Chapter 9

Tree Microrefugia and Community-based Conservation in Tropandean Mountainscapes: A Bio-Cultural Approach for Heritage Management of "El Collay" Protected Forest in Southeastern Ecuador

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Abstract

Geoecological researchers have viewed mountain biodiversity as a response to interactive climate variables (i.e., elevation, temperature, precipitation), while conservation planners have built on this view to develop schemes to satisfy positivist, reductionist frameworks based on indicator species. More recently, montological researchers have incorporated the human dimension to understand how mountain biotas are also determined by ancestral practices of land stewardship. The resulting manufactured landscapes emphasize utility, sacred values, and productivity and are more holistically viewed as socio-ecological systems (SES). We provide examples of this synergy of nature-culture hybridity in the highlands of southeastern Ecuador, in a local assembly of autonomous, decentralized municipalities, comprising the 'El Collay' Commonwealth and its protected forest.

The political process of empowerment mimicking traditional reciprocal work (*ayni*), has operated to benefit commonwealth members who joined for the common purpose (*minga*) of protecting the 'páramo' vegetation and mountain forests in the headwaters of the eastern Andean flank. This area has long been seen as the Amazon gateway, ever since the first Europeans explored the *Marañón* (sea-river) of the South American lowlands. The area, flanked by the *Sangay* National Park, a UNESCO World Natural Heritage Site, the 'Rio Negro-Sopladora' National Park and the *Podocarpus* National Park, in

southeastern Ecuador, is a ripe exemplar of community-based conservation oriented to a sustainable future through respect for agrobiodiversity traditions. An interdisciplinary group of scientists and conservation practitioners are experimenting with new approaches of political ecology and critical biogeography, to add the SES component to the development of management strategies for 'El Collay'. Key strategies include using Payment for Environmental Services and Complex Adaptive Systems methodologies to ensure protection of the existing reserve. Part of the long-term strategy is to extend protection to an adjacent area, thereby creating an ecological corridor for regional conservation of charismatic species, including the Andean bear (*Tremarctus ornatus*), the mountain tapir (*Tapirus pinchaque*), the sparkling violetear (*Colibri coruscans*) and many other bird species unique to the montane cloud forest ecosystem. By looking at paleoecological data on "romerillos" (*Podocarpus oleifolius*) and its correlation with the present distribution of "guabisay" (*Podocarpus sprucei*), we are seeking to synergize understandings of community perceptions and valuations of these species with their capacity to withstand climate change. Areas where both traditional ecological modeling and assessments of future human land-use indicate long-term survival of these flagship species are identified as potential microrefugia in extreme scenarios.

The 'El Collay' biocultural territorial planning initiative aims to provide a secure cultural and financial basis for future biodiversity conservation. Ensuring the cultural revival of indigenous practices and a comprehensive modeling scenario whereby ethnotourism, ecotourism and agrotourism could secure consistent, communitarian revenue flow to help maintain the larger 'El Collay' Protected Forest's long-term refuge condition in an exemplary Socio-Ecological System of the production mountainscape.

Keywords: Microrefugia, Community-based Conservation, *Ayni*, *Minga*, Tropical Andes, El Collay

Country	Ecuador
Province	Azuay and Morona Santiago
District	Chordeleg, el Pan, Gualaceo, Paute, Santiago de Méndez and Sevilla de Oro
Size of geographical area [1]	29.000 hectares
Number of indirect beneficiaries [2]	90.000 persons
Dominant ethnicity	Mestizos

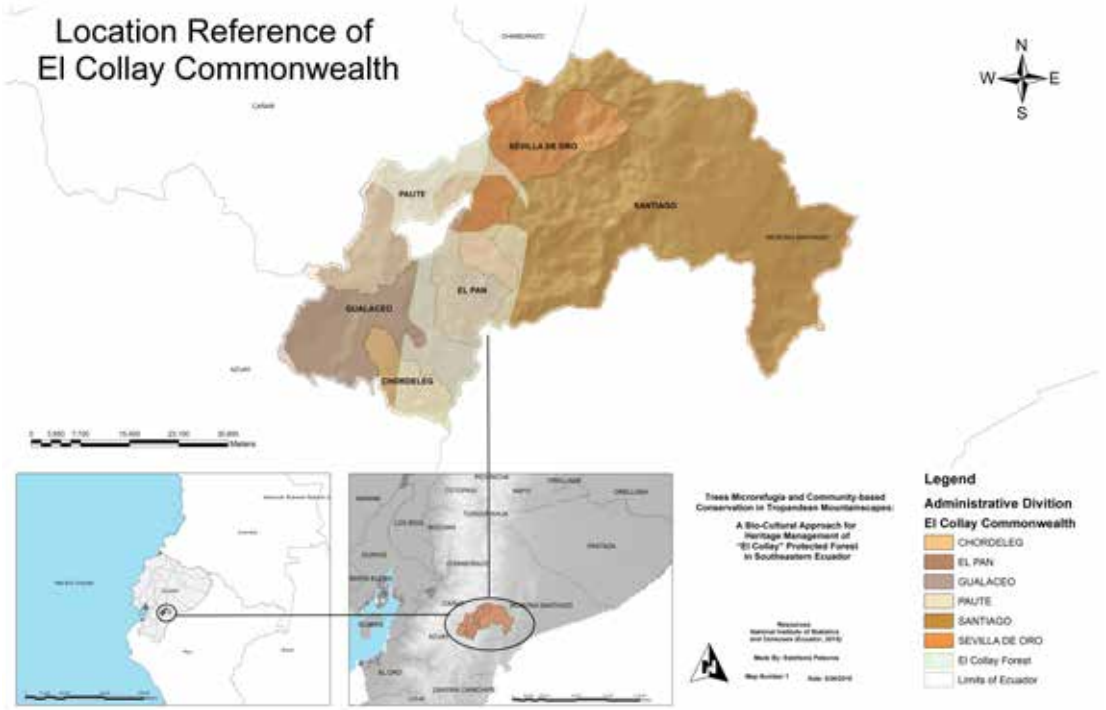

Figure 1. Map of the country and case study region

Size of case study/project area [1]	7.995 hectares
Number of direct beneficiaries [2]	23.000 persons
Geographic coordinate (longitude and latitude)	2°47'32.96"S 78°29'29.14"O
Dominant ethnicity	Mestizos

