

Reciprocal Contributions between People and Nature: A Conceptual Intervention

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Throughout human history, Indigenous and local communities have stewarded nature. In the present article, we revisit the ancestral principle of reciprocity between people and nature and consider it as a conceptual intervention to the current notion of ecosystem services commonly used to inform sustainability transformation. We propose the concept of reciprocal contributions to encompass actions, interactions, and experiences between people and other components of nature that result in positive contributions and feedback loops that accrue to both, directly or indirectly, across different dimensions and levels. We identify reciprocal contributions and showcase examples that denote the importance of reciprocity for our ecological legacy and its relevance for biocultural continuity. We suggest that the concept of reciprocal contribution can support transformation pathways by resituating people as active components of nature and restructuring institutions so that ethical principles and practices from Indigenous and local communities can redirect policy approaches and interventions worldwide.

Keywords: reciprocity, empathy, stewardship, sustainability, biodiversity conservation

“What we do about ecology depends on our ideas of the [hu]man–nature relationship.”

—Lynn White (1967, p. 1206)

The world is facing a sustainability crisis that is due in part to our unidirectional relationship with nature, whereby humans extract resources and benefit from them with few, if any, responsibilities and little, if any, accountability to sustain nature (Dempsey 2016). However, there are many examples in history and across cultures of diverse people–nature relationships, where reciprocity is a core element of people's worldviews about nature (e.g., Rozzi et al. 2008). In this article, we revisit the ancestral principle of people–nature reciprocity practiced by different communities, including Indigenous, local, urban, periurban, and rural. We also seek to contribute to this dialogue and explore people–nature reciprocity as a conceptual intervention into the currently unidirectional nature–people relationships that remain dominant in theory and practice, in order to support policies that catalyze transformative pathways toward sustainability.

Multiple frameworks have been deployed in efforts to reconceptualize the nature–people relationship and improve sustainability outcomes. For example, the ecosystem service framework—the benefits people obtain from

ecosystems—has been developed to change how communities view and value natural resources (Costanza et al. 2017). But there is scant evidence that the ecosystem services framework has improved biodiversity conservation outcomes (Dempsey 2016). Recently, Diaz and colleagues (2018) proposed a shift from ecosystem services to nature's contributions to people (NCP), incorporating broader and more inclusive perspectives of nature–people relationships. The NCP framework encompasses “all the positive contributions, losses or detriments, that people obtain from nature” to understand the beneficial and harmful effects of nature (Díaz et al. 2018, p. 270). The NCP framework emerged from the Intergovernmental Science–Policy Platform on Biodiversity and Ecosystem Services (IPBES), which was established by the United Nations (Díaz et al. 2018). The framework has roots in the social sciences, biocultural diversity, and Indigenous or local perspectives (Díaz et al. 2018). Despite their differences, however, both the ecosystem services and NCP frameworks emphasize a unidirectional flow of nature–people relationships, from nature's services or contributions to people (Comberty et al. 2015, Kenter 2018). The supplemental material in the NCP article mentions subtly that, in some cases, the relationship between nature and people is highly reciprocal (Díaz et al. 2018), and recently, there have been developments to better incorporate reciprocity into the NCP framework (see below). We

posit that frameworks such as ecosystem services reflect the worldview that humans are apart from nature, whereas the principle of reciprocity reflects the worldview that humans are a part of nature.

Reciprocity ideas are emphasized by Indigenous studies scholars, pushing back against a unidirectional nature–people relationship that is rooted in human supremacy. Robin Wall Kimmerer (Potawatomi), for example, has raised concerns about land being reduced to a natural resource or ecosystem service, where complex biodiverse relationships are rendered down into human property (Kimmerer 2013). In contrast, she writes, “in a culture of gratitude, everyone knows that gifts will follow the circle of reciprocity and flow back to you again” (see Kimmerer 2013, p. 381). We took the Kimmerer teachings as an invitation to explore reciprocity beyond the linear flow of cost–benefit accounts. Therefore, a reciprocity understanding should encompass diverse lenses of human dimensions offering new avenues for sustainability.

Social–ecological studies have also raised reciprocity as an important value for assessments into nature–people relationships. For example, the concept of relational values has emerged to consider the multiplicity of people–nature relationships that include actions and habits conducive to a good life grounded in values such as justice, care, virtue, and reciprocity (Chan et al. 2016). To better bring reciprocity into the ecosystem service framework, Comberti and colleagues (2015) proposed the concept of services to ecosystems, where people can also benefit species or ecosystems. Refreshed perspectives from the NCP framework mention that “NCP provides for both unidirectional and bidirectional relationships that include reciprocity” (see Hill et al. 2021, p. 913). This approach is particularly important for interwoven and context-specific perspectives of NCP assessments.

