RESTORATION ECOLOGY
The Journal of the Society for Ecological Restoration

SER SOCIETY FOR ECOLOGICAL RESTORATION

RESEARCH ARTICLE

Differences in stakeholder perceptions about native forest: implications for developing a restoration program

Jessica A. Castillo[1,2,3], Cecilia Smith-Ramírez[4,5,6], Vivianne Claramunt[7]

Ecological restoration is a global priority. Incorporating stakeholders' perceptions has been established as a critical factor to improve the success of restoration and conservation initiatives and decrease future social conflicts; however, it has barely been incorporated. Our objective was to analyze and compare the differences in the perceptions of Chilean dryland forest restoration of three groups: local community, experts, and government managers. We asked about: (1) what is the knowledge, importance, and uses that they have and give to the native forest and its restoration? (2) What is the willingness to restore the native forest? (3) What are the most valuable goods and services provided by the forest? (4) Where to begin to restore? (5) What criteria must be considered to prioritize areas to restore? To determine if the criteria selected were related to the stakeholder group, a semi-parametric multivariate analysis of variance (MANOVA) was performed. Semi-structured interviews were carried out with 61 stakeholders. The community gave greater importance to restoring the ravines and creeks, the experts to restoring areas that increase landscape connectivity, and both experts and government managers to restoring areas of greater biodiversity and ecological value. The experts gave a lower value to both social and economic criteria compared to the local community and government managers. The differences among stakeholder perceptions must necessarily be considered in the restoration programs. Research on perceptions can contribute to decision-making and will favor the social approval and long-term success of restoration programs.

Key words: central Chile, dryland forest, ecological restoration, prioritization, priority areas, sclerophyllous forest

Implications for Practice

- Water provision should be one of the priority objectives in restoration programs of dryland forest landscapes in Chile.
- Since there is consumption of forest products, areas of forest management to obtain forest products should be considered in restoration programs. This consumption must be validated and regulated so as not to affect the conservation of the forest.
- There are differences among the stakeholders' perceptions of the forest and its restoration. The restoration programs should seek to resolve the differences and possible conflicts among stakeholders, and to empower them to make informed decisions about restoration actions.

Introduction

In recent decades there has been increasing recognition by society of the importance of stakeholder participation (e.g. local community, research at institutions, nongovernmental organizations [NGOs], and public policymakers, among others) in the decision-making process of environmental issues (Burger et al. 2005, 2007; Burger 2013; Urgenson et al. 2017). For example, policymakers are increasingly encouraging landowners to protect and recover native forest on their lands through subsidies or incentives to conserve and restore. However, lack of knowledge of stakeholders' perception toward conservation and restoration of the forests can lead to low participation of landowners. Moreover, it has been recorded that the farmers' perceptions of biodiversity conservation are

Author contributions: JAC, CSR conceived the research; JAC, VC, CSR designed the study; JAC, VC performed the interviews; JAC, VC, CSR analyzed the data; JAC, CSR wrote and edited the manuscript.

[1]Instituto de Turismo, Facultad de Ciencias Económicas y Administrativas, Universidad Austral de Chile, Isla Teja s/n, Valdivia, 5090000, Chile
[2]Escuela de Graduados, Facultad de Ciencias Forestales y Recursos Naturales, Universidad Austral de Chile, Isla Teja s/n, Valdivia, 5090000, Chile
[3]Address correspondence to J. A. Castillo, email jecacm@gmail.com
[4]Departamento de Ciencias Biológicas y Biodiversidad, Universidad de Los Lagos, Av. Fuchslocher 1305, Osorno, 5290000, Chile
[5]Instituto de Ecología y Biodiversidad-Chile (IEB), Las Palmeras 3425, Ñuñoa, Santiago, 7800024, Chile
[6]Instituto de Conservación, Biodiversidad y Territorio, Facultad de Ciencias Forestales y Recursos Naturales, Universidad Austral de Chile, Isla Teja s/n, Valdivia, 5090000, Chile
[7]Facultad de Ciencias Agronómicas, Universidad de Chile, Av. Santa Rosa 11315, La Pintana, Santiago, 8820808, Chile

doi: 10.1111/rec.13293
Supporting information at:
http://onlinelibrary.wiley.com/doi/10.1111/rec.13293/suppinfo

directly related to their participation in conservation activities (Lovell & Sullivan 2006; McCraken et al. 2015). To know and incorporate the stakeholders' perceptions provides guidelines and baseline information for developing restoration and conservation programs, which will allow greater social acceptability and appropriateness, higher participation, and a long-term success (Burger et al. 2005, 2007; Higgs 2005; Chazdon 2008; Davies et al. 2010; Geneletti et al. 2011; Haden et al. 2012; Niles et al. 2013; Mansourian & Vallauri 2014; Niles et al. 2015; Bennett 2016; Urgenson et al. 2017).

Ecological restoration (ER) has been considered as a global priority and a key component of sustainable development (Aronson & Alexander 2013). However, there is little knowledge about stakeholders' perception in restoration (Burger 2002, 2010; Cottet et al. 2013; Celentano et al. 2014; De Wit et al. 2020) and how they differ from each other (Ianni & Geneletti 2010). For example, Burger (2002) researched perceptions about several attributes of restoration and related concepts in Santa Fe (New Mexico, U.S.A.), finding the highest prioritization rating was assigned to maintaining functioning ecosystems. Burger (2010) studied public perceptions about who is responsible for resource restoration and which resources should be restored in coastal New York and New Jersey; 98% of interviewees said that resources should be restored, and more than 40% of them thought the government should restore them. Celentano et al. (2014) studied the local perceptions toward environmental changes and restoration, proposing a riparian forest restoration strategy in Alcântara, Eastern Amazon.

An important step in a restoration program is to define priority areas to restore, considering that there are large areas of degraded land and the financial resources available are limited (Margules & Pressey 2000; Crossman & Bryan 2006; Bottrill et al. 2008; Chazdon 2008). But we find a remarkable lack of analysis in the literature of the perceptions of all stakeholders together in this process, finding only a few studies (e.g. Ianni & Geneletti 2010; Lagabrielle et al. 2011; Orsi et al. 2011; Thompson 2011; Uribe et al. 2014). The experts' perception (mainly scientists) is considered in most prioritization studies, ignoring other stakeholders. In this process of prioritization, it becomes relevant to recognize the different perceptions in relation to the forest and its restoration. Moreover if we consider that forest restoration is long terms, it is of great importance to have a collaborative approach, where different stakeholders work together to resolve conflicts and develop a shared vision (Urgenson et al. 2017). Here the concept perception refers to the way humans observe, understand, interpret, and value forests and forest restoration and conservation (Bennett 2016).

