



The genetically engineered American chestnut tree as opportunity for reciprocal restoration in Haudenosaunee communities[☆]

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ABSTRACT

As genetic engineering becomes a part of the toolkit for the conservation and restoration of biodiversity, a broad range of social science frameworks are required to understand how different groups of people perceive these emerging technologies. Reciprocal restoration is one such framework that offers Indigenous-specific perspective on new applications of genetic engineering for conservation and restoration. The restoration plan for the American chestnut tree includes the potential wild release of a genetically engineered tree in close proximity to the sovereign Haudenosaunee communities of Central and Upstate New York. This paper uses reciprocal restoration as a framework for evaluating if a restoration project that uses a genetically engineered species could support broader cultural restoration efforts in these communities. Results are complex, but suggest that reciprocal restoration may be possible if certain foundational dimensions – such as kincentric relationships and spiritual responsibilities – are attended to. Reciprocal restoration also offers insight for future cases where Indigenous perspectives on the use of genetic engineering for conservation and restoration are important dimensions of broader governance considerations.

1. Introduction

The potential for using genetic engineering to safeguard and restore global biodiversity garners growing consideration and attention (Sutherland et al., 2017; Taylor and Gemmell, 2016; Thomas et al., 2013). Examples include the restoration of a number of forest tree species threatened by pests and pathogens (Dumroese et al., 2015; Merkle et al., 2007); genetic rescue of small populations of charismatic species like the Florida panther and the gray wolf (Whiteley et al., 2015); and untold potential applications of CRISPR technologies (Johnson et al., 2016) such as the use of gene drives to reduce rodent pests of island bird populations (Campbell et al., 2015). These applications of genetic engineering for conservation may aim at public goods, but they emerge in the shadow of broader controversies, especially agricultural biotechnology, which have attracted criticisms ranging from ecological impacts to human health risks to the privatization of life to the exploitation of farmers (Delborne and Kinchy, 2008;

Kinchy, 2012).

Alongside these high-tech solutions, Indigenous communities are regaining some traditional management authority over biodiversity and its management. These practices stem from a recognition that Indigenous cultural diversity and biological diversity have a long-established co-occurrence; biodiversity hotspots generally coincide with Indigenous territories (Gorenflo et al., 2012). These management shifts speak to some reorientation of conservation and restoration goals to better acknowledge and make amends for troubled histories of colonialism and injustices (Ford and Martinez, 2000; Anderson and Barbour, 2003; Lyver et al., 2015).

Thus, genetic engineering enters the conservation and restoration toolkit when Indigenous communities are regaining management authority over globally significant centers of biodiversity (Anderson and Barbour, 2003; Gorenflo et al., 2012; Hill et al., 2012). Potential tensions, worldview clashes, complexity, and surprise seem inevitable, particularly since many Indigenous organizations and scholarship

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frame genetic engineering as a violation of sovereignty, of nature, and of self-determination (Antoine, 2014; Francis, 2015; IEN, 2016; Roberts, 2005).

This paper responds to the pressing need to address inevitable intersections of these two trends – Indigenous management of biodiversity conservation and restoration, and genetic engineering for conservation and restoration – with a focus on the American chestnut tree as a case study. After a blight devastated the American chestnut population in the early 20th century, efforts to restore the iconic tree to its natural range have been considerable (Griffin, 2000; Jacobs et al., 2013; Nuss, 1992; Powell, 2016; Thompson et al., 2012). Currently, the American Chestnut Foundation – founded specifically to restore the chestnut – includes a genetically engineered chestnut tree as a central part of its hoped-for restoration success (TACF, n.d.). In many respects, the restoration of a beloved tree species may be seen as an uncontested good, but the use of genetically engineered chestnut trees as a foundational component of restoration makes the case of American chestnut restoration complex and controversial (Graef, 2014; Piaggio et al., 2017).

Because the Genetically Engineered American Chestnut (GEAC) is designed to spread in the environment, it has the potential to cross sovereign tribal boundaries. Therefore, one important set of stakeholders is the Indigenous communities in the chestnut's historic range. Indeed, the primary sites of research for the GEAC, the current field sites, and proposed release sites are situated in the heart of traditional and contemporary territory of the Six Nations of the Haudenosaunee Confederacy of Central and Upstate New York. As part of their outreach, GEAC scientists deploy narratives about its historical importance to American Indian communities (Powell, personal observation, October 21, 2017), suggesting that its restoration should also be important to Indigenous communities. However, the chestnut's disappearance coincides with major cultural disruption and loss in Haudenosaunee communities, such that virtually no living memories of the chestnut tree survive as part of any cultural practice.

