Chile: Increasing Connectivity for Nature and People in Highly Anthropogenic Landscapes

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Aníbal Pauchard, Eduardo Fuentes-Lillo, Darío Moreira-Arce, J. Cristóbal Pizarro, and Mónica Ortiz

Crop fields and farms at region del Maule, Chile (Photo: Jose Luis Stephens/Adobe Stock)

A. Pauchard (✉) · E. Fuentes-Lillo
Laboratorio de Invasiones Biológicas (LIB), Facultad de Ciencias Forestales, Universidad de Concepción and Institute of Ecology and Biodiversity (IEB), Concepción, Chile
e-mail: pauchard@udec.cl

D. Moreira-Arce
Departamento de Gestión Agraria, Facultad Tecnológica, Universidad de Santiago de Chile and Institute of Ecology and Biodiversity (IEB), Concepción, Chile

J. C. Pizarro
Facultad de Ciencias Forestales, Universidad de Concepción. Laboratorio de Estudios del Antropoceno, Universidad de Concepción, Concepción, Chile

Institute of Ecology and Biodiversity (IEB), Concepción, Chile
e-mail: jpizarrop@udec.cl

M. Ortiz
Institute of Ecology and Biodiversity (IEB), Concepción, Chile

Departamento de Geografía, Facultad de Arquitectura, Urbanismo y Geografía, Universidad de Concepción, Concepción, Chile

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Abstract

The central zone of Chile is currently exposed to various threats derived from historical land use, the increase in the frequency of wildfires, and the extension of non-native forest plantations. These factors have had a direct impact on the fragmentation of the native forest and the decrease in biodiversity in the region. These impacts are aggravated by the fact that only 10% of this area is protected under some category. The main challenge for the conservation of these ecosystems lies in increasing connectivity between forest fragments that have become isolated. Currently, strategies are being implemented to create natural corridors to connect these remaining forest fragments, thus preventing the isolation affecting ecosystem and species, including endangered native mammals such as *Lycalopex fulvipes* and *Leopardus guigna*. Participation of local and Indigenous communities is essential to advance public policies that promote management strategies capable of reducing biodiversity threats and promote landscape connectivity.

Keywords

Anthropogenic disturbances · Fragmentation · Biological invasions · Land use · Biological corridors

A Biodiversity Hotspot in Grave Peril

The ecosystems of south-central Chile, the transition zone from Mediterranean shrublands and forests to temperate forests and wetlands, are a major biodiversity hotspot and in great danger due to a combination of land-use change, climate change, and invasive species expansion (Myers et al. 2000; Echeverría et al. 2006; Miranda et al. 2017; Heilmayr et al. 2020; see Fig. 26.1). South-central Chile encompasses the ecosystems from the Maule region (35° S) to the Araucanía region (40° S), with less than 10% of the total area conserved within designated conservation areas (Pliscoff 2022).

Land-use changes caused by agriculture and forestry supplanting native forest areas have reduced biodiversity in the region (Fig. 26.1; Miranda et al. 2017; Heilmayr et al. 2020). Current spatial and temporal models of land change and land use indicate that Chile could experience a 90% increase in the area used for forestry and a nearly 140% increase in urbanization by the year 2080 (Benavidez-Silva et al. 2021). The areas transformed by these developments are concentrated in the central and southern regions of the country, restricting the connectivity of the remaining areas harboring great biodiversity to isolated protected areas that are distributed unevenly across Chile (Pliscoff 2022). Declining biodiversity and ecosystem functions place many of nature's contributions to humans at risk (Brauman et al. 2020; Heilmayr et al. 2020), and the loss of biodiversity and ecosystem connectivity in the central Chile region has severe consequences for the affected people.

