



RESEARCH ARTICLE

Forested habitat preferences by Chilean citizens: Implications for biodiversity conservation in *Pinus radiata* plantations

Preferencia por hábitats forestales por ciudadanos chilenos: Implicancias para la conservación de biodiversidad en plantaciones de *Pinus radiata*

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ABSTRACT

The need for conservation outside protected areas has prompted the modification of productive practices to allow the maintenance of wild biota in productive landscapes such as those associated to timber production. Forest plantations could cooperate in conserving biodiversity outside protected areas if they have a developed understory. However, the success of the production changes depends on the social support they receive. Therefore, we evaluate Chilean citizens' preference for five habitats of different types of forest management. In addition, we assessed perceptions regarding the relationship between pine plantations and native wildlife through surveys administered in Chillán, Santiago and six rural localities in the VII and VIII region. Despite there is not a unanimous opinion regarding pine plantations as a threat to biodiversity, people prefer pine plantations that serve as habitat for endangered fauna. In fact, they agree on paying more for forest products to contribute to conservation in forest plantations, and actually prefer plantations with a developed understory better than those without it. This would suggest that measures aimed at conservation in forest plantations could be supported by the Chilean society.

Key words: Chile, habitat evaluation, pine plantations, understory.

RESUMEN

La necesidad de la conservación fuera de áreas protegidas ha llevado a la modificación de las prácticas productivas para permitir el mantenimiento de la biota silvestre en paisajes productivos tales como los asociados a la producción de madera. Las plantaciones forestales podrían cooperar en la conservación de la biodiversidad fuera de áreas protegidas si tienen un sotobosque desarrollado. Sin embargo, el éxito de los cambios en la producción depende del apoyo social que estos reciben. Así, evaluamos la preferencia por cinco paisajes con diferentes tipos de manejo forestal. Además, se evaluó la percepción acerca de la relación entre las plantaciones de pino y la fauna nativa a través de encuestas realizadas en Chillán, Santiago y seis localidades rurales de la VII y VIII Región. Pese a no haber una opinión pública unánime respecto a considerar las plantaciones de pino como una amenaza a la biodiversidad, las personas en general prefieren las plantaciones de pino que sirven de hábitat para la fauna en peligro de extinción. De hecho, están de acuerdo en pagar más por productos forestales que contribuyan a la conservación en plantaciones forestales, prefiriendo especialmente plantaciones forestales con un sotobosque desarrollado. Estos resultados sugieren que las medidas destinadas a la conservación en las plantaciones forestales podrían ser apoyadas por la sociedad chilena.

Palabras clave: Chile, evaluación de hábitat, plantaciones de pino, sotobosque.

INTRODUCTION

The increasing demand for wood products has triggered an increase in the area intended for forest plantations worldwide, which rose by 29.6 % since the early '90s, reaching a total of 271 million hectares by 2006 and continues to rise. Further, World's industrial wood production

coming from planted forest is expected to increase by 50 % by the year 2030 (FAO 2009). Forestry plantations generate considerable controversy regarding their environmental impacts, such as native forest replacement and associated biodiversity loss, decline and degradation of other natural resources like water courses, all changes regarded as negative

externalities (e.g., Potton 1994, Heaton 2006, Brockerhoff et al. 2008). However, while the majority of forest plantations are less favorable than native forests as habitats for different taxa, in some cases diversity and abundance of native species in forest plantations can be as diverse as in natural systems (Carnus et al. 2006, Brockerhoff et al. 2008, Nájera & Simonetti 2010, Ramírez & Simonetti 2011).

Current evidence suggests that richness and abundance of some taxa are higher in structurally complex plantations. That is, plantations with a well developed understory could hold a greater number of species than those with simpler structures (Brockerhoff et al. 2008, Nájera & Simonetti 2010). If adopted as an operational practice, stands with well developed undergrowth might minimize or mitigate biodiversity loss brought about by forestry activities. To foster such an adoption, forestry plantations with dense understory vegetation ought to be accepted by people, which usually have negative opinions and attitudes toward intensively managed plantations (e.g., Williams 2009). Therefore, it is necessary to address public perception towards forested habitats, including the role of understory in their preferences (Ribe 1989), perceptions which may vary according to personal characteristics such as age, gender, study level, and residence among others (Bernáldez 1985).