Using Kimmerer's *reciprocal restoration* (2011) as a guiding framework, this paper investigates if the process of restoring the chestnut – using a transgenic tree – might also restore important dimensions of Haudenosaunee cultural practices. After introducing the reciprocal restoration framework and our research methodology, we offer in-depth analysis of six dimensions in the context of the GEAC project: language and culture revitalization, customary use, cultural keystone species, traditional ecological knowledge, spiritual responsibility, and kincentric relationships. We conclude with insights about how this case offers insights and instructive guidance for the intersection of Indigenous worldviews and applications of biotechnology in restoration and conservation.

2. Reciprocal restoration

Ecological restoration is the suite of technoscientific and socio-cultural practices that inform restoration, which is generally considered to be the “return of an ecosystem to a close approximation of its condition prior to disturbance” (National Research Council, 1992 in Geist and Galatowitsch, 1999). This process has long focused on the structure and function of an ecosystem. *Biocultural restoration* highlights how such restoration goals are better achieved when human dimensions are integrated explicitly, and draws attention to the moral considerations of restoration (Allen, 1988; Higgs, 2003, 2005; Janzen, 1988).

Subsequent research has generated a variety of frameworks and terminologies for integrating cultural dimensions to ecological restoration. Geist and Galatowitsch introduced one model for *reciprocal restoration* in 1999 that was rooted explicitly “Western worldviews.” In this model, they sought to recouple human well-being with ecological health: people who participate in ecological restoration develop respectful, caring, mutually beneficial, and accountable relationships with the environment being restored. While Geist & Galatowitsch

acknowledge that many Indigenous traditions are already characterized by deep relationships with the rest of nature, their focus on Western worldviews treats Indigenous teachings as separate from Western scientific management.

Dennis Martinez, founder of the Society for Ecological Restoration's Indigenous People Restoration Network, put forth *ecocultural restoration*, which attends to the mutually reinforcing processes of ecological and cultural revitalization (Higgs, 2003). Eric Higgs suggests *focal restoration*, in contrast to what he terms technological restoration, as a means of highlighting explicit integration of community engagement and local culture – restoration as cultural practice (Higgs, 2003). *Ethnoecological restoration* attends to revitalization of cultural landscapes, integrating human (often Indigenous) practices as part of reference ecosystems (Beckwith, 2005).

Some evidence suggests that these forms of restoration are taking hold; the inclusion of traditional knowledge bases is an increasingly popular feature of restoration projects (Ens et al., 2015; Gavin et al., 2015; Geist and Galatowitsch, 1999; Phipps et al., 2011; Upreti et al., 2012). In fact, the 2004 Society for Ecological Restoration Primer notes that “the restoration of such [cultural] ecosystems normally includes the concomitant recovery of Indigenous peoples and their languages as living libraries of traditional ecological knowledge” (SER, 2004, cited in Kimmerer, 2011, p. 270).

Kimmerer's, 2011 *reciprocal restoration* builds on these ideas to generate a framework that is based Indigenous perspectives. Ecological restoration, from an Indigenous perspective, is rooted in reciprocal relationships (Martinez, 2003). Dimensions of Kimmerer's reciprocal restoration include: language and culture revitalization, customary uses, decolonizing diet, cultural keystone species, traditional ecological knowledge, spiritual responsibility, land management, and kincentric relationships (Kimmerer, 2011). This model of *reciprocal restoration* serves as an analytical tool for exploring the Haudenosaunee perspective about the potential use of the transgenic chestnut for restoration. While reciprocal restoration does call for the explicit contribution of traditional ecological knowledge, it also calls for the appropriate use of restoration science so that the repair of ecosystem services contributes to cultural revitalization (Kimmerer, 2011). As such, the framework is ideal for exploring this intersection of genetic engineering and Indigenous worldviews. Using six dimensions of reciprocal restoration, this paper investigates if the proposed restoration of the American chestnut with a transgenic tree may – or may not – embody the characteristics of reciprocal restoration.