Although many frameworks point to the importance of reciprocity, none to date provide a definition or a detailed engagement with the concept. This is the gap we aim to fill. For example, although Hill and colleagues (2021) improved NCP assessments by including unidirectional and bidirectional reciprocal relations, they do not unpack what reciprocity means in practice. Similarly, social–ecological frameworks (e.g., relational value) have helped to highlight reciprocity as an important value, but the specifics of what counts as reciprocal are not fleshed out. Our goal is not to replace or overlap with other concepts such as relational values but, rather, to expand on the notion of reciprocity so that it can be better incorporated into other frameworks. We examine ideas relevant to reciprocity through three dimensions (symbolic–linguistic–cultural, biophysical, and institutional–social–political) and four organizational levels (household and individual, community, national, global) and propose the concept of reciprocal contributions as an intervention to reestablish the importance of reciprocity in different aspects of society and conservation efforts. The idea of reciprocal contributions can promote conceptual and practical interventions for sustainability

transformation—transformations that are intended to generate evidence and propose solutions to solve our environmental crises (Wiek and Lang 2016). However, the most important reason of revisiting the role of reciprocity is because it addresses our responsibilities (a moral covenant, as it was framed by Kimmerer) “for all we have been given, for all that we have taken” (see Kimmerer 2013, p. 384). This moral covenant can trigger symbolic, ecological, economic, social, political effects. Today, reciprocity is relevant because many nations or plurinational states are in the process of revitalizing or restructuring constitutions (as in Chile), and people–nature reciprocity can be incorporated into such endeavors. Centering reciprocal contributions is a major conceptual intervention for scientific and governmental agencies to internalize because in practical ways nature–people reciprocity is core to many Indigenous and local communities and settings—land and sea or urban, rural, and periurban—even if those efforts are not always recognized.

Reciprocal contributions

We propose that the concept of reciprocal contributions can expand the role of reciprocity in social–ecological frameworks. Therefore, we begin by offering a definition: Reciprocal contributions encompass actions, interactions, and experiences between people and other components of nature (considering people as part of nature) that result in positive contributions and feedback loops that accrue to both—directly and indirectly—across different dimensions and levels (see box 1 and figure 1). A significant body of literature exists that has tracked the multiple contributions or services that nature provides to people (e.g., Costanza et al. 2017). Therefore, in this work, we focus on people’s contributions to nature—which have received less attention in scientific frameworks—but these contributions are not unidirectional, because they can generate mutual benefits for beings other than humans and for human societies. Reciprocal contributions generated from people to nature are promoted by a variety of factors, including relational values, empathy, a sense of place, kinship, ethics, beliefs, emotions, exchanges, stewardship, and livelihood sustainability, all of which can support the maintenance of healthy ecosystems and human well-being (Comberti et al. 2015, Chan et al. 2016). Although we emphasize mutually beneficial contributions, we recognize that reciprocal contributions can include indirect negative effects or trade-offs on other nontarget species, people, or ecosystems (see box 1).

In developing the concept of reciprocal contributions, we used the biocultural ethic framework developed by Rozzi (2015, 2018) to categorize the different human dimensions of reciprocal contributions. We think this framework is particularly appropriate because it embraces a moral covenant between people and other components of nature and already recognizes that there are numerous communities (living cities, rural, or remote areas) with cultural traditions that have ethical values aligned with sustainable practices and low environmental impact (Rozzi 2015). Rozzi’s

Box 1. The concept of reciprocal contributions.

Reciprocal contributions encompass actions, interactions and experiences between people and other components of nature (considering people as part of nature) that result in positive contributions and feedback loops that accrue to both—directly or indirectly—across different dimensions and levels.

In its most archaic form, *reciprocity* comes from the Latin word *reciprocus* and means “back and forth, to and fro” (Glare 1982). The adjective *reciprocal* means “given or done in return,” and the noun *reciprocity* means “a situation in which two parties provide the same help or advantages to each other” (Soanes 2001). Some Indigenous traditions include gift economies that embrace reciprocal relationships—implying generosity by balanced or unbalanced exchange—between peoples and between people and nature (see Mauss 1966, Trosper 2009). We adhere to the important characterization of reciprocity proposed by Robin Wall Kimmerer. She notes how, “in a culture of gratitude, everyone knows that gifts will follow the *circle* of reciprocity and flow back to you again” indicating that reciprocity is circular, not linear (Kimmerer 2013, p. 381). Reciprocity is not only an action or interaction. It is also an experience because the learning process implies reflection of lived experiences with other humans and other-than-human beings (Varela 2000). This conceptual distinction is important because actions emphasize a biophysical perspective, interactions recognize our ecological role in ecosystems, and lived experiences name our cognitive–reflective connections with nature’s phenomena. *Lived experiences* encompass the biocultural continuity of reciprocity, important for passing knowledge of reciprocity (e.g., Gould et al. 2019, and see box 2). For instance, Kimmerer writes, “our elders say that ceremony is the way we can remember to remember” (Kimmerer 2013, p. 383). Therefore, biocultural memories of elders and sharing lived experiences with them promote continuity of reciprocity through time. That is why we added the word *direct* because it emphasizes our learning with others.

We include the word *indirect* in the definition for two reasons. First, people or communities undertake actions that can have unintended effects in or far away from their territories and can transform into reciprocal contributions for them and nature. Today, these actions can be influenced by social media (see D’Ambrosi 2017, Olafsson et al. 2021). Second, our reciprocal contributions can involve indirect negative effects or trade-offs on other nontarget species, people, or ecosystems. For example, in the coastal temperate rainforest of British Columbia, in Canada, Indigenous peoples used fire as a tool for resource management to foster the abundance of specific plants or trees (e.g., Labrador tea, salmonberry) by generating mosaics of vegetation in different stages of succession (Hoffman et al. 2017). However, this local management could have had trade-offs for some species such as western hemlock and Sitka spruce that have a low resistance to fire (Hoffman et al. 2017).

