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Potential for greenery from degraded temperate forests to increase income of indigenous women in Chile

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Abstract There has been much emphasis placed on the economic contribution that non-timber forest products (NTFP) can make to rural livelihoods of people living in or near forests. In this study we focus on the benefits of greenery obtained from two tree species, romerillo (*Lomatia ferruginea* (Cav.) R. Br.) and avellano (*Gevuina avellana* Mol.), collected by indigenous women in southern Chile. Trees producing commercial-quality leaves grew in secondary forests dominated by species usually abundant in ecological formations that follow forest degradation. Natural availability of greenery was relatively low (658 and 38 commercial leaves per hectare for romerillo and avellano, respectively) which added to restrictive market conditions resulted in modest financial returns and a contribution to household income of less than 1%. Our results confirm that trade on NTFP does not always lead to significant income generation. Yet, the information provided, represents a basis to explore management alternatives, such as agroforestry schemes, which can potentially expand greenery yield and economic returns.

Keywords Non-timber forest products · Greenery · Female collectors · Rural livelihoods · Temperate rainforests

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Introduction

Wickens (1991) states that non-timber forest products (NTFP) correspond to "all biological material, other than industrial round wood and derived sawn timber, wood chips, wood-based panel and pulp, that may be extracted from natural ecosystems or managed plantations that can be used within the household, marketed, or have social, cultural or religious significance". Chamberlain et al. (1998) propose that NTFP are "plants, parts of plants, fungi, and other biological material that are harvested from within and on the edges of natural, manipulated or disturbed forests". These definitions suggest that the collection of NTFP occurs across a wide variety of bio-geographical, ecological, economic, social, and historical conditions across territories and vegetation types. Policies, therefore, should be implemented focusing on local circumstances (Chamberlain et al. 2004).

Non-timber forest products have been considered to provide a "green social security" for billions of people (Chamberlain et al. 2004) and a "safety net" for rural dwellers around the world in the form of building materials, income, fuel, food, and medicines (Shackleton and Shackleton 2004). They usually symbolize the goals of conservation, development and production activities. Yet, their economic importance in rural livelihoods has been sharply argued in the literature with some evidence suggesting that their financial contribution has been overstated (Wunder 2001).

Among the wide range of NTFP, floral greenery includes the group of plant structures such as branches, leaves, and fronds used as floral decoration. Floral greenery is harvested and sold around the world and although some species are grown agriculturally, most species used in the floral greenery industry are harvested from the wild (Cocksedge and Titus 2006).

In Chile, of 330 NTFP currently identified, floral greenery is considered the second most important after medicinal products in terms of abundance, with 98 different products (Valdevenito et al. 2002). These products come almost exclusively from the temperate rainforest of the Valdivian Rainforest Ecoregion (35° S; 48° S) and are produced by a variety of trees, shrubs, vines, ferns, and mosses that may form early successional communities or be part of the understory of the forest. These products have been much less studied than their industrial (timber) counterparts. Many species are yet to be described and limited information exists beyond their geographical distribution. For example, existing information is extremely scarce regarding the status of the resource base, the potential ecological impacts of collecting practices, and sustainable harvesting areas and flows, among others. As a result, the natural resources from which these products originate are scarcely included in forest ecosystem management.

In this paper we focus on floral greenery collected by indigenous women from two tree species, romerillo (*Lomatia ferruginea* (Cav.) R. Br.) and avellano (*Gevuina avellana* Mol.), that grow mostly in patches of secondary forests in the coastal range of the Valdivian Rainforest Ecoregion. They are among the most important wild-harvested greenery bearing species of the temperate forests due to the attractiveness of their leaves (shape, size and color) for floral arrangements. At present, the range of greenery formally marketed is considerably below that formally traded. In turn, market formalization is constrained by infrastructure and it suffers from varying qualities and small supply.

The need for objective ecological and economic appraisals as the basis for NTFP management activities has been stressed by different public and private stakeholders in Chile. This research contributes to that need by focusing on three objectives: (i) to characterize the forest communities where romerillo and avellano grow; (ii) to calculate the natural availability of greenery from these species; and (iii) to estimate the economic value of greenery and its contribution to rural income. We also derive recommendations to guide improved management alternatives.

Materials and methods

This study is part of a long-term initiative started in 2001 and funded mainly by non-governmental organizations aimed at consolidating the management and commercialization of greenery products among indigenous female collectors in the coastal range of southern Chile. The ultimate aim of this initiative is to jointly address forest conservation and poverty alleviation using a community-based resource management approach. The results presented here are based on the fieldwork carried out between 2001 and 2005.

Study area and species characterization

The study took place in four neighboring indigenous districts located in the commune of San Juan de la Costa (40°22′ S; 73°50′ O), in the coastal range of the Valdivian Rainforest Ecoregion. According to the last census (2002), San Juan de la Costa has a population of 8,435 people of which 88.3% live in rural areas, over 70% have an indigenous (Mapuche-Huilliche) background, and 42.1% live in poverty conditions. It is the poorest rural commune of the country with a daily per capita income inferior to US$2.