3. Methodology

When we began this project, interaction between GEAC scientists and Haudenosaunee leaders was limited; Haudenosaunee leadership was just learning about the GEAC and its proposed deployment for restoration. Although their contemporary land-holdings are but a fraction of their traditional territories, Six Nations has generally operated under continuously traditional governments based on clan mothers and chiefs (for an in-depth discussion of history and government, see www.haudenosauneeconfederacy.com/). We approached this inquiry with the normative stance that Haudenosaunee leaders *should* be more meaningfully involved in restoration decisions. As such, we sought ways to facilitate increased and improved deliberation, and to observe these interactions as they unfolded. Acting as *participant observer* in spaces where Haudenosaunee leadership interacted with chestnut project leadership has led to research as intervention (DeWalt and DeWalt, 2011).

Relationship, rapport, and trust-building are important dimensions of this project, consistent with participant observation (DeWalt and DeWalt, 2011), and central to working with Indigenous nations (Lincoln and González y González, 2008; Sikes, 2006; Smith, 2013). One of our research team members had previous experience working with some of our collaborators at SUNY-ESF's Center for Native Peoples

and the Environment. We had ongoing collaborations, and engaged in multiple rounds of informal dialogues, about the shape of this project.

We conducted participant observation at two agency meetings for tribal leaders (one US Environmental Protection Agency and another at the New York State Department of Environmental Conservation) where the GEAC project was on the agenda. We also engaged in participant observation at one meeting of the New York Chapter of TACF where Haudenosaunee perspectives of American chestnut were presented.

We conducted seven participant-directed interviews from a convenience sample of meeting attendants and from Nation members who lived locally. Additionally, we interviewed two organizers from the Indigenous Environmental Network and three scientists at the American Chestnut Research and Restoration Project at SUNY-ESF. While the sample size here is relatively small, these leadership networks are small and tightly linked. Previous work with HETF indicates that these are the leadership networks that work consistently to engage regional environmental issues. These leaders offer insight into broader environmental leadership in Haudenosaunee communities (Barnhill, 2009). Secondary sources provided historical context, to triangulate data, and for background about Haudenosaunee histories.

We performed thematic coding and analysis of meeting recordings and notes, interview transcripts, and presentation recordings (Braun and Clarke, 2006). We developed a code from the reciprocal restoration framework for a deductive analysis (Braun and Clarke, 2006). We performed multiple rounds of semantic coding, focusing on the specific content of participant responses as they related to an existing framework (Braun and Clarke, 2006). We used MAXQDA to partially transcribe and analyze interview and participant observation data, coding respondents' names to protect identities. We distinguish between Haudenosaunee Environmental Task Force or community members (coded H1, H2, etc.) and Indigenous organizers (I1, I2, etc.) because these distinctions are relevant to understanding how local issues fit with broader trends.

4. Reciprocal restoration and the genetically engineered American chestnut tree

To embody reciprocal restoration, the chestnut project should demonstrate – or offer the potential for – elements of these dimensions: revitalization of language and culture, attention to customary use, decolonization of diet, cultural keystone species, traditional ecological knowledge, spiritual responsibility, land management, and kincentric relationships (Kimmerer, 2011). As expected in reflections of a worldview characterized by interconnectivity, these categories are deeply interconnected and at times overlapping. Perhaps unsurprisingly, the results are mixed, with each dimension revealing complexity and nuance.

4.1. Language & culture revitalization

Language and culture revitalization are foundational to reciprocal restoration. The Six Nations are part of the Iroquois language group, where each nation has its own distinct – but broadly mutually intelligible – language (H2, personal communication, October 20, 2017). In Haudenosaunee communities, there are challenges to using chestnut restoration to anchor language and culture restoration. The chestnut population declined dramatically during the early twentieth century, while federal Indian policy focused on assimilation. As described by one of our participants, this era “... was a time for great change for Iroquois communities. We lost a lot of our language. People were discouraged from speaking, especially in schools. So we had cultural loss coinciding with this chestnut loss...the stories and any linguistic relevance right now for chestnuts in Haudenosaunee communities is almost lost” (Abrams & Patterson, personal observation, October 20, 2017). In fact, several Iroquois languages no longer have words for chestnut (Abrams & Patterson, personal observation, October 20, 2017). The impacts of

assimilation cannot be overestimated. In a presentation to TACF-NY, Patterson describes this part of history, noting that so much is lost because of Indian boarding schools, where generations of children were taken from their families and placed in boarding schools. Therefore, out of all of the traditional knowledge in Haudenosaunee communities, language is in “the greatest states of decline” (personal observation, October 21, 2017). And because worldview and culture are encoded in language (H2, personal communication, October 20, 2017), language loss signals cultural loss; by extension, language revitalization means that more Haudenosaunee people could live more in line with their worldview.