We propose to use the adjective form *reciprocal* and to join it to the noun *contributions*. The noun *contribution* means “a gift or payment to a common fund or collection” or “to help to cause or bring about” (Kenter 2018). We think that the reciprocal contribution concept can be fed into the NCP framework, thereby expanding our collective understanding of reciprocal relations in NCP assessments.

(2015) biocultural ethic framework has three dimensions: a symbolic–linguistic–cultural dimension (linked to words, languages, emotions, and narratives embedded in a habitat that can trigger biocultural diversity), a biophysical dimension (centered on an ecosystem perspective where species, such as humans, interact with other species in a habitat), and an institutional–social–political dimension (organizational processes of human societies). We use these dimensions to discuss reciprocal contributions at multiple scales (household and individual, community, national, and global). We draw on examples from Indigenous and local communities to recognize and value reciprocal contributions but also to describe some constraints. We emphasize that reciprocity also has a temporal component. Many palaeoecological records show that Indigenous peoples started developing actions for improving their ecosystems hundreds and sometimes thousands of years ago (Jackson and Hobbs 2009, Root-Bernstein and Ladle 2019). Therefore, the temporal scale is a reminder that it is urgent to initiate reciprocal contribution strategies, but that we must respect the time it takes to achieve positive outcomes. In other words, the rhythm of nature is not the same rhythm of modern society. The concept of reciprocal contributions may help us move toward sustainability at local, national, and global levels and

can create dialogues between social–ecological frameworks by further clarifying how embedded humans are within ecosystems and how human activities not only are a cost to ecosystems but can be of ecological benefit under particular circumstances.

Human dimensions in contributions to nature. We examined different reciprocal practices by conducting an integrative literature review (Snyder 2019). We selected key articles from Indigenous and social–ecological approaches that contain case studies demonstrating nature–people reciprocity (see supplemental table S1). We chose these key articles because they stem from different disciplines (or interdisciplines) and continents and can be used as a starting point for future studies and practitioners to build on. In these articles, we identified 21 reciprocal contributions (figure 1) and categorized them at different scales, and by the human dimensions of Rozzi’s (2015) biocultural ethic framework: symbolic–linguistic–cultural, biophysical, and institutional–social–political dimensions. We showcase examples to highlight how reciprocity appears in each human dimension at different scales. The purpose of our literature review was to combine perspectives and insights from different research fields that have engaged with ideas

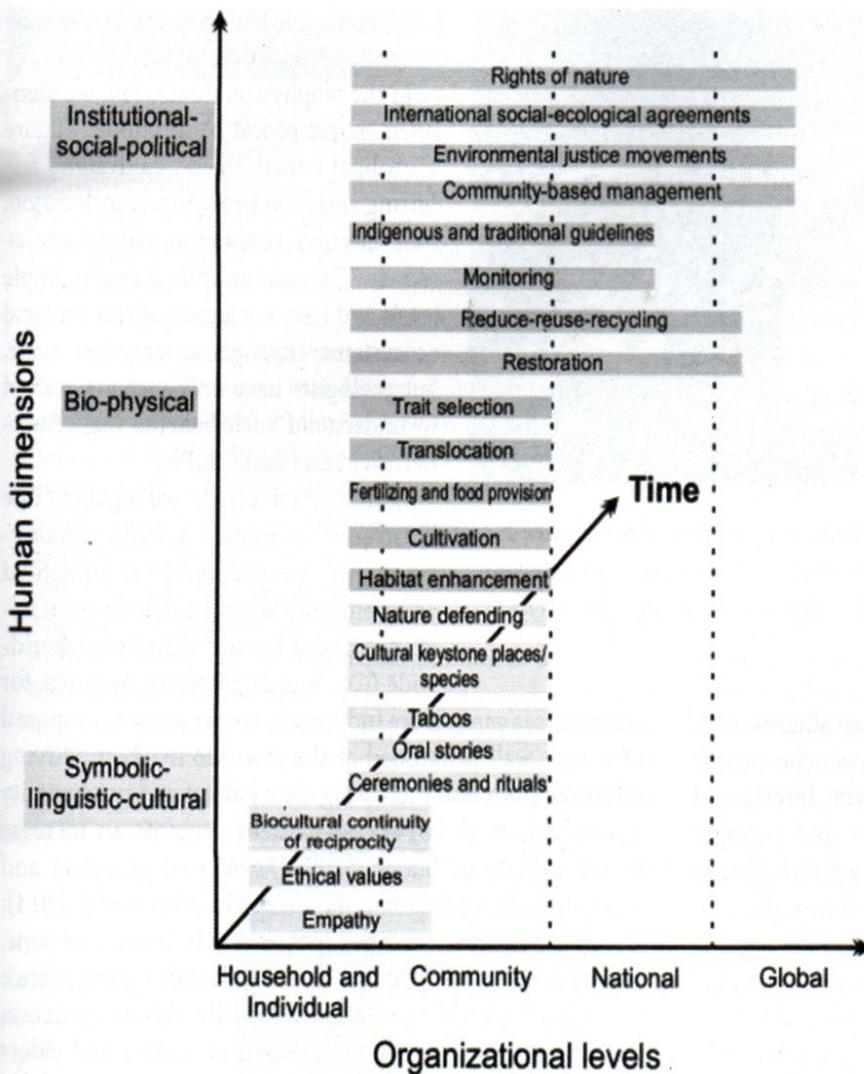


Figure 1. Examples of reciprocal contributions, by human dimensions (symbolic-linguistic-cultural, biophysical, and institutional-social-political) and organizational levels (household and individual, community, national, global). The time axis highlights the importance of assessing the temporal scale of reciprocal contributions in future studies.

relevant for reciprocity. The intent was not to cover all related literature but, rather, to provide a starting point for conceptualizing reciprocal contributions.