Figure 2. Land use and land cover map of case study site

1. Introduction

Mountainscapes are excellent laboratories to understand the coupled human-environment dynamics. Habitat heterogeneity and the variety of microclimates along the elevational gradient of the Andean flank showcase plasticity of adaptation to mountain environments (Terborgh 1977, Gentry 1988, Bunkse 1981). Disjunct distributions provide evidence of migrational responses to past and ongoing climate change (Pennington & Dick 2010). Animals and plants adjust their ranges locally or by physiological and genetic variations to respond to new conditions (Cheddadi et al. 2017). Fossil pollen records (Bush, Silman & Urrego 2004, Groot et al. 2011) and modern vegetation surveys (Feeley et al. 2011) provide evidence of the pace of response to climate change on the Andean Amazon flank. Superimposed on this evidence are vegetation responses to anthropogenic change, with modified species composition through grazing and fire (Mosblech, Bush & van Woesik 2011, Borsdorf & Stadel 2015). While we recognize the need to maintain extensive mountain protected areas for the reasons highlighted in the old "single large or several small" (SLOSS) debate of species distribution and heterogeneity (Diamond 1975, Burkey 1989), we argue that the conservation of biodiversity is assured not only by the establishment of single large conservation areas, often connected with ecological or biological corridors, but also by small and very localized Community-Based Conservation (CBC) areas that are kept because of the production of unique ecosystem services or the protection of flagship species as Other Effective Conservation Measures (OECMs). These small locales are valued by the people who live and work in these tropical Andean Amazonian flanks. The long-term protection of these areas, possibly for reasons only remotely connected to biodiversity conservation *per se*, is key in maintaining microrefugia for endemism, rare habitat types, and genetic polymorphism. As we see with the study of 'El Collay' in Ecuador, these areas often rely on the community buying-in to the ideals of, and sharing from, a well-managed conservation enterprise (Sarmiento et al. 2015) (see Fig. 1 and 2).

1.1 Biocultural heritage as a paradigmatic framework

The Andean crescent supports a conservation hotspot (Myers et al. 2000), and can be subdivided into a number

of biodiversity hotspots (Killeen et al. 2007). Few places comparably capture the rich complementarity of a coupled nature-human system as clearly as the Tropical Andes (Wulf 2015). Increasingly it is evident that many Andean systems once thought to be pristine, natural systems, are indeed manufactured landscapes. Through the use of fire and grazing, the original montane tropical cloud forests (White 2013, Moore 2014) have been modified into the socio-ecological production landscapes (SEPLs) of today. In so doing, the bioengineers of antiquity created what Hobbs, Higgs and Harris (2009) termed "hybrid" systems. But with the importation of post-colonial exotic species, many systems have been transformed into "novel" ecosystems (Hobbs, Higgs & Hall 2013), i.e. if abandoned, they would not revert to a natural state through ecological succession.

Forest clearance and vastly increased fire activity induced by human actions throughout the Holocene probably caused large areas to transform from Andean forest to the grassland páramo of the northern Andean highlands (Sarmiento 2012). Nevertheless, the ancient history of the area is still uncertain (Bush 2002), and its future remains a mystery (Malhi et al. 2010). The origin of these grasslands continues to provide fertile scholarship, particularly when realizing that we deal with Socio-Ecological Systems (SES) and their many facets (Berkes, Folke & Colding 2000; Valencia et al. 2018) (Fig 3). Thus, we follow the Christensen Fund's (2016) beliefs that it is only by incorporating the successive human fabric (or ecological palimpsest) of biocultural landscapes that we could understand how conservation and development should co-exist for a sustainable future (Pungetti 2013). We, hence, ascertain that the core of those uncertainties lies in our inability to discern the natural and cultural divide, the extent to which human disturbance can be correlated with how climate has changed in Tropandean landscapes (Fig. 4). This understanding is needed not only to understand the history of settlement, social development and biogeography of Andean regions, but also in making informed prognostications regarding the coupled, complex SEPLs under ongoing climate change.

Tropical Andean landscapes are renowned for their impressive diversity in culture (Moore 2014), luxuriant biota (Young 2009, Swenson et al. 2012), and extreme vulnerability to climate change (Malcolm et al. 2006, Ortega-Andrade et al. 2015). Within the paradox of development and the need for conservation of natural resources, managing cultural uses becomes paramount to a successful bridging of