In Mediterranean climate regions there is a type of dryland forest that harbors about 20% of the world's plant species, many of which are endemic, but only represent less than 5% of the Earth's surface (Cowling et al. 1996). These ecosystems are one of the least protected (MEA 2005) and most threatened in the world due to high anthropogenic pressure (Gauquelin et al. 2016). The dryland forest in central Chile is highly fragmented and is considered a threatened biodiversity hotspot (Myers et al. 2000; Olson & Dinerstein 2002). This area is the most populated and productive of central Chile (Metropolitan and Valparaiso regions concentrate approximately 50% of the population; https://datosabiertos.ine.cl/dashboards/20568/censo-2017/) and there are serious conflicts with productive land use regarding restoration and conservation activities. From 1975 to 2008, 42% of remnant dryland forests in central Chile disappeared because of land use change (Schulz et al. 2010), mainly due to agriculture intensification (vineyard and fruit farming) and recurrent, extensive anthropogenic fires. In addition, grazing of livestock and rabbits (introduced species) is widespread, thus hindering forest regeneration (Jaksic & Soriguer 1981). Besides, remnant degraded native forests continue to be a source of firewood, extraction of soil made of leaves and other non-timber forest products used by the community (Smith-Ramírez et al. 2019). At the same time, however, extensive abandoned and highly degraded or bare lands with *Acacia caven* formations occur, giving dryland forests an opportunity to recover (Fuentes-Castillo et al. 2012). Thus, establishing effective ecological dryland forest restoration programs in central Chile is a priority need (Newton 2008; Lara et al. 2010), for which knowing the perceptions of the stakeholders in relation to the dryland forest and its restoration is a relevant factor (Bennett 2016).

The objective of this study was to know and compare the perception of dryland forest and its restoration among three stakeholder groups (local community, experts, and government managers). We studied and compared the perceptions of stakeholders in five areas: (1) what is the knowledge, importance and uses that they have and give to the native forest and its restoration? (2) What is the willingness to restore the native forest? (3) What are the most valuable goods and services provided by the forest? (4) Where to begin to restore? (5) What criteria must be considered to prioritize areas to restore? Since ecological restoration has only recently become known in Chile, and considering that the main stakeholders that have participated in restoration initiatives are NGOs, government, companies, and universities in Chile (Smith-Ramírez et al. 2015), our hypothesis is that the three stakeholder groups, especially local community, have different perceptions about the value of native forests and its restoration. We focus and discuss the differences and similarities found among stakeholders in order to eventually determine the main objectives and recommendations that a long-term restoration program in the Chilean dryland forest should include.

Methods

Study area. The study was conducted in Quilpué commune, located in one of the most degraded areas of central Chile, but with the possibility to implement a successful environmental restoration experience since it conserves forest nuclei that can help in the recovery of degraded areas. Quilpué commune (32°56′7″S–33°59′14″ and 70°59′14″–71°39′53″, Fig. 1) has a surface area of 170,897 ha and 151,708 inhabitants (INE 2017). The population is mainly urban (98.6%) and is concentrated in the city of Quilpué and its surroundings (Fig. 1). Only 6.6% of the population is indigenous people. Quilpué is located in a low mountain range (from 15 to 2,129 m) and the climate is temperate Mediterranean (Di Castri & Hajek 1976). The average annual temperature is 14.4°C; annual average rainfall is 588 mm (Luebert & Pliscoff 2012). The vegetation is mainly dryland

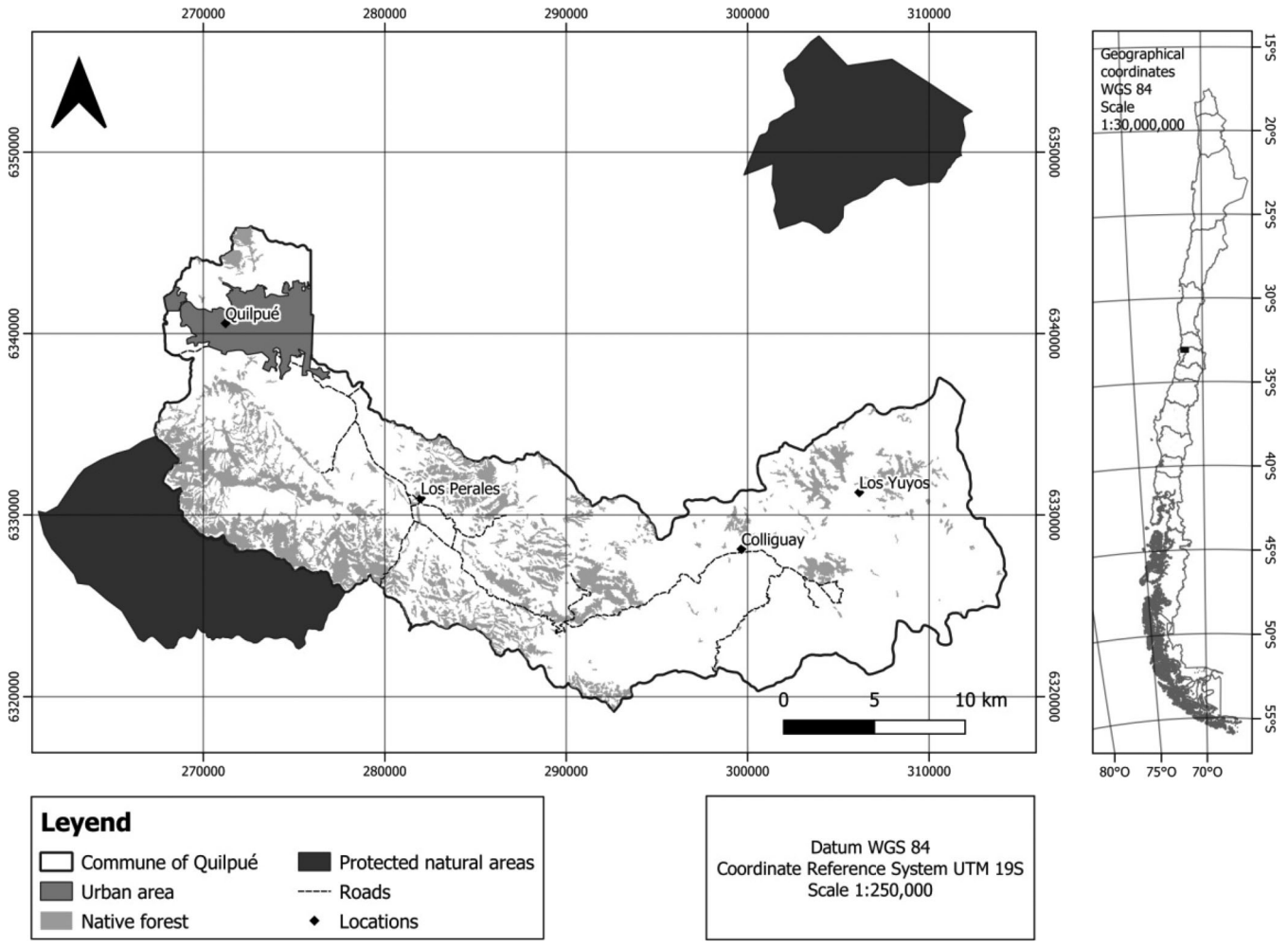

Figure 1. Location of the study area (Quilpué commune) in Chile.

forest of the Mediterranean central Chile (Luebert & Pliscoff 2012). Dryland forest regeneration occurs mainly in more mesic areas with increased humidity (southern aspect in the Southern Hemisphere).