The four selected districts are named Aleucapi (AL), Punotro (PU), Puquintrín (PQ), and Trafunco Los Bados (TR) and together they comprise 3.2% of the commune's rural population and 13.2% (20,000 ha) of the commune's total area.

The forests in this latitudinal range have been classified by the Global 200 initiative of World Wildlife Fund and the World Bank (Olson and Dinerstein 1998) among the most threatened in the world. Most of the Ecoregion is also considered as part of the world's 25 hotspots for biodiversity conservation and some of its forest types are included among the last frontier forests of the planet (World Resources Institute 2002).

The climate prevailing in the study area is temperate with a mediterranean influence. The mean annual temperature is 10.7°C, with a summer mean of 14°C and a winter mean of 5°C. Mean annual precipitation reaches 1,350 mm and concentrates between March and August (71.2%).

The dominant forest types are evergreen forests composed of a mixture of over fifteen tree species. Romerillo and avellano grow mostly in areas covered by dense and semidense second-growth forests, which typically correspond to different stages of successional forests resulting from anthropogenic disturbances such as fire and high-grading. High-grading is a type of selective cutting, where some or all of the biggest and best trees are cut. Over time this practice can give rise to forest stands containing stems of less value in terms of timber quality.

In the southern part of their distribution romerillo and avellano can establish stands in open areas where forest vegetation has been disturbed, and are important components of successional secondary communities.

Romerillo is a native evergreen tree that belongs to the family Proteaceae. The range of this species in Chile extends from 35°50′ S to 56°30′ S. It is a small-sized semi-shade intolerant tree that can reach 6–10 m in height and more than 30 cm in diameter. It has pinnate or double pinnate fern-like composite and persistent leaves, 10–20 cm long (Fig. 1), pubescent and brownish beneath, and dull green above. The leaves are used as floral decoration and also for medicinal purposes (Wilhelm de Mösbach 1999). Its fruit is a black follicle (4–5 × 1.5–1.7 cm), containing many seeds ferruginous, winged and truncated in the apex (1.5 × 0.5 mm) that are disseminated by wind.

Avellano, known as "Chilean hazelnut", is a semi-shade intolerant evergreen tree that belongs to a monospecific genus of the family Proteaceae and is restricted to the southern forests of South America.

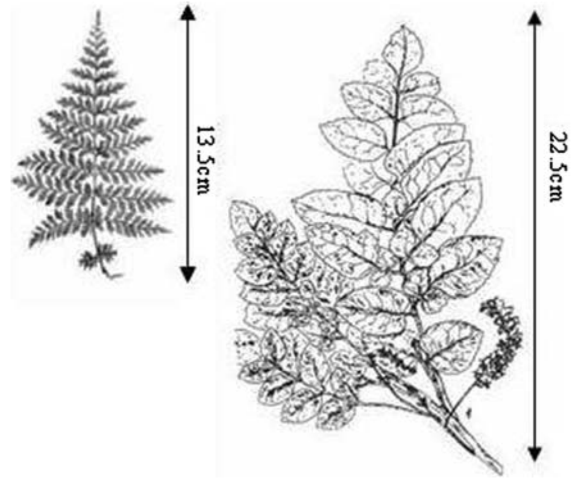

Fig. 1 Composite leaf of romerillo (left) and avellano (right)

The range of this species in Chile extends from 32°15′ S to 45° S (Donoso 2007). Avellano is a medium-sized tree, 10–12 m in height, rarely over 15 m. It has persistent leaves, bold, glossy, dark green, and coriaceous with serrated margins used primarily as floral decoration. Each leaf is compound, either simply pinnate with only 5–11 leaflets, or doubly pinnate, with as many as 95 leaflets. The overall compound leaf can measure between 10 and 35 cm (Fig. 1). Its fruit is a round nut indehiscent (1.5–2 cm of diameter) that takes 1 year in ripening and therefore shows flowers and fruits simultaneously. The fruits are disseminated by small native mammals but the species can also re-sprout from the roots. Avellano is considered a multipurpose tree given its production of greenery, nuts, and fine-quality timber.

Commercial greenery from both species is characterized by dark green leaves 20–30 cm long depending on the type of floral decoration. They need to be sufficiently lignified to resist dehydration and with no faded areas or visible insect damage. The desirable commercial features of the foliage vary depending on the environmental conditions, with forest canopy cover and light availability affecting leaf size, color, and lignification.

Vegetation survey and plot layout

An initial vegetation survey was carried out in 2001 in the four districts. During this initial stage of the

Table 1 Number of forest stands and nested plots set in each district within the study area

District[a]	Forest stands		Plots
	No	Total area (ha)	No
AL	2	21.4	100
PU	2	5.3	20
PQ	2	13.9	100
TB	3	12.8	85
Total	9	53.4	305

[a] Aleucapi (AL), Punotro (PU), Puquintrín (PQ), Trafunco Los Bados (TR)

research we relied on the knowledge of local female collectors to identify zones where commercial-quality greenery could be found. Once the zones in each district were identified, we used aerial photographs (1:20,000) to delimit nine forest stands which covered a disaggregated area of 53.4 ha (Table 1). In these stands 305 nested plots were laid out using transects oriented from north to south. The number of plots across stands varied according to the estimated tree density variability of avellano and romerillo in each stand. Within each stand, the first nested plot was randomly set and from this initial point, further plots were laid out separated 20 m along the transects and with 50 m between transects. Each plot contained three nested sampling units (SU) associated with different vegetation strata (Fig. 2). The size of each sampling unit was chosen based on studies conducted by other authors in similar forests of low altitude and shrubs (Zöhrer 1980; Halpern and Hibbs 1999).