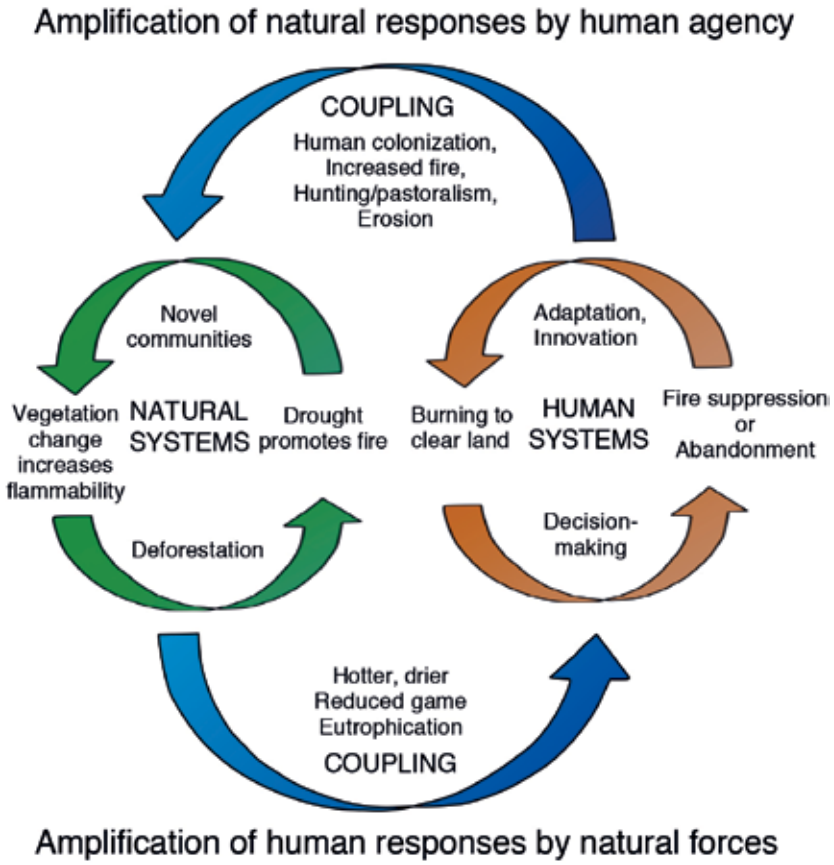

Figure 3. Coupled Human-Environment Model of the Andean Amazon flank showing the flows of energy, matter and processes to function as a Socio-Ecological System. Modified from Prof. Mark B. Bush's ideogram of the complex, adaptive system operating in Tropanden landscapes.

Figure 4. The flower of the Andinist (*Chuquiraga excelsa*) is depicted here as an iconic element of the páramos, exemplifying the bias towards the pristine. A closer look to the specimen -and its surroundings- points to the pyrophytic habit of this Asteraceae plant that makes it an indicator species of past controlled fires and thus, a testament of past human interference in the high Andean forests, becoming a proxy for biocultural heritage. Photo: Fausto Sarmiento.

conservation and societal aspirations (Odum & Sarmiento 1998, Bradshaw & Bekoff 2001). These goals are consistent with the sustainability and development goals of the United Nations, i.e., to identify how people will respond to climate change, while also conserving biodiversity in Andean forests (Mathez-Stiefel et al. 2017). Critical to this agenda is maintaining intact cultural heritage values and increasing countries' fulfillment of the Aichi Targets for biodiversity conservation. One way to aid in the goal "living in harmony with nature" of the UN Convention of Biological Diversity, is to debunk the pristine myth and to accept the new biocultural diversity paradigm with its tenets of complexity, adaptability, resilience, self-organization, memory and transcendence, to develop vernacular strategies to conserve both culture and nature (Castree 2014, Sarmiento & Viteri 2015) in the management of protected areas (Sarmiento et al 2015). By recognizing the intricate relationship of culture and nature in creating the current landscape configurations of the Andes, we will embrace the new paradigm of biocultural landscape and heritage conservation as a guiding principle of our work towards sustaining productive landscapes and seascapes (Cocks 2006, eds. Convery & Davis 2016). "Critical geography" has emerged as a discipline that attempts to hybridize the concept of nature-pristine with that of human-agency within cultural ecology and agrobiodiversity parameters (Zimmerer 2004, Sarmiento et al. 2015).

1.2 Andean Satoyama landscapes

The International Partnership for the Satoyama Initiative (IPSI) promotes SEPLs to highlight traditional knowledge of land use practices with harmonious interactions within the complex mosaics where human well-being is coupled with high biodiversity (Dublin & Tanaka 2014). Spatially, biodiversity conservation occurs not only in protected areas, but also in production landscapes, whether located in the periphery of core areas or interspersed throughout the biocultural territory (Brown, Mitchel & Beresford 2005). One of the authors has already claimed the need to revalue the contribution of agrobiodiversity conservation in the toolbox of territorial planning of complex adaptive systems (Sarmiento 2008, eds. Messier, Puettmann & Coates 2013). There are many examples that can be found in the Andes region, while including the sacred dimension that is pivotal in Andean cultural landscape research on SEPLs (Sarmiento 2003; Sarmiento, Cotacachi & Carter 2008).

Several Andean sites are already active in the International Partnership for the Satoyama Initiative (IPSI), including the 'Alto Huayabamba' Conservation Concession in Bolívar, Peru; the mangrove estuaries of Chone and Portoviejo, the dry forest of Cordillera del Bálsamo in Manabi, Ecuador; and the agroforestry system of the San Vicente de Chucurí, Santander, Colombia (Tsunekawa 2003). We are including here an example from highland Ecuador, where the principles of IPSI have been implemented in a very effective and efficient way. The 'El Collay' Commonwealth of southeastern Ecuador comprises six autonomous, decentralized governments (GADs for the Spanish acronym) that have formally agreed to collaborate in the maintenance of rural livelihoods for food sovereignty and security. Spanning both highland and lowland communities, the strategy includes the conservation of the community protected forest of 'El Collay' (Fig. 5 and 6) in addition to OECMs. Since the UN Food and Agriculture Organization (FAO) recently recognized two Satoyama areas in Japan as Globally Important Agricultural Heritage Systems (GIAHS) sites, we envision that 'El Collay', with its wealth of agrobiodiversity, heirloom species and cultural heritage, will soon become the first such GIAHS site in Ecuador.