Like many Indigenous communities worldwide (Nelson, 2008), language revitalization is taking place across the Nations, and the number of language speakers is growing (H4, October 20, 2017). Haudenosaunee collaborators are conducting research (1) to uncover the chestnut in traditional stories and recorded history, and (2) to develop a linguistically and culturally accurate representation of transgenic chestnut tree so Nation elders can make sense of this new technology in terms of their worldview. This second point is particularly compelling for how Indigenous communities understand genetic engineering. For chestnut restoration to be reciprocal restoration, Haudenosaunee elders (repositories of knowledge and identity) must be able to access information about transgenic trees within constructs of their own worldview. Growing the ability to communicate about the GEAC in native languages could serve to situate restoration within this worldview.

Additionally, the Center for Native Peoples and the Environment already facilitates cultural programming about language and other cultural practices that specifically include ecological restoration. (See www.esf.edu/nativepeoples and <http://www.onondaganation.org/> for specific examples.) Here there may be space to integrate chestnut restoration, as the GEAC could be another teaching tool for cultural practices and worldview reflection.

To that end, framing the GEAC as potential reciprocal restoration may help Haudenosaunee communities understand what scientists present to them, and help scientists identify their own assumptions about Haudenosaunee people (H2, personal communication, October 20, 2017). For example, using the English term GMO often brings negative assumptions; however “you have an opportunity to present it as something else within the sovereign language” (H2, personal communication, October 20, 2017). But Iroquois language do not have old words to describe a genetically engineered tree. In explaining the GMO ban at Akwesasne (Mohawk), one community member is quoted as saying, “GMOs, we have no songs for. GMOs, we have no ceremonies for. Because that's not what the Creator made as seeds; that was by man. So we don't have songs for them” (Francis, 2015).

As such, our collaborators return to basic linguistic structures to learn how to construct Iroquois words for terms like gene, transgenic, and genetic engineering. In developing new terms, they are making deep dives into the “relationships that are encoded in these words” (Abrams & Patterson, personal observation, October 20, 2017). Therefore, investigating how a transgenic chestnut might fit into their worldview has invited meaningful re-engagement with old ways, rooted in resurgent language and cultural practice.

Language and cultural revitalization, as well as chestnut restoration, are both multidimensional and dynamic processes. Chestnut restoration may bolster existing language and cultural revitalization efforts throughout Haudenosaunee communities as Indigenous researchers use chestnut restoration to springboard linguistic and cultural inquiry.

4.2. Customary use

A second dimension of reciprocal restoration – and an important dimension of restoring cultural practice – is the return of customary use, or being able to use the restored resource in traditional ways. The chestnut case highlights ongoing struggles for Haudenosaunee

communities to access resources for customary uses (Patterson, personal observation, October 21, 2017), but whether or not Nation members would *want* to use a transgenic chestnut for customary uses is certainly contested. Traditionally, the chestnut was used for medicines. One Onondaga elder says

we wouldn't use the changed tree [for medicine]. [Our traditions] use old names – traditional language names – for the medicines....would you really trust that this new being will have the ability to hear it when it's spoken to and understand that you're speaking to it? (H3, personal communication, October 20, 2017).

The elder describes needing space for their own investigation. Not unlike the rounds of research required for deregulation, their “own research takes time to see if this plant is good for a cold,” describing repeating trials for herbal efficacy (H3, personal communication, October 20, 2017).

And while skeptical of both, this same elder would actually be more comfortable with the GEAC than the conventionally-bred backcrossed chestnut because less has been changed in the GE version (H3, personal communication, October 20, 2017), which dovetails with biotechnologists' claims (Powell, 2016). Outright opposition to genetic engineering does not seem to be the inherent problem; changes from original forms seem problematic. This a departure from the narrative that Indigenous peoples are opposed to genetic engineering on principle, and certainly an avenue worthy of additional research.

If reciprocal restoration relies on the customary use of a restored resource, then notable skepticism about potential medicinal uses of the “changed” chestnut do not fit neatly into this framework. Whereas medicine requires a certain level of purity, other potential uses like woodworking or consumption may not have the same requirements. And, like any other group of people, not everyone agrees. A traditional woodworker from Onondaga Nation has never seen a chestnut tree, yet says that he has “always wanted to see them, to work with them. I want to eat the nuts. I want to smash them up and mix them in with things, do what used to be done.” He continues, imagining restored chestnuts: “I would like...to be able to take my chainsaw, cut down a chestnut tree and use the wood.” (H5, personal communication, October 20, 2017).