In SU I (4 × 6 m) or tree stratum, we inventoried all tree species above 6 m of height. In SU II (2 × 4 m) or intermedium stratum, we recorded all vegetation between 2 and 6 m. In SU III (1 × 2 m) or understorey stratum, we recorded all vegetation between 1 and 2 m and tree regeneration below 1 m. In each plot, commercial leaves per tree were visually identified and manually counted.

Based on the inventory data we calculated relative density, relative frequency, and the importance value index (IVI) (Phillips 1980) for all tree species per district and sampling unit, as well as the frequency and density of avellano and romerillo and their number of commercial leaves per hectare. Frequency corresponds to the number of occasions that a tree species occurs in the total sample size (in percentage). Density is the number of individuals per unit area (hectare). Relative density is a measure of the density of one species in an area to the total number of individuals of all species within the same unit. Relative frequency measures the occurrence of a species as the ratio of the frequency of a given species to the sum of the frequency values of all species present. Importance value index is a

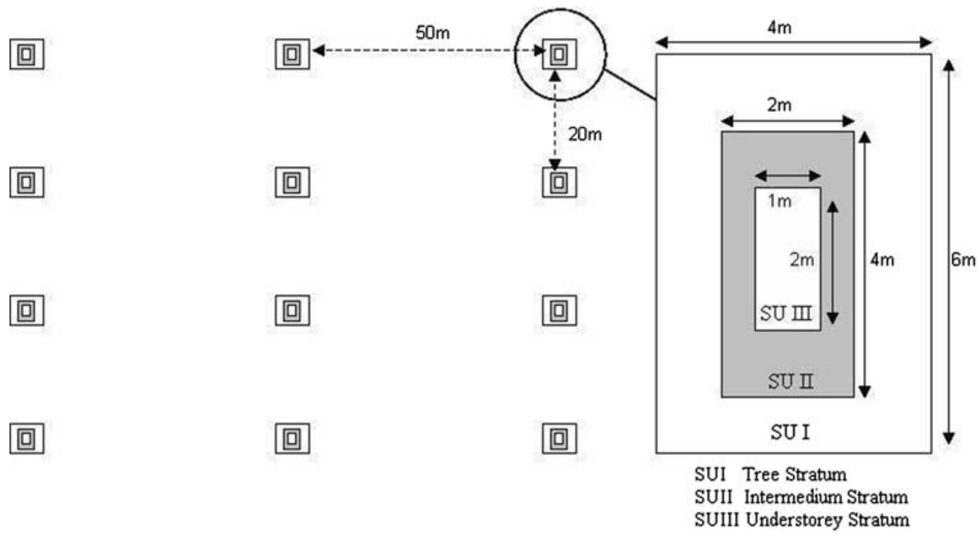

Fig. 2 Plot layout within a forest stand showing the detail of a nested plot with its three sampling units (SU)

measure of the overall importance of a given species in a community, which in this case was calculated as the sum of the relative density and the relative frequency.

Female collectors and individual interviews

In southern Chile the extraction of NTFP is strongly rooted as a tradition among indigenous people living in rural areas. They combine farming practices with fuelwood extraction and collection of different NTFP such as food, tinctures, medicinal plants, and ornamental products, which sustain a modest subsistence economy. The appreciation of the value of these products to indigenous groups is illustrated by the fact that between 78% and 95% of the local plants have known uses (Villagrán et al. 1983; Wilhelm de Mösbach 1999).

In 1999, with external funding and technical assistance from non-governmental organizations, a group of female collectors created a formal commercial association originally formed of 46 members. Since 1999, different projects have provided training on extraction techniques and organizational skills and the basic equipment and infrastructure needed for the commercialization process. We conducted closed individual interviews with the 18 members of the association that remained in 2005, to obtain information on volumes extracted and traded, collection times, and prices. At the time of the interview, female collectors were on average 44 years old (range 22–69 years) with less than 6 years of formal education in 85% of cases. The majority of them (89%) practiced subsistence farming. The average household income was US$ 677 per year (US$ 1.85 per day), obtained mainly from the sale of livestock, firewood, and charcoal. The average farm size was 52 ha (range 5.5–201 ha) and in all cases they had tenure. Of this owned area, 48% was second-growth forests, 44% was native shrub, 4% was natural pasture, 3% was *Eucalyptus* spp. plantation, and 1% was crops.