A view of the park rangers arriving to the tourism project "La Tranca" in the mountain landscape of El Collay, where the imprint of Fuzhio and Chordeleg communities have managed the landscape with ancestral practices, aiming for maintenaining both rich cultural heritage and impressive natural capital in the cloud forests and páramos of southeastern Ecuador. Photo: Fausto Sarmiento.

Figure 5 and 6. A view of the park rangers arriving to the tourism project "La Tranca" in the mountain landscape of El Collay, where the imprint of Fuzhio and Chordeleg communities have managed the landscape with ancestral practices, aiming for maintenaining both rich cultural heritage and impressive natural capital in the cloud forests and páramos of southeastern Ecuador. Photo: Fausto Sarmiento. (Photos by Fausto Sarmiento and Estefanía Palacios)

1.2.1 Ecuadorian conservation scenarios in the Aichi flexible framework

The first Ecuadorian Congress of Geography, held at the Pontifical Catholic University of Ecuador on 14-16 February 2018, showed that conservation follows conventional tenets of species-based or habitat-based priority settings for protected areas. However, several presentations dealt with the need to incorporate biocultural territorial planning (Kong 2018, Palacios 2018, Sarmiento 2018) if the best management practices for biodiversity conservation and the fulfillment of the different Aichi Biodiversity Targets are to be achieved. Changing conservation strategies have been clearly addressed as a national priority, not only in the Ecuadorian case, but also throughout the Andean world (Sarmiento et al. 2017). However, primacy of "almost untouched" páramos and cloud forests in the 'Río Negro–Sopladora' has justified the creation of a brand-new National Park in Ecuador, effectively incorporating 30,616 hectares of the area into the state-owned Heritage Natural Areas Subsystem (PANE) of the National System of Protected Areas in Ecuador. 'El Collay' is immediately adjacent to this "pristine" area, flanked by the duality of male and female *Apu*, the telluric watershed guardians: *Kari* Collay and *Warmi* Collay hills. 'El Collay' represents the best case to promote SEPLs as it demonstrates the likelihood of biodiversity conservation and situated development of OECMs, aiding in obtaining the Aichi Targets for 2020.

1.2.2 Transdisciplinary approach as a guiding principle for Satoyama landscapes in the Andes

The new tendency of integrative conservation is evident in the application of IPSI principles in the Andes. As long as legal recognition of community-based conservation (CBC) is granted, the objectives of sustainability based in biodiversity indicators will remain biased towards the totemic species, supporting ideas of "fortress conservation." The emphasis on "pristine" samples of mountain ecosystems without human interference (Sarmiento forthcoming) may identify areas of high-quality habitat for conservation, but, in doing so for the wrong reasons, may initiate future management problems. First, if the area has actually been modified by human activity, some level of such management will be needed to maintain it. Second, the desirable "near pristine" state may actually be reliant on adjoining areas that are more overtly managed. If those areas are not also maintained, the conservation strategy may fail. The IPSI contribution to debunking the pristine myth helps in understanding the imperatives of cultural agency in designing current landscape configurations, and provides a more realistic foundation for biocultural diversity conservation. We present a case study in southeastern Ecuador, where many assumptions of physical geography have been challenged in favor of the new transdisciplinary trend of bridging western science with local, traditional ecological knowledge to understand the *mosaicism* of ecological niches and the self-organized *cellularity* of emergent new ecosystem pathways within the lived-in biocultural landscape fabric (Naveh et al. 2002), providing for situated nuances of refugial ecotopes as target conservation loci for microrefugia as OECMs. As a truly participatory outcome of CBC, we present the case study of the 'El Collay' Commonwealth in southeastern Ecuador.

2. Methodology

2.1 Study area

'El Collay' Commonwealth is located in Azuay Province and spans different bioclimatic zones from the continental divide at ca. 4,000 meters above sea level (MASL) to the Amazonian piedmont of colline areas of the Morona River in the lowlands at ca. 1,000 MASL (**Aichi strategic goal C**). 'El Collay' ridge

Figure 7. Map of the distribution of the ECPFV (or in Spanish 'Area de Bosque y Vegetación Protectora' —ABVP— El Collay) located amidst the Andean highland (Azuay province) and the Amazonian lowlands (Morona-Santiago province). Source: Alexandra Vázques 2014. Mancomunidad de El Collay: Sistema Innovador y Participativo de Gobernanza Ambiental. Sistematización del proceso de conformación, fortalecimiento y consolidación de la Mancomunidad de El Collay. Quito: Fundación Futuro Latinoamericano.