If forest plantations could play a role in the maintenance of native species in landscapes bound to produce consumer goods, this could represent an opportunity for biodiversity conservation outside protected areas, at least for a suite of species (Brockerhoff et al. 2008). However, environmentally friendly practices could involve increased operating costs for forestry companies and consequently, more expensive products for consumers (Vlosky et al. 1999). Therefore, the adoption of conservation practices, such as the ones that favor the presence of biodiversity in plantations, would heavily depend on social support (Kellert 1985).

Forest plantations in Chile are a case in point. Currently 2.3 million hectares (3 % of the continental surface) are used for forests plantations, 64 % of which is exotic *Pinus* (INFOR 2011). These plantations are criticized due to its environmental and social impacts. (e.g., Lara & Veblen 1993, Clapp 2001,

Montalba et al. 2005). Further, plantations are the worst evaluated landscape by different social groups in Chile (Muñoz-Pedreros et al. 2000). On the other hand, plantations with well developed understory support several native species, including some endangered ones like *Leopardus guigna* (Molina, 1782) (Simonetti 2006). However, in order to promote more environmentally-friendly practices, structurally complex plantations ought to be adopted by forest companies. Generally, these companies focus their forest management plans on economical and biological issues (like endangered species), without considering social aspects (Wyatt et al. 2011). However, social support will be relevant, accepting the wildlife-friendly habitat and being willing to pay for eventual increased prices in forest products in case the allowing understory growth is a managerial practices implying additional operating costs or reduced productivity.

Within this framework, we will analyze whether Chilean people have different preferences for pine plantations with and without understory cover. If people prefer plantations with a developed understory better than those without it, this could result in supporting, directly or indirectly, pine plantations as habitat for endangered native species. Because people attach different values to the preservation of endangered species (Kellert 1985, Shindler et al. 2002), it is important to address the specific public opinion towards the conservation of species such as *L. guigna*, regarded as a poultry depredator which could skew the opinion of individuals regarding its conservation needs and efforts.

Perceptions may vary depending on people's gender, age, locality where they live, and education level or activity (Bernáldez 1985). People who live closer to forest plantations should have a more negative perception towards plantations than those who live distant and therefore are not directly in contact with plantation's negative consequences. Concerning people's activities, forest workers (who's earning depend on plantation forestry) should weigh externalities less negatively than urbanites, and therefore should be less likely to pay for more expensive forest products. In this context, this study assesses preferences for diverse habitats, including different types of exotic plantations management, and identifies

the implications of these perceptions on the possibility of conserving native biodiversity in forest plantations. If such activity is supported, forest companies would have an opportunity to change their management not only into a more environmentally-friendly one, but also into a management that results in habitat types that consumers prefer and for which they are willing to pay for.

METHODS

Study areas

Study areas are located in the VII, VIII and Metropolitan regions (Chile), and comprise two urban areas: Santiago and Chillán, and six rural communities: Canelillo, Chovellén, Curanipe, Pelluhue, Quirihue, and Ramadillas (Fig. 1). The study sites were chosen according to their closeness to forest plantations: far (Santiago), close

(Chillán) and immersed in a pine plantation landscape (rural localities).

Survey

Standardized surveys were used to determine social preferences for different habitats and citizens' opinion concerning the interaction between pine plantations and biodiversity. Questionnaires are suitable tools to unravel public perceptions in ecological management (White et al. 2005), and have been successfully used to assess perceptions and attitudes toward the biota in Chile (e.g., Muñoz-Pedrerros et al. 2000, De la Fuente et al. 2004 as examples of other survey-based studies).