Estimation of economic returns

We calculated two financial estimators: net financial return per collector (NFR_c) based on the average volumes traded and prices paid to the collectors in 2005, and net present value per hectare (NPV_{ha}) based on the sustained flow of greenery that can be obtained from a hectare of forest in the study area valued at market prices. The annual NFR_c was calculated as:

$$NFR_c = GFR - DC \quad (1)$$

where GFR is the annual gross financial return calculated as the volume of greenery sold by each collector multiplied by the price paid by a first intermediary, and DC are the direct labor costs corresponding to the value of time spent in finding, extracting, and carrying greenery to the closest road. The time spent in these activities was reported by each woman in the individual interview and corroborated by field observation. To value this time we used the daily 8-h wage that a woman would obtain working as a housekeeper in nearby towns, which corresponded to US$ 8.2 per day. Due to their socioeconomic conditions, especially their low education level, these women have limited employment alternatives. Furthermore, few jobs are available in the districts. For these reasons, the opportunity cost was assumed to be the same for all female collectors and equal to the forgone income from working as a housekeeper.

The net present value per hectare (NPV_{ha}) was calculated as:

$$NPV_{ha} = NFR_{ha}/[1 - \exp(-tr)] \quad (2)$$

where NFR_{ha} is the net financial return per hectare calculated as the difference between the gross return and the direct cost of extracting a sustained flow of commercial leaves per hectare and assuming that this flow remains constant over time; t is the number of years between harvests; since greenery products can be annually extracted, t equals 1 and the flow of revenues is treated as an annuity (Paoli et al. 2001); r is the annual discount rate, which we set at 5%. This rate is lower than the average market rate that prevailed in Chile during the study period (8%) and the social discount rate used by Chilean government agencies (12%). Its selection is justified on the basis that benefits from greenery extraction accrue at perpetuity as reflected in Eq. 2. The higher the discount rate the lesser the market value that is attached today to yields in the future. Hence, if NTFP extraction takes place in the long run, a high discount rate will favor near-term revenues compared to benefits that accrue in the future (Pearce and Pearce 2001). The concept of discount rate is essential to economic analysis. Yet, the most critical single problem with discounting future benefits and costs is that no consensus exists about what rate of interest should be used.

Results and discussion

Floristic composition and structural attributes of forest communities

A total of 77 species were identified, from 50 families of which over 90% were native species. Of the 77 species found, 30% were trees, 23% shrubs, 25% herbs, 12% vines, and 10% ferns and mosses; 33 of them produced at least one type of NTFP (i.e. fruits, tinctures, natural oils, crafting material, honey, and medicinal products), and nine supplied greenery (Appendix 1). Most of these products did not have a commercial use at the time.

The spectrum of species identified, reflected the general floristic richness of the study area typically found in the evergreen forests of the Chilean coastal range. The forests in the study area were dominated by luma (*Amomyrtus luma* Legr. et Kaus.) and canelo (*Drimys winteri* J.R. et G. Forster) in most districts and strata (Table 2). These tree species are usually abundant in ecological formations that result from degradation of native forest, especially following fire (Donoso et al. 1999).

In the tree stratum (SU I), luma and canelo were present in most districts. Romerillo was found in all districts among the four most important species, whereas avellano appeared in only three districts and its IVI was commonly lower than that of romerillo. An unusual situation occurred in Punotro (PU) where greenery was collected from stands dominated by *Eucalyptus* spp. trees in the upper strata. Monoculture plantations of this species have been promoted in the districts by governmental agencies with the purpose of recovering degraded areas and obtaining forest products (firewood and timber) thus reducing the pressure on the native forest. Some native trees, such as romerillo, can regenerate underneath eucalyptus trees originating mixed stands where this species dominates the tree stratum whereas luma and chaura (*Pernettya mucronata* (L.f.) Gaud ex Spreng) dominate the lower strata.

In the intermedium stratum (SU II), luma was the species with the highest IVI across all districts. Romerillo was also present in all districts whereas avellano appeared only in AL and PQ with a low importance value.

In the understorey stratum (SU III), vegetation exhibited a large variety of shrub species which represented the dominant cover. The most important species were luma, chaura and romerillo, while avellano was absent from this stratum in all districts. The low participation of avellano in the understorey could be attributed to low seed availability and adverse regeneration conditions for this species, specifically due to restricted light. The regeneration rate of avellano equaled 230 individuals per hectare compared to 62,205 individuals of romerillo. The low importance value of avellano, added to its restricted regeneration capacity under the current forest structure, represents a major limitation for continuous greenery collection from this species in the study area.

Natural availability and extraction of greenery

As shown in Table 3, romerillo exhibited a substantially higher frequency and density per hectare compared to avellano, which is consistent with the results reported in Table 2. Twenty-seven percent of romerillo trees had leaves of commercial value and 32% of the avellano trees on a per hectare basis. The trees producing commercial-quality leaves were primarily those at juvenile stage (SU II and SU III) with heights varying between 0.2 and 4 m and 0.2 and 6 m, respectively. As pointed out by female collectors, trees that reach higher strata cease to produce market-quality leaves and their height precludes extraction.

Both species produced an average of two commercial leaves per individual, varying from 1 to 12 leaves in romerillo and from 1 to 5 leaves in avellano. This low number of commercial leaves per tree is to be expected since commercial-quality greenery is mainly produced by young individuals. The resulting flow of commercial greenery per hectare equaled 658 leaves of romerillo and 38 leaves of avellano.

