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Field environmental philosophy and biocultural conservation at the Omora Ethnobotanical Park: Methodological approaches to broaden the ways of integrating the social component ("S") in Long-Term Socio-Ecological Research (LTSER) Sites

Filosofía ambiental de campo y conservación biocultural en el Parque Etnobotánico Omora: Aproximaciones metodológicas para ampliar los modos de integrar el componente social ("S") en Sitios de Estudios Socio-Ecológicos a Largo Plazo (SESELP)

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ABSTRACT

In order to effectively address the problems derived from global environmental change, environmental scientists, citizens and decision-makers now recognize the need to integrate more fully the human or social component into ecological research. We propose that to achieve this integration, Long-Term Socio-Ecological Research (LTSER) networks offer an ideal platform, because such sites enable research at ecological, cultural, and political local scales, and at the same time allow addressing these issues at a global scale. However, this socio-ecological work still requires better articulation of programs developed at multiple geographic, ecological and political scales. In addition, until now the social component considered in LTSER programs has focused on economic factors, omitting ethical dimensions. A central reason for this omission is the lack of methodologies to systematically integrate ethics into LTSER programs. As a contribution to resolve this limitation, here we develop a methodological approach that we call "field environmental philosophy." It integrates ecological research and environmental ethics into biocultural education and conservation through an interrelated four-step cycle: i) interdisciplinary ecological and philosophical research, ii) composition of metaphors, and communication through simple narratives, iii) design of guided field experiences with an ecological and ethical orientation, and iv) implementation of in situ conservation areas. This cycle has been defined a posteriori, by analyzing successful experiences of biocultural research, education and conservation program at the Omora Ethnobotanical Park (OEP) in the Cape Horn Biosphere Reserve (CHBR). The Masters of Science in Subantarctic Conservation at the University of Magallanes (UMAG) adopted this cycle as a structured methodology to design theses and academic curricula for students who are creating innovative educational and ecotourism activities, such as "Ecotourism with a Hand Lens" and "Ethical Birding." To articulate the programs at multiples scales, the OEP functions at the local scale as a research center in the CHBR, at the national level as a cofounder and southernmost site of the Chilean LTSER network coordinated by the Institute of Ecology and Biodiversity (IEB), Chile, and at the international level as a reserve and field station of the Subantarctic Biocultural Conservation Program that is coordinated by UMAG, IEB and the University of North Texas (UNT). This organization of nested units has permitted to synergistically articulate the work at local, national and international scales. Collaborative research has led to the discovery of biological and cultural diversity singularities in the remote Magellanic subantarctic ecoregion, enabled education and conservation work with multiple social actors and institutions, and has strengthened the incorporation of environmental philosophy into socio-ecological research. In this way, OEP's program is contributing to broaden the definition of the social ("S") component in LTSER, and to generate methodologies to integrate, at multiple scales, ecological and ethical dimensions into socio-ecological research, as well as biocultural education and conservation programs, which could be implemented and assessed at other LTER sites.

Key words: Cape Horn Biosphere Reserve, environmental ethics, metaphor, subantarctic, Sustainable Biosphere Initiative.

RESUMEN

Para resolver los problemas derivados del cambio medioambiental global, los científicos y tomadores de decisiones reconocen que es necesario integrar más ampliamente el componente social o factor humano en la investigación ecológica. Proponemos que para lograr esta integración las redes de Sitios de Estudios Socio-Ecológicos a Largo Plazo (SESELP) ofrecen una plataforma ideal, porque los sitios permiten abordar singularidades ecológicas, culturales y políticas a escala local, a la vez que integrar escalas globales a través del trabajo colaborativo en redes de sitios. Sin embargo, este trabajo socioecológico todavía requiere articular de mejor manera los programas desarrollados a múltiples escalas geográficas, ecológicas y políticas. Además, hasta el momento el componente social considerado en los programas SESELP ha sido fundamentalmente económico, dejando fuera la dimensión ética. La integración de la ética de manera sistemática en los programas SESELP está severamente limitada por la carencia de metodologías. Para contribuir a resolver esta limitación, hemos desarrollado una aproximación metodológica que denominamos "filosofía ambiental de campo". Esta aproximación integra las ciencias ecológicas y la ética ambiental en educación y conservación biocultural a largo-plazo a través de un ciclo de cuatro pasos interrelacionados: i) investigación interdisciplinaria ecológica y filosófica, ii) composición de metáforas y comunicación a través de relatos simples, iii) diseño de experiencias de campo guiadas con un sentido ecológico y ético, y iv) habilitación de áreas de conservación in situ. Este ciclo se ha definido a posteriori analizando las experiencias efectivas del programa de investigación, educación y conservación biocultural del Parque Etnobotánico Omora, en la Reserva de Biosfera Cabo de Hornos (RBCH). El programa de Magíster en Ciencias con mención en Conservación Subantártica de la Universidad de Magallanes (UMAG) está adoptando este ciclo como una metodología estructurada para el diseño de tesis y mallas curriculares de estudiantes que están generando innovadoras actividades educativas y de ecoturismo, como el "Ecoturismo con Lupa" y el "Birding Ético". Para articular programas de trabajo múltiples escalas, el Parque Omora funciona a escala local como un centro de investigación en la RBCH, a nivel nacional como cofundador y sitio más austral de la red chilena SESELP coordinada por el Instituto de Ecología y Biodiversidad (IEB), y a nivel internacional como una reserva y estación de campo del Programa Conservación Biocultural Subantártica, coordinado por la UMAG, IEB y la Universidad de North Texas (UNT). Esta organización en unidades anidadas ha permitido articular de manera sinérgica el trabajo a escalas locales, nacionales e internacionales. La investigación colaborativa ha: 1) conducido al descubrimiento de singularidades de la diversidad biológica y cultural en la remota ecorregión subantártica de Magallanes, 2) ha posibilitado programas de educación y conservación trabajando con múltiples actores sociales e instituciones, e 3) incorporado la filosofía ambiental en la investigación socioecológica. De esta manera, el programa del Parque Omora contribuye a ampliar la definición del componente social ("S") en las redes SESELP, y a generar metodologías para integrar, a múltiples escalas, dimensiones ecológicas y éticas en programas de investigación socioecológica, como también de educación y conservación biocultural, que podrían ser implementadas y evaluadas en otros sitios o redes SESELP.

Palabras clave: ética ambiental, Iniciativa para una Biosfera Sustentable, metáfora, Reserva de Biosfera Cabo de Hornos, subantártico.

INTRODUCTION

Global environmental change has an essential ethical dimension for at least two reasons. First, the ultimate causes of the current environmental crisis are rooted in the type of relationship established by industrial society with the natural world (White, 1967; Bormann & Kellert, 1991; Rozzi 2001). Consequently, to confront this crisis we require ethical changes in the "valuing" of ecosystems, human and non-human life, and the productive practices and market policies that impact both. Environmental ethics concerns itself with human societies as much as with nature and aims for the well being of both. Second, prevailing ethical perspectives propose that the question regarding what we ought to do to confront global environmental change involves ethical decisions and values. From this perspective, the sciences contribute to identify and characterize the proximate causes of the global environmental crisis and help define what we can do. But defining what we ought to do essentially encompasses an ethical response, subject to processes of conflict and deliberation among diverse social actors with contrasting values and interests (Broome 2008). Here, we propose an alternative ethical approach which overcomes the dissociated dichotomy between what we ought to do (derived from ethics) and what we can do (determined by the sciences). This approach is centered on the interrelations between the ways of disciplinary knowing and researching nature and the ways of dwelling (Rozzi 1999). Within this interdisciplinary dynamic, ecological sciences undertake a crucial role in motivating ethical changes in the ways of relation between contemporary society and the biosphere, grounded in changes in the ways humans ecologically perceive, know and understand ecosystems and their place in them.

From this perspective—in which ecological sciences and environmental ethics reciprocally inform one another—the network of Long-Term Socio-Ecological Research Sites (LTSER) can play a critical scientific and ethical role. They metaphorically represent "lenses" through which contemporary society explores ecosystems, biodiversity and the relations that human beings have with them. For scientists, policy-

makers, educators and society generally, at each given moment and in diverse regions, LTSER networks generate an ecological image of the world (Franklin et al. 1990). To fulfill this mission, we argue that the LTSER networks must aim to forge appropriate "conceptual lenses" as much as these networks aim to forge appropriate "technological sensors" to research and monitor socio-ecological systems. In this mission, environmental philosophy and ethics undertakes a task which is as relevant as the one undertaken by environmental engineering and the environmental sciences.

The incorporation of philosophical-scientific-technological methods broadens the spectrum of socio-ecological variables investigated by LTSER and promotes the consideration of ecological worldviews fostered by different cultural expressions such art, religion, and ethics, and by diverse ethnic groups with their languages and ecological practices (Callicott 1996, Hargrove 1997, Rozzi 1997). Through the integration of philosophical-scientific-technological methods, LTSER networks can significantly contribute towards better capturing and facilitating the expression of the vast diversity of traditional ecological knowledge and ethical-environmental values exhibited by diverse socio-cultural groups inhabiting the heterogeneous ecoregions of the planet. Consequently, the international connectivity of LTSER networks extends the geographic scale at the same time as amplifying the spectrum of ecological and cultural diversity.

With this vision, the specific contributions that the Omora Ethnobotanical Park's Sub-Antarctic Biocultural Conservation Program (SBCP) aims to offer to the Chilean LTSER Network are: (i) the incorporation of environmental philosophy and ethics into the long-term socio-ecological research programs and (ii) to consolidate greater international coverage of unique ecoregions and the multiple scales (local, regional, national, global) of LTSER networks.

To be effective in the current context of the global economy and environmental change, biological and cultural conservation initiatives must address multiple geographic and political scales and consider the sociocultural and ecological contexts of each ecoregion. With the aim of preventing the blind imposition of global models for development on singular realities and to promote instead the expression of diverse forms of life and traditional ecological knowledge of regional communities, we present here a methodological approach that we call "field environmental philosophy." With this approach, ecologists, philosophers and other professionals participate in projects of long-term biocultural conservation having "face to face" (cara a cara) direct encounters with biocultural diversity. Through field philosophy experience biocultural diversity stops being merely a concept and emerges as an experience of cohabitation with diverse living beings with their life histories that regularly remain outside the scopes considered in formal education and decision-making processes (Rozzi et al. 2005, 2008a). The practice of field environmental philosophy combines methods and concepts of "universal" ethics as taught in universities and prevailing in global culture with those of socioecological research. This methodology contributes to ecological, cultural and political contextualization of the scientific and ethical proposals by critically assessing their universal character. This field methodology also promotes new types of collaborations between ecology and the humanities, particularly for education and biocultural conservation (Rozzi et al. 2003, Callicott et al. 2007, Berghoefer et al. 2008).

To implement these interdisciplinary integrations and to articulate local and global scales, LTSER networks can play a central role beyond a mere research platform. Towards this end, we broaden the prevailing "case study" approach towards a collaborative methodology that ties the local scale of the site with national and international levels, which are all essential to effectively integrate research with social processes, in general, and with education and biocultural conservation, in particular.

Since the decade of the 1980s, an increasing number of scientists and humanists have made reiterative calls to integrate ecology, economics and ethics to address problems associated with global climate change, the accelerated loss of biodiversity, acid rain, the degradation of habitats and other dimensions of global environmental change (Bormann & Kellert 1991). As a result today, scientists, decision-makers and citizens are conscious that global environmental problems require the integration of ecological and social dimensions (Holling 2004, Jax & Rozzi 2004, Rozzi et al. 2006a, Anderson et al. 2008).Moreover, the bond and interrelation between human well-being and the well-being of other living beings has become increasingly more evident in ecological research (e.g., Rozzi & Feinsinger 2001, Millennium Ecosystem Assessment 2005). In response, interdisciplinary academic programs have been developed around socioecological concepts, such as ecological restoration (Jordan et al. 1987, Elliot 1994, Palmer & Filoso 2007; Estevez et al. this issue) and ecological economics (Daly & Townsend 1993, Daily 1997, Farber et al. 2006). These new programs have generated new concepts such as ecosystem goods and services, ecosystem health and restoration that have stimulated scientific research, and, the development of policies and strategies for conservation. In this context, LTSER programs have included socio-economic studies in an increasingly effective way (Haber et al. 2006). Nevertheless, the integration of environmental ethics, cultural and philosophical approaches in LTSER programs still represents a task to be achieved.

With the goal of contributing to solve these challenges, we propose in this article methodological approaches that have been effective to: i) articulate local, national and international scales in transdisciplinary long-term socio-ecological research programs, and ii) integrate ecological and environmental philosophical research into biocultural

education and conservation programs developed in a long term socio-ecological studies site.

We elaborate these methodological approaches based on the experience gained during the first ten years of the Sub-Antarctic Biocultural Conservation Program in the Omora Ethnobotanical Park in the archipelago region of Cape Horn (Fig. 1). The Omora Ethnobotanical Park is a co-founding member of the Chilean LTSER Network coordinated by the Institute of Ecology and Biodiversity (IEB), representing its southernmost and least anthropogenically disturbed site. The remote region of Cape Horn still shelters a small human population (2,500) and vast marine and terrestrial areas with low human impact (Mittermeier et al. 2003). However, during the two last decades these pristine areas have been facing increasing pressures of growth and development, massive tourism, salmon-culture, and other forms of natural resources exploitation. Within this context, the team of researchers of Omora Park has undertaken proactive measures of conservation and developed methodologies that could be useful towards broadening the integration of social and ecological dimensions on multiple geographic, cultural, political and organizational scales at other sites of the Chilean and international LTSER networks.

I. LINKING LOCAL, NATIONAL AND INTERNATIONAL SCALES IN THE SUB-ANTARCTIC MAGALLANES ECOREGION

The global environmental change arena, the free market and current global policies, demand that local-regional scale education, research and conservation programs be articulated with initiatives at national and international levels. It is important that local actors learn about global policies, and at the same time, that these local actors educate global actors about the unique regional biocultural diversity. This dialogical dynamic favors the incorporation of local and global forms of knowledge and criteria to collaboratively develop alternative processes for achieving sustainability and biocultural conservation. Otherwise, there is a risk that global policies will omit the singularities of regional biological and cultural diversity, due to public policies being oriented by purely global criteria that lead to undesirable biocultural homogenization. Biocultural homogenizations involves deliberate or accidental impositions of global biotas, languages, cultural patterns, education, administrative infrastructure, and economic systems upon the diversity of local regions, even in remote places like Cape Horn). To prevent these processes it is critical that the participants in local initiatives establish dialogue and collaborative teams with investigators, politicians and decision-makers applied at broader scales. Therefore, the Omora Park's LTSER program has defined a structure that organizes its activities of research, education and conservation with diverse institutions in three interdependent and synergistic scales: (I.1) local-regional, (I.2) national, and (I.3) international.

I.1 Local-regional scale: The Omora Ethnobotanical Park

The Omora Ethnobotanical Park covers approximately 1,000 hectares. The land is leased to the University of Magallanes (UMAG) and the Omora Foundation for a renewal periods of 25 years from the Ministry of National Lands. UMAG and Omora co-execute their programs in collaboration with the Institute of Ecology and Biodiversity (IEB). For its work at the local-regional scale, the Omora Park has played the role of a scientific center for the Cape Horn Biosphere Reserve (CHBR). In this role, it has taken as a model the Charles Darwin Field Station in Galápagos Biosphere Reserve, Ecuador to develop research programs that also provide content and criteria for sustainable tourism and conservation. To carry out this mission on the local-regional scale, the Omora Park has undertaken three main eco-social functions: i) conservation of the Róbalo River watershed, ii) identification and protection of a priority site for the conservation of biodiversity , and iii) establishment of a site for conducting research programs in environmental philosophy and environmental sciences.

I.1.1 Conservation the watershed at the end of the world

The Omora Park protects the river basin of the Róbalo River, which supplies drinking water to the town of Puerto Williams, capital of the Chilean Antarctic Province and the world's southernmost town (Fig. 1). By providing solid knowledge about the biological communities of the region, along with proposing and implementing measures to conserve the ecosystem integrity of this watershed, the Omora Park contributes to the long-term, natural regulation of both flow and quality of the water. A discovery of special relevance has been the singularity of the vegetation found in the Róbalo River basin, specifically the high diversity of non-vascular flora that characterizes sub-Antarctic forests and bogs (Rozzi et al. 2006a, 2008).

Non-vascular plants play a critical ecological role in the regulation of hydrologic flow; they contribute to the avoidance of floods when high precipitation events occur, and prevent the drastic diminution of water volumes during periods of drought. The bryophytes, lichens and other types of vegetation also contribute to maintaining the quality of the water. On the one hand, they prevent erosion; on the other, they act as a filter that retains sediments suspended in the water, especially in the peat bog habitats. The quality of the water is critical not only for drinking, but also for the operation of fishery canneries established in Cape Horn. For this industry, water use with a high degree of purity is crucial to avoid chemical processes, such as the rusting of cans that used to pack commercially valuable shellfish species, such asking

(*Lithodes santolla* Jacquinot, 1853) and queen crab (*Paralomis granulosa* Jacquinot, 1874).

The discovery of the importance of non-vascular flora illustrates how scientific research contributes to understanding characteristics of a sub-Antarctic river basin makes it different from others in the Chilean Central Andes, where the vascular flora play the most important role in hydrologic regulation. On the basis of this discovery, in collaboration with the Provincial Government and other public services, a novel model has been developed for the management of this watershed and public water resource. This model considers the ecological uniqueness of this remote region of the country and the continent. To consolidate this public-private alliance established by Omora Park's scientific program and state institutions, a Memorandum of Agreement with the Ministry of Public Works' Water General Authority and with the Ministry of National Lands are being developed. These agreements help insure the long-term protection of ecosystem services (high quality drinking water) provided by the biodiversity (especially the sub-Antarctic cryptogam flora) for the residents and industries of Puerto Williams.

I.1.2 Priority site for the conservation of Sub-Antarctic biodiversity

The Omora Park, the Róbalo River watershed and the Dientes de Navarino Mountain Range host a representative mosaic of the Cape Horn archipelago's sub-Antarctic habitats found south of Tierra del Fuego. These habitats include the world's southernmost forests. The area is dominated by *Nothofagus* species, with the evergreen Magellanic Beech forests (*N. betuloides* [Mirb.] Oerst) at low elevations (< 100 m), mixed evergreen and deciduous dominated by Magellanic Beech and High Deciduous Beech (*Nothofagus pumilio* [Poepp. et Endl.] Krasser, 1896) at intermediate elevations (100-250 m) and deciduous forests dominated by High Deciduous Beech and Low Deciduous Beech (*N. antarctica* [G. Forst.] Oerst., 1871) at the highest elevations (250-450 m; Fig. 2).