Central to potential customary use of the American chestnut is part of a broader (global) Indigenous effort to “decolonize” native diets (Kimmerer, 2011; Nabhan et al., 2010; Nelson, 2013). Haudenosaunee worldview centers interconnection, and consuming the chestnut represents one way to re-establish relationships. People are excited about the prospect of eating them, and this linkage to re-indigenizing diet may be the strongest potential for re-establishing relationships with the chestnut. Customary uses illustrate the complexity of Haudenosaunee perspectives about the chestnut: the transgenic chestnut may not be used for medicine but perhaps could be used for traditional woodworking, or for eating.

4.3. Cultural keystone species

Focusing on cultural keystone species – species that feature centrally in subsistence and spiritual practices of a culture – is yet another way to embody reciprocal restoration (Garibaldi and Turner, 2004; Kimmerer, 2011; Uprety et al., 2012). Many species serve important ecological and cultural functions; the gray wolf and American bison are two well-known examples. Because many Indigenous peoples' fates are tied to “nonhuman relatives,” attention to these relationships are often mutually beneficial for restoration and revitalization goals (Kimmerer, 2011).

The American chestnut tree certainly served as a cultural keystone species for European-Americans, and outreach efforts associated with its restoration evoke this heritage explicitly. Chestnut scientists make the case that the chestnut was also important to American Indian histories: presentations to Indigenous groups include its appearance in stories and its use as medicine (personal observation, May 9, 2017;

October 21, 2017). Historical range data also indicate that American Indian groups selected for chestnut trees as part of their agroforestry practices (Tulowiecki and Larsen, 2015). Additionally, ethnology records from Haudenosaunee nations include references to the chestnut as a food source with enough frequency to indicate that the chestnut was once a part of Haudenosaunee culture (Curtin and Hewitt, 1918).

However, none of the Haudenosaunee leaders that we spoke with recalled meaningful memories of the American chestnut tree. Therefore, the European American heritage narrative that has proven so effective for TACF is less meaningful in Haudenosaunee communities. In fact, when asked about chestnut restoration in an interview, one Onondaga elder asks, “why did they choose the chestnut? Do they have an answer?” (H3, personal communication, October 20, 2017). Similarly, an HETF member comments that “nobody came to the Nation and said, look, we have this gene splicing idea. What would you like to be gene spliced? Would we have said the chestnut tree? Save the chestnut tree?” (H4, personal communication, October 20, 2017). This disconnect between old (lost) stories and the absence of contemporary relationship challenges the potential for chestnut as cultural keystone species.

4.4. Traditional ecological knowledge

Reciprocal restoration requires the use of traditional ecological knowledge to restore a species in Haudenosaunee territory. Traditional ecological knowledge (TEK), according to Berkes et al. (2000), is a “cumulative body of knowledge, practice, and belief, evolving by adaptive processes and handed down through generations by cultural transmission, about the relationship of living beings (including humans) with one another and their environment” (p. 1251). TEK offers important biological insights and a cultural framework for environmental problem solving that incorporates knowledge and values that are passed down through generations (Berkes et al., 2000; Houde, 2007; Kimmerer, 2000; Senos et al., 2006).

Because the chestnut has been absent from Central New York since the early 20th century, TEK about the chestnut tree is all but lost. For example, an Onondaga clan mother does not remember any stories about the chestnut tree “because most of my life there hasn't been any here.” She does remember her mother pointing them out on the landscape, in large part because they were disappearing and thus a rare sighting (H3, personal communication, October 20, 2017). Another member of the Onondaga Nation remembers his grandfather talking about the chestnuts dying, noting that the traditional knowledge about the chestnut was lost with his grandparents (H5, personal communication, October 20, 2017). These considerable losses challenge the ability to engage traditional ecological knowledge as part of chestnut restoration.

However, considering Indigenous place names as reference ecosystem data has been suggested in a number of restoration projects (LaDuke, 2005; Long et al., 2003). Patterson recommends starting with the “places named after chestnut” as “insight to practitioners looking to restore some tree species” (Patterson, personal observation, October 21, 2017). This use of TEK serves as important reminder that re-establishing a relationship with the chestnut may offer ways to reconnect with land and traditions in ways that could renew traditional ecological knowledge practices.