The main attributes identified by the collectors were size, symmetry, color, and hardness, which depend mainly on the amount of light that penetrates the lower strata of the forest where the greenery-bearing trees grow as well as on the soil conditions.

Table 2 Relative density (RD), relative frequency (RF), and importance value index (IVI) of the main species identified per district and sampling unit (SU)

District[a]	SU I tree stratum				SU II intermedium stratum				SU III understorey stratum			
	Species	RD	RF	IVI	Species	RD	RF	IVI	Species	RD	RF	IVI
AL	*Eucryphia cordifolia*	26.6	24.5	51.1	*Amomyrtus luma*	25.6	15.0	40.6	*Lomatia ferruginea*	16.7	11.1	27.8
	Amomyrtus luma	22.0	16.7	38.7	*Lomatia ferruginea*	15.5	12.1	27.6	*Amomyrtus luma*	11.1	11.1	22.2
	Lomatia ferruginea	19.8	20.6	40.4	*Aextoxicon punctatum*	6.9	7.5	14.4	*Lophosoria quadripinnata*	11.1	11.1	22.2
	Gevuina avellana	9.0	8.8	17.8	*Gevuina avellana*	0.0	2.6	2.6	*Gevuina avellana*	0.0	0.0	0.0
	Others	22.6	29.4	52.0	Others	52.1	62.8	114.9	Others	61.1	66.7	127.8
PU	*Eucalyptus* spp.[b]	57.1	28.6	85.7	*Lomatia ferruginea*	40.0	26.5	66.0	*Pernettya mucronata*	22.7	24.0	46.7
	Drimys winteri	23.8	28.6	52.4	*Pernettya mucronata*	9.1	11.8	20.9	*Amomyrtus luma*	18.2	24.0	42.2
	Lomatia ferruginea	9.5	14.3	23.8	*Lomatia ferruginea*	7.3	5.9	13.2	*Lophosoria quadripinnata*	13.6	12.0	25.6
	Gevuina avellana	0.0	0.0	0.0	*Gevuina avellana*	0.0	0.0	0.0	*Luma apiculata*	13.6	12.0	25.6
	Others	9.6	28.5	38.1	Others	43.6	55.8	99.4	Others	31.9	28.0	59.9
PQ	*Amomyrtus luma*	41.7	28.8	70.5	*Amomyrtus luma*	51.2	31.0	82.2	*Amomyrtus luma*	45.5	61.3	106.8
	Drimys winteri	29.1	25.4	54.5	*Lomatia ferruginea*	9.9	10.0	19.9	*Lomatia ferruginea*	13.6	13.3	26.9
	Lomatia ferruginea	9.1	9.3	18.4	*Lophosoria quadripinnata*	8.0	10.0	18.0	*Lophosoria quadripinnata*	6.8	4.0	12.8
	Gevuina avellana	1.9	3.4	5.3	*Gevuina avellana*	0.5	1.3	1.8	*Chusquea quila*	6.8	4.0	12.8
	Others	18.2	33.1	51.3	Others	30.4	47.7	78.1	Others	27.3	17.4	44.7
TR	*Drimys winteri*	48.3	33.0	81.3	*Amomyrtus luma*	40.8	32.2	73.0	*Amomyrtus luma*	35.7	37.1	72.8
	Amomyrtus luma	18.5	19.4	37.9	*Lophosoria quadripinnata*	16.7	13.5	30.2	*Lophosoria quadripinnata*	14.3	11.4	25.7
	Gevuina avellana	1.7	2.9	4.6	*Lomatia ferruginea*	4.5	5.3	9.8	*Amomyrtus meli*	14.3	22.9	37.2
	Lomatia ferruginea	1.3	2.9	4.2	*Gevuina avellana*	0.0	0.0	0.0	*Lomatia ferruginea*	3.6	2.9	6.5
	Others	30.2	41.8	72.0	Others	38.0	49.0	87.0	Others	32.1	25.7	57.8

[a] Aleucapi (AL), Punotro (PU), Puquintrín (PQ), Trafunco Los Bados (TR)

[b] Young *Eucalyptus* spp. plantations

Table 3 Frequency, density, and commercial density of romerillo and avellano in each district

District[a]	Romerillo trees			Avellano trees		
	Frequency (%)	Density (No ha^{-1})	Commercial density[b] (No ha^{-1})	Frequency (%)	Density (No)	Commercial density[b] (No ha^{-1})
AL	59	1580	596	9	67	46
PU	15	84	21	0	0	0
PQ	55	1093	167	6	38	17
TR	45	1159	275	9	93	73
Weighted average[c]	51	1205	329	8	60	19

[a] Aleucapi (AL), Punotro (PU), Puquintrín (PQ), Trafunco Los Bados (TR)

[b] Number of trees with commercial leaves per hectare

[c] Calculated considering the number of plots laid out in each district compared to the total number of plots (305)

The collectors asserted that the best commercial leaves were those that grew protected by the canopy of the tree stratum.