Given that the Róbalo Mountain and the Dientes de Navarino Range have the highest summits on Navarino Island, the Omora Park also protects a floristically diverse altitudinal profile on the north coast of the island (Rozzi et al. 2004, 2006b). This profile extends from the coast (intertidal and subtidal zones with kelp forests, *Macrocystis pyrifera* (L.) C. Agardh, 1820), rising through peat bogs, forests and shrubs (0 to 400 m approximately) until the high Andean zone that includes cushion plant formations and a prolific vegetation of lichens and mosses (400-900 m approximately). In the alpine or high Andean zone, at tree line on the summits of Róbalo Mountain and Dientes de Navarino Range, species of lichens such as *Usnea aurantiacoatra* (Jacq) are present, which are also found on the Antarctica Peninsula (Sancho et al. 2006). These botanical discoveries reveal the biogeographic linkages between the sub-Antarctic ecoregions and Antarctica (Goffinet et al. 2006).

For education and scientific tourism, the well preserved altitudinal profile of the Omora Park allow visitors to recognize and enjoy a beautiful and diverse mosaic of sub-Antarctic habitats found in a relatively small area, easily accessible from Puerto Williams (Ibarra et al. 2007). Additionally, in these habitats we can find nationally threatened and endangered species (e.g., the Andean condor, *Vultur gryphus* Linnaeus, 1758, and the Magellanic woodpecker, *Campephilus magellanicus* King, 1828), but at the Omora Ethnobotanical Park these species are relatively common (Arango et al. 2007, Ibarra et al. 2007).

Due to its ecosystem services, its rich biodiversity, and the park's programs for education and scientific tourism, in 2002, the Chilean National Environment Commission (CONAMA) identified the Omora Park and the adjacent area of the river basin as a priority site for the Conservation of Biodiversity in the Magallanes and Chilean Antarctic Region (CONAMA 2002). This designation was reinforced in 2003 by another national program coordinated by CONAMA: the Chile Trail. The Omora Park, located next to Bandera Mountain became the entrance way to the southernmost section of the Chile Trail, which allows people to cross Chile on foot (http://www.senderodechile.cl/1310/article-44617.html). Finally, in 2008 the Omora Park became a co-founding site of the Chilean LTSER Network, coordinated by the IEB (Anderson et al. 2008, Anderson et al. this volume). This network reinforces the continuity of the research, education and conservation programs in this high priority site for the preservation of sub-Antarctic biological diversity.

I.1.3 A biocultural research, education and conservation site in the Cape Horn Biosphere Reserve (CHBR)

Omora Park is located near Puerto Williams, which includes the Beagle Naval Base and the Ukika Village, where the majority of the members of the Indigenous Yahgan Community reside. For this reason, the park offers an ideal site to explore in situ the native habitats and learn about the different forms of knowing and valuing sub-Antarctic biodiversity. The park is visited by diverse local actors including persons from elementary and pre-schools, public services, the Yahgan Community, naval personnel, tourists, residents, and tourism operators. These people possess distinct knowledges, as well as social, cultural and economic interests and needs regarding sub-Antarctic biodiversity (Berghoefer et al. 2008). Moreover, this austral biodiversity—to a great extent—is omitted from the formal education programs in the Magallanes and Chilean Antarctic Region (Rozzi et al. 2008b). Therefore, the Omora Park's outdoor classroom fills a gap in formal and informal regional and national educational system.

The omission of sub-Antarctic diversity in formal education programs not only affects biological

diversity, but also cultural diversity. For this reason, in collaboration with members of the Yahgan Community, the Omora Park developed programs regarding the Yahgan language and ecological knowledge of the flora and fauna of Cape Horn (Rozzi et al. 2003, Zárraga et al. 2005, Massardo & Rozzi 2006). In addition, we have carried out educational workshops/programs with members of various socio-cultural groups in Cape Horn regarding charismatic species such as the woodpecker (Arango et al. 2007). First of all, these activities allow visitors to discover the richness of cultural diversity in Cape Horn. Secondly, the field experiences help to interrelate the cultural diversity of the many socio-ecological groups with the woodpecker and other living birds and beings who co-inhabit Cape Horn's landscapes. Thirdly, this interrelation between both diversities allows the participants of the workshops to formulate a synthesis for an understanding of sub-Antarctic biocultural diversity. Finally, this understanding enables the singularities of sub-Antarctic biocultural diversity to be incorporated into regional educational programs, policies and environmental norms that are relevant for the well-being of the diverse co-inhabitants.

The Omora Park has served and been served by the research, education and conservation activities associated with the Master's of Science Program in "Conservation and Management of Sub-Antarctic Natural Resources" at the University of Magallanes (UMAG). This is the first graduate program in either the Argentine or Chilean portions of Patagonian (http://www.umag.cl/recursos-naturales/magister). As part of the Omora Park, the curriculum of the UMAG graduate program emphasizes the importance of: i) experiences in the field, ii) natural history, iii) the interrelation between biological and cultural diversity, iv) the interrelation of the arts, environmental philosophy and ecological sciences, v) interdisciplinary integration in work practices within biocultural education, environmental decision-making, ecosystem management, eco-tourism, and vi) the intrinsic and instrumental ethical values of biocultural diversity, and the benefits that the conservation of this diversity entails for society.

The graduate-level field courses carried out in the coastal and high-Andean forests, peat bogs and other habitats of the Omora Park have allowed philosophers and scientists to explore ways of integrating environmental sciences, environmental ethics and the arts with the purpose of developing interdisciplinary research and educational methods designed to understand and to conserve austral biocultural diversity (Estevez et al. this volume). The UMAG graduate program includes formal and informal field experiences with private and public institutions, as well as student participation in projects of long term socio-ecological research in the CHBR. The recent collaboration of the Omora Park with the UMAG's Pre-School Education Department has further opened an additional avenue to enrich interdisciplinary interactions for the students and the establishment of pre-school educational for the region. This in turn has generated environmental, ecological and ethical education programs for pre-schoolers at the national level with the creation of the Little Explorer's Club by CONICYT. In this way, the park works as a natural laboratory and an interdisciplinary research center for the CHBR, whose vitality depends on graduate students from the UMAG and other Chilean and foreign academic institutions.

I.2 National scale: Chilean Network of Long-Term Socio-Ecological Research Sites

In 2008, the Omora Park co-founded the first Chilean LTSER Network (Anderson et al. 2008) with financing from CONICYT's Basal Financing Program and the Ministry of Planning's Millennium Scientific Initiative. The network's initial goal (2008-2011) is to consolidate the existing education and research programs between the three founding sites: Fray Jorge Experimental Site (30° S) (see Gutiérrez et al. this volume), Senda Darwin Biological Station (42° S) (see Carmona et al. this volume) and the Omora Park (55° S). In its second phase (2011-2013), the initiative plans to include new study sites, especially in biomes currently underrepresented such as the Central Chilean Andes and the Atacama Desert. This network, coordinated by the IEB, provides a unique platform to develop interdisciplinary research on biodiversity, ecosystem processes and global environmental change, and on the interrelations of these with society through a theoretical and applied socio-ecological research program. The strength of this platform derives on the one hand from the quality of the groups of researchers and institutions associated with IEB, including the University of Chile, Pontific Catholic University, University of La Serena, University of Conception and University of Magallanes. On the other hand, these institutions and the three field stations cover a geographic area that: i) extends across the longest latitudinal gradient of Southern Hemisphere temperate forests, ii) this gradient includes noticeable changes in precipitation, temperature and photo-periods, iii) corresponds to the area of the world with the lowest air pollution due to atmospheric deposition (Galloway et al. 2004). In addition, the programs of the three sites accumulatively consolidate 20 years of long term research and pioneering initiatives in the integration of academic disciplines and between academia and society (Armesto 1990, 1995, Anderson et al. 2008).

The network has a fundamental mission to develop long-term research to reinforce and implement international and interdisciplinary field courses that give relevance to research in social, regional and global contexts. With respect to the research programs of this Chilean LTSER Network, a record of biophysical variables is being accumulated to characterize ecosystem and climatic processes with comparable methodologies between the three sites, and with the International Long-Term Ecological Research (ILTER)

network. The databases will be used to carry out long-term experiments and to evaluate the responses of biota and ecosystems in the face of global climatic change at different latitudes.

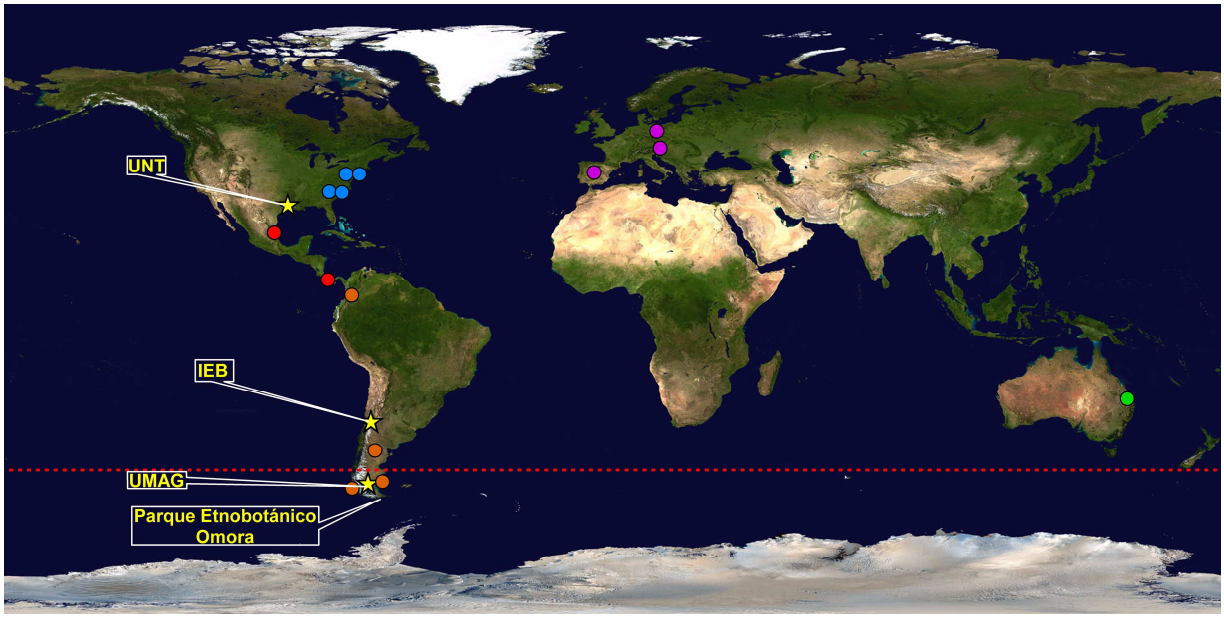
Within the scope of ecological research, the Omora Park will significantly benefit from the extensive experience of the research team at the Senda Darwin Biological Station and the Fray Jorge Experimental Site, as well as the IEB's other programs and associated institutions. In turn, Omora Park's research team contributes with: i) the longest-running monthly Passeriformes bird banding program in southern South America, carried out with the authorization and in collaboration with the Agriculture and Livestock Service (SAG) and the National Banding Office; ii) a research and control program for invasive exotic mammals, developed with SAG; iii) diversity inventories and life history studies of aquatic invertebrate fauna; iv) studies on marine biodiversity and potential use of sub-Antarctic seaweeds; and v) diversity and ecological studies of bryophytes and lichens.

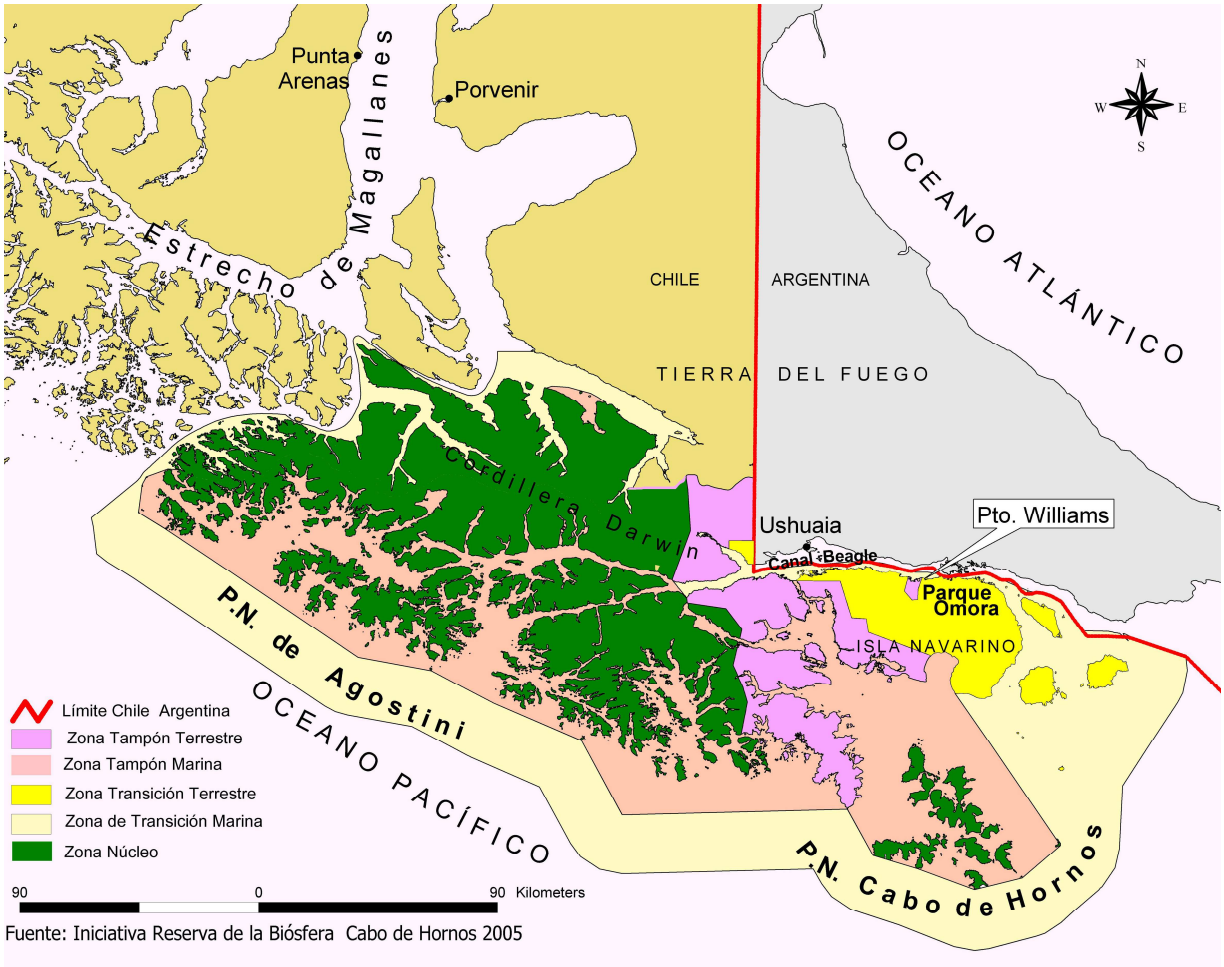
Within the LTSER Network coordinated by the IEB, the Omora Park has the specific mission to develop new methodologies and approaches for education and biocultural conservation and to contribute to the integration of the social and ecological dimensions of theoretical and applied research. Furthermore, the Basal Financing Program of CONICYT explicitly requires that selected "Centers of Excellence" contribute to enhancing the social development of Chile and its economy competitivity. Against this backdrop, the Omora Park develops scientific tourism programs that include applied research, tourism guide training, publication of materials and the implementation of ecotourism infrastructure. A specific project has been the identification and implementation of charismatic species and habitats such as the Magellanic woodpecker (*C. magellanicus* King, 1828) or the green-backed fire-crowned hummingbird (*Sephanoides sephaniodes* Lesson, 1827), called omora in the Yahgan language (Arango et al. 2007). The Omora Park is also innovating with the proposal of charismatic lichens, mosses and insects. Charismatic, or flagship, species have shown to be effective for conservation and ecotourism initiatives. Currently, the Omora Park is contributing to the identification of a flagship species for each of the LTSER sites. A long-term goal is the development of methodologies to integrate environmental philosophy into the theory and praxis of research, education and biocultural conservation. The development of this goal is based on an alliance with international institutions, in particular the University of North Texas (UNT), that possess a world renowned program in environmental philosophy and ethics that integrates environmental education and sciences.