Interviews. The interview is one of the most widespread methods in conservation to study perception (Bennett 2016). First, an exhaustive review of individuals, organizations, and institutions that are linked to ecological restoration and dryland forest locally (Quilpué commune), regionally, and nationally was done. Second, taking into account our review, we decided to classify stakeholders into three main groups: (1) local community; (2) experts (scientists, representatives of non-government organizations, and forestry managers) and (3) government managers. We differentiated experts from government managers, since the latter are representatives of the government, who largely have the decision power over environmental policies in the country. The local community was represented by individuals and community organizations linked to the environment. The experts were professionals of different universities and scientific institutions, and NGOs who work in social, economic and ecological areas in the dryland forest. The government managers were employees of government institutions linked to the environment, forest and restoration (National Forest Corporation [CONAF], Forestry Institute [INFOR], Ministry of Environment, among others). The "snowball" methodology was used, asking each respondent to propose another relevant stakeholder (King et al. 1998; Stanghellini & Collentine 2008). The stakeholders identified were contacted and invited to participate in the study. We interviewed a total of 61 people: 30 from the local community, 17 experts, and 14 government managers. We stopped inviting people when no more new persons were mentioned by the other stakeholders. Of the total, 47 (77%) were men and 14 were women.

A semi-structured interview was elaborated with the help of a social scientist (Roberto Hernández, Universidad de Chile). The interview was based on predetermined open and closed questions, along with other questions that emerged from the dialog between the interviewee and interviewer (Canales 2006; DiCicco-Bloom & Crabtree 2006; Hernández et al. 2006).

The interview was divided into seven sections: (1) personal data (name, age, gender, telephone, address, e-mail, education level, current job); (2) questions about knowledge of restoration ecology term (if the interviewee knows the term, and if so, what

does it mean), importance of the forest and its restoration and uses of native forest. A list of the main uses of the native forest was presented to each respondent (Smith-Ramírez et al. 2019); they had to select those uses that the forest gives and also add if they give it other use. (3) Question about willingness to participate in forest restoration; (4) question about goods and services provided by the forest. A list of goods and services delivered by the dryland forest was presented to each respondent (MEA 2005), which they had to order from highest to lowest importance; (5) question about where to begin restoring, (6) question about what criteria must be considered to prioritize areas to restore, and (7) question where the interviewee can propose other relevant stakeholders to interview in this study. A literary review of criteria used in forest ecosystems was conducted to select the criteria for the prioritization of areas to restore (e.g. Ianni & Geneletti 2010; García-Feced et al. 2011; Orsi et al. 2011; Veluk et al. 2012; Uribe et al. 2014), as well as studies on ecological restoration and regeneration of dryland forest of central Chile (e.g. Becerra et al. 2011; Fuentes-Castillo et al. 2012). Taking into account these two literary sources, the authors selected criteria that were relevant to the dryland forest of central Chile. Each interviewee had to evaluate this list of criteria according to their importance. The interview is presented in Table S1. The interviews lasted approximately 2 hours. The data provided by informants were recorded in a field notebook and each interview was recorded in audio format to document the information provided.

Data Analysis

Since the assumptions of analysis of variance were not fulfilled, we performed non-parametric Kruskal-Wallis tests to determine if there are differences among stakeholder perceptions about the following questions: (1) knowledge of the term ecological restoration, (2) the importance that they give to the forest and its restoration, (3) willingness to participate in restoration activities, (4) goods and services delivered by the forest most valued, (5) where to begin to restore, and (6) what criteria must be considered to prioritize areas to restore. When significant differences were found ($p \leq 0.05$), we performed a post hoc test of pairwise multiple comparisons (Dunn's test). For questions about dryland forest uses and where to begin to restore the dryland forest, systematization was carried out by grouping the answers obtained into categories; each was assigned a frequency.

We performed a semi-parametric multivariate analysis of variance (MANOVA) to determine whether the evaluation of the criteria for the prioritization of areas to restore is determined by the stakeholder group or the level of use of the native forest. The level of use of native forest products was obtained from section 4 of the interview by categorizing the responses into three levels: low level = one or two uses; medium = three to four uses; high = ≥ five uses. Finally, we used non-metric multidimensional scaling (NMDS) to analyze the overall pattern of dispersion in the interviewees according to stakeholder groups. Data that are clustered together in the resulting plots reflect the interviewees who gave similar responses. All statistical analyses were performed with R (https://www.r-project.org/index.html).

Results

Knowledge, Importance, and Uses of the Forest and Its Restoration

The experts knew significantly more about the term ecological restoration (100% of respondents) than the community did (60%, $\chi^2 = 10.09$, $df = 2$, $p < 0.01$), and there were no differences between government managers (80%) and experts, and government managers and community. The three groups of stakeholders gave high value to the native forest ($\chi^2 = 1.2$, $df = 2$, $p = 0.37$) and its restoration ($\chi^2 = 1.03$, $df = 2$, $p = 0.6$), showing no significant differences. The presence of native forest had a score of 9.8 (scale from 1 to 10 going from least to most important) for the community and government managers and 10 for experts. The importance of restoring the native forest had a score of 9.6 for the community and 10 for government managers and experts.

Honey and medicinal plants were the most frequent uses for timber and non-timber forest products for the three groups of stakeholders (83, 88, and 71% for community, experts, and government managers, respectively, Fig. 2). Other forest products used by the community were the seeds, flowers, and bark of trees. The first two were also mentioned by the government managers. In spite of massive domestic use of gas in the countryside of Quilpué (e.g. for cooking), the native forest is still used a source of charcoal by all stakeholders (53, 76, and 57% for community, experts, and government managers, respectively). When respondents were asked if they gave other uses to the native forest, 65% of the experts gave it a research use; 79% of the government managers gave it a scenic beauty use; and for both groups the forest has high recreational use (88% of experts and 71% of government managers). A low percentage of the respondents in the community gave another use to the native forest. The most frequent uses for the community were recreation (30%), tourism (30%), and education (27%, Fig. 2).

Willingness to Restore the Native Forest

The willingness to develop or participate in initiatives that contribute to the restoration of the native forest was 96% of community respondents and 100% of experts and government managers, and there was no significant difference among stakeholder groups ($\chi^2 = 2.1$, $df = 2$, $p = 0.35$).

Goods and Services Provided by the Forest

"Fresh air" was the most valued good and service delivered by native forest for the community; they gave it significantly more value ($p < 0.01$, mean 9.8, Table 1) than experts and government managers. The next three best goods and services valuated by the community were similar to those best evaluated by experts and government employees. These are: maintenance of water courses (mean score 9.6–9.9, scale ranges from 1 to 10, from least to greatest importance), followed by soil protection (9.2–9.6) and maintenance of local flora and fauna (9.1–9.4, Table 1). Wood products was the least valued good and service for the three stakeholder groups; the community gave it a significantly lower value than the experts ($p = 0.03$, Table 1). Also, the community gave significantly more importance to "nectar and pollen for the

production of honey" than government managers ($p = 0.03$), and to "heritage for children" than the experts ($p = 0.05$).

Where to Begin to Restore?