follows a south-north trajectory, from the 'El Pan' hill towards the limits of *Sangay* National Park, a UNESCO World Heritage Site (Eyre 1990), traversing six different municipalities (see Fig. 7). With the contribution of major tributaries to the *Pauti* basin, the main river of the Azuay Province, waters collected in these mountains from the 'San Francisco', 'Santa Bárbara', 'Collay' and 'Negro' rivers drain fertile volcanic and andosol terrains towards the mouth of the *Pauti* River and towards the lowland Amazon flatlands. Several dams built in this watershed provide the majority of hydroelectricity for the entire country (Cuellar & López 2000). In the species-rich Andean forest, epiphytic gardens form a hydrological reservoir, as do the waterlogged areas of shrub 'páramo' that give way to depressional lakes and bogs, including the male and female *Kari Maylas* and *Warmi Maylas* (Páramo 2010, Torres & Tacuri 2008). Along with the provision of water and energy, the potential for many ecosystem services associated with the *Pauti* basin cannot be underestimated, including not only biophysical environmental services, but also cultural landscape services (Kong 2018) (**Aichi strategic goal D**). The 'Paute' mountain pass, or 'abra', has been the traditional route to connect the southern 'Sierra' of Ecuador with the 'Amazonía' region; it constituted the gateway towards the *Marañón* river (Sarmiento 1952, Ulloa 1999), the mythic sea-river of chroniclers, geodesic naturalists and colonial explorers. These lands were physically and societally hostile to European explorers. Issues ranging from highland hypoxia to lowland disease and fungus-prone settings were compounded by the fierce resistance of the original *Shwar, Achwar*, 'Motilones' and 'Bracamoros' people of southeastern Ecuador and northeastern Peru, some of them known as the mythical head-hunters (*c.f.:* shrunken heads or *Tzantza*) of yesteryear's 'jívaros' (Sarmiento 1956).

Map of the distribution of the ECPFV (or in Spanish 'Area de Bosque y Vegetación Protectora' —ABVP— El Collay) located amidst the Andean highland (Azuay province) and the Amazonian lowlands (Morona-Santiago province). Source: Alexandra Vázques 2014. Mancomunidad de El Collay: Sistema Innovador y Participativo de Gobernanza Ambiental. Sistematización del proceso de conformación, fortalecimiento y consolidación de la Mancomunidad de El Collay. Quito: Fundación Futuro Latinoamericano.

There is no agreement on the place naming of 'El Collay'. Potential origins include: (1) unconfirmed accounts at the Spanish settlement onset chronicled a brave leader, or *kuraka,* named 'Collay', whose domain extended into the region; (2) a possible reference to a northern place (*Collas*) of different but neighboring indigenous mountain villages; also, (3) the term could derive from archaic Spanish, 'collado,' that describes a low-rounded hill or low mountain pass (from Latin: *collis*), indicating the lowest level of the ridge-line between two adjacent heights, therefore, the preferred path to cross a mountain pass. This archaic Spanish definition fits well with the historical character of the 'gateway' to the Amazon via the 'Paute' river canyon (Donoso 2002). Likewise, (4) Another variant comes from the *Kañari,* that might have been a group of immigrants or *mitimakuna* of the *Inka* Empire advancing northward. A group of *Aymara* indigenous from the *puna* of southern *Inka* land or *Tawantinsuyu,* in what is now Bolivia and northern Chile, were transplanted to what is now southern Ecuador, coming from the region of *Kullasuyu.* Its local inhabitants now are called *Collas* or *Q'oyas* and live in the highlands of Argentina, Chile and Bolivia. This fact could also explain the linguistic oddity of *Kañari* toponymy, very different to prevalent *Kichwa* or Spanish/*Kichwa* combinations (Encalada 2000), as well as their similar mythology, theogony, diet and garb (Pichisaca 2001).

The 'El Collay' Protected Forest (ECPF) is a legally created CBC area with the engaged agreement of the six municipalities that make up the 'El Collay' Commonwealth. This protected forest initially occupied 7,955 ha, which was later modified to include 29,000 ha, making it one of the most representative provincial public conservation areas (**Aichi strategic goal A**). 'El Collay' also occupies an important place in the hearts and minds of the residents of these municipalities including parochial organizations, women's groups and other community groups belonging to the commonwealth, as it was conceived with a participatory communal effort via *minga*, the ancestral reciprocity practice of Andean cultures or *ayni* (Palacios 2017). The commonwealth protects the abundant wildlife of the cloud-shrouded high Andean ecosystems, as it seeks to sustain and revive ancient practices of mountain travelers (Guallpa, Ivan & Ulloa 1999), and the ethno-tourism or agro-tourism of traditional

lifescape practices (Gutiérrez, Maldonado & del Pilar 2014; Borja, Lasso & Paola 2015) (**Aichi strategic goal B**).

The area supports many rare species of fauna and flora (Table 1), among which are *Chuquiraga jussieui*, which has the common name the Flower of the Andes, and the Azuay knot emblem, the *gañal (Oreocallis grandiflora*). There are remnants of old growth native coniferous woodlands with isolated 'romerillo' (*Podocarpus oleifolius*) and abundant 'guabisay' (*Podocarpus sprucei* c.f. *glomeratus)*. Also, isolated trees of 'mogollón' *(Retrophyllum rospigliosii)* are observed in faraway reaches of the range. Some nurse trees have been left amidst the clearings for pastures made decades ago, when agrarian reform favored takeover of unclaimed forests as a means to provide eminent domain and, therefore, titling and land ownership for settlers (Sarmiento 2002). Curiously, in the high ravines towards lakes and bogs, some of them considered "enchanted" by the locals, robust populations of native trees of *Buddleia incana, Gynoxis baccharoides* and *Eugenia myristica* can be observed; there are also tree ferns (*Cyathea brucei*) and even high elevation palms (i.e., *Geonoma monospatha*, *Ceroxylon andicola*). In the upper reaches, the effect of grazing is obvious by the erosion type known as 'pie-de-vache', from French, describing the zigzagging lines of trampling on the slopes (Jampel 2016). Moreover, the presence of reeds and bulrushes (*Schoenoplectus californicus*, *Phragmites spp*.) is noticeable in the lacustrine environment, obviously planted long ago. Unmanaged reeds contribute to lakes becoming eutrophic and unsuitable for native aquatic fauna and prone for introduced species. The native fish, for instance, have long been gone, making the ubiquitous rainbow trout (*Salmo mykiss*) one of the precious trophies for local fishermen in the white-water brooks often surrounded by 'pajonal' of straw grass, such as *Calamagrostis*, *Festuca* and *Stipa*. Amidst the grass tillers or in its waterlogged roots, frogs (*Atelopus* spp) and big lizards or *guagsa* (*Stenocercus guentheri*) exist.