Reciprocal contributions in the symbolic-linguistic-cultural dimension operate mainly at individual to community scales, and therefore, cognitive science can provide several insights into how reciprocity emerges in this dimension and how it supports nature–people reciprocity. First, empathy (sometimes called *intersubjectivity*) is how humans learn from others through embodied encounters, such as facial expressions, emotional reactions, and touch (Varela 2000). In other words, human knowledge emerges from physical cohabitation with humans and other-than-human beings. We propose that *empathy* can be one basis or root of nature–people reciprocity. Second, all cognitive phenomena entail emotional–affective processes, and therefore, emotions can generate transformations in our cohabitation (Varela 2000). Third, human experiences emerge from lived experiences with others (habitats and inhabitants), which result in cognitive reflection about lived experiences

(Varela 2000). Empathy, emotions, and lived experiences are ontological components of reciprocal contributions but are also inherent to ethical values, a sense of place, and biocultural continuity practices through generations. Therefore, if we lose our capacity to reflect on our cohabitation with local biodiversity, we simultaneously might miss our ability to learn and value nature–people reciprocity. Aldo Leopold's famous encounter with a female wolf described in the essay "Thinking Like a Mountain" exemplifies the reflection of empathy and ethical values (Leopold 1949). When Leopold was hunting a wolf, he said, "In those days, we had never heard of passing up a chance to kill a wolf. In a second, we were pumping lead in the pack.... We reached the old wolf in time to watch a fierce green fire dying in her eyes. I realized then, and have known ever since, that there was something new to me in those eyes—something known only to her and to the mountain" (Leopold 1949, p. 130). This transformative experience changed Leopold's life, helping to make him one of the most important contributors to the fields of environmental ethics and ecosystem management in the United States.

The circle of reciprocal cohabitation embodied in cognitive experiences can be interconnected with cultural, linguistic, and symbolic practices—biocultural diversity (see Maffi 2005)—which are

critical for biocultural continuity, sense of place and relational values (Chan et al. 2016, Masterson et al. 2017, Thompson et al. 2020). For example, Mapuches have gathered wild edible plants for centuries as a complement to their crop–livestock sustenance systems (Barreau et al. 2016). *Mapuche* means "people" (*che*) "of the land or Earth" (*mapu*). They have three subgroups: Lafkenches, Williches, and Pewenches. Pewenches are people of the *Pewen* or monkey-puzzle tree (*Araucaria araucana*) forests on the volcanic Andean mountain range in southern Chile and Argentina (figure 2a; Rozzi et al. 2008). For Pewenches, the gathering of *Pewen*'s seeds (*piñones*; figure 2b) is a crucial practice because *piñones* have a nutritional significance for them (Rozzi et al. 2008), and they have cultural and economic importance (Barreau et al. 2016). Artisanal harvesting is a household tradition in which children, adults, and elders share traditional ecological knowledge through harvesting practices, stories, and watching activities (Cortés et al. 2019). When a Pewenche takes *piñones* from a *Pewen* tree, she must ask permission from

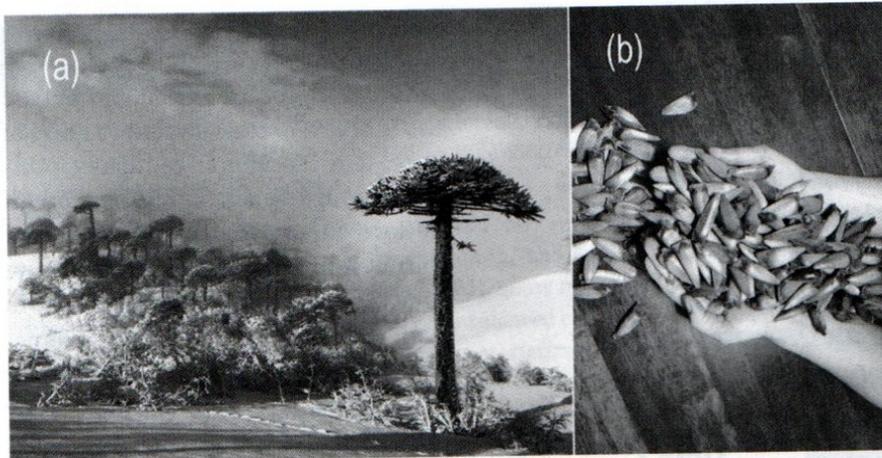


Figure 2. (a) Pewen or monkey-puzzle tree (*Araucaria araucana*) forests are a key ecosystem for the Pewenche, Chile. (b) Pewen's seeds (*piñones*) are relevant for food and cultural traditions. Photographs: Tomás Altamirano (forest) and Fabiola Troncoso (seeds).

newenes (natural strengths), accentuating her alliance with the Pewen forest (Skewes et al. 2017). Pewenche people therefore have a responsibility toward Pewen forests and have acted as land defenders. Both elders and younger generations of Pewenches have been defending Pewen forests because of the rapid and uncontrolled expansion of private property claims, dam constructions, and logging corporations (Barreau et al. 2016). These threats, coupled with commodification of the seeds, constrain Indigenous gathering practices, undermine the sense of place, and reduce seed abundances (Cortés et al. 2019). The Pewenche land defense demands the protection of the Wallmapu–Mapuche territory that is a living entity with material and nonmaterial elements (Molina Camacho et al. 2018). Authentic recognition of reciprocal contributions—and, particularly, Pewenche's contribution to nature—can foster outcomes linked to educational practices and cultural continuity and simultaneously support Pewen forest health and local biodiversity.