Greenery was gathered individually using the home as a base (i.e. a woman took round trips during the day). They collected greenery mainly from their own farms although some of them also entered authorized neighboring areas. Within each farm there were no areas specially delimited for greenery collection as forest and shrubland continue to be used for livestock.

Greenery was gathered using a strict extraction protocol where a prime consideration was the availability of commercial leaves per tree. For both species the extraction rate of commercial leaves was 3:1 (i.e. only one out of three commercial leaves was collected), which according to the collectors secured the adequate growth of new plant structures and a continuous flow of greenery, without noticeable harm to the trees. In calculating NPV_{ha} we considered this level of extraction as a sustained flow of greenery.

Sustained-yield harvest should not be confused with ecological sustainability. Evaluating the latter requires long-term and multi-scale monitoring to determine relevant aspects such as tree regeneration patterns, effect of foliage extraction on the trees, and the period of the life span of a tree during which commercial leaves are produced. Likewise, it requires determining the potential effects of harvest on other flora and fauna and on the ecosystem structure, as well as the inclusion of social, economic, and policy considerations (Siebert 2004). In planning sustainable harvest, ecological and economic factors must be taken into account, recognizing that the extraction of NTFP will invariably affect target species populations to some extent (Gould et al. 1998).

Economic returns from greenery extraction

In 2005 sales concentrated in only 1 month of the year and each female collector sold an average of 429 leaves of romerillo and 624 leaves of avellano. To collect these volumes each woman worked an average of 8.2 h which implied costs per package (10 leaves) of US$ 0.070 and US$ 0.075, respectively. The average price paid in 2005 by a first intermediary was US$ 0.13 per package resulting in annual GFR per collector of US$ 5.6 and US$ 8.1 from romerillo and avellano, respectively (Table 4). It is important to remark that the same tendencies in volumes and prices occurred in previous years as reported by the collectors.

Direct costs of labor represented 53.6% and 58.0% of the GFR from romerillo and avellano, respectively. The literature suggests that labor costs can vary widely depending on the type of NTFP extracted and the conditions of extraction. Paoli et al. (2001) estimated that labor costs represented 30.1% of gross return. Shackleton et al. (2002), report opportunity labor costs that varied between 14% and 61% of gross income with an average of 37%. Dovie et al. (2002) estimated that the

Table 4 Estimations showing the average economic results from greenery extraction

Species	Leaves sold per collector	Maximum flow (commercial leaves ha^{-1})	Total collection time (h)	GFR	DC	NFR_c	Contr. to income (%)	NFR_{ha}	NPV_{ha}
			Per collector					Per hectare	
Romerillo	429	658	3.1	5.6	3.0	2.6	0.38	3.9	80.0
Avellano	624	38	5.1	8.1	4.7	3.4	0.5	0.2	4.1

Average annual family income equals US$ 677

opportunity cost of labor represented a 9% of gross income.

Commercialization of greenery, as is usually the case in NTFP trade in Chile, is dominated by middlemen. In this case there were three intermediaries. They purchase greenery from different groups of collectors and sell the products to other intermediaries, to regional and national flower shops, or to exporting firms. The participation of intermediate sellers is usually one of the reasons for low farm-gate prices that do not reflect the costs involved in NTFP extraction.

The resulting net returns per collector were very modest and represented an annual contribution to income of 0.38% and 0.50% from romerillo and avellano, respectively, ranging between 0.2% and 5% depending on the collector.

Based on the sustained flow that can be obtained per hectare and the associated costs of extraction, NPV_{ha} was calculated at US$ 80.0 and US$ 4.1 from romerillo and avellano, respectively (Table 4). These estimates are of similar magnitude to those obtained from tropical and temperate forests of the northern hemisphere. Pearce and Pearce (2001) provide an extensive survey of valuation studies where economic values of NTFP varied from few dollars up to near US$200 per hectare, with the highest values related to readily accessible forests and values near zero for non-accessible sites.

Our findings corroborate the observations of a number of recent studies which state that trade on NTFP would not necessary achieve the goal of poverty alleviation for many reasons, including lack of markets and low-priced products (Shackleton and Shackleton 2004; Delang 2006).

Besides the constraints arising from forest composition and structure, the low economic benefits obtained from greenery extraction can be attributed to market and social reasons. Among the former, the low farm-gate prices do not reflect the direct costs involved in extraction and market instability results in very sporadic sales. Several studies recognize that NTFP trade is highly susceptible to changes in market requirements and while some products have large, diversified and stable markets, others face highly volatile markets or demand that is seasonal and subject to sharp price fluctuations (Arnold and Ruiz-Pérez 2001). Among social reasons, is the fact that female collectors still lack marketing skills to improve trade beyond the current conditions. This is particularly complex given their average age and education level. The literature indicates that the lack of status and power of the poorest members of forest communities to control the resources that generate the higher potential profits, prevent them from becoming successfully involved in the marketing of NTFP (Delang 2006). In this sense the role of development agencies in providing training and financial assistance will continue to be relevant to design and expand initiatives on NTFP production and trade.