Surveys were personally conducted under informed consent for both men and women over 18 years old to determine social preferences for different habitats and their opinion concerning the interaction between pine plantations and biodiversity. The survey comprised three parts. The first one allowed the collection of four social variables: gender, age, locality, and education level/activity of the person interviewed. Activity was sorted into six categories: student, forest

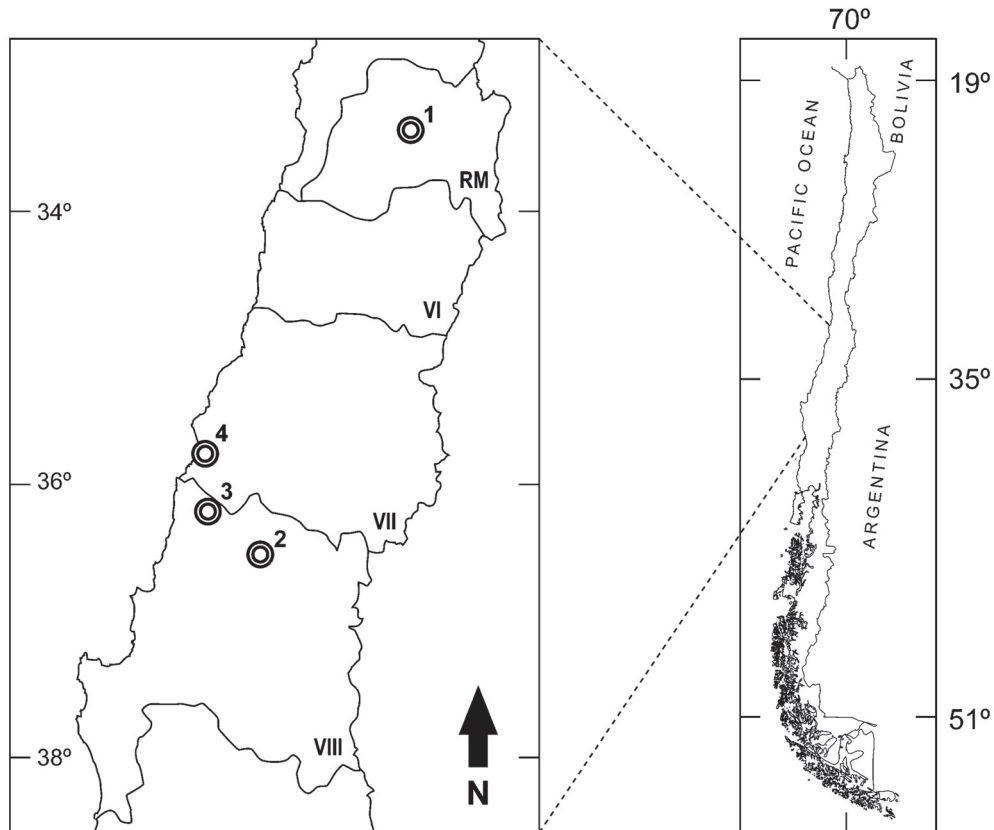


Fig. 1: Map of the study areas showing: 1. Santiago, 2. Chillán, 3. Quirihue, 4. Canelillo, Chovellén, Curanipe, Pelluhue and Ramadillas. RM stands for Región Metropolitana (Metropolitan region), and Roman numbers stand for the number of Chilean administrative regions.

Mapa del área de estudio. Los números corresponden a las localidades: 1. Santiago, 2. Chillán, 3. Quirihue, 4. Canelillo, Chovellén, Curanipe, Pelluhue y Ramadillas. RM indica región metropolitana; los números romanos corresponden a la región administrativa.

