



Society & Natural Resources

An International Journal

ISSN: 0894-1920 (Print) 1521-0723 (Online) Journal homepage: <https://www.tandfonline.com/loi/usnr20>

Rooted in Recognition: Indigenous Environmental Justice and the Genetically Engineered American Chestnut Tree

S. Kathleen Barnhill-Dilling, Louie Rivers & Jason A. Delborne

To cite this article: S. Kathleen Barnhill-Dilling, Louie Rivers & Jason A. Delborne (2020) Rooted in Recognition: Indigenous Environmental Justice and the Genetically Engineered American Chestnut Tree, *Society & Natural Resources*, 33:1, 83-100, DOI: [10.1080/08941920.2019.1685145](https://doi.org/10.1080/08941920.2019.1685145)

To link to this article: <https://doi.org/10.1080/08941920.2019.1685145>



Published online: 05 Nov 2019.



Submit your article to this journal [↗](#)



Article views: 402



View related articles [↗](#)



View Crossmark data [↗](#)



Citing articles: 4 View citing articles [↗](#)



Rooted in Recognition: Indigenous Environmental Justice and the Genetically Engineered American Chestnut Tree

S. Kathleen Barnhill-Dilling^a , Louie Rivers^a, and Jason A. Delborne^{a,b} 

^aDepartment of Forestry and Environmental Resources, North Carolina State University, Raleigh, NC, USA; ^bGenetic Engineering and Society Center, North Carolina State University, Raleigh, NC, USA

ABSTRACT

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. As such, inclusive deliberative frameworks are needed to consider the implications for these communities. Indigenous environmental justice highlights the importance of recognizing tribal sovereignty and Indigenous worldviews as foundational to more just environmental governance. This paper examines how the case of genetically engineered American chestnut tree highlights the importance of recognizing tribal sovereignty and Indigenous worldviews in considering a GE organism for species restoration.

ARTICLE HISTORY

Received 26 February 2019
Accepted 14 September 2019

KEYWORDS

Chestnut restoration;
genetic engineering;
indigenous environmental justice

Introduction

With the introduction of the fungal pathogen *Cryphonectria parasitica* in the early 20th century, the population of the once-dominant American chestnut (*Castanea dentata*) has been rendered functionally extinct in the Eastern United States from the dramatic effects of the resulting chestnut blight (Merkle et al. 2007; Pinchot 2014; Powell 2016). Diverse efforts to confer blight resistance to restore this once economically and ecologically important tree have spanned nearly a century (Griffin 2000), with recent successes in genetically engineered lines being touted as an important dimension of restoring the American chestnut (NASEM 2019; Pinchot 2014; Powell 2016).

While the genetically engineered American chestnut (GEAC) is not designed to spread any more quickly than wildtype chestnuts, that it is meant to outcross and spread freely at all makes it different from GE plants that are currently being planted and managed for containment (NASEM 2019). Therefore, the potential for transgenic material to move across sovereign borders of federally recognized tribal territories represent a distinct possibility. The GEAC has the potential to fundamentally reshape the shared environment, and thus calls for deliberative and inclusive decision-making in shared environments (Jasanoff, Hurlbut, and Saha 2015). Using interviews and participant observation data, this paper examines how the case of genetically engineered

American chestnut tree highlights the importance of recognizing tribal sovereignty and Indigenous worldviews in considering a GE organism for species restoration.

Indigenous Environmental Justice

Environmental justice (EJ) emerged in response to the injustices of low-income communities of color experiencing heightened exposure to toxic or hazardous environmental risk (Sze and London 2008). As such, EJ addresses how racial and cultural identity fundamentally shape participation in environmental decisions that impact marginalized communities uniquely or disproportionately (Holifield, Porter, and Walker 2009; Ishiyama 2003). These scholarly and activist traditions attend to both historical and contemporary dimensions of power, thus centering communities and groups long excluded (Gonzalez 2006; Ishiyama 2003; Mohai, Pellow, and Roberts 2009). EJ scholarship offers three specific dimensions that give shape to its analyses: distribution, recognition, and participation (Holifield 2012; Schlosberg and Carruthers 2010). Each of these three dimensions, described below, attends to power dynamics that underpin environmental decision-making.