Much reciprocity knowledge still lives in the collective memory of our elders. Indigenous and local communities continue to pass on knowledge through conceptual and practical experiences, such as stories, rituals, and observations (see Ibarra et al. 2021) whereby elders share experiences between generations and nurture the biocultural continuity of reciprocity. Certainly, knowledge about reciprocity also exists in many different groups of people (e.g., for urban citizens, see Huang 2021, and, for immigrants, see Pizarro and Larson 2017) who can revitalize this knowledge, and governmental agencies should promote them. Addressing the biocultural continuity of reciprocity also recognizes the value of the temporal scale. From a future perspective, maintenance of options through the biocultural continuity of reciprocity should be incorporated as an educational intervention with short, mid, long-term strategies. Therefore, community participation, including the wisdom of elders, is critical for the coproduction knowledge and

restructuring learning strategies for sustainability transformations.

In the biophysical dimension, we identified six reciprocal contributions (figure 1): habitat enhancement, cultivation, fertilizing and food provision, translocation, trait selection, restoration, reduce–reuse–recycle. They can operate across multiple levels and have ecological effects on local ecosystems through a temporal scale, but ecologists have only recently started to understand such benefits (e.g., Root-Bernstein and Ladle 2019).

In the present article, we highlight one illustrative example, *habitat enhancement*, that operates mainly at household or community levels, has a long-term relevance, and is broadly distributed worldwide (e.g., box 2). In North America, for

example, sea gardens are Indigenous constructions composed of a rock wall positioned at the low-tide mark, modifying intertidal slope and increasing clam habitat and productivity (Groesbeck et al. 2014). Sea gardens promote an increase in the density of butter clams (*Saxidomus gigantea*) and native littleneck (*Leukoma staminea*; Groesbeck et al. 2014), benefiting people and other species (birds, bears, raccoons, among many others; Deur et al. 2015). Hands-on experience is essential to build the wall, and initially, this construction was laborious, requiring the wisdom of leaders and elders (Deur et al. 2015). The temporal scale is important in this reciprocal contribution, because a sea garden did not have an immediate effect on clam abundance. To some extent, this Indigenous aquaculture innovation was built thinking of the next generations (Smith et al. 2019). Although the practice of building sea gardens was undermined by colonization (Deur et al. 2015), community knowledge remains and can be engaged for ecocultural restoration. For example, in 2014, the WSÁNEĆ and Hul'q'umi'num nations started working in partnership with Parks Canada in the Clam Garden Restoration Project to manage, restore, and conserve sea gardens in the Gulf Islands National Park Reserve (Olsen 2019). WSÁNEĆ and Hul'q'umi'num harvesters acknowledge that a healthy sea garden is directly related to care and management, helping to demonstrate how reciprocal contributions are essential for healthy productivity and Indigenous rights (Olsen 2019). This is just one example in which reciprocity supports the resilience of customary management, providing lessons to intervene with stewardship strategies and rationale to restructure governmental institutions to include different approaches attuned to reciprocal contributions (Abson et al. 2017).

Practicing nature–people reciprocity through restoration strategies is a vital intervention in all social–ecological systems and especially urban settings. Over 50% of the world's population lives within urban areas (UN 2019). Urban development has contributed to the overexploitation

Box 2. Fishponds in Patagonia as an example of reciprocal contributions.

At the southern reaches of South America (Patagonia, Chile), fishponds (or *corrales de pesca* in Spanish) are a traditional fishing method built by Indigenous and local communities (e.g., Chilotes) who used boulders to create a rock wall (see figure 3a). *Corrales de pesca* generated reciprocal contributions for people and coastal biodiversity. They enable capture of fishes such as *róbalo* (*Eleginops maclovinus*) or *jurel* (*Trachurus symmetricus*), and fishponds simultaneously promote increased mollusk abundance and the presence of fish-eating birds (Alvarez et al. 2008). These structures are present across many coastal areas in Patagonia (Torres 2009), but their density is higher in the Chiloé archipelago (Alvarez et al. 2008). Many Chilotes are mestizos among Williches (a subgroup of the Mapuche people), Chonos (canoeist Indigenous people), Spaniards, and Chileans (Saldívar 2017). Indeed, Darwin (1839, p. 334) referred to Chilotes as “the inhabitants appear to have three-fourths of Indian blood in their veins.” Chilotes are known as artisanal fishers and small farmers who developed multiple marine relations with fishponds (traditional food, ceremonies, and mythologies; see Alvarez et al. 2008). In the last century, fishponds were linked to other important cultural spaces on the land, such as artisanal firepits (or *fogón* in Spanish; see figure 3b) that were relevant in the cultural continuity of marine traditions. Particularly, on Chiloé island, a family fished and gathered using a fishpond, and then carried their catch to the artisanal firepit, where they were stored or cooked. Around the firepit, elders, adults, and children shared food, oral stories, and management guidelines about the sea and fishponds (Hilda Gallardo, Chilote elder, Punta Arenas, personal communication, 7 December 2020). Between the 1960s and the 1980s, traditional uses of fishponds started to decline for multiple reasons (other fishing methods, migration from urban to rural areas, megathrust earthquake), including their prohibition for many years because of a Chilean fishing law that banned all permanent fishing methods (Alvarez et al. 2008). Currently, *corrales de pesca* are legally recognized as archaeological monuments. Many Indigenous and local communities note their importance as a customary practice to apply to marine and coastal areas for Indigenous peoples. Likely, these sea innovations and their cultural legacy can be revitalized in the future, where organizational processes will play a crucial role in rebuilding reciprocal contributions.