I.3 International scale: The Sub-Antarctic Biocultural Conservation Program

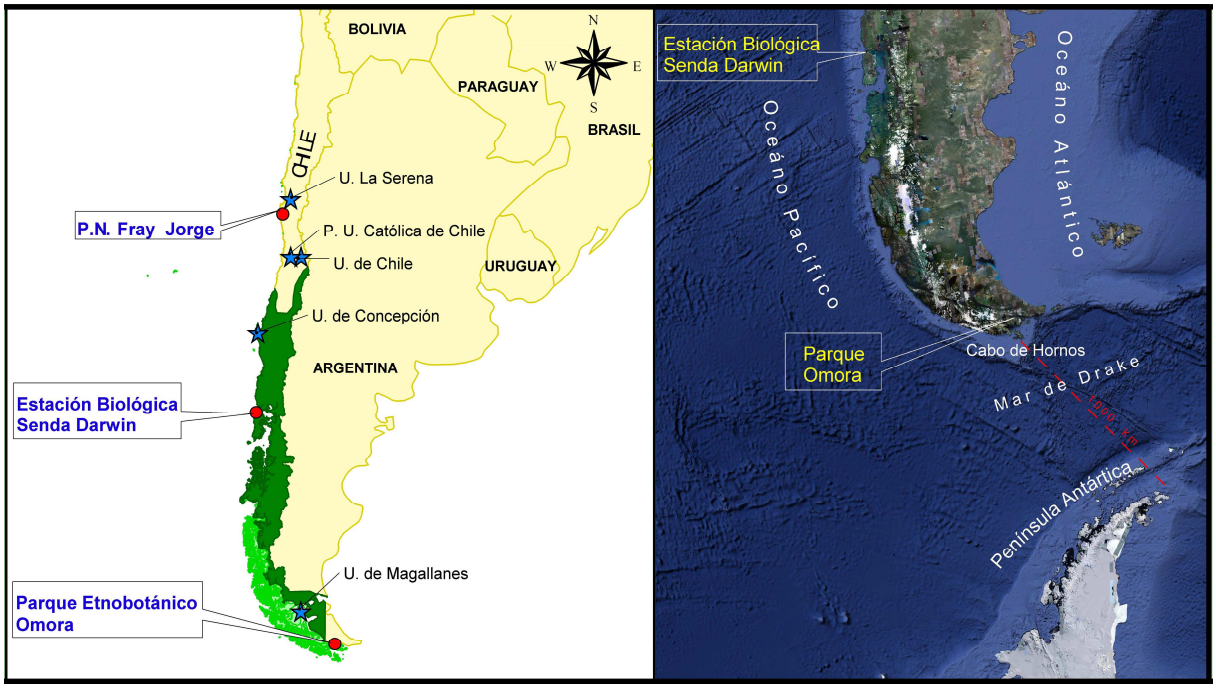
As stated in the Introduction, the Omora Park's program has defined two main goals for its ecological research in order to achieve social relevance in the context of global environmental change: i) by linking research programs on local and national scales with global levels, and ii) by integrating ecological sciences and environmental ethics. To achieve these two goals, UNT has been an ideal collaborator for two reasons. First, it hosts the non-profit Center for Environmental Philosophy (CEP; http://www.cep.unt.edu), which in 1978 founded the first and the world's leading journal in the field, Environmental Ethics (Hargrove 1988). By the end of the 1990's, we initiated a collaboration with CEP that introduced a series of articles on environmental ethics, conservation and education in Chile (e.g., Hargrove 1997, Oelschlaeger & Rozzi 1998). This collaboration also stimulated the creation of the South American Chapter of the International Society of Environmental Ethics in 1998 (http://www.cep.unt.edu/ISEE.html). The second reason is that UNT has integrated environmental sciences and ethics into education and research in undergraduate and graduate programs. Moreover, recently the university prioritized the objectives of interdisciplinarity, internationalization and diversity as the three key themes of its strategic plan (UNT 2008). Against this backdrop, at the beginning of the 2000's, UMAG in association with IEB initiated collaborations with UNT, leading to the was formal creation of the Sub-Antarctic Biocultural Conservation Program in 2007 (http://www.chile.unt.edu and http://www.umag.cl/williams). The program now maintains offices at the UMAG campuses in Puerto Williams and Punta Arenas, Chile, and at UNT's main campus in Denton, Texas, USA. The coordinating institutions of each country finance their own personnel and offices, and for the academic consolidation of the program, UNT and UMAG are both hiring new professionals who are developing collaborative projects between these two core institutions, the IEB and other associated academic centers (Fig. 1a, b).

Currently, this alliance is coordinated by three Chilean institutions - IEB, UMAG and the Omora Foundation (http://www.ieb-chile.cl, http://www.umag.cl, http://www.omora.org) - and by three U.S. institutions, UNT, CEP and the non-profit organization OSARA (Omora Sub-Antarctic Research Alliance; http://www.osara.org; http://www.unt.edu, Anderson et al. 2008). In some regards, this partnership of six institutions has looked to the Organization for Tropical Studies (OTS), housed at Duke University and with offices in San Jose, Costa Rica (http://www.ots.duke.edu/), as an example of an international, organizational model. Founded in the 1960's, OTS maintains three biological stations in Costa Rica, among which La Selva Biological Station is by far the best known. These biological stations have been fundamental for the discovery of the high biodiversity in tropical ecosystems, and similarly, for communicating the planetary importance of these ecosystems. OTS today consists of a consortium of





Fuente: Iniciativa Reserva de la Biósfera Cabo de Hornos 2005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Senda Darwin
U. de Magallanes
Parque Etnobotánico
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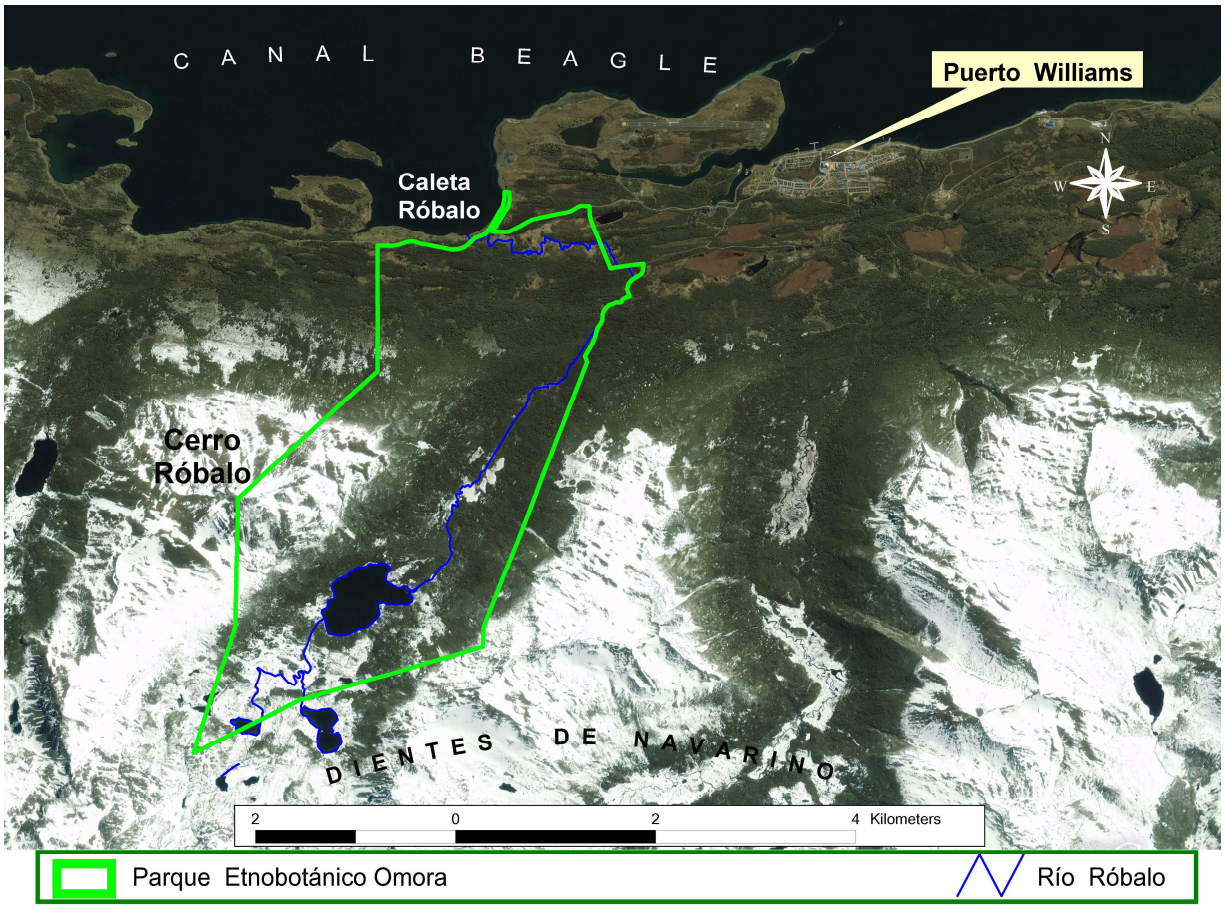
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partners formed by 60 universities and institutions from North America, Latin American (Costa Rica, Mexico, Peru), South Africa and Australia.

OTS has served as a model for the development of our Sub-Antarctic Biocultural Conservation Program. Yet, our program stands out for the significant symmetry between the Chilean and U.S. institutions, which is not the case for OTS. In addition, our program is distinguished from OTS in three fundamental aspects: i) with respect to the geographic area, we concentrate on high latitudes that have received less conservation attention compared to tropical latitudes; ii) with respect to course methodology, our program emphasizes the integration of Latin American and U.S. students who participate together, whereas the OTS offers separate courses for U.S. and Latin American students; and iii) with respect to the thematic core, OTS historically has concentrated on ecological research, and recently incorporated some socio-economic questions, while our courses and research primarily emphasizes a socio-ecological approach, integrating ecological sciences, environmental ethics and the arts into the theory and practice of eco-tourism, education and biocultural conservation. These interesting complementary approaches of the OTS and the Sub-Antarctic Biocultural Conservation Program provide a foundation for fruitful collaborations between both programs.

With the aim of promoting a dialogue between Latin American and North American ecologists, philosophers and other environmental thinkers, the Sub-Antarctic Biocultural Conservation Program has inaugurated a series of bilingual publications (Spanish and English) on environmental philosophy, ecology and conservation. This series includes Occasional Papers posted online through the International Society of Environmental Ethics and the Center for Environmental Philosophy (http://www.cep.unt.edu/iseepapers/index.htm), and a number of special issues in the journal Environmental Ethics (2008, 30[3] and 2011, in preparation). This bilingual special edition of the Revista Chilena de Historia Natural (2010, 83[1]) complements this series. Additionally, a joint publishing line between UNT and UMAG Presses has been created, including three types of books: i) annotated translations of fundamental Anglo-Saxon and Latin American environmental philosophy works translated into Spanish and English, respectively; ii) tourism field guides on sub-Antarctic biocultural diversity and conservation for educators, operators and the general public; iii) academic books based on original research in ecology, natural history, biocultural diversity and conservation of the temperate and sub-Antarctic ecoregion of southern South America.

This series of publications, and the program in general, promotes the theory and practice of biocultural conservation and its implementation into long-term international research programs. It emphasizes the interrelation between ecological sciences and environmental ethics (Estévez et al. this volume). The network of academic collaborations in long-term ecological research is embedded in international networks of botanical gardens (e.g., Network of Latin American Sister Ethnobotanical Gardens), alliances of community participation and leadership (e.g., AVINA), and international education initiatives (e.g., Audubon's Schoolyard Ecology Program) that promote sustainability.

II. TWO INFLUENTIAL INTERNATIONAL INITIATIVES

Among the international networks that promote ecological and social sustainability, two have been especially influential for the defining of methodologies for Omora Park's education, research and biocultural conservation programs: i) the Man and the Biosphere Program, run by the United Nations Educational, Scientific and Cultural Organization (UNESCO) and ii) the Sustainable Biosphere Initiative (SBI), created by the Ecological Society of America (ESA).

II.1. UNESCO "Man and the Biosphere" Program: A stimulus for the creation of the Cape Horn Biosphere Reserve

The Man and the Biosphere Program (MaB) of UNESCO began in 1970 with the purpose of overcoming preservationist approaches to biological conservation, which excluded humans from protected areas. It had the intention of promoting, instead, a perspective that would reconcile social, cultural, recreational and ecological needs (Guevara & Laborde 2008). A fundamental element of the MaB Program's method was the establishment of an international network of biosphere reserves. This network has come to include a mosaic of world unique sites that correspond with the planet's major ecosystems through the development of research programs, monitoring, education, conservation and sustainable development. Today MaB has central objectives that are similar to the Omora Park's: i) to diminish the losses of biological diversity, ii) to regenerate and bring back consciousness about the interdependence of biological and cultural diversity, and iii) to promote environmental sustainability through the worldwide Biosphere Reserve Network.

During the 1990's, a diverse team of residents, authorities and academics associated with the creation of the Omora Ethnobotanical Park noticed the largely parallel objectives of the MaB Program with our biocultural approach. Moreover, in 1996 the MaB Program defined the Seville Strategy (UNESCO 1996) whereby biosphere reserves must achieve three complementary functions: a) biodiversity conservation, b) sustainable social and economic development, and c) logistical support for research, education and monitoring.

Given the coincidence of MaB's objectives with our own, the Omora Park began a close collaboration with the Regional Government in 2001 to facilitate a process to present before UNESCO the Cape Horn archipelago as a site that is unique in the world that

deserved the designation of biosphere reserve. The application process was led politically by the Chilean Antarctic Provincial Government, the Chilean National Forestry Corporation (CONAF), the Chilean National Environment Commission (CONAMA), the Ministry of National Lands, the Chilean Navy and the Municipality of Navarino. The latter changed its name to Cape Horn Municipality in 2002 as part of the process of building an identity (Barros & Harcha 2004). During this time, the research team of the Omora Park assumed a technical role for the preparation of the document proposal that was approved during the annual meeting of the International Coordination Council of the UNESCO MaB Program on June 27th, 2005;which is recognized as the official date of the creation of the Cape Horn Biosphere Reserve (CHBR; Rozzi et al 2006b).

During the five year process of preparing the CHBR proposal, the Omora Park's researchers worked with authorities: i) facilitating the participation in the process of the major sectors of the local community, particularly the education community and the Indigenous Yahgan Community,; ii) to coordinate inter-institutional collaboration, especially with the Corporation for the Promotion of Production (CORFO), the National Tourism Service (SERNATUR), the Agricultural and Livestock Service (SAG), the National Corporation for Indigenous Development (CONADI), the National Fisheries Service (SERNAPESCA) and the Undersecretary for Navy Affairs Office of the Ministry of Defense; iii) to promote the association of local researchers with national research centers (e.g., Chilean Antarctic Institute, Chilean National Museum of Natural History) and international institutions (Fig.1a). This continuous inter-institutional working plan generated three processes and products that are coherent with or are demanded by the MaB Program: 1) definition of the zoning for the CHBR, 2) control of invasive and harmful species to prevent environmental degradation in the CHBR, and 3) development of innovative themes, trails and navigation routes, and activities for sub-Antarctic scientific tourism to contribute to economic and environmental sustainability in the CHBR.

II.1.1. Territorial planning: Zoning of the Cape Horn Biosphere Reserve (CHBR)

Delimiting the territory of the CHBR required a complex integration of ecological, historical, social, political and economic research. The results of this research provided a baseline for the intense processes of discussion and deliberation to define the zoning of the CHBR. The proposed zones included all of Cape Horn County in the Chilean Antarctic Province and a sector of Timaukel County in Tierra del Fuego Province. The marine and terrestrial areas included almost exclusively state lands subject to the administration and regulation of diverse public services at the county, provincial, regional and national levels. The three types of basic zones that constitute a biosphere reserve and that comprised a significant and intense discussion were (i) core zones (areas of strict preservation), (ii) buffer zones (areas where low impact activities are permitted, such as ecotourism and artisanal fisheries), and (iii) transition zones (areas that permits development activities, as well as infrastructure for tourism and other sustainable economic activities).

The biosphere reserve model demands that the core zone posses a degree of legal protection. As a result, the only core zones that qualified were the national parks regulated by Law 18.362 of the State Protected Wilderness Areas. The advisors from UNESCO, as well as researchers from the Omora Park, recommended to include Cape Horn (44,000 ha) and Alberto de Agostini (1,400,000 ha) national parks as core areas. This recommendation was accepted by the authorities and other actors (Figure 1c). In contrast, regarding the buffer zone and the transition zone, the debate between the local community, public services and private industry was intense, especially with respect to the geographic areas where salmon farming would be permitted or where tourism infrastructure would be allowed. As a result, transition areas were defined that would support the development of necessary tourism infrastructure (e.g., hotels, airports, port facilities) and also industrial development, following the best environmental practices and held accountable to strict environmental norms (Barros & Harcha 2004). In these transition areas, facilities and essential services would be provided for sustainable tourism without impacting the core or the buffer zone. For example, in the transition zone, the visitors could embark on yachts, fishing boats or other vessels adapted to tourism and navigate through the pristine areas (core zone) and visit areas that allow low impact activities in the buffer zone. This zoning favors (a) the local economy, (b) the quality of the experience for the visitor that sails through Cape Horn, which is how the area has been visited ancestrally, (c) the national and global economy because it offers a unique activity, and (d) biocultural conservation because the pristine character of the area is maintained, as well as the cultural traditions such as navigating and artisanal fishing. In spite of this favorable zoning for multiple actors and that the zoning map expresses the consensus achieved between governmental authorities and the majority of the owners or leases of the land and the scientific committee (Figure 1 C), the debate over territorial planning has continue after UNESCO designated the CHBR in 2005. For example, investors from other regions and national or foreign tourism companies have repeatedly presented proposals to construct infrastructure for lodging in the core areas. Such proposals would undermine the four types of benefits: economic, social, cultural and ecological, which were achieved by the current territorial plan.

In this context, the long-term socio-ecological sites provide an appropriate strategy to satisfy demands for local and regional information and technical capacities. Political processes, such as the defining of the CHBR zoning, do not only require

submitting technical reports and scientific information at the beginning of the process, but it also demands a technical-scientific team that is capable and available to continually interact with authorities and diverse social actors over the long term. For this reason, the researchers of the Omora Park have created long-term research, education and conservation programs that maintain continual participation, offering the best technical criteria and scientific information in the debates, such as the zoning of the CHBR, to maintain and adapt economic and sustainable environmental practices in ever-changing political and ecological scenarios (Rozzi et al. 2007).

II.1.2. Inventory and management of invasive exotic species

One of the principal biological threats to the preservation of biodiversity in the Cape Horn Archipelago is the rapid geographic and population expansion of invasive exotic mammals, such as the North American beaver (*Castor Canadensis* Kuhl, 1820) and the muskrat (*Ondatra zibethicus* L., 1766), which arrived to Navarino Island from Tierra del Fuego in the 1950s or 1960s (Anderson et al. 2006). More recently, in 2002, the researchers at the Omora Park detected the arrival and rapid expansion of the American mink (*Neovison vison* Schreber, 1777) (Rozzi & Sherriffs 2003). This latter species is an voracious predator which has drastically impacted endemic species, such as the flightless steamer duck (*Tachyeres pteneres* Forster, 1844), and the kelp goose (*Cloephaga hybrida* Molina, 1782). Both species nest on the ground and evolved under low predatory pressures by native mammals (Ibarra 2008, Ibarra et al. 2009, Schüttler 2009, Schüttler et al. 2008, 2009).