The community gave significantly greater importance to restoring the ravines and creeks (30% of respondents mentioned it) than the government managers, who did not mention it ($\chi^2 = 5.94$, $df = 2$, $p = 0.05$), while it showed no significant difference between experts (13.3%) and government managers, and experts and community. The experts gave significantly more importance to restoring areas that increase landscape connectivity (53.3%) than community (3.3%) and government managers (7.1%, $\chi^2 = 18.69$, $df = 2$, $p < 0.0001$). Experts (40%) and government managers (35.7%) gave significantly greater importance to restoring areas of greater biodiversity and ecological value than the community (0%, $\chi^2 = 13.84$, $df = 2$, $p < 0.001$). The three stakeholder groups mentioned "around wetlands and water courses" (23.3% of community, 33.3% of experts, and 21.4% of government managers) and "most degraded areas" (23.3 of community, 20% of experts, and 7.1% of government managers), without significant differences between them ($\chi^2 = 0.67$, $df = 2$, $p = 0.72$ and $\chi^2 = 1.65$, $df = 2$, $p = 0.44$, respectively).

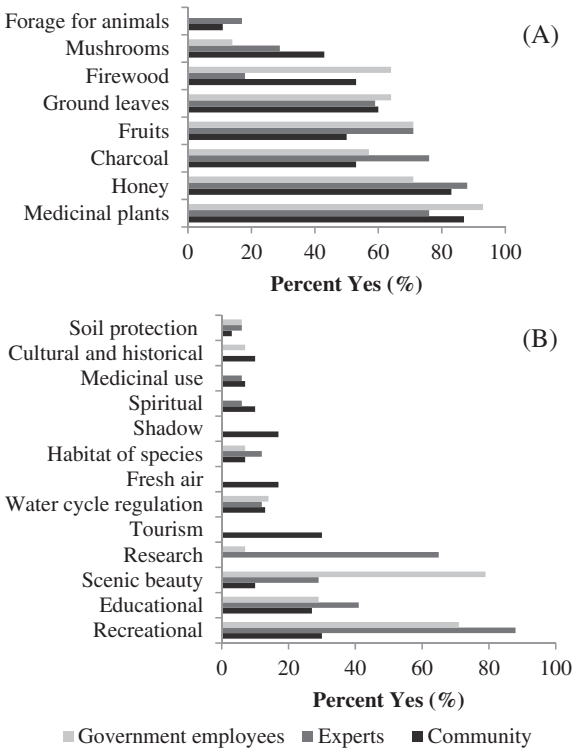

Figure 2. Respondents by stakeholder group (%) that(A)use timber and non-timber forest products and (B) mention other uses of the native forest.

What Criteria Must Be Considered to Prioritize Areas to Restore?

The criterion of prioritization of areas to restore the dryland forest that had the highest value for the community (rating 3.8, scale 0–4, Table 2) and government managers (3.9) was "threatened native species" (areas with presence of threatened native species), while for experts the best valued criterion was "landscape connectivity" (3.5, areas with greater connection between remaining vegetation). The criterion that had the lowest valuation for the community was type of property (2.0); for the experts it was "distance to population centers" (1.5, areas far from populated centers) and "land income" (1.5, favoring land that generates less income); and for government managers it was land income (1.8), similar to the experts (Table 2).

The community gave a significantly higher valuation to the "distance to watercourses" criterion (areas with smaller distance to watercourses) than experts (Table 2), but did not differ

Table 1. Stakeholders' perception about goods and services delivered by the dryland forest. Ten-point scale (1 = minor importance, 10 = major importance). Significance of results from Kruskal-Wallis test with Dunn's multiple comparison tests is shown next to each category name. Letters indicate significant differences.

	Mean + SD					
Goods and Services	*Community*	*Experts*	*Government Employees*	p *Value*	χ^2	df
Maintenance of water courses	9.63 ± 0.96	9.94 ± 0.25	9.71 ± 0.61	0.47	1.5	2
Soil protection	9.47 ± 1.01	9.25 ± 2.05	9.64 ± 0.93	0.6	1.02	2
Fresh air	9.8 ± 0.48[a]	8.25 ± 1.66[b]	8.15 ± 2.41[b]	**<0.01**	13.54	2
Maintenance of local flora and fauna	9.4 ± 1.3	9.13 ± 1.63	9.17 ± 1.85	0.76	0.56	2
Forage for animals	4.29 ± 3.39	4.88 ± 3.4	5.08 ± 4.01	0.82	0.41	2
Beauty of the landscape	8.47 ± 1.93	7.88 ± 1.75	7.21 ± 2.99	0.22	3	2
Nectar and pollen for the production of honey	7.7 ± 3.34[a]	7 ± 2.8[ab]	6.21 ± 3.04[b]	**0.03**	6.86	2
Provision of firewood	3.39 ± 3.04	5.33 ± 2.77	4.14 ± 3.53	0.14	4	2
Medicinal plants	7.2 ± 3.19	6.5 ± 2.68	5.69 ± 3.61	0.2	3.21	2
Heritage for children	8.13 ± 2.6[a]	6.53 ± 2.96[b]	8.27 ± 2.34[ab]	**0.05**	6.06	2
Provision of human food	4.6 ± 3.43	5.56 ± 3.08	4.77 ± 3.96	0.65	0.87	2
Recreation opportunities	6.93 ± 3.19	6.71 ± 3.02	6.86 ± 3.08	0.74	0.61	2
Wood products	2.72 ± 3.12[a]	4.81 ± 2.61[b]	3.71 ± 3.58ab	**0.03**	7.03	2
Cultural values	7 ± 3.25	7.29 ± 2.1	7.27 ± 2.74	0.96	0.08	2

In bold, p values ≤ 0.05.

Table 2. Stakeholders' perception of criteria that can be considered when deciding where to restore the dryland forest of central Chile. Scale: No score = if you do not know if it is or is not important, or do not respond, 0 = should not be considered, 1 = not important, 2 = low importance, 3 = medium importance, 4 = high importance. Significance of results from a Kruskal-Wallis test with Dunn's multiple comparison tests is shown next to each category name. Letters indicate significant differences.