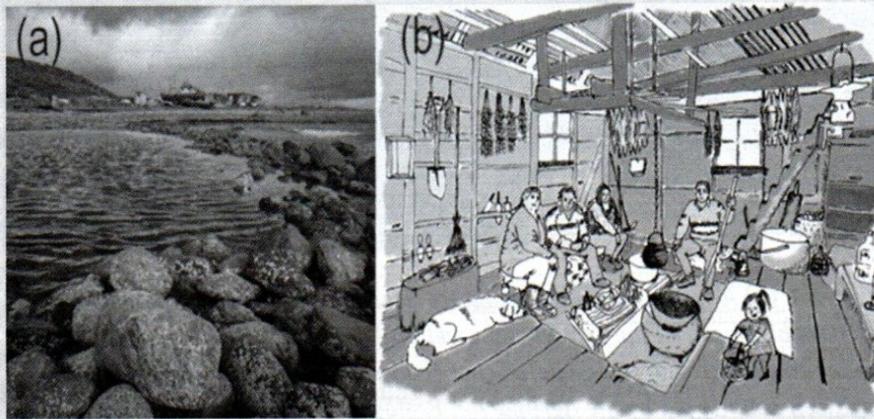


Figure 3. (a) A fishpond wall located in Otway Sound, Chile, and (b) the illustration shows the environment and elements that composed an artisanal firepit. Images: Alex García.

of ecosystems through urbanization, material demands, and consumption (Grimm et al. 2008), negatively affecting global biodiversity and creating a biophysical barrier to knowing and valuing nature (Maxwell et al. 2016, Celis-Diez et al. 2017). This issue has caused weak feedback loops between human societies and ecosystems (Cumming et al. 2014). Restoration as an intentional biophysical activity to recover ecosystems can act as a reciprocal contribution in cities. In box 3, we illustrate three cases in which citizens' contributions to nature can improve ecological indicators (such as bird diversity or green areas) and elicit relational values with a long-term effort. The challenge is to articulate and escalate public awareness of nature–people reciprocity for sustainable urban design.

In the institutional–social–political dimension, six reciprocal contributions were linked to human organizational processes that can provide improvements in current governance strategies. To illustrate this, we provide an example of how Indigenous guidelines about nature–people reciprocity can support community-based management. The Haida scholar Russ Jones and colleagues (2010) described six Haida values crucial to support marine planning in Haida Gwaii (Canada). Most relevant, Jones and colleagues described how the Haida value *Isda ad diigii isda* and how “giving and receiving (reciprocity) is a respected practice in our culture, essential in our interactions with each other and the natural world. We continually give thanks to the natural world for the gifts

Box 3. Urban freshwater restoration can change cities.

Water gathers people for restoration movements. Worldwide, there are many citizen programs for restoring rivers, creeks, wetland, and small lagoons. Restoration practices can promote a circle of reciprocity in emotional, educational, economic, and political spheres in cities (see Murphy et al. 2021). For example, in the city of Victoria (Canada), the Bowker Creek Restoration Plan is an intergenerational commitment. Urbanization, invasive species, and water pollution undermine native vegetation and key cultural species such as native salmon. Today, this watershed initiative gathers community organizations, municipalities, and institutional agencies to implement a long-term effort to restore native vegetation and wildlife, and provide a community greenway to connect neighborhoods (see BCI 2021). In southern India's Bengaluru City, urban lakes have been undermined by housing development, dumping and waste, and neglect by governmental agencies (Murphy et al. 2021). Local groups who live around lakes have led restoration efforts (green cleaning areas) to generate reciprocal contributions for them (e.g., healthy sites and fishing in periurban lakes) and for the local environment (e.g., enhancing bird habitats; see Murphy et al. 2021). In Punta Arenas City (Patagonia, Chile), for 14 years, urban organizations restore and defend the Tres Puentes wetland (see figure 4), which is surrounded by industrial buildings and neighborhoods. It was a large wetland in the past, but because of urbanization, the wetland is now a small area, with 50 hectares hosting 91 bird species (Gómez et al. 2014). For many years, governmental agencies have wanted to build an elevated highway over the wetland. Urban organizations continue restoring while wetland biodiversity generates educational and touristic activities (figure 4; Cárcamo et al. 2012). These urban cases highlight that it is possible to promote citizens' contributions to nature through biophysical restorations and to bring nature back in cities.