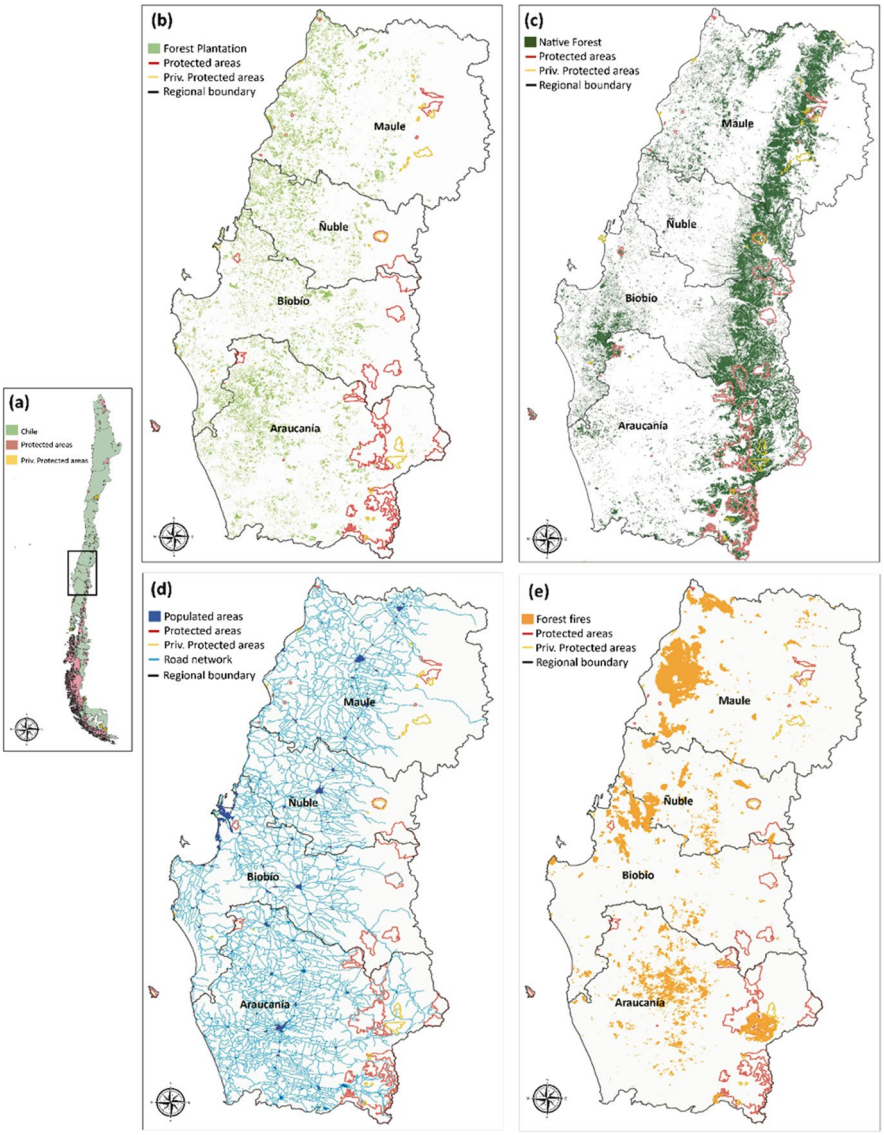

Fig. 26.1 Protected areas and native forests, and their major threats in south-central Chile: (**a**) SNASPE (National System of State-Protected Areas) (red) and private protected areas (yellow) in continental Chile. (**b**) Forest plantations (e.g., *Pinus* sp. and *Eucalyptus* sp.). (**c**) Native forests in south-central Chile. (**d**) Populated areas and the road network. (**e**) Wildfires during the past decade

The increase of anthropogenic activities and urban sprawl—including the growth of road networks, subdivision for second homes, and tourism infrastructure—significantly increases the spread of non-native invasive species as well as wildfire frequency and intensity (McWethy et al. 2018). As a result, the central zone of Chile

characterized by the highest population density and per capita growth also exhibits the highest concentration of non-native species and has been extensively damaged by extreme wildfire events in recent years (Figs. 26.1 and 26.2; Fuentes et al. 2015; Fuentes-Lillo et al. 2021).