Scientific Name	Local Name	Heritage marker
Plants		
Podocarpus oleofolius	Romerillo	Home of the wild 'duende' or *sinsin*
Podocarpus sprucei	Guabisay	The home of the toucanets
Podocarpus rospiglossy	Mogollón	Strength of tallest timber softwood
Chuquiraga jussieui	Flor del Andinista	Untouchable but tempting
Oreocallis grandiflora	Gañal	Flagship of Azuay knot
Buddleia incana	Arbol del Inca	Sacred tree for sculptures and effigy
Gynoxis baccharoides	Yagual	Andean flower with yellow overtones
Eugenia myristica	Arrayán	Fruit ethnomedicinal
Cyathea brucei	Helecho arbóreo	Incorruptible wood
Geonoma monospatha	Palma de altura	Decumbent and sinuous stem growth
Ceroxylon andicola	Palma de cera	Tall and elegant nursing tree
Calamagrostis spp,	Paja de páramo	Multipurpose uses
Festuca spp.	Paja azulada	Insulation
Stipa ichu	Paja ichu	Fire starter
Chusquea spp	Suru	Restorative of landslide scars
Pteridium aquilinum arachnoideum	Helecho araña	Restorative of fire scars in the slopes
Prunus serotine capuli	Capuli	Restorative of fire scares in the valley
Alnus jorulensis,	Aliso blanco	Restorative of rockslides
Alnus acuminata	Aliso rojo	Restorative of alluvial mudslides
Puya spp	Aguarongo	Emblematic highland plant

Animals		
Tremarctos ornatus	Oso de anteojos	Emblematic wild beast (ukumary)
Tapirus pinchaque	Danta de monte	Seven meats and disease vector
Colibri coruscans	Quinde picaflor	Iridescent reflections
Salmo mykiss	Trucha arcoiris	Protein source
Atelopus spp	Sapa Jambato	Flagship of highland wetlands
Stenocercus guentheri	Guagsa	Sacred reptile (tale breaker)
Sarcoramphus papa	Zopilote real	Restorative cleaning
Harpya harpija	Aguila harpía	Emblematic jungle master
Odocoileus virginianus ustus	Venado	Adaptability and vigor
Pseudalopex culpaeus	Lobo de páramo	Nuanced analyst
Penelope purpurascens	Pava de monte	Good tidings greeter

Table 1. Examples of the emblematic assemblages of flora and fauna in 'El Collay' Protected Forest and Páramo pointed in the text. Names come from the Herbarium of the University of Azuay in Cuenca and from the Ecuadorian Museum of Natural History in Quito. Modified from Dr. Danilo Minga Ochoa's plant list and from Sarmiento's Ecuadorian Ecological Anthology (1987).

Notwithstanding the rich biodiversity, the matrix of anthropogenic landscapes has retained some secondary growth after ancient burnings in the region, so the pyrophytic 'surales' of *Chusquea* spp. and 'pampales' of bracken fern (*Pteridium aquilinum*) remain as clear indicators of fire disturbance. Species associated with either the burning practice intermediate-disturbance (serotiny) or with the slope failure catastrophic-disturbance (geotiny) appear later, including woodlands of Andean alder (*Alnus jorulensis*, *A. acuminata*), cherry trees (*Prunus serotina capuli*), climbers such as *gullay (Passiflora spp)* or ground bromeliads or *aguarongo* (*Puya* spp). Here, the signature of human drivers of the Andean treeline continues to be unmistakable (Sarmiento & Frolich 2002) in determining the fate of Tropandean biocultural landscapes.

2.1 Participatory environmental governance process

The "environmentality" of 'El Collay' Commonwealth is indicative of profound changes in conservation policy and decision-making in Ecuador. In the last ten years, the National System of Protected Areas has generated processes to motivate social participation (c.f., inclusion) in protected areas. The National Environmental Authority (NEA) has introduced gradual changes in the narrative of conservation, such as incorporating sustainable use of biodiversity, protecting culturally significant areas and especially valuable natural resources, and restoring degraded ecosystems. In consequence, those actions have opened the possibility to integrate other actors into protected areas management, including educational institutions, community leaders and civil society. In this sense, but under the context of cultural heritage, the Ecuadorian law on Territorial Planning, Autonomy and Decentralization of 2011 is much more specific when defining the competences that municipalities must assume in matters of culture and heritage. In article 55, it indicates exclusive competences of the municipal decentralized autonomous government in cultural matters: to preserve, maintain and disseminate the architectural, cultural and natural heritage of the canton, and to build public spaces for these purposes. On the other hand, article 144 states that the competence to preserve, maintain and value cultural heritage, corresponds to the decentralized Ecuadorian municipalities. Therefore, the biocultural heritage management increasingly involves the local community's participation, not as an option but rather as an obligation.