Patterson and Abram's considerable community-based research efforts (described above) indicate that through reciprocal restoration, Haudenosaunee people may restore relationships with the chestnut so that stories and TEK can regrow and start anew. At the New York State DEC Indian Leaders' meeting, as one of the scientists passed around American chestnuts, Patterson said to the group “this is the first time I've ever had my hands on an American chestnut...This is something that our people have been doing for thousands of years, harvesting these chestnuts” (personal observation, October 20, 2017). The potential interconnected restoration of chestnut, language, culture,

traditional knowledge, and diet felt very powerful in that moment.

These moments offer important balance to understanding the chestnut project in purely scientific terms. Scientific attention to transformation events, tissue culture, laboratory experiments, and field trials cast restoration in a technoscientific space within a mechanistic view of nature. In fact, the highly technical approach to chestnut restoration may hinder the meaningful integration of TEK, as “attempting to draw on traditional knowledge and practice may be less effective in highly engineered projects where restoration practitioners are exclusively technical specialists” (Senos et al., 2006, p. 397). Beyond the scope of specific projects, Eric Higgs notes, “with the expansion of technological approaches to life it becomes more difficult to imagine how restoration...might be done otherwise” (Higgs, 2003, p. 243).

However, careful attention to how chestnut restoration may reconnect to traditional ecological knowledge may also restore relationships to place – perhaps starting with Indigenous place names. While the chestnut has been absent for generations, and traditional knowledge about it has all but vanished, new relationships could lead to new stories in ways that are consistent with Haudenosaunee principles of reciprocity. Moreover, TEK offers both specific examples of knowledge bases to include in restoration processes, as well as alternative frameworks for approaching restoration more broadly. This alternative perspective disrupts rather mechanistic approaches to restoration – particularly true of species restoration that includes a genetically engineered species – and instead sees humans as one of many beings that contribute to the well-being of a system (Kimmerer, 2011). A pivotal question thus emerges: does the use of a genetically engineered chestnut represent the ultimate mechanistic view of nature, or can such intense attention to restoring one species be an example of responsible care-giving?

4.5. Spiritual responsibility

Chestnut restoration raises complex questions about the line between care-giving as spiritual practice, and interventionist management, which may not be consistent with Original Instructions. Dennis Martinez describes ecological restoration as a type of “care-giving” or spiritual practice (Martinez, 2003; Martinez et al., 2008). On the one hand, one member of the Onondaga Nation believes that because “a life without chestnut trees is unnatural” and since scientists *can* make a transgenic tree that may help restore the chestnut, they *should* (H5, personal communication, October 20, 2017). In his opinion, “it’s all sacred” (H5, personal communication, October 20, 2017). This echoes Martinez’ articulation of ecological restoration as spiritual practice: humans using their (scientific knowledge) gifts to return a tree to the earth; “let’s bring something good back to this world” (H5, personal communication, October 20, 2017). Chestnut restoration, in this sense, is consistent with the Original Instructions and thus could be an example of reciprocal restoration.

But other Nations members interpret this responsibility differently. “We have everything we need” translates to, according to another member of the Onondaga Nation in an interview, being “taught [that] you don’t change something. You don’t create something” (H1, personal communication, May 9, 2017). Original Instructions teach Haudenosaunee citizens to accept whatever may be here because there are always systems beyond our immediate understanding. The natural world is a gift, and humans should not engineer nature.

Similarly, one HETF leader says:

Our job is not to steward the environment. Our job is to live within the existing cycles of the environment as best as we can. If those cycles include all kinds of invasive plants and all kinds of species loss, I don’t want to say it doesn’t matter. It’s heartbreaking and it’s traumatic, but that does not change our Original Instructions to live with the cycles of what is on earth now (H6, personal communication, February 16, 2018).

Much of this mentality is explicitly about genetic engineering. An

HETF leader from Cayuga says that chestnut biotechnologists are engaged in genetic engineering “because they can, because science allows them to,” which brings them “closer, if you’re religious, to what God is doing, or what the creator is doing.” He wonders, “is that man’s doing the creator’s work?” (H1, personal communication, May 9, 2017). Other respondents echo these questions, asking if humans should be engaged in genetic engineering at all (I1, personal communication, October 20, 2017), or if humans should follow science or nature (H4, personal communication, October 20, 2017). These comments and questions belie tensions and uncertainty about what humans’ role should be. But again, the projects of restoration and genetic engineering seem to overlap in ways that make distinguishing perspectives difficult. These tensions demonstrate the need for careful attention to Haudenosaunee perspectives in order to better understand how restoration and genetic engineering fit into their worldviews, especially to determine if chestnut restoration is indeed in line with their spiritual responsibilities.