Criteria	*Definition*	*Community*	*Experts*	*Government Managers*	p *Value*	χ^2	df
Microclimate							
Aspect	Areas with mesic aspect	2.5 ± 1.71	3 ± 1.37	3.29 ± 1.27	0.34	2.14	2
Altitude	Areas with higher altitude	2.58 ± 1.55	1.76 ± 1.35	2.08 ± 1.19	0.11	4.36	2
Slope	Areas with low to medium slope	2.55 ± 1.48	2.41 ± 1.37	2.29 ± 1.07	0.59	1.07	2
Humidity	Areas with higher soil moisture	3.4 ± 1.19	2.82 ± 1.33	3 ± 1.11	0.09	4.78	2
Natural regeneration							
Distance to watercourses	Areas with shorter distance to watercourses	3.55 ± 1.06[a]	2.88 ± 1.27[b]	3 ± 1.41[ab]	**0.03**	7.29	2
Distance to remnant vegetation	Areas with less distance to remaining vegetation	3.23 ± 1.07	3 ± 1.54	3.64 ± 0.63	0.42	1.72	2
Percentage of coverage of remnant vegetation	Areas with greater cover of remaining vegetation	3.03 ± 1.15	2.24 ± 1.64	2.86 ± 1.46	0.27	2.64	2
Seed dispersers	Areas with presence of seed dispersers	3.55 ± 0.74	2.88 ± 1.27	3.5 ± 0.65	0.09	4.79	2
Forest degradation and disturbance							
Soil erosion	Areas with low to medium erosion	2.7 ± 1.62	2.88 ± 1.41	3.21 ± 1.25	0.63	0.93	2
Fire risk	Areas with low fire occurrence probability	2.53 ± 1.41	2.35 ± 1.46	3.14 ± 1.1	0.24	2.86	2
Presence of invasive species	Areas with low presence of invasive species	3.07 ± 1.15	2.13 ± 1.55	2.71 ± 1.64	0.14	3.92	2
Road density	Areas with low road density	3.39 ± 1.23	2.47 ± 1.36	2.5 ± 1.56	0.07	5.44	2
Distance to population centers	Areas far from populated centers	2.48 ± 1.6	1.53 ± 1.33	2.43 ± 1.5	0.08	5	2
Rate land use change (%)	Areas with lower rate of change of land use (%)	2.5 ± 1.62	2 ± 1.07	2.36 ± 1.5	0.26	2.72	2
Cattle density	Areas with low or medium density livestock	2.9 ± 1.23	2.5 ± 1.51	2.5 ± 1.51	0.63	0.92	2
Biodiversity							
Species richness	Areas with higher number of species	3.6 ± 1.07	3.29 ± 1.16	3.23 ± 0.93	0.15	3.82	2
Threatened native species	Areas with presence of threatened native species	3.83 ± 0.38[ab]	3.35 ± 1.06[a]	3.93 ± 0.27[b]	**0.04**	6.54	2
Minimum area required for target animal species	Areas that achieve the required minimum area for target animals	3.37 ± 1.13	3.29 ± 1.16	3.23 ± 0.93	0.73	0.62	2
Areas with forest originally	Areas that originally had forest	3.24 ± 1.15	2.76 ± 1.35	3.43 ± 0.65	0.28	2.53	2
Landscape connectivity							
Landscape connectivity	Areas with greater connection among remaining vegetation	3.45 ± 1.09	3.47 ± 0.72	3.14 ± 1.41	0.71	0.7	2
Distance to priority areas for conservation	Areas close to conservation priority areas	3.34 ± 0.72	2.71 ± 1.45	3.64 ± 0.63	0.08	5.03	2
Distance to protected areas	Areas close to National Protected Areas	3.38 ± 1.08[ab]	2.82 ± 1.47[a]	3.79 ± 0.58[b]	**0.04**	6.41	2
Willingness of local community							
Improvement in the standard of living	Areas where there is a lower standard of life	2.97 ± 1.43[ab]	2.8 ± 0.86[a]	3.57 ± 0.85[b]	**0.05**	5.68	2
Community organization	Areas where local community is more organized	3.5 ± 0.68[ab]	2.81 ± 1.11[a]	3.71 ± 0.47[b]	**0.03**	7.13	2
Concern about native forest conservation	Areas where local community has higher concern to conserve native forest	3.63 ± 0.85[a]	3 ± 1.06[b]	3.71 ± 0.61[a]	**<0.01**	9.4	2

Table 2. Continued

Criteria	*Definition*	*Community*	*Experts*	*Government Managers*	p *Value*	χ^2	df
Experience in restoration activities	Areas where local community has been doing restoration more years	3.31 ± 1.17	2.56 ± 1.41	3.36 ± 1.15	0.07	5.23	2
Willingness to participate in restoration	Areas where there are more people willing to participate in restoration	3.2 ± 1.32	2.87 ± 1.25	3.57 ± 0.65	0.25	2.81	2
Interest in restoration	Areas where the local community has more interest in forest restoration	3.43 ± 0.97	3.06 ± 1.06	3.29 ± 1.14	0.28	2.53	2
Level of conflict in local community	Areas where there is a lower level of conflict in the community	2.6 ± 1.28	2.56 ± 1.15	2.29 ± 1.44	0.76	0.54	2
Restoration costs							
Accessibility to roads	Favor areas with greater accessibility to roads	2.7 ± 1.21	2.18 ± 1.29	2 ± 1.35	0.19	3.32	2
Land economic value	Favor land with lower economic value	2.03 ± 1.5	1.6 ± 1.35	1.86 ± 1.46	0.89	0.64	2
Land income	Favor land that generate less income	2.23 ± 1.5	1.53 ± 1.51	1.79 ± 1.48	0.29	2.5	2
Operational costs of restoring	Favor areas with lower operating cost	2.77 ± 1.41	2.24 ± 1.39	2.57 ± 1.34	0.37	2.01	2
Type of property	Promote areas of public property	1.97 ± 1.73[ab]	1.63 ± 1.67[a]	3.21 ± 0.89[b]	**0.03**	7.11	2

In bold, p values ≤ 0.05.

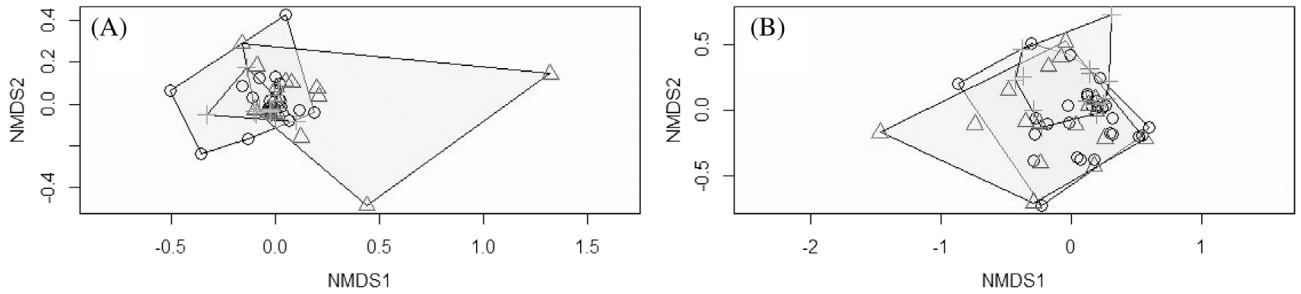

Figure 3. Non-metric multidimensional scaling (NMDS) plot showing the responses given of criteria for prioritizing areas to restore grouped by stakeholder group for the criteria: (A) willingness of local community, (B) restoration costs (circle: community, triangle: experts, plus sign: government managers).

significantly from government managers. Experts gave a significantly lower valuation to the criteria "threatened native species", "distance to protected areas" (areas close to National Protected Areas), "improvement in the standard of living" (areas where there is a lower standard of life), "community organization" (areas where local community is more organized), and "type of property" (promote areas of public property) than government managers, while there was no significant difference with the community (Table 2). Government managers gave a significantly higher valuation to the criterion "concern about native forest conservation" (areas where local community has more concern to conserve native forest) than the experts and the community (Table 2).