Particularly in the context of biodiversity conservation and restoration, recent EJ scholarship has explored the discursive and practical limitations of the dominant western liberal tradition of *distributive* justice (Martin et al. 2016; Sikor et al. 2014). Instead, Martin and other scholars (2013; 2015; 2016) suggest that *recognition* is central to justice and a necessary precondition for *participating* in environmental decisions. This paper focuses on *recognition* as the crucial organizing principle, and as the necessary precondition for effective inclusive GEAC governance. Recognition can signify an “affirmation of group difference and identity,” or “overcoming institutional harms [that prevent] meaningful” engagement with mainstream social and political institutions (Holifield 2012, 592). Affirmation of group identity may mean simply acknowledging a culturally distinct group of people who may be impacted uniquely by an environmental decision. This act of recognition is an essential first step for decision-making processes that are rooted in Indigenous environmental justice (IEJ).

Indigenous environmental justice (IEJ) makes explicit the ways in which sovereignty and worldview as cultural survival embody key dimensions of power and justice present in Indigenous environments (Holifield 2012; Weaver 1996; Whyte 2011). Because contemporary environmental decision-making is dominated by one way of relating to the environment, “these institutions have evolved ways of doing things out of histories in which the very idea of Indigenous environmental governance was overtly and subtly marginalized” (Whyte 2013). Here, an IEJ lens allows us to recognize both tribal sovereignty and Indigenous worldviews as foundational to justice-oriented decision-making.

Genetic engineering more generally offers important space for interrogating tribal sovereignty and Indigenous worldviews. Scholarly and activist literature suggests broad Indigenous opposition to genetic engineering, with GE even being seen antithetical to Indigenous worldviews or even as an attack on sovereignty (Antoine 2014; Di Chiro 2007; IEN 2016; n.d.). These critiques have been largely embedded in Indigenous food sovereignty discourse (Adamson 2011; Francis 2015; Gonzalez 2006; Harry 2001; Whyte 2016) or situated in Australian or New Zealand aboriginal contexts (Hudson et al. 2012;

Roberts 2005; Wilcox et al. 2008). Since the GEAC case also attends to broader Indigenous relationships with land as foundational to their existence (Whyte 2016), these traditions of opposition to GE pushed us to ask questions about Indigenous perspectives about the use of a GE organism for species restoration, particularly one that would outcross freely into a shared environment with no foreseeable “opt out” option for Indigenous or other groups that may oppose its use.

Moreover, the GEAC case specifically offers a particularly compelling example of the importance of recognizing tribal sovereignty and Indigenous worldview as part of just environmental decision-making. The restoration of the American chestnut tree has been cast largely as an uncontested public good (Powell 2016), but that framing is situated within a western scientific and cultural worldview that prioritizes certain kinds of ecological relationships and histories over others, and which has explicit ties to colonialism (Martin et al. 2016; Sikor et al. 2014; Whyte 2011). While “restoring the American chestnut to its historic range” is a compelling narrative, there are other ways to perceive the GEAC that warrant recognition. Recognition of neighboring tribal sovereignty and broader Indigenous worldviews is particularly important here because the GEAC will most likely be the first genetically engineered organism both designed and approved for use in species restoration.

Study Area

The genetically engineered American chestnut (GEAC) is mostly a product of the Powell-Maynard labs at the State University of New York College of Environmental Science and Forestry (SUNY-ESF) American Chestnut Research and Restoration Project (ACRRP). The end goal of this project is public distribution of seedlings for planting throughout its historic range, which would require the GEAC to be deregulated (see www.esf.edu/chestnut). Historic chestnut range extends throughout the Appalachian Mountains of the eastern United States, and therefore other North American tribal nations – particularly the Eastern Band of Cherokee Indians – have a stake in the chestnut release (see IEN n.d.). SUNY-ESF, current field trials, and proposed release sites are all located within traditional territories of the Haudenosaunee Confederacy of Central and Upstate New York. The Haudenosaunee Confederacy is comprised of the Seneca, Cayuga, Onondaga, Oneida, and Tuscarora Nations. Therefore, the Haudenosaunee communities may be the first to see an unconfined transgenic chestnut tree planted near their lands.

Methodology

Research Approach

This paper is situated in broader social science inquiry around the politics of the potential use of transgenic chestnuts in restoration efforts (See Barnhill-Dilling and Delborne 2019, Barnes 2018; Barnhill-Dilling 2018; Delborne et al 2018). A dialogue between the GEAC innovation team and regional Indigenous leaders began in early 2015, and our research team sought to both facilitate and interrogate greater Indigenous inclusion and participation in ongoing governance processes about the GEAC. Cognizant of the

history of conducting research in North American Indigenous communities, we approached research question development with participatory methodologies and include co-production sensibilities (Lincoln, González, and González 2008; Sikes 2006; Smith 2013), and all activities were reviewed and approved by the Institutional Review Board at North Carolina State University (Human Subjects Protocol #6372). We designed this project to leave open research approaches and areas of focus to emerge organically as we worked closely with the Center for Native Peoples and the Environment (<https://www.esf.edu/nativepeoples/>) and the Haudenosaunee Environmental Task Force (HETF) (<http://www.hetf.org/>).