In the case of beavers, their negative socio-economic impact was apparent to authorities during a period of intense rainfall and flooding in 2002. A series of beaver dams that were built from the headwaters to the outflow of local river systems did not resist the high flood waters and broke, provoking a “domino effect” that destroyed the bridges along the north coast of Navarino Island. The high economic cost to rebuild this infrastructure made clear to governmental authorities that these exotic mammals represent a negative cost not only in ecological terms, but also economically.

Feral domestic animals, such as dogs, cats and pigs, also constitute a grave problem for the ecological integrity, economic activities and cultural patrimony of the island (Anderson et al. 2006). For example, dogs threaten a small population of guanacos (*Lama guanicoe* Mueller, 1776) remaining on Navarino Island. Dogs also provide economic losses by decimating livestock. Feral pigs have had irreparable harm on historical and cultural legacies associated with millenary Yahgan archeological sites. Yahgan shell middens, stone workshops and burial grounds have been devastated by these animals on the north and west coast of Navarino Island (La Prensa Austral 2009a, 2009b).

The scientific findings conducted by the scientific team of the Omora Park, since 2000, alerted the authorities and the community to the threats that exotic, invasive mammal species represent in terms of ecological, social and cultural impacts. In this way, research and monitoring of these species stimulated collective work between Omora Park researchers, the Chilean Antarctic Provincial Government and the Chilean Agricultural and Livestock Service (SAG) to formulate and implement a program of detection, evaluation and control of harmful species, which was then applied to the entire Magallanes and Chilean Antarctic Region in 2004. The establishment of this control program in the region, with a special emphasis on the CHBR, served to illustrate the political and economic relevance that long-term socio-ecological research sites, such as the Omora Park, can have.

The Omora Park’s program emphasizes in situ interdisciplinary and inter-institutional collaborations that enable the detection of socio-ecological problems and the creation of public awareness about them (Rozzi et al 2006a). Under this methodological approach, the scientists and graduate students need to be trained and be on call to collaborate with authorities and the community. The long-term programs at LTSER sites enable not only address the diagnosis and the communication of socio-ecological problems. They also enable collaborative to conceive of potential solutions and achieve the political and economic consensuses which are necessary to implement the proposed solutions, as illustrated by the case of the program for exotic species control in the CHBR and the Magellanic and Chilean Antarctic Region.

II.1.3. Scientific tourism and subantarctic ecotourism

The current Regional Development Plan for Magallanes and the Chilean Antarctic defines tourism as one of the five principal priorities for economic development. Among tourism activities, nature tourism represents the principal attraction for visitors to the region (Chacón 2002, García 2004). The subantarctic ecoregion of Magallanes, the Cape Horn Biosphere Reserve and the Chilean Antarctic Peninsula represent one of the last "wild" destinations for the global citizen, who is day-by-day, increasingly urbanized, industrialized and homogenized. This is reflected in the increasing number of foreign visitors documented for the Magallanes and Chilean Antarctic Region and the town of Puerto Williams (Figure 4). During the last decade, the number of foreign tourists has doubled in the region and increased by an order of magnitude in Puerto Williams. The explosive increase in the number of foreign visitors to Puerto Williams is in part the result of the opening of a border crossing from the Argentine city of Ushuaia, located on the north coast of the Beagle Channel. Ushuaia receives more than 300,000 foreign tourists each year, who since 2003 have had the opportunity to visit Chilean areas by directly crossing the Beagle

Channel.

Considering that the number of visitors to Cape Horn has increased exponentially, the prevention of negative impacts generated by tourism is critical to avoid harmful effects to biological and cultural diversity (cfr. Fennel & Ebert 2004). Ecotourism can be a long-term "gold mine" for the region, if planned and managed in an adequate way. As former regional governor Eduardo Barros stated in CHBR pre-proposal, this type of ecotourism would "represent a shift in the State's vision of development, previously based on short-term economic cycles based on extractive and unsustainable activities, including the hunting of whales and the gold rush of the 19th century or oil exploitation during the 20th century" (Barros & Harcha 2004). For this reason, the researchers of the Omora Park have collaborated with the Regional Government and the National Tourism Service to define criteria for ecotourism that contributes to the conservation and valuing of the singularities of subantarctic biocultural conservation. Specifically, these researchers have collaborated with the development of sustainable tourism in the CHBR through three essential ways:

i. The Omora Park has become a scientific tourism attraction. In this long-term socio-ecological site, visitors are guided by graduate students or local specialized field guides, who help them to discover the beauty and diversity of such things as aquatic and marine invertebrates in the world's purest waters (Ojeda et al. 2010).

ii. The researchers and graduate students have created novel topics and activities that diversity the scientific tourism offerings in Cape Horn and the Antarctic Peninsula through practices such as "Tourism with a Hand Lens" that permit visitors to appreciate and enjoy the ecological importance of these colorful lichens that grow in the sub-Antarctic forests, tundra and intertidal zones (Rozzi 2005, Goffinet et al. 2006).

iii. In association with the UMAG's Master's of Science Program, the Puerto Williams Elementary School has established a program for the formation of specialized guides for scientific sub-Antarctic tourism with a solid education in ecological sciences, environmental ethics, biocultural diversity and conservation (Rozzi et al. 2006b).

These contributions to sustainable tourism illustrate again the importance of LTSER sites with groups of researchers and students prepared and available to interact beyond the circle of scientific colleagues. This place-based work cannot be substituted by submitting scientific publications or technical reports. Long-term activities permit dynamic development of participative education that offers an effective way of communicating and sharing the results of scientific research in such a manner that complements publications, and at the same time it is integrated in a dialogue with the changing scenarios of the market (e.g., tourism), the necessities of local inhabitants and new scientific discoveries. These are essential characteristics of the UNESCO MaB Program goals. To achieve them, the Omora Park's approach emphasizes the relevance of a long-term transdisciplinary methodology (sensu Hirsh-Handom et al. 2008), which integrates not only disciplines but also a diverse array of institutions and actors.

II.2 A Chilean adaptation of the Sustainable Biosphere Initiative (SBI)

In 1988, the Ecological Society of America (ESA) generated the Sustainable Biosphere Initiative (SBI) with the goal of defining the research priorities for ecological sciences in terms of its potential to advance scientific knowledge, as well as to contribute to human well-being (Lubchenco et al. 1991). With respect to the second objective, at the end of the 20th century, the necessity of possessing solid ecological knowledge had become evident to promote the sustainable use of the planet's natural resources: "[to] ameliorat[e] the rapidly deteriorating state of the environment and enhanc[e] its capacity to sustain the needs of the world's population" (Mooney & Levin 1991). In Chile, the SBI document was translated, published and commented upon in the Revista Chilena de Historia Natural (Fuentes & Castilla 1991, Huntley et al.1991, Lubchenco et al. 1991b). In spite of the fact the SBI was criticized in some quarters as utopian (Rubenstein 1993), its approach motivated the first author of this article to work at the interface of ecology and society, and it has a strong influence on the initial conceptual framework for the creation of the Senda Darwin Biological Station on Chiloé Island (42° S) in 1994 and the Omora Park on Navarino Island (55° S) in the Cape Horn archipelago in 1999 (see Rozzi et al. 2000, 2006b).

The multi-faceted program of the Omora Park adopted the SBI's triangle that proposes three essential areas of work for "i) basic research for the acquisition of ecological knowledge, ii) communication of that knowledge to citizens, and iii) incorporation of that knowledge into policy and management decisions" (Lubchenco et al. 1991a, p. 373). Regarding this last aspect, the principle objective of the SBI was "making ecological knowledge available to managers and decision-makers" (Barber & Matson 2000). This affirmation emphasizes a type of unidirectional communication of ecological knowledge from science to society. This concept of one-directional outreach (i.e. "reaching out") is notably embedded in the LTER programs and the majority of scientific institutions. In Chile, for example, the official education program of CONICYT establishes explicitly that its activities are oriented "to communicate the benefits and advances of science and technology" (http://www.conicyt.cl/573/article-3463.html). Under this approach, science education programs are conceived fundamentally as a task of reaching out towards society to incorporate the results and methods from scientific research into decision making and education programs.

The Omora Park's program has tried to reverse this one-directional communication by means of continuous collaboration with authorities, educators and other relevant actors during political processes about decision-making regarding environmental, developmental and educational initiatives. More than focusing on preparing scientific reports and publications that eventually could be read and used by decision makers or educators, we have established multi-directional working dynamics. Symbolically, to underline this dialogic process for decision making and reciprocal learning, the Omora Park's researchers have modified the original SBI triangle to incorporate bidirectional arrows (Fig. 5). Additionally, we substituted the third domain of activities in the triangle ("the incorporation of scientific knowledge into decision making and environmental policies") by "biocultural conservation". This redefinition emphasizes again that to contribute to sustainability it is not sufficient for scientists to generate knowledge for decision makers, but rather it is essential for them to participate in long-term inter-institutional collaborations with diverse socio-cultural groups. Although subtle, this change in the design of the triangle has served to promote interactions that are reciprocal between ecologists and other social actors participating in transdisciplinary programs of long-term socio-ecological research (Rozzi et al. 2006a).

In summary, to achieve a sustainable biosphere and to integrate the MaB Program, our local adaptations to the existing agendas of the ESA and UNESCO, respectively, underline the importance of establishing LTSER sites that include researchers who are prepared and in the disposition to be on call to collaborate with diverse social actors. It is not sufficient to publish scientific articles or generate consultant reports, which are the "methodologies" that are most rewarded by academic evaluation for faculty, and by national and international funding agencies. Based on the experience of the Sub-Antarctic Biocultural Conservation Program at Omora Park, the participants from universities, the community and the Chilean government have identified a posteriori ten principles that have been effective in integrating long-term socio-ecological research in the implementation of sustainable environmental policy (adapted from Rozzi et al. 2006a):

1) Place-based experience with decision makers, researchers and other participants for "direct encounters" (face-to-face) with human and non-human beings in their regional habitats;

2) Transdisciplinary integration of sciences, arts, philosophy and environmental decision making;

3) Identification and implementation of charismatic species such as the green-backed fire-crowned hummingbird (*Sephanoides sephaniodes*), or omora in Yahgan language, which act as symbols of the regional biocultural richness;

4) Continuous communication of the results, conflicts, and actions through the media;

5) Participatory approach, collaboratively working in education and conservation with others, and not only providing information;

6) Cross-institutional cooperation to bridge academic, community and governmental day-to-day work;

7) Multiple scaled creation of collaborative networks with research, education and/or conservation centers at local, regional and international levels that permit the identification of causes and propose solutions for environmental problems at diverse geopolitical scales;

8) Economic sustainability through strategies that link ecosystems and local trade practices with national and international economies, such as ecotourism;

9) Administrative sustainability through the establishment of infrastructure, conservation areas and LTSER programs, such as the Cape Horn Field Station associated with the Omora Park or territorial planning through the zoning of the Cape Horn Biosphere Reserve, adapting the UNESCO MaB model;

10) Conceptual sustainability through adaptive, transdisciplinary, site-based, long-term research, education and conservation programs, which are attuned to the ever-changing political, economic and environmental systems, at local, national and international scales.

In other articles, we have described in detail the ten principles that have guided the contribution of the Omora Ethnobotanical Park for the creation of the Cape Horn Biosphere Reserve, and the establishment of a sub-Antarctic biocultural research, education and conservation program. These ten principles could offer a methodological orientation for the incorporation of the social dimension in other LTSER programs, aimed at sustainability and socio-ecological well-being (cfr. Rozzi et al. 2006a). In the final section of this article, we present a specific methodology to integrate ecology, environmental ethics and art in the context of broadening the "social" component of LTSER and contribute to biocultural conservation, sustainability and the integration of human beings with the biosphere.

III. THE FOUR STEP CYCLE: A METHODOLOGY FOR INTEGRATING BIOCULTURAL RESEARCH, EDUCATION, AND CONSERVATION

The vitality of the Omora Ethnobotanical Park Program depends largely on the participation of academics and students interested in developing research areas which cover ecological, social and political figures involved in environmental decision making. However, to sustain this activity in the long term, and to integrate into biocultural education and conservation the domains of ecological and social research e _-especially of the research in environmental ethics— we had to face the challenge of designing new methodologies and curriculums to enable graduate students to achieve this integration in a systematic and formal way. First we analyzed what steps had been critical to achieving

results in the integration of ecological and ethical dimensions into biocultural education and biocultural conservation during our ten-year program at Omora Park, and identified a simple four-step cycle including: i) interdisciplinary ecology and philosophy research, ii) composition of metaphors and communication through simple narratives, iii) design of field activities guided with an ecological and ethical orientation, and iv) the identification and implementation of in situ conservation areas.

These four steps allow graduate students to develop theoretical research and integrate it into innovative biocultural education and conservation activities. Below is a brief summary of the concepts and activities that are included in this synthesis of the four-step cycle, which we complement with an illustration of the methodological steps in two cases that are part of thesis work developed by students of the Master Program in Sub-Antarctic Biocultural Conservation at UMAG (Figures 7 and 8).

III.1 Synthesis of the four-step cycle

The four steps that have enabled the integration of ecological and social research within the education and conservation programs of Omora Park can be summarized into the following concepts and actions.

Step 1: Interdisciplinary Ecological and Philosophical Research

LTSER sites enable the development of transdisciplinary research programs with the participation of diverse institutions, disciplines and sociocultural groups, which have different languages, knowledge forms and ecological practices. The Omora Park's biocultural research program investigates the subantarctic biodiversity at the same time as the diversity of perceptions, names, ecological practices and worldviews about this biodiversity. For example, with respect to the Greenbacked Firecrown (*Sephanoides sephaniodes*) the researchers study the sugar content in the nectar of the flowers visited by this hummingbird, at the same time they record the stories associated with its name in various languages: Yahgan, omora; Mapudungun, pinda; English, hummingbird; and in Spanish, picaflor (Fig. 6). With a finer resolution biocultural filter, we also research the ecological knowledge and perspectives, and the environmental ethics held by different sociocultural groups and institutions, such as the authorities of government, professors of school or personnel of the Chilean Navy. Comparative analyses of the ecological knowledges possessed by diverse sociocultural groups, their ecological perspectives and values, and the respective comparison with ways of understanding and valuation derived from ecological sciences and environmental ethics, has allowed the identification of similarities and differences among the various ways of knowing, valuing and coexisting with biocultural diversity. These comparative analyses also help to recognize more specific causes of some environmental problems along with opportunities for solving them (Appendix 1). With this last objective, the research also broaches questions about how to integrate ecological and environmental philosophy research into concepts and activities within biocultural education and conservation, as addressed in the other steps of the cycle.

Step 2: Composition of metaphors and communication through narratives

The program of Omora Park incorporates the composition of metaphors as an essential phase, and requires that participating graduate students compose metaphors with a double intention: (i) to generate communicative figures with the general public, and (ii) to integrate the discoveries of the ecological and philosophical research through analogical thought that leads to a conceptual synthesis of facts, values and action in biocultural education and/or conservation. In contrast with prevalent viewpoints during the second half of the 20th century which maintain that metaphors cannot be part of scientific discourse, recently it has been proposed that they constitute cognitive-linguistic figures, which are part of our conceptual schemes and generate an acute clarifying character of the abstract, as much in the everyday as in scientific thought (Diaz 2006). From this perspective, metaphors do not constitute a purely linguistic expression, but rather represent a fundamental cognitive structure of human beings. Hence, metaphors are not only an effective means for communicating with the public, but they are also effective for generating novel synthesis of ecological and ethical concepts. The practice of composing metaphors recovers the ancient meaning of the Greek term poeisis, which integrates the dialectic relationship between invention and discovery into the research experience of the students. During the last decade the central role that metaphors have played in the development of scientific thought has been widely documented (e.g. Lakoff & Johnson 1980, Rozzi 1999, 2001, Pickett & Cadenasso 2002, Larson 2006).

When we launched the Omora Park educational program, we emphasized in its conceptual framework the importance of analogical and playful thought (Maturana 1997, Rozzi wet al 1997). Then, we identified two metaphors used by Charles Darwin in the development of his evolutionary theory which synthesized central concepts of evolutionary-ecological sciences as well as of environmental ethics: the tree of the life and the web of life (Rozzi 1999). In the first metaphor, the common trunk of the evolutionary tree offers a visual representation of Darwinian evolutionary theory that emphasizes the common biological origin that humans share with all living beings. This image of a common evolutionary genealogy stimulates a sense of kinship which defies the traditional western ethics by demanding an extension of ethical respect beyond the limits of our own species. The sense of evolutionary

kinship provides one of the most appealing scientific foundations to support the notion of the intrinsic value of non-human life. , The second metaphor, the web of life, provides a complementary image that evokes the multiple ecological interactions that happen between nutrients, plants, seaweed, animal, fungi, bacteria, nutrients, water, solar energy and soil that form biotic communities and ecosystems. This understanding of ecological interrelations provides one of the most appealing scientific foundations to support the notion of instrumental value of biodiversity, because it illustrates how biodiversity provides ecosystem services for human societies.

The Darwinian metaphors have become "cultural messengers" that have stimulated the imagination of scientists, writers, and conservationists around the world. In the Omora Park Program, these metaphors have helped to conceive the integration of ecological and ethical notions through the composition of new metaphors and field activities based on those metaphors. The image of the tree of life offered an initial stimulus to conceive the experience of looking into the eyes of the birds, in their habitats or when captured in mist-nets and held in the hands of students and visitors (Rozzi et al 2005). Then, this experience lead to an innovative ecotourism activity entitled "Cara a Cara" (Face to Face) with the "Caracara" or Chimango Caracara (*Milvago chimango*) (Fig. 8). The image of the web of life inspired the creation of another metaphor: the "Miniature Forests of Cape Horn," which has facilitated the appreciation of the web of interactions between mosses, lichens, insects and other small organisms through the activity of eco-tourism with a hand-lens (Figure 7). The composition of these metaphors has arisen from interdisciplinary interactions among graduate students, ecologists, philosophers, and other participants, such as musicians, sculptors, journalists, professors and students in education and eco-tourism workshops, or during biocultural conservation undergraduate and graduate courses.

Step 3: Field activities guided with an ecological and ethical orientation

The Omora Park Educational Program emphasizes "direct encounters" of students and visitors with diverse human beings, and with mosses, lichens, birds, seaweed, rivers and other beings composing the ecosystems (Rozzi et al 2002, 2005). These ecological, environmental, philosophical and educational field experiences are designed to stimulate the perception of and valuation towards biological and cultural diversity in specific sites and moments (Rozzi et al 2006a). Through these "direct encounters" with biocultural diversity, we recover an awareness of our coexistence with a multiplicity of human and non-human beings, with whom we cohabit in our regional habitats (Rozzi et al 2008a).