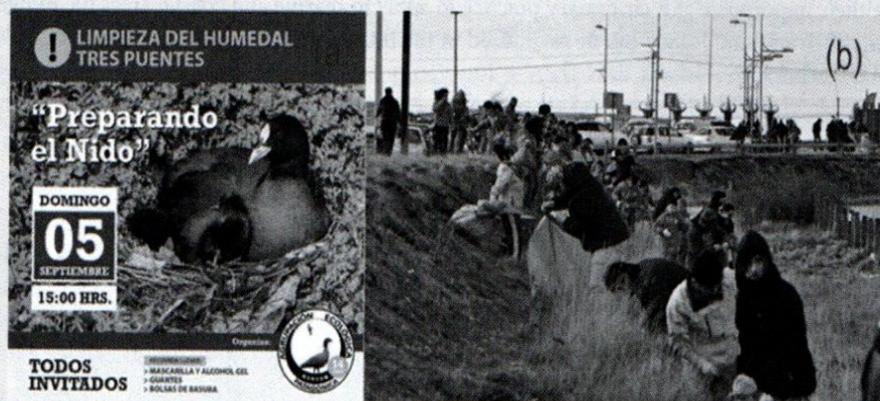


Figure 4. (a) Advertising poster promotes cleaning and restoring activities to prepare bird nests in the Tres Puentes wetland during the spring season. The poster shows a nest of red-gartered coot (*Fulica armilata*). (b) The photo shows a citizen activity led by the *Agrupación Ecológica Patagónica* and elementary schools in Punta Arenas City. Poster: Sebastián Saiter. Photograph: Marcelo Ian McLean.

that we receive” (see Jones et al. 2010, p. 5). Haida values contribute to managing local fisheries, and they are core elements of the Haida Land Use Vision that supported the Haida Gwaii land-use agreement between the Council of the Haida Nation and Province of British Columbia (Jones et al. 2010). By seeing nature as gifts provided to people, rather than natural resources that can be exploited or ecosystem services that could be commodified, liquidated, or replaced, a conservation ethic is deeply embedded in Haida culture. Worldwide, there are many Indigenous peoples and local communities who are working hard to revitalize ethical practices with reciprocal contributions as part of community-based governance (Tran et al. 2020). Still, obstacles from Western colonization remain in many governmental and scientific agencies and the worldviews informing them.

The failure of governmental agencies and national policies to include community-based management approaches that are attuned to reciprocal contributions is a significant barrier to achieving a sustainability transformation. One example in which this is being attempted is in southern Chile through marine and coastal areas for Indigenous peoples (MCAIP). This national policy aims to maintain Indigenous customary uses (fisheries, traditions, and ceremonies) with environmental sustainability goals, giving access and rights to manage marine spaces (Hiriart-Bertrand et al. 2020). However, there are at least two constraints. First, the MCAIP application is framed by Western science protocols (Hiriart-Bertrand et al. 2020), where Indigenous peoples have to demonstrate their customary historical uses associated with local areas. Second, 79 MCAIPs have been requested, but granting these seascapes can take many years because of

government bureaucracy and resistance from industrial interests, such as salmon farming (Araos et al. 2020). We suggest that some of these limitations can be addressed by more fully integrating the reciprocal contribution approach into decision-making, thereby fostering the recognition of Indigenous and local lifeways in marine stewardship.

The rights of nature, depicted in figure 1 as part of the institutional–social–political dimension, can also be seen as an umbrella reciprocal contribution and represents a moral covenant between people and nature. The rights of nature stipulate that nature is a subject with rights and that humans are responsible for complying with these rights (Millaleo 2019). For example, in South America, Ecuador and Bolivia have started advocating for the rights of nature and have enshrined the concept into their constitutions (Guardiola and Gracia-Quero 2014). Chile is now in the middle of a new constitutional process, and nature–people reciprocity is part of current dialogue. For example, Salvador Millaleo, a Mapuche scholar, advocates that a new moral covenant in Chile must encompass obligations of reciprocity with nature and emphasizes that a new constitution should include the kinship notion between people and Mother Earth (Millaleo 2021). This highlights that reciprocal contributions can trigger a conceptual and practical intervention for restructuring institutions—a leverage point for a sustainability transformation (Abson et al. 2017)—at national and international scales.

Cross-cutting reciprocal contributions. Although the categorization of reciprocal contributions is helpful to understand the many and varied forms these contributions can take, in reality, reciprocal contributions cut across multiple dimensions. For example, for sea gardens and *corrales de pesca* (biophysical dimension), people cultivated a kinship notion to nature (symbolic–linguistic–cultural dimension) through community-based management (institutional–social–political dimension). Coastal First Nations in Canada consider clams as marine relatives in a different form. Oral stories describe how the first *lokiwey*—a sea garden in the Kwak'wala language—was created by a mink, a powerful being. The mink established a precedent for following strategies that supported cultural and economic health (Deur et al. 2015). In Chile, some elders in rural communities mention that it is inappropriate to capture fish in fishponds during the spawning season because, like us (humans), they (fish) need privacy (Alvarez et al. 2008). Certainly, kinship notions, empathy, management strategies, and biophysical actions are connected. The future challenge is how these reciprocal contribution ideas can be used to reconnect people to nature, restructure institutions, and rethink how knowledge is created and used in seeking sustainability.

Understanding reciprocal contributions through methodological approaches. Several methodological frameworks can facilitate understanding of reciprocal contributions in a given social–ecological system (e.g., relational values, Chan et al.