Our collaboration grew through informal conversations and interviews that largely preceded formal data collection, and the project evolved in an attempt to match the needs of the Haudenosaunee environmental leaders. For example, we engaged leadership from SUNY-ESF's Center for Native Peoples and the Environment as co-PIs, and their budget has supported community-based research focusing on linguistic analysis and revitalization. Neil Patterson, a Tuscarora citizen and long-time member of the HETF, has been instrumental in fostering relationships with other community leaders, offering ongoing guidance and enrolling interview participants. Patterson has given presentations at the New York chapter of the American Chestnut Foundation and to the National Academies of Science and Medicine forest biotechnology committee (NASEM 2019). We also have worked together to establish some reciprocity of the research process itself and offer ongoing support to local leadership in preparation for further possible engagement and for potential formal tribal consultation with federal agencies.

Data Collection

We identified research participants primarily from an ongoing dialogue with Patterson, as he facilitated introductions and interviews. Patterson served as our primary contact for the tribal leaders' meetings that we were invited to attend, and for Haudenosaunee community contacts. While his facilitating contacts may have framed our research scope by convenience, these leadership networks are small and tightly linked, and previous work with HETF indicates that these are the leadership networks that work consistently to engage regional environmental issues (Barnhill 2009; Barnhill-Dilling and Delborne 2019). Additionally, working with Indigenous communities require trust-building, and our work with Patterson – who has served liaison roles for thirty years – as a gatekeeper demonstrates respect for tribal politics and customs.

We attended two agency meetings where American Chestnut Research and Restoration Project (ACRRP) scientists presented about the chestnut project to tribal leaders – the USEPA Region 2 Tribal Leaders meeting (May 2017) and the New York State Department of Environmental Conservation Indian Nations Leaders meeting (October 2017). We also attended the New York chapter meeting of the American Chestnut Foundation (October 2017), where Patterson presented on Haudenosaunee perspectives on chestnut restoration. We conducted participant observation at these meetings and recruited interview participants. We conducted in-depth interviews with seven Haudenosaunee community leaders in attendance, or who lived locally. Because these interviews depended on willingness and availability to meet within the timing of

our travel, our participants represent a convenience sample; therefore, members of the Onondaga Nation (less than ten miles from Syracuse, New York) are represented more heavily. Additionally, representatives from the Indigenous Environmental Network (Indigenous Environmental Network, n.d.) attended both tribal leaders' meetings; we interviewed two IEN organizers to situate data from Haudenosaunee leadership in a broader Indigenous context. For all of our interviews, we focused on open-ended questions about participants' perspectives of the GEAC project as was presented by the scientists and restoration proponents; perceptions and themes described below emerged from the data. We also draw on interviews of three scientists at the American Chestnut Research and Restoration Project at SUNY-ESF for broader context of the project. We use secondary sources for historical context and background information about important Haudenosaunee and policy histories.

Data Analysis

Guided by the elements of Indigenous environmental justice described above, we performed thematic coding and analyses of meeting notes, interview transcripts, and presentation recordings (Braun and Clarke, 2006). We used the outcomes of one round of open coding (Strauss and Corbin 1990) to focus on 1) Haudenosaunee sovereignty as it is situated in the GEAC case and 2) Haudenosaunee worldviews as they relate to the GEAC. To refine our analysis, we performed the third round of coding and explored dimensions of *recognition* through latent analysis, in which we identify and analyze underlying ideas to investigate broader social and cultural themes (Braun and Clarke 2006). Phased analysis allowed for additional triangulation via secondary sources and other interview data, and for reflection on how our subjectivities may be – inevitably – shaping data analysis.

Participants had a range of confidentiality preferences, so we coded respondents' names to protect identities. However, we do make distinctions between Haudenosaunee Environmental Task Force or community members (coded H1, H2, etc.) and Indigenous organizers (I1, I2, etc.); these distinctions are relevant to understanding how local issues fit with broader trends. We used MAXQDA to transcribe and analyze interview and participant observation data. We present the data in narrative form as excerpts.

Results and Discussion

Our results address two main themes about environmentally just governance of the GEAC: the importance of recognizing (1) Haudenosaunee sovereignty and (2) Haudenosaunee worldviews. Naturally, the distinctions between sovereignty and worldview are heuristic devices, and overlap is expected.