More than 50 % of the human population lives in cities today worldwide (Flavin 2007). Therefore the knowledge that the majority of people have about biological and cultural diversity is acquired in urban contexts, distanced physically and emotionally from remote eco-cultural habitats such as Cape Horn, where the lives of the majority of the biological species and the languages at the beginning of the 21st century take place. Direct exposure to natural habitats, its beauty and its diversity of inhabitants, has become an increasingly rare experience in formal education (Feinsinger et al 1997, Feinsinger 2001, Leopold 2004, Louv 2005, Smith 2004). The knowledge which is acquired by those living within urban areas about biocultural diversity is distanced still further from the unique nature of other living beings, languages and cultures, because such knowledge is taught through the "conceptual lenses" imposed by a few languages and mathematical models particular to those urban areas (Rozzi 2004).

More than 50 % of the world human population speak today one of the ten dominant languages (Mandarin, Hindu, Spanish, Arab, English, Russian, German, French, Portuguese and Bengali) (Rozzi & Poole 2007). Less than 500 languages of the 6,912 languages that still are spoken in the world are taught in formal education within large city and rural schools (Krauss 1992, Maffi 2001). This filter excludes more than 90 % of the languages and worldviews which include and inhabit the world, and generates a conceptual slant in the knowledge scattered through audio-visual books, computers and other means that are based on a few languages and mathematical models (Rozzi et al 2005).

The educational approach of Omora Park tries to remediate this reduction of biocultural diversity. Towards this end, we design workshops and field courses that allow for crossing the physical barriers of the urban and technological infrastructure, as well as the conceptual barriers of the languages that mediate and bias understanding of biological and cultural diversity. For the participants in the workshops, the experience of a direct "face to face" encounter (or re-encounter) with living beings in their habitats in Cape Horn, has been essential towards obtaining a biocultural understanding. One is not only reading about birds such as the little hummingbird omora, or simply learning the bird's Yahgan history and name, but moments of coexistence are generated in which the biocultural diversity stops being solely a concept. Rather, biocultural diversity becomes an experience of cohabitating with diverse living beings and their life histories, which otherwise remain consistently outside the experiential dominion of formal education. The experiences of ecology and field environmental philosophy compensate for the excess of information that prevails in current formal and informal education. They promote, alternatively, experiences of "direct encounters" in the terrestrial and marine habitats that transform not only the knowledge about biodiversity, but also, the ethics of living and coexisting in regional

ecosystems with its diverse inhabitants (Rozzi et al 2005, 2006a).

Step 4: Implementation of areas for in situ biocultural conservation

The discovery and implementation of physical spaces as in the Omora Ethnobotanical Park for in situ conservation has three essential purposes: i) preservation of the diversity of species of vascular and not-vascular flora, vertebrate and invertebrate fauna, and other groups of organisms; ii) protection of the habitats and the ecological interactions between the species that form the biological communities; iii) enables visitors to experience, observe, and enjoy in situ the ecological interactions between the biodiversity, and to have for a moment the experience of coexisting immersed in this living biocultural diversity. The ultimate purpose of in situ conservation in the Omora Park recovers an ancestral sense of ethics (Callicott 1997), as ingrained in the Greek term ethos (Rozzi et al. 2008).

The word ethics originated from the Greek term ethos, which signifies in its more archaic form den: the dwelling of an animal. By an extension of the use of this word, its meaning came to include the dwellings of human beings, and later this noun also become the verb to dwell. This double interpretation of the Greek term ethos—as a noun and a verb—was expressed later by two Latin words: habitat and to inhabit. At the same time, from the recurrent action of inhabiting in a specific way a particular habitat, recurrent forms of inhabiting emerge and configure customs, or the habits, that in turn define the ethos or identity of the human and non-human animal inhabitants. The experiences made possible in conservation spaces such as the Miniature Forest Gardens of Cape Horn (Figure 7), allows for the recovery --at the beginning of the 21st century-- of an understanding of ethics as a concept that integrates not only the habitat, but also the habits that arise in the ways of co-habitance in regional ecosystems (Rozzi 2009). Through the work of identifying these conservation areas in situ, the students and participants acquire a sense of responsibility as citizens who are ecologically educated and ethically active in the care of the habitats, their various forms of life and the ecosystem services they provide (Rozzi et al 2008).

III.2. Implementation of the four step cycle in Sub-Antarctic ecotourism

Methods and models enable translating concepts into effective actions (Pickett & Cadenasso 2002). To illustrate the methodological steps involved in the integration of ecological science and field environmental philosophy in the practice of biocultural conservation and education, we describe two sub-Antarctic ecotourism activities designed and implemented by the Omora Park's team, utilizing the model of the four step cycle: 1) Ecotourism with a hand lens, and 2) Face-to-face ecotourism with birds.

III.2.1. "Ecotourism with a Hand Lens"

Figure 7 illustrates the methodological model for the four step cycle, utilized in the creation of ecotourism with a hand lens. Each step is identified in blue (first line of text in each circle), the method is in green (second line of each circle) and the conservation achievements are in black (third line of each circle). The development of the four steps has been carried out within the Omora Ethnobotanical Park (OEP), which is embedded within the Cape Horn Biosphere Reserve (CHBR). The lines and arrows indicate the multidirectional nature of the interactions between the four steps. Below, we succinctly describe each of the steps.

Step 1. Interdisciplinary research: Inventories of non-vascular flora

For a decade now, an interdisciplinary team at the park has developed floristic inventories in the CHBR. This line of inquiry has determined that the most diverse flora in the region can be found in bryophytes, which include at least 450 moss and 368 liverwort species making a total of 818 for the Magellanic subantarctic region (Rozzi et al. 2008b). This number supersedes the total of 773 vascular plant species registered for the ecoregion, and at the world level this is very striking for two reasons:

i) At the planetary level, 300,000 vascular plant species have been identified, but only 15,000 non-vascular (bryophyte) species are known to science. In the majority of the planet's ecoregions, the diversity of vascular plants is approximately 20 times greater than that of bryophytes.

ii) The Magellanic subantarctic ecoregion represents 0.01 % of the earth's surface area. However, in this relatively small archipelago, we find 5 % of the known species of bryophytes on the planet. Additionally, it is estimated that the degree of endemism of these taxa is greater than 50 % (Engel 1978, Matteri 2000, Villagrán et al. 2005).

For these two reasons, the Magellanic subantarctic ecoregion has been identified as a global "hotspot" for bryophyte diversity (Rozzi et al. 2008b).

Step 2. Composition of metaphors and communication through narratives: The Miniature Forests of Cape Horn

The previous results captured the attention not only of the scientific community, but also authorities, decision-makers, tourism operators and the general public. However, the scientists were challenged with transmitting and communicating about the high diversity of bryophytes, given that frequently these small plants lack common names and are completely

unknown by the majority of the public. To overcome this difficulty, the invention of a metaphor proved useful, and by working together with students in the primary school in Puerto Williams, scientists began to refer to the "Miniature Forests of Cape Horn" to denote the biotic community formed by the diverse species of mosses, liverworts, lichens, mushrooms and invertebrates (Rozzi et al. 2002).

This metaphor resulted from an analogical thought that compares the small communities of non-vascular plants with those of formed by large trees, vines and epiphytes inhabited by better known birds and other large organisms. This analogy significantly helped the general public to understand the ecological interactions and processes taking place in the small formations of bryophytes, lichens, fungi and associated bacteria and fauna. In addition, the perception about the organism that formed these biotic communities and ecosystems acquired an ethical dimension through expressions such as the "little insect folk" coined by schoolchildren.

Through its ecological and ethical images, the metaphor of the miniature forests have stimulated activities that integrate sciences, the arts and environmental ethics such as the puppet show "The Cladonia Diva," or "Little Explorers of the Miniature Forests of Cape Horn" project supported by the Chilean National Science Foundation (CONICYT). The latter contributed to the creation of a new educational line in CONICYT at the national level called the "Little Explorers Clubs". These clubs formally integrate pre-schoolers into science education for the first time in Chile. In this way, the use of the metaphor demonstrated its appeal to a broad spectrum of age and socio-cultural groups, for whom the existence of bryophytes was previously unknown (Medina et al. in preparation).

Step 3. Field activities guided with an ecological and ethical orientation: Tourism with a hand lens

Through another metaphorical name, "Tourism with a Hand Lens", the floristic discoveries and the experience of exploring the miniature forests of Cape Horn have been translated into an innovative scientific tourism activity. This activity invites visitors, hand lens at the ready, to observe, enjoy and value the beauty, diversity and ecological importance of small organisms like lichens, mosses, mushrooms, insects and other invertebrates that usually pass by unnoticed and which were previously not incorporated into tourism attractions in Chile (Rozzi 2005). The graduate students in this case act as guides themselves or train other local guides by sharing their scientific knowledge in a didactic, entertaining and interactive way, using interpretative trails in the OEP and accompanied often by authorities, teachers, members of the local community, reporters and ecotourists.

Tourism with a hand lens constitutes today a new scientific tourism activity for the Magallanes and Chilean Antarctic Region that allows: a) getting to know the beauty, diversity and ecological importance of the non-vascular flora at the extreme tip of the Americas; b) inviting the visitors to stop, slow their pace and re-connect with other living beings; and c) generating new opportunities to develop environmental tourism that is economically sustainable for the local community of the CHBR, as well as the regional, national and international community. This innovation has been developed with the support of the government of Chile through the financing of training courses and publications about bryophytes and lichens (Goffinet et al. 2006).

In the past decade, tourism and the number of visitors has increased annually at a rate of 7.7 % in Chile, a figure which is greater than the world average of 4.1 % (Chacón 2002). In the Magallanes and Chilean Antarctic Region, the number of visitors surpassed the one million mark in 2008, a figure which is an order of magnitude higher than the previous two decades (SERNATUR 2009). In this scenario, tourism with a hand lens represents a diversification and strengthening of the region's tourism offerings, which under the coordinated administration of authorities and public services promotes a revenue source that is environmentally and economically sustainable for the local community of the CHBR and which could be replicated in other parts of the country and the world. The sustainable character of this activity relies principally on six attributes of tourism with a hand lens:

i) Year-round, in contrast to other nature tourism activities such as bird and whale watching which are highly summer-oriented.

ii) Low environmental impact, given that it requires a small area where the tourist can observe a great diversity of species.

iii) Prolongs the stay of tourists in the area, given that it requires a calm attitude and long observation time to discover and appreciate the flora of each rock, trunk and other substrates.

iv) "Unique" to the sub-Antarctic region, given that it is a singularity that the Magallanes Region possess, due to its subpolar character, and can stand out compared to other latitudes. As a result, the practice of tourism with a hand lens and its attention to the "miniature forests" could be transferable also as a concept to other subpolar and polar regions of the planet that also present a flora dominated by mosses, liverworts and lichens.

v) Of high educational, aesthetic and ethical value because it allows the average person to discover, enjoy and appreciate the value of unperceived organisms, and marvel at them, with their beauty and their singular life forms.

vi) A contribution to regional identity because it makes apparent the most diverse and idiosyncratic flora of the Magallanes and Chilean Antarctic Region.

Step 4. Implementation of areas for in situ biocultural conservation: Garden of the Miniature Forests of Cape Horn

The discovery of the high diversity of austral bryoflora and the development of tourism with a hand lens stimulated an interdisciplinary group of scientists, philosophers, architects and artists to design and implement a "Miniature Forests of Cape Horn Garden" in the OEP. With a network of trails that extends approximately 2 km with 20 interpretative stations implemented with sculptures, hand lenses and signage, this garden protects bryophyte species in situ and maintains ecological interactions that can be observed by visitors in their native habitats. Across the globe, the Miniature Forests of Cape Horn Garden is the first botanical garden of its kind, dedicated to bryoflora with criteria of conservation, education, ecotourism and field environmental philosophy (Rozzi et al. 2005).

From the perspective of tourists and other visitors, the Garden does not only allow us to observe different worlds, but also the activity of tourism with a hand lens carries with it a way of living and acting that diverges from the globalized habit of "that which is easy and fast". This type of tourism activity requires a change of pace, to be willing to concentrate and take time to allow the foliar textures to emerge before one's eyes, as well as the plants' pigments and colors and the movements of small invertebrates in this micro-forest. The discovery of the miniature forests carries with it the necessary disposition of calm and attention to perceive expressions of life that remain ignored if we pass walking rapidly, "wanting to see it all and seeing nothing". This way of living re-invigorates the visitor, who also discovers through the miniature forests of Cape Horn that small is beautiful. These events provoke and awe the tourist who comes from a world dominated by rapidity and quantity, where "more is better" and it is customary to praise the grand. In the act of inquiry with respect to the micro-biodiversity, calmness to observe with a hand lens that which is small carries with it also an attention to observe ourselves, with our respiration, emotions and wonder. In this way, an ecotourism, ethical and recreational, informal education experience is achieved embedded in the webs of biological and cultural diversity (Rozzi 2005).

The discovery and observation of these "invisible" beings feeds our awareness about how little we know about our co-inhabitants. The observations of these "invisible" beings with their constant variations and interactions, and the aesthetic experiences that arise having stopped to look through the lens (or the zoom of a camera) invite us to revise the limitations of the prevailing modes of knowing in educational practices that have a marked bias towards learning based on a single alphabet and numerical system (Rozzi et al. 2005, 2006a). The consciousness of our ignorance with respect to the diversity of beings that co-inhabit with us should invite us to tread more carefully. In this context, tourism with a hand lens represents an ethical practice that contributes to a respectful "convivencia" or joyful co-existence with the biocultural diversity in which we are immersed.

III.2.2. "Cara a cara" or "face-to-face" ecotourism with the birds in their habitats

A second, new sub-Antarctic ecotourism activity, generated by the field environmental philosophy and biocultural conservation program of Omora Park integrates ornithological Research and analysis of its implications for environmental ethics. Figure 8 illustrates —analogously to Figure 7— the methodological cycle of the four steps involved in the genesis of this activity.

Step 1. Interdisciplinary ecological and philosophical research: Surveys of the birds of the Cape Horn Biosphere Reserve

The inventories of terrestrial vertebrates in the CHBR have determined that birds are the most abundant, diverse and conspicuous taxa (Venegas & Sielfield 1998, Rozzi et al. 2006b). Reptiles and amphibians are completely absent in the subpolar region, which is too cold for ectothermic vertebrates. Terrestrial native mammals include only 9 species from 8 genera, 5 families and 4 orders: 3 species of the order Rodentia of the Cricetidae family (*Euneomys chinchilloides*, *Oligoryzomys longicaudatus* and *Abrothrix xanthorhinus*), 3 species of the order Carnivora with two mustelids (*Lontra feline* and *L. provocax*) and a canid (*Lycalopex culpaeus*), 2 Chiroptera from the Vepertilionidae family (*Histiotus montanus* and *Myiotis chiloensis*), and the guanaco (*Lama guanicoe*), a camelid that is the only representative of the order Artiodactyla (Rozzi et al. 2006b). In contrast, there are at least 100 bird species, from 76 genera, 34 families and 17 orders (Rozzi et al. 2006b, Pizarro in preparation). As a result, the birds present a species richness that is one order of magnitude greater than the other terrestrial vertebrates combined in this region.

Birds also occupy the entire spectrum of terrestrial (high Andean, Magellanic tundra complex, shrublands, and forests), freshwater and coastal habitats (Anderson & Rozzi 2000, Ibarra 2007, Ippi et al. 2009). The transect and point-count surveys of birds carried out on Navarino Island have determined that the chimango caracara (*Milvago chimango*) is one of the most generalist species with regards to use of coastal and terrestrial habitats (Pizarro in preparation). It is also a resident species that abounds in the forests, shrublands and intertidal zones throughout the year. In the intertidal zone, it is frequently observed eating carrion or invertebrates. While in the forest the chimango caracara nests and perches on branches. Under these perching sites, we have collected on the forest floor the exoskeletons of crustaceans and echinoderms (e.g., *Pseudochinus magellanicus*) and shells from at least eight species of mollusks: Chilean blue mussel (*Perimytilus purpuratus, Mitilus chilensis*), Chilean ribbed mussel (*Aulacomiya ater*), keyhole limpet (*Fisurella* spp.), true limpets (*Nacella deurata* and *N. magellanica*), chitons (*Plaxiphora aurata* and

unidentified polyplacophorans) (Pizarro et al. in preparation). These remains of marine prey that are transported by the caracara possess high concentrations of some ions (e.g., Ca and N), as well as traces of Mg, Si, Zn, P, and other elements that could provide an important nutrient source, and at the same time modify the pH of microsites in subantarctic forests. In this way, the caracara could generate a "trans-ecosystem link" between coastal-marine and terrestrial habitats of the Magellanic subantarctic archipelago, where soils are often thin, new and nutrient poor (Pizarro in preparation).

Birds also occupy a central place in the Yahgan worldview. According to Yahgan narratives in ancestral times the birds were humans (Rozzi 2001, 2004). This Amerindian worldview, as much as Darwinian evolutionary theory, evoke a genealogical kinship among birds and human beings, which expresses itself in the similarity of the birds and faces of both (Rozzi et al. 2001, 2005). The attention toward the face has led us to research the ethics of the "face to face" encounter of Emmanuel Lévinas (1969), and to develop comparative studies among the Amerindian worldviews, new evolutionary scientific perspectives and notions derived from the young sub-discipline of environmental ethics (Leopold 1949, White 1967, Hardin 1968, Naess 1972, Pizarro in preparation).

Step 2. Composition of metaphors and communication through narratives: Face-to-face with the Chimango caracara

To link ecological and ethical notions and to communicate to a wide audience the discoveries derived from research about the assemblage of birds in Cape Horn in general and about the autoecology of the Chimango Caracara in particular, we have composed the metaphor: "face-to-face with the caracara" (cara-a-cara con el caracara in Spanish).