worker, tradesman, technician, professional and other activities/education level. The second part assessed the social valuation of forest habitats through a set of five unlabeled photographs corresponding to different types of habitats that were sorted by the respondents from highest to lowest preference, pointing out which elements induced that order (Fig. 2). Photographs were presented simultaneously and arranged randomly. Respondents were also asked to offer their impressions on their first and last preference. The photographs considered two types of pine plantation management: with and without understory, and three other Chilean habitats: Maulino forest and sclerophyllous scrub representing native habitats, belonging to the VII and Metropolitan regions respectively, and a grassland, typical anthropogenic landscape found mainly in southern Chile, used for cattle raising. Photographs adequately represent environmental conditions for landscape quality assessments and environmental perception research. Assessments of habitat beauty, quality or other aspect based on photographs positively correlates with onsite evaluations of the same habitats. Hence, evaluations of photographs depicting valid representations of the habitat under scrutiny area can

hence be used for assessing habitat preferences (e.g., Stamps 1990; see Muñoz-Pedrerros et al. 2000 and De la Fuente et al. 2004 as examples of photograph-based assessment of landscape preferences in Chile).

Finally, the survey evaluated the respondent's assessment regarding the relationship between pine plantations and biodiversity through four statements concerning: (1) impacts on biodiversity caused by pine plantations; (2) preference for pine plantations that sustain biodiversity; (3) preference for pine plantations which contribute to the guña (*L. guigna*) conservation; and (4) willingness to pay more for forest products coming from sustainably managed forest plantations. A five points Likert scale was used (1 = strongly disagree; 2 = disagree; 3 = neutral; 4 = agree; and 5 = strongly agree), allowing a statistical analysis between social groups. Responses were analyzed according to (a) gender (female, male), (b) age (grouped as 18-29, 30-39, 40-49, 50-59 and, 60+ years old), (c) locality (Santiago, Chillán, rural localities), and (d) education level/activity (student, tradesman, forest worker, technicians, professionals, other activities). To assess if these variables influence habitat preferences, mean scores were tested through Mann-Whitney or Kruskal-Wallis

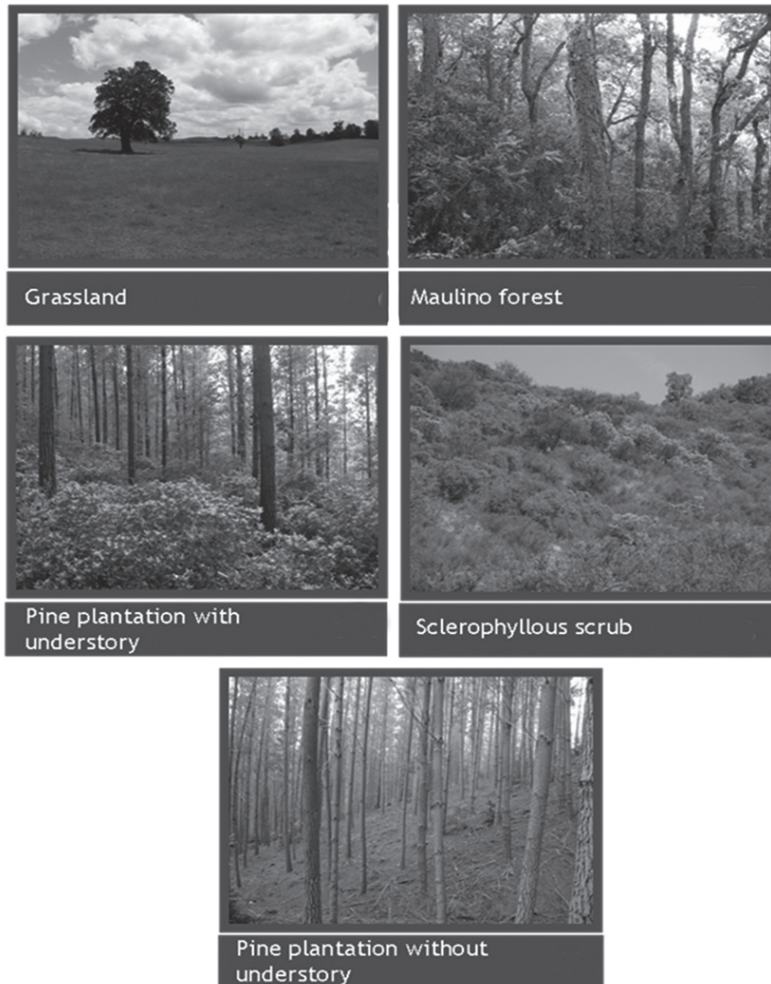


Fig. 2: Photographs of different habitats utilized in surveys of preferences.