Haudenosaunee Sovereignty

Recognition of tribal sovereignty is one important component of engaging in environmentally just decision-making about the GEAC. Sovereignty considerations include

acknowledgment of traditional Haudenosaunee governance institutions, tribal treaty context, and the troubled histories of tribal consultation.

Haudenosaunee Governance

Indigenous governance processes are exercises in tribal sovereignty, and thus an important feature of just and inclusive decision-making about shared environments (Whyte 2013). In many instances, these are largely internal tribal governance processes and respecting fully independent governance structures is crucial for broader respecting broader tribal sovereignty. Within these independent dialogs, one IEN organizer, says that for any decision, a tribal decision-maker

needs the opportunity ... [to] presenting [traditional] scientific research, and the Traditional Indigenous Knowledge of our elders and medicine peoples that will allow everyone to make completely informed choices (I2, personal communication, February 7, 2018).

Informed choices will come from opportunities for dialogue: “part of our decision making is consulting with others who know the subject and with others who are doing similar work” (I1, personal communication, October 20, 2017). There may be other Indigenous communities that have faced comparable issues from whom they can learn; this is particularly important for the potential use of a GE organism for species restoration since the issue is complex and layered.

Another dimension of these decision-making processes is time: Indigenous governance processes may not suit the regulatory or grant cycle timelines, which may make difficult certain forms of collaboration (Dockry, Gutterman, and Davenport 2018). Two specific examples of potentially time-extensive processes in Haudenosaunee communities relevant to the GEAC case are linguistic analysis and traditional medicine research. Linguistic research that literally builds new Iroquois words for concepts like genes, DNA, or transgenic will take time (H2, personal communication, May 9, 2017). Similarly, part of their position-making comes from understanding if or how the GEAC operates as traditional medicine, the testing for which will take many rounds of research (H3, personal communication, 20 October 2017).

The tribal research and internal dialogs would lead to “a meeting in the council, probably have at least most of the council chiefs and maybe some clan mothers or all of the clan mothers too” (H4, personal communication, October 20, 2017). The linguistic work, medicinal research, and Grand Council meetings will inform how they make internal positions and may be inaccessible to scientists and other restorationists. Culturally-appropriate dialogs can involve not only Indigenous science but also culturally-specific dialogue and decision-making processes; parallel examples already exist specifically about emerging biotechnologies (Hudson et al. 2012). While this exclusion may trouble some scientists, separate decision-making spaces are important dimensions of tribal sovereignty that must be respected as part of a just governance process.

Two Row Wampum

Also framing the Grand Council’s perspective in GEAC governance – and Haudenosaunee sovereignty more broadly – is the Two Row Wampum, a 1613 treaty

between the Haudenosaunee and the Europeans that ultimately means that these two governments are “not supposed to interfere with each other” (H1, personal communication, 9 May 2017; see also Muller 2007; Parmenter 2013). Distinct lifeways, customs, and governments should not impact the other’s ability to live their respective worldviews; both should be able to live in the same river of life. The two groups can learn from each other, but they do not expect their governing decisions to impact European-Americans (now the United States government and citizens), and expect the same courtesy in return (H4, personal communication, 20 October 2017).

Important to note is that in 1613, the Haudenosaunee Confederacy was much more powerful than their colonial counterparts; the Two Row, in many respects, is, therefore, an example of humanitarian diplomacy (Parmenter 2013). Despite a history of broken treaty promises, Haudenosaunee leaders still invoke treaties as the basis for their sovereignty, and as guidelines for their own behavior. They still communicate frustration when they are ignored. One HETF representative describes their perspective about the relationship between treaties, projects, and sovereignty: “if you can’t come to the agreement, the project still goes on. That’s not honoring that Two Row” (H1, personal communication, 9 May 2017). In other words, honoring Haudenosaunee worldviews as part of participation in broader governance would be an example of justly ‘honoring the Two Row,’ thereby honoring tribal sovereignty.

The Two Row Wampum treaty suggests that Haudenosaunee government has no interest in interfering in US government decisions that do not impact tribal sovereignty. As noted above, the GEAC is meant to persist and spread in the environment, and it may cross sovereign borders, which may disrupt these preferences for non-interference with the other government. Exploring how mutual sovereignty can be maintained for the case of the GEAC – using tribal treaties as a foundation – represents yet another way to respect Haudenosaunee sovereignty, and may well be instructive for other cases that involve the environmental release of genetically engineered organisms for species protection.