The participatory research methods of planning for environmental governance were built on the painstaking groundwork provided by the 'Fundación Futuro Latinoamericano' (FFLA 2014), with major breakthroughs in the establishment of the first legally recognized Ecuadorian commonwealth to protect the natural vegetation and the forest cover of the 'El Collay' region in Azuay Province. With several meetings and communal gatherings (or *minga*), the enterprise was informed and affirmed with a horizontal, rhizomic approach of previous informed consent. No preconceived hierarchical decisions were proposed, but a real exchange of dreams and wants of local community leaders of civil society and elected officials of the area's organizations took place. These included: El Pan, Sevilla de

PRINCIPLE	STRATEGIC GOAL	AICHI TARGET	OBTAINED
Adaptive approach	E	17,18,19	√
Commonality of setting the stage	E	4,17,18	
Multiscalar	A	2,1,11	√
Multifunctional	D	4,14,15,16,19	√
Multi-stakeholders	E	4,14,17,18	
Transparently negotiated	A	1,4	√
Clear rights and responsibilities	D	4,14,16,18	√
Participatory monitoring	A,B,D	9,12,13,14,15	√
Resilience	C	9,12,13,14,15	√
Capacity building	E	1,17,19,20	√

Table 2. Integration of the Aichi targets considered in the study area of the El Collay Commonwealth's protected forest and vegetation.

Oro, Guachapala, Chordeleg, Gualaceo, Paute and Santiago de Méndez. One of the authors served as the 'promotora' (Vázques) from FFLA that validated the participatory research and sharing of information prior to the establishment of the legal document. A "commonwealth" category was preferred over a simple "consortium" of municipalities, to enable equal participation of elected officials (who hold the office of Chair every year on a rotating basis, bringing an added factor when elected officials are placed in the ballot). The ECPF also comprises a technical unit staff to manage it, local park rangers hired with funds from the Electric Corporation of Ecuador (CELEC), residents and several interested community groups, including farmers, fruit growers, floriculturists, tour operators, women assemblages and even educational institutions.

2.2 Community-based findings for Aichi Targets

Some premises for reciprocity of communal labor were shared in the initial phases, when focus workshops and mountain hikes took place to motivate social actors' engagement (**Aichi strategic goal E**). Of note was a three-day excursion following the centuries-old mountain pathways that brought the Salesian missionaries into these regions, bringing the Roman sanctorum and their pastoral work towards the unknown Amazonian lowlands (Guallpa, Iván & Ulloa 2015). Indeed, one of the pillars of the commonwealth was to rescue their historic heritage. The route of Father 'Albino del Curto', from Sevilla de Oro towards Santiago de Méndez, is targeted as a touristic attraction for visitors to know the once rich gold-producing mining of El Pan, Sevilla de Oro and placer mining sites on downriver shoals.

3. Results on target evaluation

The successful establishment of the 'El Collay' Commonwealth provides effective protection to almost 29,000 ha of Andean forests and páramos. Currently, efforts to increase the acreage have received enthusiastic support. This endogenous synergy prompted international organizations (i.e., Nature/Culture International, Latin American Future Foundation and their donors) to look even closer at the wealth of biodiversity in the area. Just recently (10 February 2018), a new Ecuadorian protected area was declared for the 34,388 ha area adjacent to 'El Collay' in the 'Río Negro-Sopladora' National Park, located between two large conservation areas: *Sangay* National Park to the north and *Podocarpus* National Park to the south. The new designation effectively protects the longest conservation corridor along the Andean flanks and serves to integrate management efforts across this vast landscape. The renewed focus on biodiversity has also added many new species records for the region, including newly discovered endemic amphibians. One of the authors (Aguilar) produced a list of the orchids of the *Uchucay* Community Reserve in Gualaceo, where new *Andinia* spp. were found (Doucette, Portilla & Cameron 2017). Several emblematic species were targeted for protection along the Andean Amazon flank, including the Andean spectacled bear (*Tremarctos ornatus*), the mountain tapir (*Tapirus pinchaque*), the royal buzzard (*Sarcoramphus papa*) and the Harpy eagle (*Harpya harpija*). Many rare local endemics, including parrots, toucans and waterfowl, are indeed commonly seen in 'El Collay'.

With the creation of 'El Collay' Protected Forest we have achieved the integration of the majority of the Aichi Targets (see Table 2). The participatory process contributed to Targets 1 to 4. Contributions to Target 5 are as yet unsure,



Figure 8, 9 and 10. A group of coauthors and members of the local communities of Chordeleg and Fuzhio, including the major and the technical staff of the 'El Collay' Commonwealth, after a visit to the 'cerro de la alegría' after mountain trekking through cloud forests and páramos in the heartland of Kañary ancestral lands. (Photos by Guido Román and Estefanía Palacios)

but this achievement made advances in securing Targets 6, 8 and 9, with the establishment of an alliance between Ecuagenera Cía. Ltda. and the 'GAD municipal del Cantón Gualaceo' to establish the community reserve of *Uchucay* (Bustos 2017). Target 7 remains a work in progress, but we obtained consensus among stakeholders that the ECPF will not be subjected to deforestation pressures and will continue to be monitored by park rangers. Funding for that critically important monitoring was derived from revenues for ecosystem services provided by the national utility, CELEC, funneled to the 'El Collay' Technical Office for watershed conservation operations. Target 10 did not apply to our mountainous region. With the biocultural territorial planning to be executed in the 'El Collay' next year, contributions to Targets 11, 12 and 13 were ensured for the inclusion of natural and heritage management to protect genetic diversity and heirlooms. Targets 14 and 15 were secured with restoration areas and the implementation of payment for ecosystem services (Zilberman, Lipper & McCarthy 2008), but Target 16 is not yet defined. Targets 17, 18 and 19 are fully integrated in the operation of ECPF. Likewise, Target 20 is secured at the local level with the financial commitment of the municipalities and GADs that are members of the 'El Collay' Commonwealth.