Fotografías de diferentes hábitats empleadas para determinar preferencias.

tests as appropriate. The survey is available online as Supplementary Material.

RESULTS

A total of 553 people responded the survey, with an equal gender distribution: 46 % female, 54 % male ($P = 0.06$) and an average age of 35 years. Regarding location, 72 % of interviewees live in urban settings (41 % of the respondents live in Santiago, 31 % in Chillán) and the remaining 28 % in rural localities, approaching the urban/rural ratio in the studied areas (INE 2003). Students represented 21 % of the respondents, forest workers 15 %, people associated to commercial activities 13 %, technicians 9 %, professionals 8 %, and other activities/education level 34 % of the sample.

Habitat preference

Habitats are differently preferred by people (Kruskal-Wallis test; $H = 1000.3$; $P < 0.001$). Grasslands are the most preferred one (Dunn-Sidák posteriori test; $Q > 8.7$; $P < 0.05$), considering them as “naturals”, followed indistinctly by pine plantations with understory and Maulino forest (Dunn-Sidák posteriori test; $Q = 0.347$; $P > 0.05$). Thirdly in preferences is the sclerophyllous scrub (Dunn-Sidák posteriori test; $Q > 9.5$; $P < 0.05$). Pine plantations without understory was the least preferred habitat type (Dunn-Sidák posteriori test; $Q > 9.5$; $P < 0.05$; Fig. 3).

Comparing only the two types of pine plantation, 90 % of respondents preferred the pine plantation with understory better than the pine plantation without understory ($T = 10711$; $P < 0.001$), arguing that they liked the “vegetation and green color” of pine plantations with understory rather than the “sad and dry appearance” of pine plantations without understory.

Urban citizens, especially from Chillán ($T = 5527.5$; $P = 0.91$), generally exhibit a similar preference for Maulino forest and pine plantation with understory, unlike forest workers who prefer the Maulino forest and recognizes it as native in opposition as pine plantations who explicitly mention as exotic ($T = 1254.5$; $P = 0.03$), stressing out pine plantations with understory to be an exotic plantation and Maulino forest to

correspond to native vegetation, just as they identify sclerophyllous scrubland native as well. In addition, forest workers identify pine plantations without understory to be their working habitat type, and prefer pine plantations with understory despite recognizing that this configuration might involve harder working conditions for them. Professionals on the other hand, do not prefer the Maulino forest over pine plantations ($T = 0.67$; $P = 0.50$). However, they do recognize pines as an exotic species like forest workers do.

Forest plantations and biodiversity conservation

Overall, respondents hold a neutral opinion concerning whether pine plantations threaten biodiversity. However, professionals and forest workers agree with the statement that pine plantations threaten native biota (Kruskal-Wallis test; $H = 19.9$; $P = 0.001$; Dunn-Sidák posteriori test; $Q = 0.894$; $P > 0.05$). The region where respondent live also has an effect on their opinion regarding this statement (Kruskal-

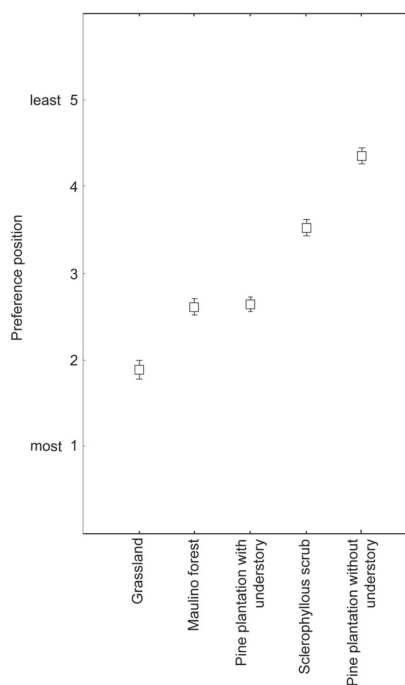


Fig. 3: Respondents' preference for different types of habitats. Squares are mean habitat's preference position \pm 0.95 confidence interval.