In some respects, there is ongoing uncertainty about ecological restoration as reciprocal, care-giving practice or as a form of intervention that, according to some, violates the Original Instructions. The HETF leader from Onondaga notes that, in the context of the restoration effort, perhaps it is “the fate of the chestnut tree is to become extinct.” (H4, personal communication, October 20, 2017). An Onondaga elder, also reflecting these tensions, says, “if [the chestnut’s] not out there, that might be how it was supposed to be.” However, she then pauses, and continues, almost to herself, “although it really wasn’t because we didn’t ask people to bring that critter here. It wasn’t a natural thing that a critter came here, humans brought it here. So what you’re trying to do is mend things after humans screwed it up” (H3, personal communication, October 20, 2017).

The GEAC raises a number of questions about spiritual responsibilities. One, is ecological restoration a form of spiritual care-giving, and if so, could a genetically engineered tree serve within the umbrella of this responsibility? Or is restoration altogether a managerial perspective that violates Original Instructions? In the end, while the debate about restoration persists, the broad (with exception) majority of participants do not currently think that the GEAC is consistent with their spiritual responsibilities.

4.6. Kincentric relationships

Haudenosaunee participants understand restoration to be more about restoring relationships than restoring species, and have expressed concern that the current approach to chestnut restoration focuses too specifically on returning the *form* of the tree to the forest and not enough on the *functional relationships* with the trees (H6, personal communication February 16, 2018). Moreover, the question persists of whether a relationship with a near-stranger – the chestnut – could be meaningfully restored to the point of kinship.

Higgs (2003, 2005) cautions against restoration projects being too technological, and if one focuses on the technoscience referenced above – the transformation event, transgenics, tissue culture, etc. – then this project does focus on one dimension of species restoration at the near exclusion of others. That the chestnut is talked about in the context of species restoration (as opposed to ecological or ecosystem restoration) speaks to that limitation. In short, the technoscience focus de-emphasizes the kincentric relationship while emphasizing the managerial relationship with the chestnut tree.

In the Haudenosaunee worldview, repairing the relationship between people and the land (and its inhabitants) is a first step, one that often calls for ceremony or spiritual practice (Kimmerer, 2011; Martinez et al., 2008). Reflective of this relational understanding, an IEN staff member asks, what is “the larger place for that chestnut....-what’s the family?” (I1, personal communication, October 20, 2017). In this worldview, the reintroduction of a species begins with re-establishing a relationship. At the end of the DEC Indian Leaders meeting,

chestnuts were passed around, and for many of the tribal leaders, this was the first time that they had ever held American chestnuts. Patterson invited those leaders present to “develop a new relationship with chestnut.... [to] re-acquainting ourselves with the species first and then think about what is our position on a new variety, a new type of American chestnut” (personal observation, October 20, 2017). Later that weekend, one thousand (non-transgenic) chestnuts were distributed to different tribal members to eat or to plant, further establishing a new relationship – at once symbolic and material – with a once-lost tree.

This scene manifests some of the challenges of kinship-centric reciprocal chestnut restoration. Will reacquainting Haudenosaunee elders and leaders effectively re-establish a long lost relationship such that chestnut restoration may be meaningful to them in their own terms? After working in different communities, saying “we need to be engaged and we need to protect and we need to restore,” one HETF leader has found that “there’s just this sort of malaise that I can see in their eyes...” (H6, personal communication, February 16, 2018). The chestnut trees are relative strangers, and if this is how community members react to the prospect of chestnut restoration, it seems unlikely that chestnut restoration could reflect or strengthen kincentric relationships with the environment.

5. Conclusion

This paper asks if a restoration project that uses a genetically engineered tree could embody Indigenous-centered reciprocal restoration, despite the apparent cultural divide between biotechnology labs and Indigenous worldviews. Reciprocal restoration offers a framework to interrogate this confluence of Indigenous resource governance and genetic engineering for conservation and restoration of biodiversity. Chestnut restoration, even using a transgenic tree, exemplifies some dimensions of reciprocal restoration via caregiving: giving back to the land by repairing the damage wrought by a human-induced forest pathogen. Chestnut restoration offers the potential to support ongoing *language and cultural revitalization*, as evidenced by linguistic research associated with the GEAC project. The GEAC also may be a part of some (but not all) *customary uses* – some Haudenosaunee members are excited about eating chestnuts as part of resurgence of traditional foods; others look forward to the prospect of chestnut in their woodworking. And finally, the GEAC may serve to rebuild some of the now-lost *traditional ecological knowledge* about chestnut trees, beginning with the use of Haudenosaunee place names as sites of restoration.