In addition to the effect of land-use change and invasive species, climate change is a key factor in this equation that contributes to biodiversity loss in Chile (Marquet et al. 2019). Current climate change models predict that by the year 2080, the richness of native plants (a reduction of 25%) and the phylogenetic diversity of native

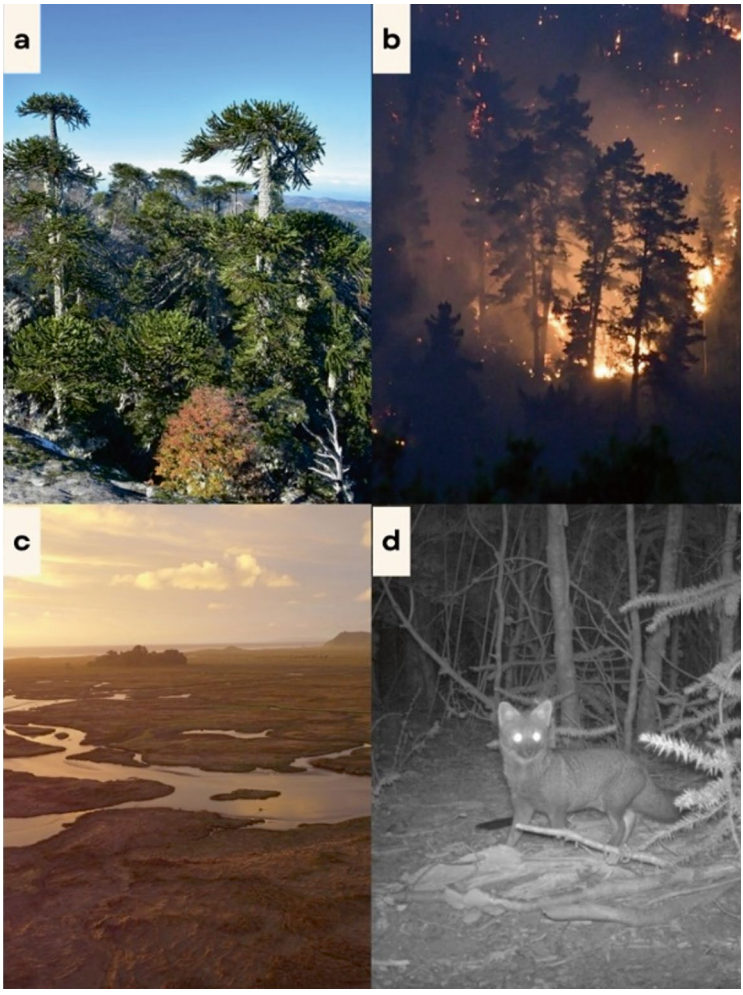

Fig. 26.2 Characteristic elements of south-central Chilean landscapes (from top right, clockwise): (**a**) Coastal range *Araucaria araucana* forests, (**b**) wildfires affecting vegetation dominated by invasive pines, (**c**) coastal wetlands, (**d**) Darwin's fox (*Lycalopex fulvipes*) in *Araucaria araucana* forests

plants in Chile will significantly decrease both in the central regions and in the Andes Mountain range (Fuentes-Castillo et al. 2019). In this scenario, land-use change is expected to cause the loss of approximately 75% of sclerophyllous forests, 45% of native shrubs, and 43% of grasslands (Benavidez-Silva et al. 2021; Fuentes-Castillo et al. 2019).

Increasing Connectivity in South-Central Chile

In a matrix dominated by non-native tree plantations (Fig. 26.1) and experiencing increasing human pressure, forest restoration initiatives should focus on increasing the capacity of existing "natural corridors" to connect the last remnant forests. The mosaic of anthropogenic uses and the reduction of native ecosystems has led to significant impacts on both nature and people, including the displacement of nearby communities and the Indigenous Mapuche people (Torres-Salinas et al. 2016). From 1975 to 1998 alone, 40% of native forests were replaced by pine plantations, which have significant impacts on native biodiversity and water security (Uribe et al. 2020, Braun et al. 2017; Torres-Salinas et al. 2016). Promoting the connectivity of remnants of native forests is therefore critical for the persistence of biodiversity in production-oriented landscapes dominated by tree plantations, agricultural lands, and human communities.