The scoring for social criterion "willingness of the local community" (MANOVA F model = 2.436, df = 2, p = 0.018) and for economic criterion "restoration costs" (MANOVA F model = 3.338, df = 2, p = 0.005) were significantly related by the stakeholder groups by 7.6% and 9.9%, respectively (Table S2). The experts gave a lower value to both social and economic criteria compared to the local community and government managers (see Table 2). No significant differences were found among stakeholder groups in the ecological criteria (microclimate, natural regeneration, forest degradation and disturbance, biodiversity, and landscape connectivity) (Table S2). The "forest degradation and disturbance" (MANOVA F model = 2.556, df = 2, p = 0.033) and "restoration costs" (MANOVA F model = 2.279, df = 2, p = 0.044) criteria were explained by the level of use of the native forest (8.1% and 6.8%, respectively, Table S2). The respondents who made more use of the native forest gave a lower score to the forest degradation and disturbance criterion, and a higher score to the restoration costs criterion.

The NMDS plot (Fig. 3) showed that the experts were the most heterogeneous group in their answers, that is, their responses were more different from those given by the local community and government managers. In Figure 4 we show different distribution models of the perceptions of the three groups of stakeholders. The answers of all stakeholders were grouped between model b and d (Fig. 4), that is, the answers were more clustered than scattered.

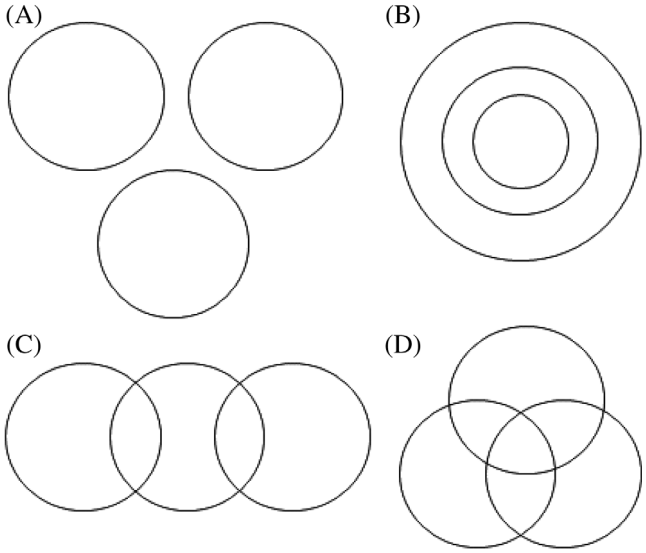

Figure 4. Some of possible distributions of the perceptions of different stakeholder groups (each circle represents a group of stakeholders—local community, experts,and government managers) about native forest and its restoration.

Discussion

There were important differences in the perception of the three groups of stakeholders studied, but also some similarities. We accept our hypothesis partially, because it was the experts that showed the greatest differences in their perceptions compared to the community and government managers. Differences were observed in the perceptions of the stakeholders in relation to the uses of the forest, where to begin to restore, and what criteria must be considered to prioritize areas to restore. For example, in the dryland forest of central Chile restoration should consider areas for research and education (perceived by experts and community, respectively), recreation (perceived by experts and government managers), and tourism (perceived by community). Areas of forest management to obtain timber and non-timber forest products should also be considered, because all stakeholders said they use these products to a greater or lesser extent, which has also been observed in other studies (Ovalle et al. 1996; Smith-Ramírez et al. 2019), even though wood products were the least valued goods and service for the three stakeholder groups. This situation occurs in a similar way in other communities within Latin America. For example, in the Brazilian Amazon, Celentano et al. (2014) recorded that the community depended primarily on slash-and-burn subsistence agriculture, so that they proposed a successional agroforestry combining annual crops and trees as a suitable transitional phase for restoration.

De Wit et al. (2020) studied how stakeholders perceive ecosystem services of a degraded coastal lagoon and how they value them in order to establish a multidisciplinary approach to ecological restoration in France. Similar to what was found in this study, stakeholders gave great importance to the services related to biodiversity and water. At the same time, they observe differences in stakeholders' perceptions of the value of cultural ecosystem services. In our study, we found differences in the "Heritage for Children" service, where the community gave it a higher value than the experts. For the other cultural services, no differences were found among stakeholders.

The creation of a restoration program should be a collaborative process, in which the goal is to balance multiple objectives (ecological, economic, and social; Urgenson et al. 2017). Considering our results, in addition to the objective of biodiversity conservation, there is the maintenance of water provision. These two objectives coincide with the forest goods and services that were better evaluated by all stakeholders. Water scarcity is currently one of the most serious problems facing central Chile, due to: (1) deforestation and degradation of dryland forest (Schulz et al. 2010) causing a negative impact on water provision (MEA 2005); and (2) a reduction in rainfall in central Chile that has taken place in the last century (CONAMA 2006; Le Quesne et al. 2006) and for which climate change is accountable (IPCC 2007). Although the effects of forest restoration on water yield are not as clear (Filoso et al. 2017), a positive correlation has been found in Chile between native forest cover in watersheds and total streamflow in the dry summer season (Lara et al. 2009), indicating a positive effect of the native forest on water provision. It has also been found that the riparian vegetation plays an important role in the level of runoff, which increases with the increase in riparian vegetation width (Little et al. 2015).

Where to begin to restore is another of the relevant points in a restoration program. In this study we observed differences among stakeholders, which should be taken into account. Priority areas to restore are ravines and creeks (proposed by the community), areas that increase landscape connectivity (proposed by experts), and areas with greater biodiversity and ecological value (proposed by experts and government managers). We suggest that the ravines and creeks were identified by the community since the inhabitants have noticed and been more affected by the changes that have taken place in their territory in relation to deforestation and decrease of water courses.

The ecological criteria had the highest valuation by stakeholders to prioritize areas to restore. Especially important were "threatened native species" (by the community and government managers) and "landscape connectivity" (by the experts). Experts had a more dissimilar perception than the community and government managers. We found that the experts gave a lower score to social and economic criteria to prioritize areas to restore compared to the local community and government managers. This may be because experts see it as a theoretical exercise, not linked to any real restoration program; however, both economic resources and social participation should be considered in restoration planning (Aronson et al. 2006). Our results indicate that including only the perception of the experts to prioritize areas to restore may be relegating social and economic aspects. We realize that it will be necessary to work with all stakeholders to be able to define a set of agreed criteria for the prioritization of areas to be restored in the dryland forest of central Chile.

As we observed in this study, the ecological restoration of the dryland forest in central Chile is very important for the different stakeholders so it is likely that there is support for public policies aimed at the ecological restoration of this ecosystem. It is important to consider that effective restoration of dryland forest will

depend on understanding landowner and community behavior with respect to restoration concerns, and also on economic incentives to restore (Smith-Ramírez et al. 2019). The economic incentives that currently exist in Chile to promote restoration are not cost-effective for landowners to decide to restore their lands (Schiappacasse et al. 2012), and require that they be accompanied by strong programs to explain the benefits social in terms of the provision of goods and services (Smith-Ramírez et al. 2019).