Conclusions and implications

The main conclusions of this study are: (i) Floral greenery from romerillo and avellano is produced in secondary forest communities that have already been subjected to anthropogenic disturbances; (ii) based on the structural attributes of the forests in the study area, there are serious limitations on continuous greenery extraction of avellano in the study area, even though avellano is the species in highest demand; (iii) trees producing commercial-quality leaves were primarily those in a juvenile stage with heights varying between 0.2 and 6 m, growing under the canopy of the tree stratum; (iv) net financial returns per collector resulting from the volumes sold by each woman were modest and represented an average contribution to household income of less than 1%. Net present value per hectare was equal to US$ 80.0 and US$ 4.1 from romerillo and avellano, respectively.

Overall, the results obtained in this study suggest that given the present forest composition and structure and the market conditions, greenery collection will continue to have a minor role for rural economies in the study area. Extraction cannot be further increased unless forest management strategies are designed to improve availability, which is currently limited by tree density, especially in the case of avellano, and the production of commercial leaves per tree. One management strategy to increase the number of total and commercial leaves would be to control forest cover by selective cutting of individual trees. For example, romerillo regenerates better in small gaps within the forest, while the availability of light promotes the development of a larger number of leaves per tree. These gaps can be artificially created through management to promote the growth of commercial leaves. In this sense, a long-term evaluation of greenery availability is required to determine relevant aspects such as regeneration patterns and effect of extraction on ecological sustainability.

Domestication could also be a potential alternative using agroforestry schemes. In this case, domestication does not have to occur outside the forest. On the contrary, domestication can be seen as a continuum, from management of trees in the forest to monocultural plantations. The level of domestication will be dictated by biological, social and market factors. Some authors argue that commercial extraction of NTFP in Chile is increasing in response to a rising demand in local, national and international markets. For example, exports of NTFP grew from US$ 12.7 million in 1990 to US$ 33 million in 2003 with greenery products representing 3.25% of total export value in 2003 (Instituto Nacional Forestal 2004). Locally, demand for greenery could expand further given the rapid growth of the flower market resulting from the steady increase in per capita income in Chile.

However, there are many potential risks in the increased commercial exploitation of greenery as well as other NTFP that need to be considered. As demand increases with a fixed supply, prices can increase with a consequent risk of higher pressure on forest ecosystems. A supply increase in local markets with a limited demand can result in a decrease in prices thus reducing net returns. From a social point of view changes in market demand or supply resulting in increased volumes collected and traded can have negative impact on other farm activities carried out by female collectors. From a conservation point of view increasing market demand could lead to over collection with the consequent environmental degradation and further loss of biodiversity.

Finally, the implementation of new initiatives on NTFP in the study area, should first recognize the products with the highest potential of making an economic contribution given the market conditions, and second it should identify those people who can really improve their living through the collection of greenery and other NTFP beyond the current level of subsistence.

For temperate forest ecosystems in the Valdivian Ecoregion more research is required before it can be concluded to what extent and in what ways extraction and trade on greenery and other NTFP can contribute to rural livelihoods and be compatible with forest conservation. The information provided here represents a basis from which to explore management schemes that can potentially expand greenery yield and economic benefits.

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Appendix

Appendix 1 List of species identified in the study area

Scientific name	Family name	Common name[a]
Trees		
Aextoxicon punctatum R. *et* P.	Aextoxicaceae	Olivillo
Amomyrtus luma Legr. *et* Kaus.	Myrtaceae	Luma[f]
Amomyrtus meli (Phil.) D. Legr. *et* Kaus.	Myrtaceae	Melí[g]
Aristotelia chilensis (Mol) Stuntz	Elaeocarpaceae	Maqui[f,t]
Caldcluvia paniculata (Cav.) D. Don	Cunoniaceae	Tiaca
Dasyphyllum diacanthoides (Less.) Cabr.	Asteraceae	Trevo
Drimys winteri J. R. *et* G. Forster	Winteraceae	Canelo
Embothrium coccineum J.R. *et* Forst.	Proteaceae	Notro[h]
Eucalyptus globulus	Myrtaceae	Eucalipto[e,h]
Eucryphia cordifolia Cav.	Eucryphiaceae	Ulmo[h]
Gevuina avellana Mol.	Proteaceae	Avellano[f,g,h]
Laureliopsis philippiana (Looser) Schodde	Monimiaceae	Tepa
Laurelia sempervirens (R. *et* P.) Tul.	Monimiaceae	Laurel
Lomatia ferruginea (Cav.) R. Br.	Proteaceae	Romerillo[g]
Lomatia hirsuta (Lam.) Diels. ex Macbr.	Proteaceae	Radal[f,t]
Luma apiculata (DC.) Burret *et* Macbr.	Myrtaceae	Arrayán[f]
Nothofagus nitida (Phil.) Krasser	Fagaceae	Coigue de Chiloé
Persea lingue (R. *et* P.) Nees *et* Kopp	Lauraceae	Lingue[t]
Pilgerodendron uviferum (D. Don) Florin	Cupressaceae	Ciprés de las Guaitecas
Podocarpus nubigenus Lindl.	Podocarpaceae	Mañío macho
Saxegothaea conspicua Lindl.	Podocarpaceae	Mañio hembra
Tepualia stipularis (H.*et* A.) Griseb.	Myrtaceae	Tepú[g]
Weinmannia trichosperma Cav.	Cunoniaceae	Tineo, Palo Santo[m]
Shrubs		
Azara lanceolata Hook. f.	Flacourtiaceae	Corcolén
Baccharis concava (R. *et* P.) Pers. var.	Asteraceae	Vautro[t]
Chusquea quila Kunth	Poaceae	Quila[c]
Fuchsia magellanica Lam.	Onagraceae	Chilco[m]
Latua pubiflora (Griseb.) Baillon	Solanaceae	Latúe
Pernettya mucronata (L.f.) Gaud ex Spreng	Ericaceae	Chaura
Rhaphithamnus spinosus (A.L. Juss.) Mold.	Verbenaceae	Espino
Ribes glandulosum Grauer.	Grossulariaceae	Parrilla[f]
Rosa rubiginosa	Rosaceae	Mosqueta[f]
Senecio sp.	Asteraceae	Palpal[m]
Ugni molinae Turcz.	Myrtaceae	Murtilla[f]
Myrceugenia parvifolia (DC) Kausel	Myrtaceae	Lumilla
Greigia sphacelata (R. *et* P.) Regel	Cyperaceae	Chupón[f,c]
Crinodendron hookerianum Gay	Elaeocarpaceae	Chaquihue
Pseudopanax laetevirens (Gay) Franchet	Araliaceae	Sauco del diablo
Ovidia pillopillo (Gay) Hohen. ex Meissn.	Thymelaeaceae	Pillo-Pillo[t]