The English name chimango caracara (*Milvago chimango*) derives from the onomatopoeia (caracara) of Tupi-guaraní origin that has been incorporated into English and refers to a group of American falcons with long legs, carrion-eating habits and a generalist diet (Pizarro in preparation). Chimango is the common name given to this bird in Argentina and by the old-time residents of the CHBR as well. For example, Úrsula Calderón and other elder members of the Yahgan community referred to this bird as yoskalía in Yahgan, but chimango in Spanish, reflecting an Argentine influence. In the rest of the Chilean territory, as well as in the case of new arrivals to the CHBR, the common name for this bird is derived from a Mapudungun onomatopoeia triuki that alludes to its characteristic vocalizations (Rozzi et al. 2003a).

"Face-to-face" (cara-a-cara in Spanish) is an expression utilized by the Jewish Lithuanian philosopher Emmanuel Lévinas. "Face-to-face" occurs when we find ourselves directly facing and looking into the eyes of another person. In these encounters, the emotions, such as suffering, of another person are transmitted by their facial expressions. This "face-to-face" evokes as a result an immediate responsibility in the other person before any subsequent action or decision. In this way, Lévinas proposes to define human ethics from the responsibility of "the other" and a philosophy that begins in the ethic of the other; not in the ontology of an I am Cartesian ego. Lévinas coined this expression that defines an ethical relationship between two human beings, while he was held in a concentration camp at Stammlanger, during the Second World War in1940 (Dussell 1999).

In spite of that fact that Lévinas' original conception of "face-to-face" was within the realm of human ethics (Davy 2007), its ethical force could be extended towards encounters with other non-human beings (Rozzi et al. 2008a). This extension coincides with the intentionality of the concept of "direct encounters", promoted through field environmental philosophy at the OEP (Rozzi et al. 2005, 2006). "Direct encounters" refer to experiences of encounters with other human and non-human beings in their native habitats. In this experience of encounter, the beings can display their habits and as a result fully express their identity, generated as a result of their recurrent evolutionary interactions with other co-inhabitants (Rozzi 2009). This experience of "direct encounters" enables one to transcend the comprehension of biodiversity that frequently is reduced to a list of names and numerical indicators, by persons who have not had experiences in the field (Rozzi et al. 2005). In summary, the metaphor of face-to-face with the caracara invites a "direct encounter" experience between the observer of the birds (i.e. birder) and the birds themselves; emotion and vitality of the "direct encounter" allows the birder to recuperate the comprehension of the caracara (the birds and other organisms) as moral subjects and integral living beings.

Step 3. Field activities guided with an ecological and ethical orientation: "Ethical birding"

Birding is the English name for the activity of recreational viewing of birds, and it involves a life style that is based on sustainable co-living with them (cfr. ABA 2006, JC Pizarro, in preparation). In the OEP, we have adapted recreational viewing of birds as an ecologically-oriented activity based on: i) ecological findings about the role that the caracara and other birds play in trophic interactions, dispersal of seeds, transport of nutrients between terrestrial and marine ecosystems and other ecosystem processes; and ii) having an ethical experience of face-to-face encounters with birds and other organisms. For this, we have designed guided visits with pre-schoolers, elementary school children, university students, teachers and general visitors to the shoreline, forest, high Andean and wetlands, where they conduct observations of birds' anatomy, behavior and ecological interactions.

Special attention is placed on the caracara feeding on mollusks and other invertebrates in the intertidal zone, and how it flies with its food to the forest to perch and often leaves behind shells and exoskeletons. Then, we identify these remains and discuss the potential importance of birds as transporters of these invertebrates from the coast for the fertility of the forest soils. As such, the students and tourists share "micro-experiences" of scientific inquiry more than passively receiving information about avifauna and their ecosystems. Through these observations, inquiries and reflections, the participants may arrive upon the conclusion that the caracara and other birds connect the sea and the land in the archipelago and could provide an "ecosystem service" that is relevant for the human population, such as the role of providing nutrients to the soil. In this stage of reflection, the guide facilitates the contextualization of observations and conclusions made in the field with ecological understanding and broader geographical scales. For example, participants are invited to think about large accumulations of guano in the breeding colonies of birds such as the penguins that inhabit Horn Island or the sea gulls that can be found on the north coasts of Chile and North America that have a better known and documented impact on vegetation and soil (Pisano 1980, Ellis et al. 2006). On the one hand, these conclusions awaken in the students and visitors a scientific curiosity to research in greater depth the ecological role of these birds as "marine-terrestrial trans-ecosystem links". On the other hand, the comprehension of ecosystem services provided by birds allows us to value their function, informed by ecological science, which in terms of environmental ethics also carries with it an understanding of the instrumental value of birds for human societies and ecosystem integrity.

Complementarily to the previous ecological inquiry, while observing the birds, we make an emphasis on the examination of the morphological characteristics, especially the face and eyes. The participants conduct a detailed description by drawing, writing stories and other ways of expression. Through these descriptions and observations, we formulate questions about similarities and differences that are detectable between, for example, the human eye and the eye of birds. These questions carry us to reflect about our kinship and the ways of living with birds based on a "face-to-face" field experience, which occurs in marine, as well as terrestrial habitats that human beings share with birds and other living beings. In terms of environmental ethics, this experience facilitates that participants internalize an understanding of intrinsic value about the lives of birds. Through direct, face-to-face encounters, participants conceive of the possibility that birds' lives acquire value in and of themselves, independent of their utility to humans. That is to say, we are able to overcome through this methodology the dualistic ethical vision of human/non-human, and it becomes apparent that ethical considerations can extend themselves to all life forms beyond that which is of direct interest to humans, including birds and the community of animals with which they live (Rozzi 2004).

Step 4. Implementation of areas for in situ biocultural conservation: "Omora Subantarctic Bird Observatory"

To observe and enjoy the beauty of the diversity and abundance of subantarctic birds, as well as appreciating their ecological functions, it is necessary to conserve the habitats where these winged inhabitants express their habits. At the same time, it is of utmost importance to create physical spaces in these habitats that allow the practice of ecologically-oriented activities such as ethical birding to facilitate the "face-to-face" encounter with birds and other living beings. For example, upon observing the chimango caracara carry out its ecological role as a trans-ecosystem vector, it then becomes apparent why it is necessary to conserve intertidal habitats, as well as the forest (Pizarro et al. in preparation).

Besides protecting habitats and constructing physical spaces, it is also important to consolidate organizational "spaces" so that people from diverse walks of life, such as researchers, students, and members of the community, interested in studying, knowing and enjoying the biocultural diversity of birds can come together and interact through different engagements. The diverse physical conditions, habitats and inhabitants of the Róbalo Bay on the coast of the OEP provide refuge and reproduction and feeding sites for twenty-nine species of marine, coastal and terrestrial bird species in the summer (Pizarro et al. in preparation). Here, we have defined and are implementing an interpretative trail that permits: i) minimizing the impact of visitors on the birds; ii) defining stations to highlight the beauty and diversity of the "inhabitants, habits and habitats" (see Rozzi et al. 2008a) of the bay and coastal forests; and iii) providing narratives that enrich the communication of scientific discoveries and ethical notions associated with each of the interpretive stations along the trail.

CONCLUDING REMARKS

In the context of rapid environmental, social, and economic global changes, one of the major challenges confronted by ecologists at the beginning of the 21st century is to achieve ecological research—which still remains focused on local scales—can address global scales, thereby enabling to also increase the diversity of participants in all facets of research and decision making (Herrick & Saruhkán 2007, Adger et al. 2009). This challenge can be undertaken in a more robust way if it is approached with a network of sites as done with ILTER or the Chilean LTSER. These networks maintain programs of socio-ecological research at the local scale, while at the same time they can address questions and generate programs at the global scale through the collaborative research network. The hierarchical system of levels of organization in these LTSER networks

enables access to global scales without overlooking the heterogeneous biocultural mosaic, which can be grasped only through research at the local scale. Local scales acquire an increasing relevance in order to avoid worldwide processes of biological and cultural homogenization derived from the dominance of global development models, which are recurrently insensitive to the regional biocultural singularities (Rozzi et al. 2008a). To address this two-fold challenge of articulating global and local scales, the networks of LTSER sites provide an ideal platform because they research and participate in eco-social processes which take place at multiple interdependent scales.

In order to implement the multiple scale approach, the Omora Ethnobotanical Park program has defined three working levels: at the local scale it functions as a scientific center of the Cape Horn Biosphere Reserve; at the national scale as the southernmost site within the first Chilean LTSER Research Network coordinated by the Institute of Ecology and Biodiversity (IEB); at the international scale as a core site of the Sub-Antarctic Biocultural Conservation Program, coordinated by the UMAG, IEB and UNT. This organization of nested units has enabled the articulation of synergistic work on the local, national and international scale (Fig. 2). These three layers of infrastructure at the local, national and international scales have allowed innovative transdisciplinary research to: (i) discover biological and cultural diversity singularities in the remote subantarctic Magellanic ecoregion, (ii) incorporate environmental philosophy into LTSER network, and (iii) integrate this research into actions that favor economic and environmental sustainability, while at the same time favoring conservation of and respect for biological and cultural diversity.

This interdisciplinary innovation has permitted us to address a second central challenge of LTSER at the beginning of the 21st century: to broaden the spectrum of social dimensions included in LTSER programs. Currently, social variables in LTSER are almost equated to economic ones, and there is a critical need to introduce ethical questions into these research and education programs (Likens 1991, Gardiner 2004). One of the major difficulties for the integration of ethics into the LTSER programs derives from the drastic diminution of its teaching within science education programs in the USA and other regions of the planet (Likens 1991, Leopold 2004). This decrease in the education of ethics has led to a forgetfulness of the vocabulary and methods for ethical deliberation (cfr. MacIntyre 1984). The emphasis in cost-benefit analysis reduces ethics to a narrow utilitarian perspective(Groome 2008) and stimulates a disciplinary dichotomy between environmental ethics and ecological sciences (Golley 1993). Therefore, it is urgent to overcome the ethical insufficiency of interdisciplinary methodologies and allow systematically interrelating philosophical and scientific research, ethical values and ecological facts in LTSER programs, as well as education programs, policies and decision-making.

In this article we have set out a methodology of field environmental philosophy and biocultural conservation that contributes to resolving the previous challenge, integrating ecological and ethical dimensions through a cycle of four steps in the formation of new professionals in graduate programs. This cycle is also applicable in programs of research, public schools, training, and conservation in other LTSER sites. Concisely, this cycle considers the following sequence of steps. Step 1: interdisciplinary ecological and philosophical research about components, patterns and processes of biological and cultural diversity, and the multiple ways of perceiving and cohabiting with biocultural diversity on the part of different sociocultural groups and institutions that are living and working within local, national and international scales. Step 2: composition of metaphors that lead to a conceptual synthesis of the results and ecological and ethical understanding achieved through the transdisciplinary research in "Step 1". These metaphors must also be attractive to communicate this ecological and ethical synthesis to academic and not-academic audiences. Step 3: field activities guided by the metaphors generated in "Step 2" that seek to free ourselves from biases in perception and valuation of biocultural diversity generated by the presence of two types of barriers which pervade formal education and everyday life of the majority of people and institutions of the world at the beginning of the 21st century. These barriers include physical barriers, such as urban and technological infrastructure that mediate our contact with biocultural diversity, and conceptual barriers, derived from the dominance of a few colonial languages, and the mathematical and economic models that shape our perceptions of biocultural diversity. Through "direct encounters," the methodology of field environmental philosophy contributes to overcoming these barriers, and to recover a clearer awareness and understanding of our coexistence with diverse human and non-human beings in biocultural heterogeneous habitats. Step 4: Implementation of conservation areas in situ that allow for the continuity of diverse biocultural interactions in their local habitats, and make possible the participant to undertake responsible actions, which are ecologically and ethically informed.

The sequence of the four steps explores the interrelations between ecological and ethical research that diversify prevalent approaches of utilitarian ethics, embedded in cost-benefit calculations (Broome 2008). In addition, biocultural research and the participatory construction of educational activities and eco-tourism themes and activities foster a multicultural approach to environmental ethics, ingrained in specific cultural ecological contexts. This methodology of field environmental philosophy promotes transformative experiences for students, researchers and other participants, who journey from ecological-philosophical research towards ethically responsible actions. These actions stimulate new questions of research, metaphors

and activities in the field. In this way, a dynamic spiral of ecological and ethical integrations is generated. In a dialectical manner and immersed in an experiential awareness of co-inhabitation, these integrations recover the deep ecological sense of ethics, rooted in the pre-Socratic meaning of the term ethos, which gave origin to the word ethics (Rozzi et al. 2008a).

The effectiveness of the four-step cycle methodology for the integration of ecology and environmental ethics in education programs is being evaluated currently through the project Integrating ecological sciences and environmental ethics for the biocultural conservation of the subantarctic region in southwestern South America. This is a three years project supported by the International Research Experiences for Students (IRES) program by the USA's National Science Foundation (NSF), and by Chilean counterparts, which allow Latin American and United States' graduate and undergraduate students to work together along with researchers in Omora Park and the Chilean LTSER Network. The goal to value biological and cultural diversity is shared with the Strategy for Ecology Education, Diversity and Sustainability (SEEDS) of the Ecological Society of the United States of America (ESA).

The NSF-IRES project has allowed that SEEDS participates in the evaluation of the effectiveness of field environmental philosophy, and its four steps of the cycle methodology. In turn, our NSF-IRES project has allowed SEEDS program to incorporate for the first time an international component into its own initiative. This synergy underscores the fertility of international partnerships. Both programs try to promote multicultural perspectives and to contribute as much to biocultural conservation and sustainability at both local and global scales. This year 2010, the ESA will hold a summit in education entitled "How will Ecological Education be seen in 2020?" This conference has defined the question of advances in transformative experiences in ecological education in long-term socio-ecological research networks and the design of new curricula as one of the conferences three core thematic areas (Lowman & Randle 2009).

Launched as a local initiative, the Omora Ethnobotanical Park program has subsequently expanded its associations on national and international scales to confront global challenges in an effective way. It established an alliance of academic institutions located mainly in Chile and the United States, and incorporated a network of collaborations with researchers from Latin America, Europe, and other regions of the world. For its integration of the academy and society, the Omora Park program was recognized with the Science and Practice of Ecology and Society Award in 2008 (Hargrove et al. 2008). This prize expresses how the ability of the Omora Park to obtain significant goals in the long term is evaluated not only by its studies in biocultural diversity, but also for its effectiveness to resolve challenges of sustainability and biocultural conservation by interrelating the theory and praxis of research, within administrative infrastructure, educational institutions and conservation programs.

This work has forged innovative and effective ways to extend the definition of the social component ("S") in LTSER networks (Anderson et al. 2008) by acknowledging the ethical and cultural dimensions of society, as well as the participatory role of the researcher. The approach of field environmental philosophy --and its four step cycle to integrate research, education and biocultural conservation-- has been critical to tie United States and Chilean programs of graduate study through comparable methodologies. These field methodologies allow the Omora Park to educate a cohort of new graduate students who are able to interrelate ecological and ethical concepts, biological and cultural diversity, and to continuously adapt its LTSER program to address new challenges posed by the next decade in view of 2020 on the horizon.

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LEYENDAS DE FIGURA

Fig. 1: Multiple scales at which the biocultural research, education, and conservation programs associated with the Omora Ethnobotanical Park takes place.

A. International scale = Subantartic Biocultural Research and Conservation Program, coordinated by the University of North Texas (UNT), the Institute of Ecology and Biodiversity (IEB), and the Universidad de Magallanes (UMAG) (yellow stars). The circles indicate the core collaborators in the United States of North America (light blue = Institute of Ecosystem Studies, University of Connecticut, University of Georgia and the Ecological Society of America), in Mexico and Costa Rica (red = Ibero-MAB at the Instituto de Ecologia Xalapa, and the Universidad de Cooperación Internacional de Costa Rica), in South America (orange = Universidad Nacional de Colombia, Instituto Antártico Chileno, Centro Austral de Investigaciones Científicas - Ushuaia, Argentina, and Red AVINA Patagonia), in Europe (lilac = Center for Environmental Research UFZ, Leipzig in Germany, Universidad Complutense de Madrid in Spain and Parco Dolomiti Bellunesi in Italy), and in Australia (green = University of Sunshine Coast).

B. National Scale = Chilean Network of Long-Term Socio-Ecological Research (LTSER) Sites coordinated by IEB. The map shows the location of the five involved universities (blue stars) and the three LTSER sites (red circles), whose locations cover an extensive latitudinal range along the Pacific coast of Chile, encompassing the whole latitudinal range of the South American temperate forests biome (golden color); from the semi-arid ecosystems in Fray Jorge to the temperate evergreen rainforests on Chiloe Island, and the sub-Antarctic ecoregion (light green) in Cape Horn. Together with gradients in precipitation, temperature, and photoperiod these sites a gradient of anthropogenic disturbnace, from the rural-urban in the north to the pristine in the extreme south. The sites in Fray Jorge National Park and Omora Park are located in UNESCO-designated Biosphere Reserves, while Senda Darwin is a private reserve associated with Chiloe National Park.

C. Local-regional scale = the Cape Horn Biosphere Reserve (CHBR). Map of the extreme south of South America, indicating the zoning of the CHBR. In green: core areas that correspond in their totality to the areas included in Alberto de Agostini and Cape Horn National Parks, administered by the National Forestry Corporation (CONAF). In dark pink: terrestrial buffer areas that are made up almost entirely of state lands, administered by the Ministry of National Lands and the coastal border under the control of the Ministry of Defense. In light pink: marine buffer areas located in interior waters, administered by the Ministry of Defense and the Sub-secretary of Fisheries. In dark yellow: terrestrial transition zones where we find the town of Puerto Williams and other small human settlements. In light yellow: marine transition zones that encompass the area surrounded by the marine buffer areas. Note that Omora Park on the northern coast of Navarino Island forms part of a buffer area of the CHBR, and it has also been designated as a priority site for the Preservation of Biodiversity by the National Environmental Commission (CONAMA 2002). D. Local Scale = Omora Ethnobotanical Scale. The boundaries of Omora Park are indicated on the satellite image of the Robalo river watershed. Upper right is the town of Puerto Williams, which obtains its drinkable water from the Robalo river that flows from the adjacent mountain, Dientes de Navarino, into Robalo bay in the Beagle Channel.

Múltiples escalas de trabajo de los programas de investigación, educación y conservación biocultural asociados al Parque Etnobotánico Omora.