2016; leverage points, Abson et al. 2017). In the present article, we showcase two approaches: a sense of place and the NCP framework. Psychological researchers and human geographers have emphasized how a sense of place can inform reciprocal actions in the human society (see Raymond et al. 2021). This approach depicts people's connection to places, encompassing attachments that people feel for a place embedded in meanings (Murphy et al. 2021). These meanings describe people's symbolic relations to a place (Raymond et al. 2021). Traditionally, a strong attachment leads to groups of people willing to advocate for nature in their home place, although there are multiple motivations for this advocacy (Masterson et al. 2017).

Investigating the sense of place, using quantitative (structured surveys) or qualitative (narrative interviews) tools, can reveal reciprocal contributions (see Raymond et al. 2021). For instance, in box 3, we show that local groups, who live around lakes in Bengaluru City, have led restoration efforts to generate reciprocal contributions for human well-being, agriculture, and migratory waterbirds. Murphy and colleagues (2021) used the sense of place as a methodological approach to understand that restoration efforts can have several motivations. For example, the remediation of pollution was an important goal for some citizens, and the collective memories of the healthy lake system in the past were also important motivations for old neighbors. In the 2000s, public protests started because people did not have access to restore and maintain lakes, and in the 2010s, the residents and the municipality started an agreement for comanagement (Murphy et al. 2021). The sense of place offers myriad ways of understanding nature–people reciprocity by identifying changes, differences, and consensus of multiple groups who inhabit social–ecological environments.

The NCP framework can also inform nature–people reciprocity. An outstanding case of this framework is the IPBES Pollination Assessment, which has local to global contributions (Díaz et al. 2018, Hill et al. 2021). Due to the global relevance of NCP, we believe this inclusive framework should have a permeable capacity for feedback, including other voices beyond the IPBES groups. For example, Hill and colleagues (2021) briefly mentioned that interwoven and context-specific perspectives can capture bidirectional reciprocal relationships between nature and people. Hill and colleagues (2021) did not define *reciprocity*; we offer a definition of *reciprocal contributions* that can create novel avenues to explore reciprocity. In addition, we provide examples with multiple dimensions and levels together to emphasize the role of the temporal scale for assessments.

In specific terms, the categorization of reciprocal contributions can also generate bridges or connections between NCP perspectives. On one hand, in the symbolic–linguistic–cultural dimension, we remarked that maintenance of options for biocultural continuity helps to support oral stories, rituals, nature defending, or habitat enhancement. On the other hand, in the generalizing perspective of NCP, the category of maintenance of options, which includes regulating, material,

and nonmaterial contributions, is attuned to sustainability futures, but it only considers the more-than-human world (the “capacity of ecosystems, habitats, species or genotypes to keep options open to support good quality life,” Díaz et al. 2018, table S1). As Thompson and colleagues (2020) suggested, the maintenance of options should embrace bidirectionality and should emphasize reciprocal relationships between people and nature. We believe that symbolic–linguistic–cultural dimensions spotlight the role of maintenance of options for biocultural continuity, where intergenerational knowledge is crucial for biocultural diversity.

Conclusions

We suggest that the idea of reciprocal contributions offers conceptual support to current pathways for sustainability transformation, particularly by emphasizing the embeddedness of people in nature, rethinking how knowledge is created and used, and restructuring institutions (Abson et al. 2017). Through many examples (see box 2 and *piñon* harvesting), we have demonstrated that it is necessary to explore lived experiences, actions (direct or indirect), and interactions of the reciprocity phenomenon where different dimensions and scales can offer more clues of nature–people relationships and restructuring institutions. We think that the maintenance of options for biocultural continuity can promote reciprocal contributions and can feed into frameworks such as NCP. The biocultural continuity of reciprocity opens the door to discuss how governmental agencies promote an authentic inclusion of teaching nature–people reciprocity in formal and nonformal institutions. We know that Indigenous communities are making many efforts to pass traditional knowledge and customary management techniques from one generation to the next (Berkes and Turner 2006). Therefore, we think that the unveiling of reciprocal contributions can promote biocultural learning strategies, self-organization of societies, and adaptive capacities.

Currently, social–ecological frameworks mention nature–people reciprocity as an essential value (Chan et al. 2016, Díaz et al. 2018, Hill et al. 2021). In the present article, we seek to provide a more robust conceptualization of reciprocity because we think it can help address current and future sustainability challenges. From a global perspective, explicitly incorporating the idea of reciprocal contributions into interwoven perspectives of the NCP framework is possible and can promote a reflection of how knowledge of nature–people reciprocity is created, shared, and used. Ultimately, cultivating moral covenants that include a culture of gratitude to nature and authentic inclusion of reciprocity across different social institutions is vital to remedying our ecological crisis. At national and local scales, reciprocal practices from Indigenous and local communities can contribute to policy interventions into countries, such as the ongoing constitutional process in Chile. We believe that reciprocal contributions can support sustainability transformation by evidencing that nature–people reciprocity is happening all the time (and has been for millennia; Root-Bernstein and

Ladle 2019), in many places, at different human scales. Therefore, we must give voice, value, and power to this kind of relationship, articulating strategies and tools for better understanding, learning, and implementation.

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Supplemental material

Supplemental data are available at *BIOSCI* online.

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