A restoration program in the dryland forest of central Chile must consider an ecological and socioeconomic dimension, as is proposed by forest landscape restoration (FLR; Mansourian 2005; Maginnis et al. 2007, Mansourian & Vallauri 2014). We propose five restoration objectives in the dryland forest of central Chile, in order of importance: biodiversity conservation, maintenance of water supply, forest management for productive use, research/education, and recreation/tourism. These objectives must be adjusted over time, as ecological restoration is a long-term process, and several socio-economic and ecological variables are likely to change over time (Holl & Aide 2011; Mansourian & Vallauri 2014).

Our results highlight the need to generate participatory and collaborative restoration programs that seek to resolve the differences and possible conflicts among stakeholders, and to empower stakeholders to make informed decisions about restoration actions. This requires recognizing and incorporating the different trade-offs generated by the land restoration and incorporating appropriate compensation measures (Mansourian & Vallauri 2014).

Acknowledgments

We thank CONICYT (Chile) for PhD fellowship N° 21120237 to JAC and for their contribution to Natalia Neira, Tania Rosselot, Jorge Pérez, Roberto Hernández, all the interviewers and Denise Fliegel for the English edition. This study was supported by projects FONDEF N° CA13I10276 from CONICYT (Chile) and ICM 05-002 and PBF-23 and AFB 170008 from Institute of Ecology and Biodiversity-Chile (IEB).

LITERATURE CITED

Aronson J, Alexander S (2013) Ecosystem restoration is now a global priority: time to roll up our sleeves. Restoration Ecology 21:293–296

Aronson J, Clewell A, Blignautd J, Milton SJ (2006) Ecological restoration: a new frontier for nature conservation and economics. Journal for Nature Conservation 14:135–139

Becerra P, Smith-Ramírez C, Echeverría C, Armesto J (2011) Effect of fragmentation on plant communities of Central Chile. Pages 121–122. In: Newton A, Tejedor N (eds) Principles and practice of forest landscape restoration: case studies from the drylands of Latin America. Gland, Switzerland: UICN

Bennett NJ (2016) Using perceptions as evidence to improve conservation and environmental management. Conservation Biology 30:582–592

Bottrill MC, Joseph LN, Carwardine J, Bode M, Cook C, Game ET, et al. (2008) Is conservation triage just smart decision making? Trends in Ecology and Evolution 23:649–654

Burger J (2002) Restoration, stewardship, environmental health, and policy: understanding stakeholders' perceptions. Environmental Management 30: 631–640

Burger J (2010) Public perceptions of natural resource damages and the resources that require restoration. Journal of Toxicology and Environmental Health, Part A 73:1325–1336

Burger J (2013) Stakeholder participation in research design and decisions: scientists, fishers, and mercury in saltwater fish. EcoHealth 10:21–30

Burger J, Gochfeld M, Kosson D, Powers CW, Friedlander B, Eichelberger D, Barnes D, Duffy LK, Jewett S, Volz CD (2005) Science, policy, and stakeholders: developing a consensus science plan for Amchitka Island, Aleutians, Alaska. Environmental Management 35:557–568

Burger J, Gochfeld M, Powers CW, Kosson DS, Halverson J, Siekaniec G, Morkill A, Patrick R, Duffy LK (2007) Scientific research, stakeholders, and policy: continuing dialogue during research on radionuclides on Amchitka Island, Alaska. Environmental Management 85:232–244

Canales M (2006) Metodologías de investigación social. Introducción a los oficios. Lom Ediciones, Santiago, Chile

Celentano D, Rousseau GX, Lex Engel V, Lima Façanha C, Moreira de Oliveira E, Gomes de Moura E (2014) Perceptions of environmental change and use of traditional knowledge to plan riparian forest restoration with relocated communities in Alcântara, eastern Amazon. Journal of Ethnobiology and Ethnomedicine 10:11

Chazdon R (2008) Beyond deforestation: restoring forests and ecosystem services on degraded land. Science 320:1458–1460

CONAMA (Comisión Nacional de Medio Ambiente) (2006) Estudio de la variabilidad climática en Chile para el sigo XXI. Informe Final. Universidad de Chile, Santiago, Chile

Cottet M, Piégay H, Bornette G (2013) Does human perception of wetland aesthetics and healthiness relate to ecological functioning? Journal of Environmental Management 128:1012–1022

Cowling RM, Rundel PW, Lamont BB, Arroyo MK, Arianoutsou M (1996) Plant diversity in Mediterranean-climate regions. Trends in Ecology and Evolution 11:362–366

Crossman ND, Bryan BA (2006) Systematic landscape restoration using integer programming. Biological Conservation 128:369–383

Davies GM, Pollard L, Mwenda MD (2010) Perceptions of land-degradation, forest restoration and fire management: a case study from Malawi. Land Degradation and Development 21:546–556

De Wit R, Leruste A, Le Fur I, Maki Sy M, Bec B, Ouisse V, Derolez V, Rey-Valette H (2020) A multidisciplinary approach for restoration ecology of shallow coastal lagoons, a case study in South France. Frontiers in Ecology and Evolution 8:108

Di Castri F, Hajek E (1976) Bioclimatología de Chile. Vicerrectoría Académica Universidad de Chile, Santiago, Chile

DiCicco-Bloom B, Crabtree B (2006) The qualitative research interview. Medical Education 40:314–321

Filoso S, Bezerra MO, Weiss KCB, Palmer MA (2017) Impacts of forest restoration on wáter yield: a systematic review. PLoS One 12:e0183210

Fuentes-Castillo T, Miranda A, Rivera-Hutinel A, Smith-Ramírez C, Holmgren M (2012) Nucleated regeneration of semiarid sclerophyllous forests close to remnant vegetation. Forest Ecology and Management 274:38–47

García-Feced C, Saura S, Elena-Rosselló R (2011) Improving landscape connectivity in forest districts: a two-stage process for prioritizing agricultural patches for reforestation. Forest Ecology and Management 261:154–161

Gauquelin T, Michon G, Joffre R, Duponnois R, Génin D, Fady B, et al. (2016) Mediterranean forests, land use and climate change: a social-ecological perspective. Regional Environmental Change 18:623–636

Geneletti D, Orsi F, Ianni E, Newton AC (2011) Identificación de áreas prioritarias para la restauración de bosques secos. Pages 289–326. In: Newton AC, Tejedor N (eds) Principios y práctica de la restauración del paisaje forestal. Estudios de caso en las zonas secas de América Latina. UICN, Gland, Switzerland

Haden VR, Niles MT, Lubell M, Perlman J, Jackson LE (2012) Global and local concerns: what attitudes and beliefs motivate farmers to mitigate and adapt to climate change? PLoS One 7:e52882

Hernández R, Fernández C, Baptista P (2006) Metodología de la investigación. McGraw-Hill Interamericana Editores, Iztapalapa, México

Higgs E (2005) The two-culture problem: ecological restoration and the integration of knowledge. Restoration Ecology 13:159–164

Holl KD, Aide MT (2011) When and where to actively restore ecosystems? Forest Ecology and Managament 261:1558–1563

Ianni E, Geneletti D (2010) Applying the ecosystem approach to select priority areas for forest landscape restoration in the Yungas, northwestern Argentina. Environmental Management 46:748–760