Connectivity is also a priority for carnivores, which have significant space requirements and may avoid entering anthropogenic habitats, perceiving productive lands as a barrier to their movement across the landscape and eventually using corridors of native vegetation as potential paths of dispersal (Smith et al. 2019). The conservation of threatened carnivores such as the Darwin's fox (*Lycalopex fulvipes*) and kodkod cat (*Leopardus guigna*) in the Nahuelbuta mountain range, an anthropogenically fragmented landscape of temperate coastal forests in south-central Chile, has required the identification of habitat elements that facilitate the species' movement, such as wildlife corridors or small patches acting as stepping stones (Smith et al. 2019; Fig. 26.2). However, human–carnivore conflict has emergent population-level consequences which increases the mortality risk for carnivores in the landscape. Consequently, a unified socio-ecological framework combining landscape structure and composition with human attitudes would provide a more comprehensive approach to incorporating the suitability that certain habitat types acquire for the movement of carnivores as anthropogenic pressure intensifies (Ghoddousi et al. 2021).

Conservation efforts in the region have shown that connectivity between these forest ecosystems is not about forests alone. In fact, wetlands are dynamic ecosystems representing natural connectors between upland and aquatic systems, with many rivers connecting the Chilean Andes with the coastal range and the Pacific Ocean. Wetland connectivity provides essential habitats for migratory birds and generates conditions for unique swamp forest types; it is crucial not only for biodiversity but also for maintaining traditional ecological knowledge and biocultural memory through these resilient systems (Molares et al. 2022). Unfortunately,

coastal wetlands and their forests are highly threatened by various local and global drivers of change including urbanization, energy and water production projects, industrial cellulose mills, pollution from industrial, domestic, and agricultural sources, and finally climate change (Pauchard et al. 2006; Hidalgo-Corrotea et al. 2023).

Moving Forward

Despite the potential for increasing forest connectivity in south-central Chile, no clear policy for promoting biological corridors in the region has been implemented. Furthermore, the last remnants of native forests are threatened by increasing pressure (e.g., from wildfires, Fig. 26.1e). However, biological corridors have been proposed as a central conservation tool for the region since the early 2000s, and a broad range of stakeholders have contributed to the design of such biological corridors: government agencies, NGOs, local and Indigenous communities, and forest companies and other landowners (World Wildlife Fund 2006). Private conservation initiatives along with a new private protected areas law in Chile can play an important role in the region (Martinez-Harms et al. 2021). Unfortunately, such efforts to increase connectivity remain isolated, and the lack of policy and funding support has impeded on-the-ground implementation. Over the past 10 years, conflicts regarding property ownership and rights—such as those between the forestry industry and local and Indigenous communities—have further increased the complexity of implementing landscape-scale conservation actions.

To make headway in terms of biological connectivity in south-central Chile, a broader view addressing the landscapes as socio-ecological systems is needed (e.g., Ostrom 2009). Sustainable and multifunctional landscapes that incorporate ecological and social connectivity are pivotal (Kremen and Merenlender 2018; Fischer et al. 2017). Within this approach, the participation of local communities in biodiversity protection will play a key role in maintaining the ecological processes and ecosystem services of the remnant forest habitats in south-central Chile. In conjunction, more research is needed to include social accessibility, human attitudes, and perceptions toward biodiversity in landscape planning for connectivity. Combining these attitudes and perceptions with spatially explicit information will allow conservation practitioners to identify "anthropogenic factors" as an essential component of a landscape connectivity planning framework. Therefore, creating opportunities for dialogue between private and public actors, communities, and Indigenous peoples is urgently required to forge a common vision for restoring and protecting native ecosystems and enhancing their connectivity.

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