4. Discussion

The rich ethnobotanical content of traditional medicine observed in the region (Neira & Luzuriaga 2000) highlights the indigenous *Shwar* ancestral knowledge of the Amazonian flanks of montane jungles or 'ceja de selva.' The area now harbors mostly mestizo, campesino people of *Kañari* ascendance from Cañar and Azuay provinces, and *Shwar* ascendance from Morona-Santiago and Pastaza provinces (**Aichi strategic goal D**) (Fig. 8, 9 and 10). There is a strong birthplace attachment, making family gatherings an observance for major holidays, whereby heirloom dishes are prepared and ancient myths are transmitted around the elders' storytelling to the youth.

A group of coauthors and members of the local communities of Chordeleg and Fuzhio, including the major and the technical staff of the 'El Collay' Commonwealth, after a visit to the 'cerro de la alegría' after mountain trekking through cloud forests and páramos in the heartland of *Kañary* ancestral lands. Photo: Guido Román.

However, in rural-to-urban migration in Azuay and Cañar provinces, people from the villages have moved to the city of Cuenca or to the capital city of Quito, but retained 'biopatry', or place attachment, in their traditional potions, diets and religious observances while living faraway (A Neira, pers. comm.). Furthermore, a major demographic change observed with international emigration to foreign destinations, mainly Spain and the United States, makes the new economic driver of remittances an important economic subsidy that is changing the *Pauti* farmscapes' fabric (Donoso & Sarmiento, forthcoming). Amenity migrants from the global North are making Cuenca and 'El Collay' one of the most popular destinations for expats (Peddicord 2017). The previous wave of foreign migrants arrived to Cuenca motivated by economic hardship in their country of origin; however, newcomers and recent retirees fleeing to the area are fleeing their country of origin as a reflection of political rather than economic drivers (A Neira, pers. comm.).

It was the trailblazing effort of circa seven years of work by the FFLA with such a strong participatory approach at all levels (i.e., community, political, sociocultural and citizenry) that made the establishment of the commonwealth

possible. The implemented process provided transparency, co-responsibility, mutual performance, strategic alliances, equity, gender equity, knowledge sharing, social engagement, communication and leadership. One of the practical outcomes was the establishment of a fund provided by the Minister of Environment (MAE) for monitoring and vigilance of the zone of conservation for the concrete action to create a Park Rangers training. Also important was the establishment of Law 047 with the mechanism to fund these guard hires from the National Electricity Company's (CELEC) mandatory 5% annual budget contribution for social and environment responsibility to the GADs of 'El Collay'. We seek to reinforce the ground already gained and keep the momentum for CBC among the villagers, knowing that federal funding for conservation has been already cut, with the CELEC contribution also diminishing or ending altogether. Going forward it is essential that we minimize environmental conflict and offer practical action-reflection to resolve issues. Similarly, we must offer the possibility of learning-by-doing supported by the new narratives of biocultural heritage and critical biogeography.

While biodiversity conservation is the main goal of the 'El Collay' Protected Forest, a renewed emphasis on cultural ecosystem services is needed to connect the lifescape of 'El Collay' with the needed protection of these species amidst climate change. Despite concern for global warming, no direct adaptation or mitigation schemes are anticipated yet in the planning of the GADs of the commonwealth. More attention has been given to the prospective lack of rain and generalized drought than to the prospects of warmer weather. Several irrigation channels have been carved into mountainsides near Gualaceo and El Pan, for instance, that require maintenance and monitoring. Hydrological management must go beyond considering amounts only and must also manage water quality. For example, three small lakes on the 'La Alegría' hill, near Puzhía, Chordeleg, have already become eutrophic and need ecological restoration to return them to fully functioning wetlands. Water continues to be at the center of sustainable development concerns. Notwithstanding this strategic resource for hydroelectric production, water will be needed for irrigation of agricultural lands and the provision of potable, piped water for household consumption. The need for forest protection is entirely consistent with the administrative imperatives to provide water and electricity to a growing population. Recognizing the ecosystem services provided by forest and soil is a critical step that must be made all the way from the farmer to the highest administrative office.

In the *Puna* grasslands of the high Andes, Sylvester, Sylvester and Kessler (2014) suggested that ledges on steep mountainsides had been protected from fire and grazing and may offer the best analog for a "natural" plant community. These ledges support more lower plant diversity than adjacent grazed lands, but one richer in shrub species. The ledges have been suggested as targets for conservation (Sylvester, Sylvester & Kessler 2014) and could be construed as an OECM. There is no doubt that small cloud forest fragments are key to the short-term conservation of tree diversity (Wilson & Rhemtulla 2018). These fragments can offer the nuclei from which afforestation can build outward or maintain genetic stock until a broader conservation effort can be undertaken. In the longer term, unless genetic connectivity is re-established, populations will ultimately fail due to inbreeding or stochastic events. Edge effects, such as fire incursion, exotic diseases, or dry microclimates, are disproportionately damaging to fragmented areas, such that microrefugia must be thought of as a temporary not permanent respite from adversity. The integration of OECM settings with larger landscapes consistent with conservation, cultures and management that foster biodiversity can provide a matrix that increases microrefugial survivability. The different communities in 'El Collay' have an elevated chance of survival through the maintenance of forest cover for either biocultural heritage or ecosystem services, and will aid in providing microrefugia to those populations of species, such as *Podocarpus, Polylepis, Cinchona and Buddleia*. While 'El Collay' management plans do not yet explicitly deal with long-term anthropogenic climate change, the decisions made so far are entirely consistent with the long-term conservation of regional biodiversity.

To secure the long-term goal, aside from the signed commitment from the local GADs, civil society and community groups need to be energized and funded. Likewise, we still need to work to mobilize international resources and secure matching grants or endowment funds that would allow the maintenance of 'El Collay' Protected Forest for perpetuity.

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