A. Escala internacional = Programa de Investigación y Conservación Biocultural Subantártica coordinado por la University of North Texas (UNT), Instituto de Ecología y Biodiversidad (IEB) y Universidad de Magallanes (UMAG) (estrellas amarillas). Sobre la imagen satelital del mundo, los círculos señalan los colaboradores centrales en los Estados Unidos de Norteamérica (celeste = Institute of Ecosystem Studies, University of Conecctcut, University of Georgia y The Ecological Society of America), en México y Costa Rica (rojo = Red IberoMaB en el Instituto de Ecología de Xalapa y la Universidad de Cooperación Internacional de Costa Rica), en Sudamérica (naranja = la Universidad Nacional de Colombia, el Instituto Antártico Chileno, el Centro Austral de Investigaciones Cientificas Ushuaia - Argentina, y la Red AVINA Patagonia), en Europa (lila = el Centro de Investigaciones Ambientales UFZ-Leipzig, Alemania, la Universidad Complutense de Madrid, España, y el Parco Dolomiti Bellunesi, Italia), y en Australia (verde = University of Sunshine Coast). Por debajo de la línea roja horizontal en el extremo suroeste de Sudamérica se extiende la ecorregión subantártica de Magallanes. La flecha indica la ubicación del Parque Etnobotánico Omora en la Reserva de Biosfera Cabo de Hornos, que alberga los ecosistemas forestales más australes del mundo y constituye el punto continental más cercano a la Antártica (1000 km).

B. Escala nacional = Red Chilena de Sitios de Estudios Socio-ecológicos a Largo Plazo (SESELP) coordinada por el IEB. En el mapa se indica la ubicación de las cinco universidades involucradas (estrellas azules) y los tres sitios SESELP (círculos rojos) distribuidos a lo largo de un amplio gradiente latitudinal en la costa chilena del Océano Pacífico. Estos sitios abarcan todo el ámbito de distribución latitudinal de los bosques templados de Sudamérica, desde los ecosistemas semi-árido en Fray Jorge, hasta los bosques templados siempreverdes lluviosos en Chiloé, y subantárticos en Cabo de Hornos. Junto a gradientes de precipitaciones, temperatura, y fotoperíodos estos sitios cubren un gradiente de perturbación antrópica, desde urbano-rural en el norte hasta prístino en el extremo sur. El sitio del Parque Nacional Fray Jorge y el Parque Omora están localizados en reservas de biosfera de la UNESCO, mientras que la Senda Darwin en Chiloé es una reserva privada asociadas al PN Chiloé.

C. Escala local-regional = Reserva de Biosfera Cabo de Hornos (RBCH). Mapa del extremo sur de Sudamérica señalando la zonificación de la RBCH. En verde: zonas núcleo que corresponden en su totalidad a áreas incluidas dentro de los parques nacionales Alberto de Agostini y Cabo de Hornos, administrados por la Corporación Nacional Forestal (CONAF). En rosado oscuro: zonas tampón terrestres que corresponden casi totalmente a tierras fiscales administradas por el Ministerio de Bienes Nacionales y la franja costera bajo la tuición del Ministerio de Defensa de Chile. En rosado claro: zonas tampón marinas ubicadas en aguas interiores administradas por el Ministerio de Defensa de Chile y la Subsecretaría de Pesca. En amarillo oscuro: zonas de transición terrestres donde se encuentra la ciudad de Puerto

Williams y otros pequeños asentamientos humanos. En amarillo claro: zonas de transición marinas que abarcan el área que rodea a las zonas tampón marinas. Nótese que el Parque Omora, en la costa norte de la Isla Navarino, forma parte de una zona tampón de la RBCH, y ha sido declarado también un Sitio Prioritario para la Conservación de la Biodiversidad por CONAMA (2002).
D. Escala local = Parque Etnobotánico Omora. Sobre la imagen satelital de la cuenca del río Róbalo se señalan los límites del Parque Omora (1044 ha). Arriba a la derecha se observa la ciudad de Puerto Williams abastecida de agua bebestible por el río Róbalo que nace en el cordón montañoso de los Dientes de Navarino y desemboca en la bahía Róbalo en el canal Beagle.

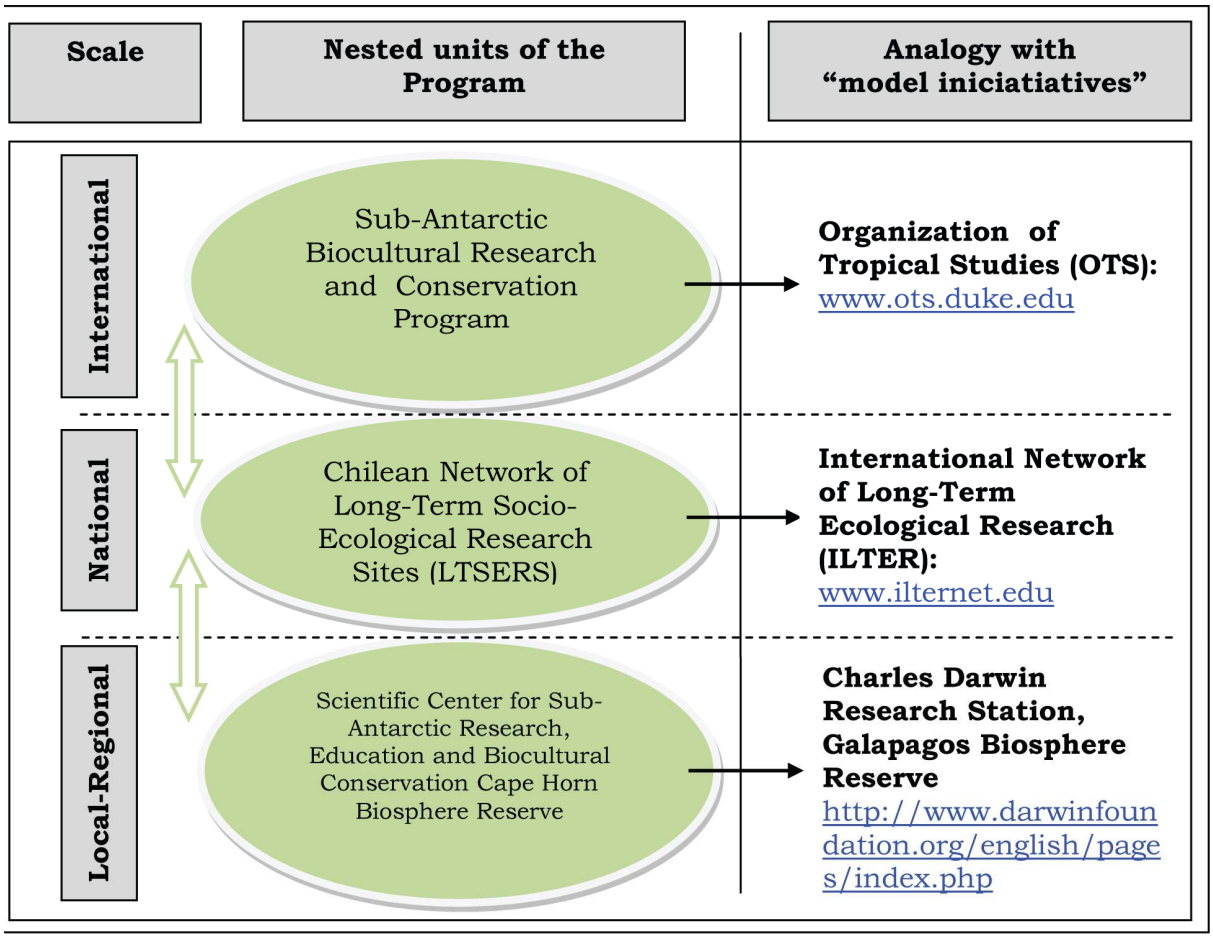

Fig. 2: A schematic representation of the nested organizational units that enable to articulate the work at local, national, and international scales, through collaborative networks of LTSER sites and institutions that bring diverse disciplines that are relevant for biocultural conservation.
Esquema de las unidades anidadas de organización que permiten articular el trabajo del programa a escalas locales, nacionales e internacionales, a través de sitios SESELP e instituciones que colaboran en red e integran diversas disciplinas relevantes para la conservación biocultural.

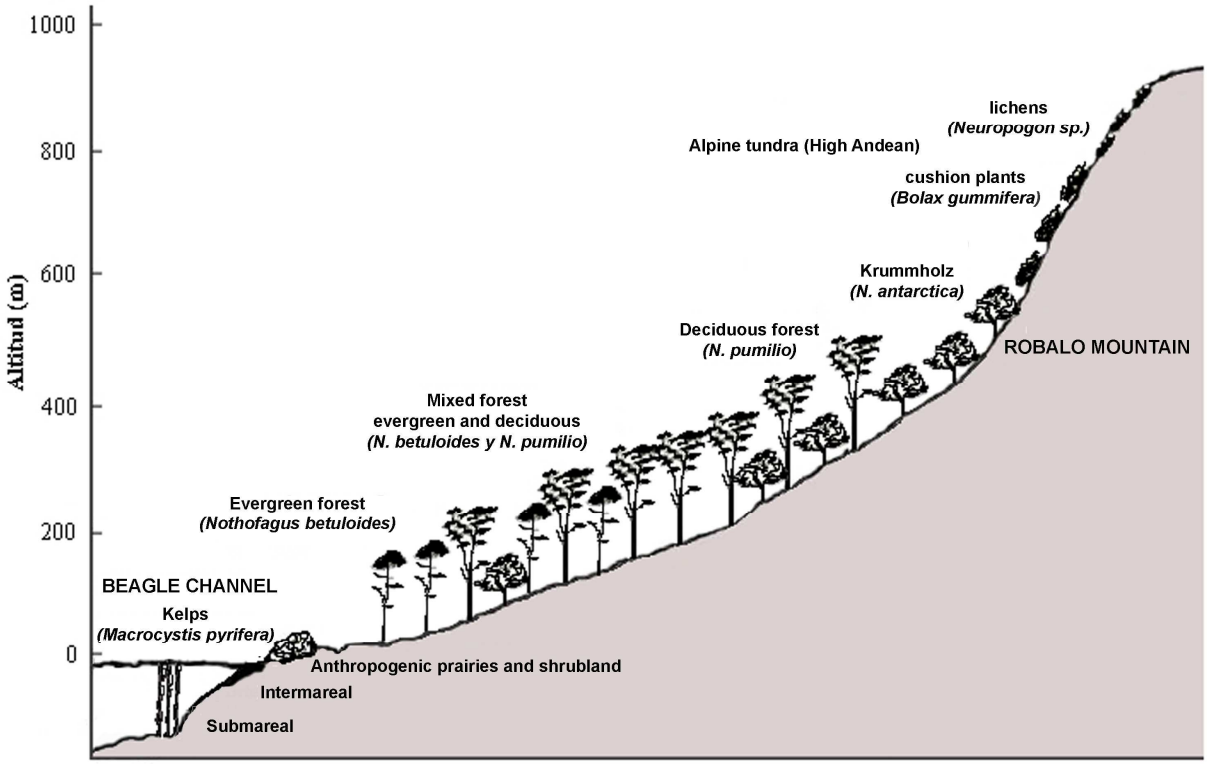

Fig. 3: Omora Park extends 920 m from the Beagle Channel to the summit of Robalo Mountain. This altitudinal gradient includes the characteristic habitat types of the Cape Horn region. From the shoreline upwards these habitats are: kelp forests of *Macrocytis pyrifera*, evergreen forests dominated by *Nothofagus betuloides*; mixed evergreen-deciduous forests dominated by *N. betuloides* and *N. pumilio*; deciduous forests dominated by *N. pumilio* and *N. antarctica*; alpine tundra dominated at lower levels by cushion plants, e.g., *Bolax gummifera*; and at upper levels by lichens (*Neuropogon* sp.).

El Parque Omora se extiende desde el canal Beagle hasta los 920 m de altitud en la cima del cerro Róbalo. Este gradiente altitudinal incluye los tipos de hábitats característicos de la región del Cabo de Hornos. Desde la línea de playa hacia arriba estos hábitats son: bosques de huiro de *Macrocytis pyrifera*, bosques siempreverdes dominados por *Nothofagus betuloides*; bosque mixto siempreverde-deciduodominado por *N. betuloides* y *N. pumilio*; bosques deciduos dominados por *N. pumilio* y *N. antarctica*; zona altoandina dominada por plantas en cojín en la parte más baja, e.g., *Bolax gummifera*; y por líquenes como *Neuropogon* sp. en las cumbres más altas.

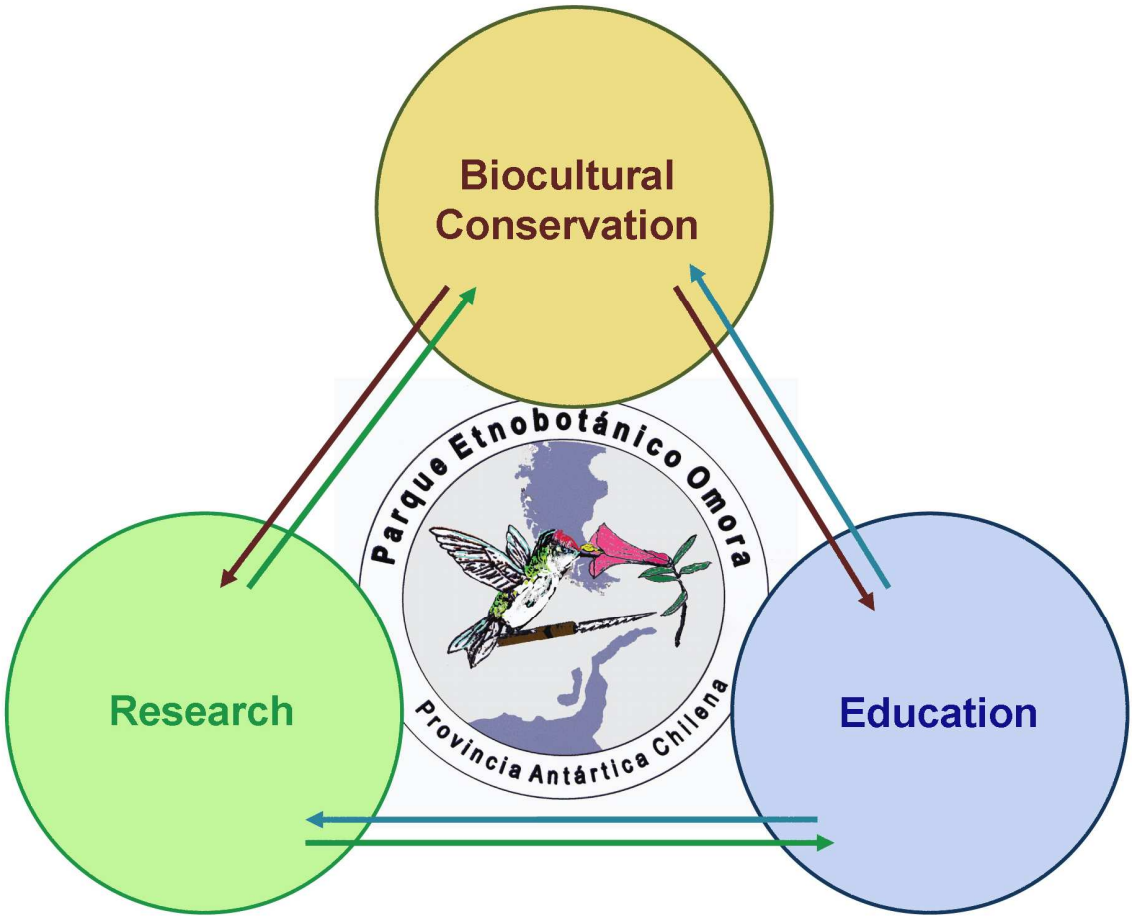

Fig. 4: The Omora Ethnobotanical Park's three domains of action are: i) transdisciplinary research, ii) formal and informal education, and iii) biocultural conservation. These domains were adapted from those proposed by the Ecological Society of America's Sustainable Biosphere Initiative: research, education, and environmental decision making (Lubchenco et al. 1991a). OEP researchers further adapted SBI's original triangle of activities by adding bi-directional arrows connecting the three domains in order to emphasize the need for multi-directional interactions. Omora's logo at the center emphasizes the integration between biological and cultural diversity by depicting the hummingbird *Sephanoides sephaniodes*, or omora in Yahgan, carrying a harpoon used by the Yahgan indigenous people to fish in the subantarctic archipelago region, while visiting a flower of the Magellanic copihue (*Philesia magellanica*), the primary source of nectar for the hummingbird in the austral ecoregion. In the Yahgan narratives, omora is seen as a bird, and at the same time a small person, a spirit who maintains social and ecological order.

El programa del Parque Etnobotánico Omora tiene tres dominios de acción: i) investigación transdisciplinaria, ii) educación formal e informal, y iii) conservación biocultural. Estos dominios fueron adaptados a partir de aquellos propuestos por Iniciativa para una Biosfera Sustentable (SBI): investigación, educación, y toma de decisiones ambientales (Lubchenco et al. 1991a). Los investigadores del Parque Omora también adaptaron el triángulo de actividades originalmente propuesto por la IBS al incorporar flechas bi-direccionales que conectan los tres dominios, con el objeto de enfatizar la necesidad de interacciones multi-direccionales. El logo de Omora en el centro enfatiza la integración de la diversidad biológica y cultural al dibujar al picaflor *Sephanoides sephaniodes* u omora en lengua yagán, portando un arpón (una herramienta tradicionalmente utilizada por el pueblo yagán para atrapar peces en la región del archipiélago subantártico) y visitando una flor de *Philesia magellanica* o coicopihue (la fuente primaria de néctar para el picaflor en la ecoregión austral). En las narrativas yaganes, omora era percibido como un ave, al mismo que un pequeño hombre o espíritu que mantenía el orden social y ecológico.

