palazon 2007).

American beavers, American mink, and muskrats are only sympatric in Finland and northwestern Russia; however, no study has investigated if synergistic interactions among these three species occur. Some studies have documented pairwise interactions that could suggest facilitative interactions similar to those we have described on Navarino Island in Chile. For instance, population trends of mink and muskrats in Poland and Sweden suggest tightly coupled predator-prey relationships, with mink populations affecting muskrats (Hjalten 1991; Brzeziński et al. 2010). Minks, in turn, have well-documented impacts on the local native biota (Macdonald and Harrington 2003; Bonesi and Palazon 2007). More interestingly, on the border between Mongolia and Russia, the European beaver, the muskrat, and the American mink coexist in the same habitat (Saveljev et al. 2015). Although there is no clear relationship between European beavers and muskrats, it seems that mink population expansion occurred only after the muskrat established a self-sustaining population and increased its population size, suggesting a facilitative interaction (Saveljev et al. 2015).

The replacement of native species with North American ecological equivalents, in addition to the degrading habitats by mink predation, geographically extends the area impacted by biotic homogenization processes described above for southern South America. The three furbearing North American species and their large impacts on habitats and ecosystem are contributing to increasing biotic and ecological similarities among the subpolar ecosystems of North America, Europe, some parts of Asia, and South America.

14.5 Conclusion

Large-scale spatial and temporal processes have generated marked contrasts between the subpolar regions of the Northern and Southern hemispheres (Axelrod et al. 1991; Lawford et al. 2012; Rozzi et al. 2012). At the same time, these subpolar regions present ecological similarities and a degree of connectivity between their biotic communities. For instance, some migratory birds travel each year from one pole to the other between the breeding and the wintering grounds connecting the two terrestrial ecosystems. These species are potentially capable of transporting propagules attached to the plumage, perhaps explaining the bipolar and disjoint distribution of some bryophyte species (Lewis et al. 2014) and vascular plants (Popp et al. 2011). Nevertheless, distributions including both poles are more common in marine organisms than terrestrial organisms (Stepanjants et al. 2006); and among animals, only a few are mammals. Orcas (*Orcinus orca*) can be seen swimming in waters of both subpolar regions. Yet, while orcas are present in all oceans, they present physiological and cultural differences that make populations unique and very distinct between different regions, including northern and southern subpolar populations (Foote et al. 2016).

Human populations at high latitudes also developed distinct cultures in each of the subpolar regions. North and South American Native American people remained quite isolated until the nineteenth century (McEwan et al. 2014). Today, economic and cultural globalization is bringing increasing development pressures that are contributing to homogenizing human cultures even in remote subpolar regions. The expansion of the fur industry stands as a prime of these pressures. In less than a century, the introduction of American beavers, muskrats, and American mink into the southern end of South America has reconfigured the structure and evolutionary course of biotitic communities, habitats, and cultures of the Magellanic sub-Antarctic ecoregion.

This trio of North American mammals represents a powerful example of the biological homogenization process that is occurring at a planetary scale in association with economic globalization and cultural homogenization. In short, today we could state that sub-Antarctic and sub-Artic regions are becoming bioculturally homogenized. With the fur industry prospering again, especially for the mink (IFTF 2017), it is crucial to take precautions to avoid further introductions and to prevent the expansions of already introduced species. Control of exotic mammal populations is critical for effective long-term conservation programs that protect the uniqueness of distinct biota and cultures of subpolar ecosystems in the Northern and Southern hemispheres.

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