Preferencias de encuestados por diferentes tipos de hábitats. Los cuadrados representan el promedio de la preferencia por los hábitats con un intervalo de confianza de 0.95.

Wallis test; $H = 8.7$; $P = 0.01$). People from Santiago do not consider pine plantations to threaten biodiversity (Dunn-Sidak posteriori test; $Q > 2.1$; $P < 0.05$), unlike respondents from Chillán and rural areas who have a neutral position to this statement (Dunn-Sidak posteriori test; $Q = 0.381$; $P > 0.05$). The same neutral position is found among women, while men do consider pine plantations as a threat to biodiversity (Mann-Whitney U test; $U = 34107$; $P = 0.030$).

Eighty-two percent of respondents prefer pine plantations that are habitat for biodiversity, without significant difference related to gender, age, locality education or activity ($P = 0.1$ in all cases). They also prefer pine plantations that contribute to conserve *L. guigna* (85 %), especially young people (Kruskal-Wallis test; $H = 44.3$; $P < 0.001$; Dunn-Sidak posteriori test; $Q > 3.8$; $P < 0.05$). However, respondents living in rural areas where the *L. guigna* inhabits (e.g., Canelillo and Ramadillas), show a negative perception towards this carnivore, associated to poultry depredation. This group manifested no interest in the conservation role that pine plantations may play in *L. guigna*'s population.

Independent of age, gender, locality, and education level or activity, 87 % of people agree on paying more for forest products that come from plantations that help biodiversity, opinion which is even stronger in Santiago (89 %).

DISCUSSION

The study of the relationships between society and productive landscapes on the basis of environmental perception and biodiversity conservation is still a new and largely unexplored field of study in Chile. Since new management practices (such as forest practices that favor the development of understory in pine plantations) require social support in order to be successful (Kellert 1985, Shindler et al. 2002), it is important to address public perception towards the new forest practice's habitat type and their environmental consequences, as the one advanced to enhance the role of forestry plantations in biodiversity conservation (Simonetti 2006).

The interaction between subjective aspects as sentiments, culture, aesthetics, and also some evolutionary conceptions, play a

significant role in the construction of people's habitats perception (Orians 2001). Other personal and non subjective characteristics, such as the ones addressed in this study, gender, age, locality, and education level or activity may also contribute defining preferences. These, in fact, impinge upon respondent perceptions toward different habitat types, particularly plantations.

Grassland preferences differ with attitudes in countries like New Zealand, where grasslands are aesthetically equally poorly evaluated than forest plantations, and less preferred than native forests (Potton 1994). This might be due to the old Chilean history of native deforestation and replacement for grasslands bound to livestock, a history old enough to make Chilean people consider grasslands as a non intervened habitat (Miller 1987, Paredes 2005).

The distance at which people live from forest plantations only partially modulates their perception towards pine plantations, regardless whether they come from rural or urban localities. While people living closer to pine plantations have a neutral opinion regarding plantations as a threat to biodiversity, people in Santiago, far from plantations, disagree with the statement that plantations are a menace.

Perception studies in Santiago have addressed that people prefer little disturbed forest landscapes, valuing in general the presence of vegetation, but also of open spaces, not distinguishing or giving great significance to whether species are native or have been introduced (Fuentes et al. 1984, De la Fuente & Mühlhauser 2006).