However, few of the Haudenosaunee community members with whom we spoke see chestnut restoration as repairing our relationship with the land, in part because the chestnut tree is not considered to be a *cultural keystone species*. In fact, most respondents see the chestnut project as another means of disrupting and trying to control nature, and therefore as inconsistent with *spiritual responsibilities* and *kincentric relationships* that are integral to the Original Instructions. Restoration, using any tree, for some runs counter to cultures of non-intervention, and as discussed above, modified chestnuts would not likely be appropriate for medicinal uses. Many Haudenosaunee environmental leaders wonder how the use of a tree that goes so counter to the old ways could be used in restoring old relationships with the land, especially since so much *traditional knowledge* about the chestnut tree has been lost.

Important to remember here is that Haudenosaunee community members were not consulted about the GEAC project until after the research team was well on their way to developing a successful product (Barnhill-Dilling, 2018). Collaborative decisions about the use of emerging technologies in conservation and restoration, while encouraged/prescribed in international agreements such as the United Nations Declaration on the Rights of Indigenous People and the Convention on Biological Diversity, are not readily included as part of mainstream restoration planning and governance. We thus join Higgs

(2003) in arguing for participation as a pre-condition. In order for restoration projects that include genetic technologies to embody reciprocal restoration, Indigenous community members should be a part of setting restoration priorities and consenting to the tools employed.

Interestingly, though our analysis indicates that while genetic engineering represents a barrier to reciprocal restoration, the barrier may not be insurmountable. Haudenosaunee resistance to genetic engineering applications is nuanced, and further research should avoid simple measures of support or opposition and instead aim to understand the attributes that underlie complex perceptions. While some participants reject GE on principle, others suggest that genetic engineering tools may have its place.

The reciprocal restoration framework also offers insights beyond the introduction of a genetically engineered American chestnut tree. As genetic engineering become integrated into conservation toolkits, reciprocal restoration identifies important spaces for engaging Indigenous communities. One specific example is the identification of *cultural keystone species* that may be appropriate for genetic interventions for conservation or restoration. Because Haudenosaunee community members have minimal surviving kincentric relationships with the chestnut tree, it cannot be described as a cultural keystone species. However, in other cases, identification of cultural keystone species for restoration may be more likely to draw on *spiritual responsibilities* and *kincentric relationships*, and therefore better align with the principles of reciprocal restoration. While the technoscientific interventions of genetic engineering would still be present, the focus on species that deeply support cultural identity may serve to bring together disparate worldviews for shared problem identification and resolving.

Returning to the GEAC, through deliberative governance activities, stakeholders have started to explore how to engage community and public audiences around potential high priority sites for chestnut restoration, and, perhaps equally importantly, sites of possible exclusion (Delborne et al., 2018). Because the GEAC has not yet been deregulated for wild release, principles of reciprocal restoration could still be integrated into these governance processes, in which Haudenosaunee leaders have already participated, to identify geographic areas where GEAC-based restoration sites may be avoided.

In other cases, dimensions of reciprocal restoration may also be included in governance processes to explicitly include Indigenous perspectives and more specifically, to identify which species may be appropriate to conserve or restore using genetic engineering, e.g. identifying cultural keystone species as mentioned above. But perhaps equally importantly, these spaces for engagement could also identify species that should explicitly *not* be genetically engineered, as genetic engineering may represent an affront to relationships with certain cultural keystone species. Similarly, reciprocal restoration may offer frameworks for engaging Indigenous communities around which landscapes or sites are appropriate for genetic interventions, or which geographic spaces should be left alone as part of broader spiritual responsibilities.

As new genetic technologies emerge to mitigate global environmental change, nuanced frameworks – such as reciprocal restoration – are required for understanding how novelty meets tradition, and for creating space where Indigenous perspectives are centered and respected. Ongoing efforts to restore the American chestnut tree, which may well represent the first application of genetically engineered species designed to spread in the environment, offers instructive insights for future cases of genetic engineering for conservation and restoration. The chestnut case highlights which dimensions of reciprocal restoration may be foundational to understanding Indigenous perspectives on using genetic engineering for conservation and restoration. While scientific approaches to conservation and restoration remain the primary worldview for decision-making, attending to dimensions of reciprocal restoration at critical junctures may create space for affected Indigenous communities to preserve important spiritual responsibilities and kincentric relationships, thus preserving important elements of

sovereignty.

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