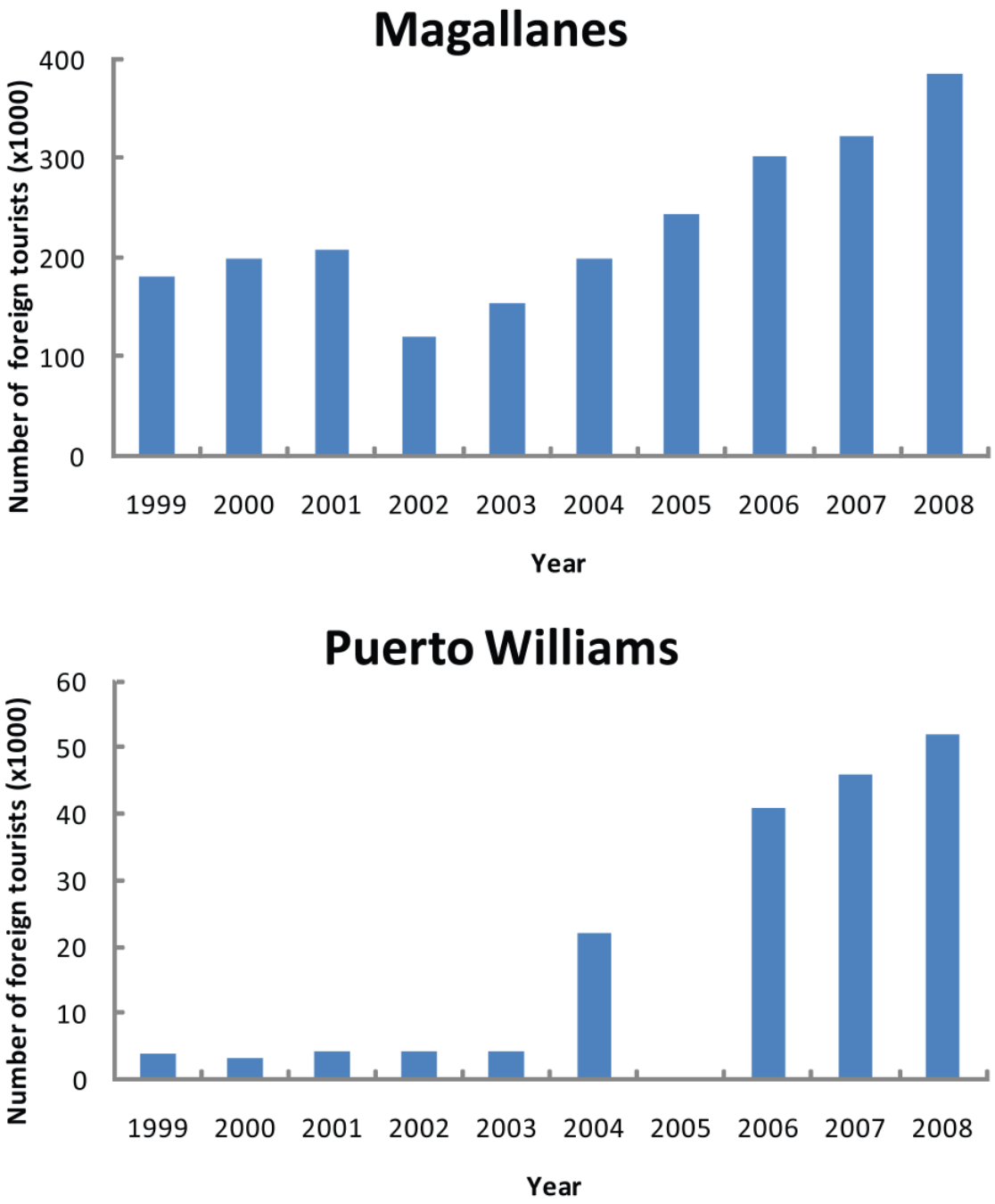

Fig. 5: Number of foreign visitors per year to the Magallanes Region (A) and Puerto Williams (B) during the last decade (Source:INE-SERNATUR 2008).

Número de visitantes extranjeros por año a la Región de Magallanes (A) y a Puerto Williams (B) durante la última década. (Fuente INE-SERNATUR 2008).

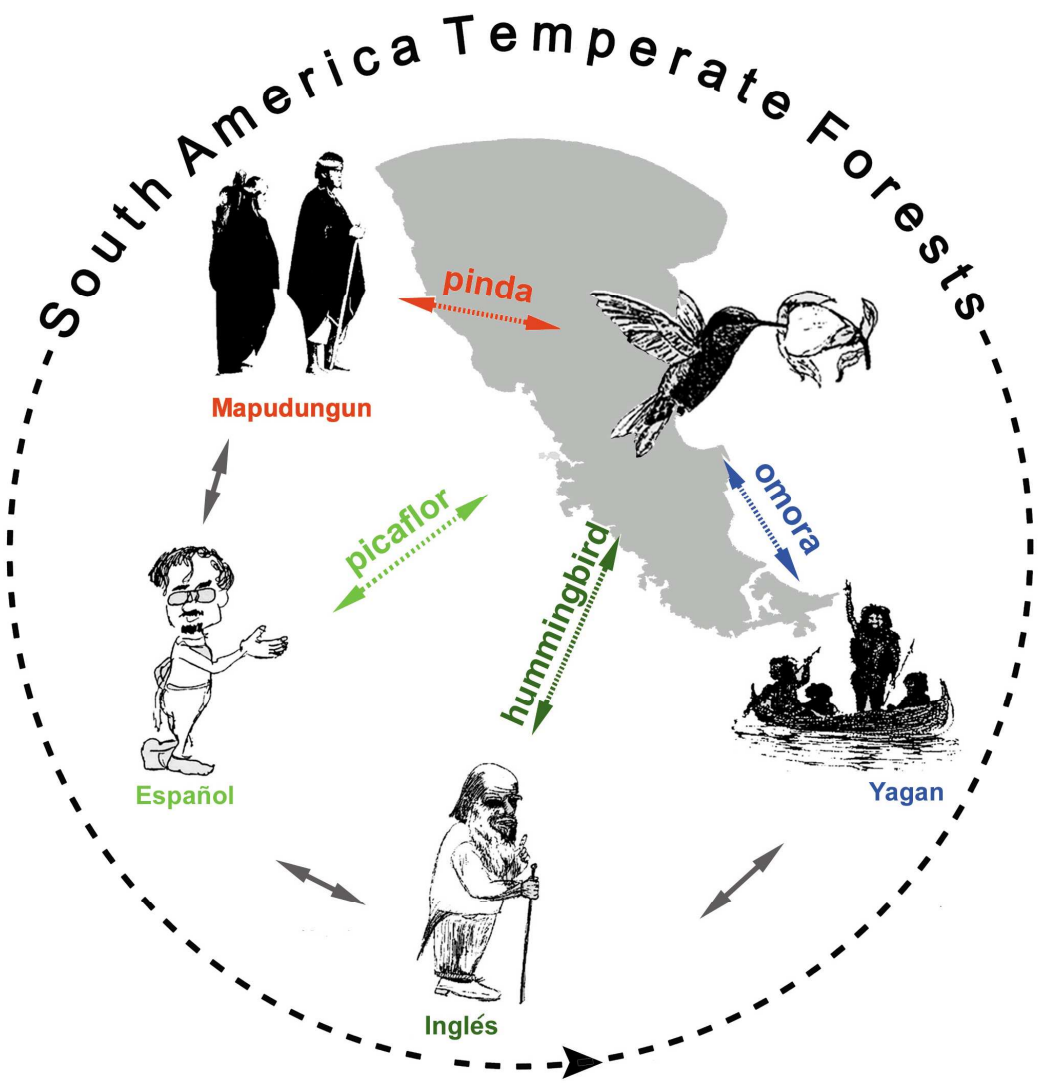

Fig. 6: Four languages spoken in the temperate and subantarctic forests of southern Chile, which involve diverse perspectives and worldviews about ecosystems, their biodiversity and ways of inhabiting, and provide a basis for comparative analysis of indigenous and scientific ecological knowledge. For example, the names in Mapudungun and English pinda and hummingbird, alude to the sound produced by the rapid movements of the wings during the flight of this little bird. The Spanish name "picaflor chico" points out to the small size of the hummingbird (*Sephanoides sephaniodes,* and the Yahgan name omora refers to its territorial behavior (Modified from Rozzi et al. 2003a).

Cuatro lenguajes hablados en la región de los bosques templados y subantárticos del sur de Chile, que involucran diversas percepciones y cosmovisiones sobre los ecosistemas, su biodiversidad y la forma de habitarlos, y proveen una base para análisis comparativos del conocimiento ecológico amerindio y científico. Por ejemplo, los nombres en mapudungun e inglés pinda y hummingbird, aluden al sonido emitido por las alas en el rápido aleteo de esta pequeña ave. El nombre español "picaflor chico" alude al pequeño tamaño del colibrí (*Sephanoides sephaniodes,* y el nombre yagán omora alude a su aguerrida conducta territorial (Rozzi et al. 2003a).

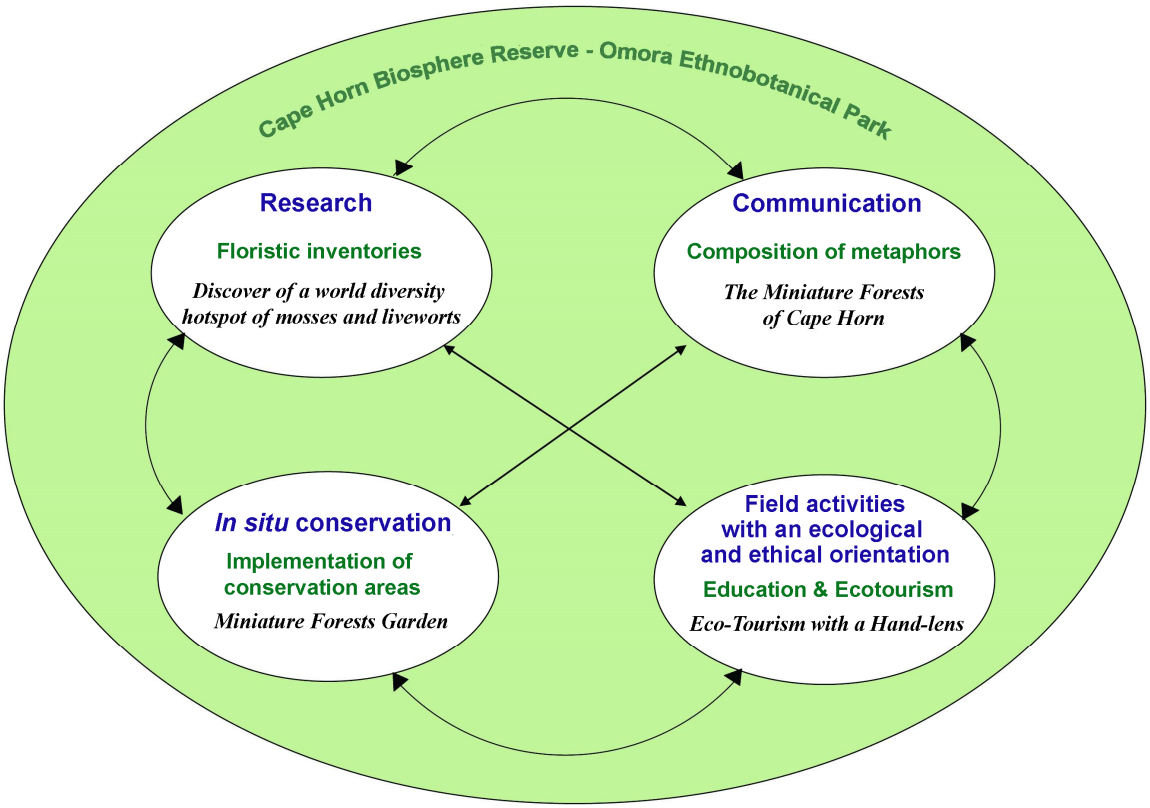

Fig. 7: The four step cycle methodology to integrate ecological sciences and environmental ethics into biocultural conservation, which is used by graduate students at the Universidad de Magallanes to develop innovative educational and ecotourism activities, such as "Ecotourism with a Hand Lens".

El ciclo de cuatro pasos para integrar las ciencias ecológicas y la ética ambiental en la conservación biocultural es utilizado por los estudiante de postgrado de la Universidad de Magallanes, quienes desarrollan actividades innovadoras de educación y ecoturismo, tales como el "Ecoturismo con Lupa" en el Parque Omora y la Reserva de Biosfera Cabo de Hornos.

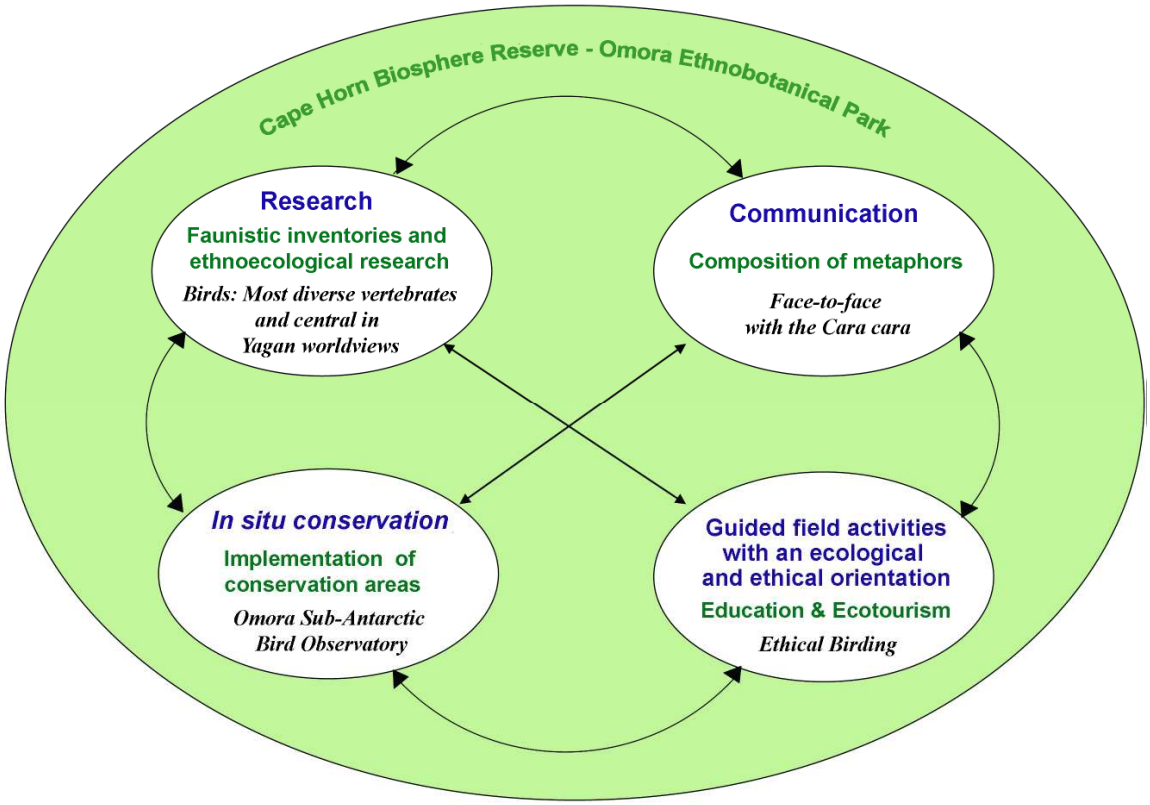

Fig. 8: Methodology of the four step cycle involved in the creation of the "Ethical Birding" activity at Omora Park in the Cape Horn Biosphere Reserve.

Ciclo de los cuatro pasos involucrados en el desarrollo de la propuesta del "Birding Ético" en el Parque Etnobotánico Omora en la Reserva de Biosfera Cabo de Hornos.

APPENDIX

Three main thematic areas of long-term interrelated ecological and philosophical research conducted at the Omora Ethnobotanical Park

General research area	Research with ecological emphasis	Research with philosophical emphasis
Sub-Antarctic biological diversity, linguistic, and socio-cultural diversity of perceptions on biodiversity	Long-term sampling and surveys of flora and fauna, considering seasonal variations and heterogeneity of terrestrial, freshwater and marine habitats.[i] It contrasts with the ecological research carried out previously in the CHBR, which was conducted almost exclusively during short periods in the summer with a focus on only a few taxonomic groups at specific sites. This type of study includes the longest-term mist-netting program for forest birds in the southern hemisphere forest avifauna.[ii]	Analysis of Amerindian worldviews, particularly focusing on Yahgan and Mapuche cultures, through the study of ethno-botany, ethno-zoology and their implications in environmental ethics.[iii]
Ecological interactions among diverse groups of organisms, including humans and their environmental ethics	Investigation of singular ecological interactions of the subantarctic ecoregion. This research has discovered remarkably low degrees of endo-parasitism in Passeriformes, high degrees of generalism in the diets of forest birds, and novel interactions such as entomophilia in mosses of the family Splachnaceae whose spores are dispersed by flies, and germinate on the feces of geese.[iv]	Studies on ecological and ethical perspectives about nature, considering different socio-cultural groups, institutions and disciplines,[v] including comparative analysis amongst these ecological knowledges, perspectives, and values, as well as between them and forms of understanding and valuation derived from ecological sciences and environmental ehtics.[vi]
Native and foreign biotas and cultures	Study of native and exotic flora and fauna in the CHBR, with focus on invasive exotic mammals, especially the North American beaver (*Castor canadensis*) and American mink (*Neovison vison*), and their impacts on forest ecosystems and ground-nesting avifauna, respectively.[vii]	Multicultural environmental philosophy, including recording and analysis of local ecological knowledge, practices, and their ethical implications, as well as translation of environmental philosophy texts, from Spanish to English (and vice-versa), with emphasis on Latin American ecological ethics.[viii]

[i] Goffinet *et al.* 2006, Rozzi *et al.* 2006b, Ippi *et al.* 2009, Mansilla *et al.* in preparation, Kennedy *et al.* in preparation.
[ii] Anderson & Rozzi 2000, Anderson et al. 2003, Rozzi et al. 2006b.
[iii] Massardo & Rozzi 2004, 2006, Rozzi et al. 2003, Aillapan & Rozzi 2001, 2004, Rozzi 2001, 2004.
[iv] Anderson et al. 2002, Brown et al. 2007, Merino et al. 2007, Jofre 2009, Jofre et al. 2009.
[v] Rozzi et al. 2001, 2003b, 2008b, Haider & Jax 2007, Berghoefer et al. 2008.
[vi] Jax & Rozzi 2004, Rozzi & Massardo 2001, Rozzi 2009.
[vii] Anderson et al. 2006a,b, 2009, Ibarra et al. 2009, Schüttler et al. 2009.
[viii] Rozzi 2007, 2008, 2009.