IPCC (Intergovernmental Panel on Climate Change) (2007) Cambio climático 2007: Informe de síntesis. Contribución de los grupos de trabajo I, II y III al cuarto informe de evaluación del grupo intergubernamental de expertos sobre el cambio climático. IPCC, Ginebra, Suiza. http://www.ipcc.ch/pdf/assessment-report/ar4/syr/ar4_syr_sp.pdf. (accessed 17 Oct 2016)

INE (Instituto Nacional de Estadísticas-Chile). (2017) Resultados Censo 2017 por País, Regiones y Comunas. http://resultados.censo2017.cl/Region?R=R05. (accessed 17 Feb 2020)

Jaksic FM, Soriguer RC (1981) Predation upon the European rabbit (*Oryctolagus cuniculus*) in Mediterranean habitats of Chile and Spain: a comparative analysis. Journal of Animal Ecology 50:269–281

King C, Feltey K, Sused B (1998) The question of participation: toward authentic public participation in public administration. Public Administration Review 58:317–326

Lagabrielle E, Rouget M, Le Bourgeois T, Payet K, Durieux L, Baret S, Dupont J, Strasberg D (2011) Integrating conservation, restoration and land-use planning in islands - an illustrative case study in Réunion Island (Western Indian Ocean). Landscape and Urban Planning 101:120–130

Lara A, Little C, Urrutia R, McPhee J, Álvarez-Garretón C, Oyarzún C, et al. (2009) Assessment of ecosystem services as an opportunity for the conservation and management of native forests in Chile. Forest Ecology and Management 258:415–424

Lara A, Reyes R, Urrutia R (2010) Bosques Nativos. Pages 107–139. In: Instituto de Asuntos Públicos, Universidad de Chile (ed) Informe País. Estado del Medio Ambiente en Chile. Universidad de Chile, Santiago, Chile

Le Quesne C, Stahle D, Cleaveland M, Therrell M, Aravena J, Barichivich J (2006) Ancient Austrocedrus tree-ring chronologies used to reconstruct Central Chile precipitation variability A.D. 1200 to 2000. Journal of Climate 19:5731–5744

Little C, Cuevas JG, Lara A, Pino M, Schoenholtz S (2015) Buffer effects of streamside native forests on water provision in watersheds dominated by exotic forest plantations. Ecohydrology 8:1205–1217

Lovell ST, Sullivan WC (2006) Environmental benefits of conservations buffers in the United States: evidence, promise and open questions. Agriculture, Ecosystems and Environment 112:249–260

Luebert F, Pliscoff P (2012) Bioclimates of the Valparaíso region, Chile. Investigaciones Geográficas (Chile) 44:41–56

Maginnis S, Rietbergen-McCracken J, Jackson W (2007) Introduction. Pages 1–4. In: Rietbergen-McCracken J, Maginnis S, Sarre A (eds) The forest landscape restoration handbook. Earthscan, London, United Kingdom

Mansourian S (2005) Overview of forest restoration strategies and terms. Pages 8-13 in. In: Mansourian S, Vallauri D, Dudley N (eds) Forest restoration in landscapes: beyond planting trees. Springer, New York

Mansourian S, Vallauri D (2014) Restoring forest landscapes: important lessons learnt. Environmental Management 53:241–251

Margules CR, Pressey RL (2000) Systematic conservation planning. Nature 405: 243–253

McCraken ME, Woodcock BA, Lobley M, Pywell RF, Saratsi E, Swetnam RD, et al. (2015) Social and ecological drivers of success in agri-environment schemes: the roles of farmers and environmental context. Journal of Applied Ecology 52:696–705

MEA (Millennium Ecosystem Assessment) (2005) Ecosystems and human well-being: synthesis. Island Press, Washington, D.C.

Myers N, Mittermeier R, Mittermeier C, da Fonseca G, Kent J (2000) Biodiversity hotspots for conservation priorities. Nature 403:853–858

Newton AC (2008) Restoration of dryland forests in Latin America: the ReForLan project. Ecological Restoration 26:10–11

Niles MT, Lubell M, Haden VR (2013) Perceptions and responses to climate policy risks among California farmers. Global Environmental Change 23: 1752–1760

Niles MT, Lubell M, Brown M (2015) How limiting factors drive agricultural adaptation to climate change. Agriculture, Ecosystems and Environment 200:178–185

Olson D, Dinerstein E (2002) The global 200: priority ecoregions for global conservation. Annals of the Missouri Botanical Garden 89:199–224

Orsi F, Geneletti D, Newton AC (2011) Towards a common set of criteria and indicators to identify forest restoration priorities: an expert panel-based approach. Ecological Indicators 11:337–347

Ovalle C, Avendaño J, Aronson J, del Pozo A (1996) Land occupation patterns and vegetation structure in the anthropogenic savannas (espinales) of Central Chile. Forest Ecology and Management 86:129–139

Schiappacasse I, Nahuelhual L, Vásquez F, Echeverría C (2012) Assessing the benefits and costs of dryland forest restoration in Central Chile. Journal of Environmental Management 97:38–45

Schulz JJ, Cayuela L, Echeverria C, Salas J, Rey Benayas JM (2010) Monitoring land cover change of the dryland forest landscape of Central Chile (1975–2008). Applied Geography 30:436–447

Smith-Ramírez C, González ME, Echeverría C, Lara A (2015) Estado actual de la restauración ecológica en Chile, perspectivas y desafíos. Anales Instituto Patagonia (Chile) 43:11–21

Smith-Ramírez C, Castillo J, Armesto JJ (2019) Willingness of rural communities to reforest with native tree species in Central Chile. Restoration Ecology 27:1401–1408

Stanghellini P, Collentine D (2008) Stakeholder discourse and water management e implementation of the participatory model CATCH in a northern Italian alpine sub-catchment. Hydrology and Earth System Sciences 12: 317–331

Thompson BA (2011) Planning for implementation: landscape-level restoration planning in an agricultural setting. Restoration Ecology 19:5–13

Urgenson LS, Ryan CM, Halpern CB, Bakker JD, Belote RT, Franklin JF, Haugo RD, Nelson CR, Waltz AEM (2017) Visions of restoration in fire-adapted forest landscapes: lessons from the collaborative forest landscape restoration program. Environmental Management 59:338–353

Uribe D, Geneletti D, del Castillo RF, Orsi F (2014) Integrating stakeholder preferences and GIS-based multicriteria analysis to identify forest landscape restoration priorities. Sustainability 6:935–951

Veluk F, De Camino R, Imbach A (2012) Mapeo de áreas prioritarias para la restauración del paisaje forestal y mejora de los medios de vida de comunidades rurales en el altiplano de San Marcos, Guatemala. Bois et forêts des tropiques 313:73–83

Supporting Information

The following information may be found in the online version of this article:

Table S1. Format of the semi-structured interview conducted in the study.
Table S2. MANOVA results for variables of stakeholder group and use level of native forest according to the criteria for prioritizing areas to be restored.

Coordinating Editor: Esther Turnhout

Received: 21 August, 2019; First decision: 10 November, 2019; Revised: 17 September, 2020; Accepted: 22 September, 2020