Appendix 1 continued

Scientific name	Family name	Common name[a]
Escallonia rubra (R.*et* P.) Pers.	Escalloniaceae	Siete camisas
Rubus ulmifolius Schott	Rosaceae	Murra[f]
Vines		
Campsidium valdivianum (Phil.) Skottsb.	Bignoniaceae	Pilpil-Voqui[c]
Lapageria rosea Ruiz *et* Pavón	Philesiaceae	Copihue[f,c]
Luzuriaga polyphylla (Hook) Macbr	Luzuriagacea	Quilineja[g,c]
Luzuriaga radicans Ruiz et Pavón	Luzuragacea	Coral
Mitraria coccinea Cav.	Gesneriaceae	Botellita
Philesia magellanica Gmel.	Philesiaceae	Coicopihue[g]
Cissus striata R. *et* P.	Vitaceae	Voqui Negro[c]
Boquila trifoliolata (DC.) Decne.	Lardizabalaceae	Voqui Pil-Pil[c]
Nertera granadensis (Mutis ex L.f.) Druce	Rubiaceae	Coralito
Ferns and Mosses		
Blechnum arcuatum Remy *et Fée*	Blechnaceae	Espina de Pescado
Blechnum blechnoides Keyserl.	Blechnaceae	Peineta
Blechnum chilense (Kaulf.) Meett.	Blechnaceae	Costilla de Vaca
Blechnum penna-marina (Poir.) Kuhn	Blechnaceae	Penamarina
Hymenophyllum sp.	Hymenophylaceae	Película
Lophosoria quadripinnata (Gmel.) C. Chr.	Dicksoniaceae	Queiye (Ampe, Palmilla)[g]
Lycopodium paniculatum A. N. Desv.	Lycopodiaceae	Palma (Pimpinela, licopodio)[g]
Dendroligotrichum dendroides (Brid.es Hedw) Broth	Polytrichaceae	Pon Pon[g]
Herbs		
Acaena ovalifolia R. *et* P.	Rosaceae	Cadillo
Colliguaja integerrima Gill. *et* Hook.	Euphorbiaceae	Duraznillo
Dichondra sericea Sw. var sericea	Convolvulaceae	Oreja de Ratón
Digitalis purpurea L.	Scrophulariaceae	Cartucho
Hypochoeris radicata L.	Asteraceae	Hierba del Chancho
Juncus procerus E. Mey	Juncaceae	Junquillo
Leontodon taraxacoides (Vill.) Mérat	Asteraceae	Chinilla
Medicago sativa L.	Fabaceae	Alfalfa
Plantago lanceolata L.	Plantaginaceae	Siete Venas[m]
Pleurophora pungens D. Don frm. pungens	Lythraceae	Lengua de Gallina
Prunella vulgaris L.	Lamiaceae	Hierba Mora
Ranunculus repens L.	Ranunculaceae	Botón de Oro
Rumex acetosella L.	Polygonaceae	Vinagrillo
Taraxacum officinale Weber	Asteraceae	Diente de León
Trifolium repens L.	Fabaceae	Trébol Blanco
Viola maculata Cav. var. maculata	Violaceae	Violeta del Campo
Carex sp.	Cyperaceae	Cortadera
Chloraea sp.	Orchidaceae	Orquídea
Family Poaceae (general)	Poaceae	Gramíneas (various species)

[a] Letters next to common names indicate the type of NTFP obtained from each species; g: greenery, e: essential oil, h: honey, t: tinctures, f: fruits, m: medicinal products, c: crafting materials

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