This preference pattern would not only be valid for respondents from Santiago, but also for respondents from Chillán and other rural locations in Chile, where people in general do not distinguish between native and exotic species. Notwithstanding, there are two activity groups of respondents who did recognize the difference between native forests and exotic pine plantations: professionals and forest workers. People that prefer natural environments and scenic beauty are usually the most educated ones (Peterson & Neumann 1969). By our results, this "educational level" may come by studying in a university, just as professionals do, but also by the continuous experience with nature to which forest

workers are exposed to. Living closer to pine plantations, forest workers are more exposed to the changes upon habitats and landscapes that forest activity implies, which probably accounts for their agreement with the assertion that pine plantations threaten biodiversity.

The public preference for pine plantations with understory is economically supported by respondents, as people manifest their willingness to pay a premium price for forest products that come from plantations that minimize externalities, despite many respondents do not recognize pine plantations as harming biodiversity. However, caution is needed when interpreting this result, because of the negative relationship between the price premium and consumer willingness to pay for environmentally friendly products: the higher the price premium is, the lowest consumers' willingness to pay (Vlosky et al. 1999). Without an estimation of price premiums for at least the most common forest products, it is difficult for respondents to evaluate whether they would actually be willing to pay for the price difference, especially considering that the "a little bit more" statement is not objective, but depends on the economic level of the interviewee. Further, the fact that forest companies impacts on the environment are Chilean's consumers second priority when making purchase decisions (Correa 2007) reinforces Chilean forest companies' awareness of the trends of international forestry caused by their exposure to international markets, which has triggered the adoption of sustainable forest management certifications by forestry companies in Chile. These voluntary management improvements have not caused any price premiums in the markets (Paredes 2005). Among respondents, forest workers recognized and valued native vegetation but also understand the importance of environmentally certified products that will assure them long-term work.

The positive influence caused by vegetation on people's perception (De la Fuente & Mühlhauser 2006) explains why people like complex pine plantations with understory better than those without it. Additionally and only considering both types of planted forest management (with and without understory), the most visually attractive habitat for

interviewees is also the one that depicting less human impact (Daniel & Vinning 1983).

On the other hand, the preference for complex pine plantations and the associated willingness to pay more for costs associated to this type of management, suggests that the adoption of actions for conservation in forest plantations could be supported by Chileans. If forest products' consumers continue to consider environmental issues in their top priorities when making purchase decisions, forest companies should make an effort to change their actual management practices into a more sustainable one.

The preference for structurally complex pine plantations might enhance the availability of this surrogate habitat for *L. guigna*. Like in other bird and mammal species, forestry plantations with well developed understory vegetation support higher numbers of species and individuals than plantations devoid of understory, including threatened ones like *L. guigna* (Nájera & Simonetti 2010, Ramírez & Simonetti 2011). Hence, plantations with understory vegetation might contribute to biodiversity conservation, providing surrogate habitats (Simonetti 2006). However, the willingness to support plantations as habitat might be locality-dependent. While urban citizens do support them, rural people disagree as *L. guigna* are perceived as poultry predator (Simonetti 2006). A paradox emerges then, as the enhancement of plantations as habitat for native biota might increase the likelihood of conflicts between rural citizens and endangered species deemed problematic as *L. guigna* (Márquez 2011).

Forestry companies that improve their practices into a more environmentally friendly management will not only fulfill current industry demands, but also one of the main consumers' concerns when making purchase decisions. If these management practices include maintaining a well developed understory that favor species conservation, people would support this habitat, and might be willing to pay for possible additional costs associated to changes in management practices. These may lead to achieving some sustainable forest managed demands: conservation of biodiversity, maintenance of economic productivity and responsibility for social needs. If the behavior depicted by the respondents is also expressed

by Chileans for other plantation types or people elsewhere, there would be strong support for modifying plantation structure in favor of biodiversity conservation while maintaining the provision of forestry goods.

SUPPLEMENTARY MATERIAL

The survey applied in this research is available online as Supplementary Material at http://rchn.biologiachile.cl/pdfs/2012/2/SM_Puschel-Hoeneisen_and_Simonetti_2012.pdf

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