Tribal Consultation Versus Free Prior and Informed Consent

The complex history of tribal consultation in the United States should also be considered in this case, as tribal consultation is a part of broader sovereign status. Additionally, tribal consultation should be considered wherever the GEAC may ultimately be planted because of the small but material potential for gene transfer across sovereign tribal borders. Some participants have seen improvements in consultation since the 1994 Environmental Justice executive order (H6, personal communication, 16 February 2018). On paper, tribal consultation extends to biotechnology, and the USDA’s Biotechnology Regulatory Services has explicit policies for broad consultation on permits for genetically engineered plants (USDA 2017). However, the parameters for which tribes are consulted for such permits are unclear, and tribal consultation generally means receiving a letter of intent that invites tribal input. One participant who has worked in these offices for decades describes this process:

what inevitably happens with these, and this goes to the lack of inclusivity ... a federal or state agency will just send a letter to our federally recognized representative and say, this is

being proposed, here is a link to the documents, everyone has 30 days to consult on this.... We have one person working on just environmental agriculture ecological issues surrounding permitting and these agencies each have multitudes of people working on that. There's an expectation that notice is adequate (H6, personal communication, February 16, 2018).

The same tribal leader continues, wondering how the kind of exchange described in the previous quote can generate meaningful dialogue about complex environmental issues. What tribal sovereignty means, and how different non-native actors may interact with its implications, are ongoing concerns for environmental decisions in Indigenous spaces, particularly when considering the use of a GE organism for species restoration.

The GEAC case seems to repeat these troubling patterns. Thus far, this Haudenosaunee environmental leader is

surprised at the lack of outreach by the federal agencies on this decision... usually we know somebody in a federal agency that we can call or turn to on a specific issue and we don't have that for [this project]... I'm still a little unclear about the regulatory role of each of these agencies in releasing this chestnut. I don't think anyone has sort of laid it out there specifically in some sort of timeline, or overall consultation plan... Just in general I'm very surprised that... each of these agencies has not said we'd like to meet with you on this particular issue. I feel like that's the most efficient and appropriate way for federal and state agencies about a specific issue in person with nation representatives and that has not happened with the chestnut. And I don't know if it's going to (H6, personal communication, February 17, 2018).

Even if federal agency consultation does take place, there remain ongoing debates about what tribal consultation really means. The perspective from an Onondaga member of HETF describes this as a trend in consultation, "we're consulting you but you have no say" (H4, personal communication, 20 October 2017). This general distrust about tribal consultation also extends to Indigenous communities more broadly. One organizer from IEN describes their perception of consultation

If you're already at the point of passing the legislation on an issue, and then... want to hear from the Indigenous community as you're walking up the steps to pass legislation. Is it really of any value? Or [is consultation] a little box to check?... Consultation for us has not been a very positive thing (I1, personal communication, October, 20, 2017).

Similarly, US Indigenous communities' "history with change [is] almost always detrimental for native peoples in so many ways, so they're very resistant to change" (H2, personal communication, 19 October 2017). To that end, one participant believes that "if everyone was to say no" about the GEAC for restoration, "well it's going to go on anyway" (H1, personal communication, 9 May 2017), an expected outcome that runs counter to maintenance of sovereign Indigenous space.

Additionally, that field sites have already been planted without consultation reinforces unease and reflects a lack of deliberation around field trial permits for designed to spread genetically engineered organisms (see Kolopack and Lavery 2017). There was no mechanism for consultation with any community for field trials, some of which are approximately three miles from the border of Onondaga Nation. When talking about the transgenic chestnut tree, one Onondaga elder asks in a knowing tone, "they're already planted over here aren't they?" (H3, personal communication, 20 October 2017). Another participant says, "I take it to the fact that the modified chestnuts already

growing. They're already in the ecosphere. They're already interacting with outdoors. It's not in a lab where it's all contained" (H4, personal communication, 20 October 2017). At the moment, their responses seemed to render empty our questions about Haudenosaunee participation in decision-making about using the GEAC for chestnut restoration. In very material ways, the potential risk of transboundary movement is already out there.

The lack of upstream engagement (Wilsdon and Willis 2004) is a problem with multiple sources. The lack of tribal consultation on the permitting of field sites reflect another limitation of academic culture to foster participation, an issue that may warrant additional attention before future 'designed-to-spread' biotechnology projects. One Haudenosaunee leader describes experiences with SUNY-based archeological projects, and how that offers instructive parallels with biotechnology permitting.

Specifically in New York State, universities have completed a plethora of archaeological investigations on our human remains and our cultural patrimony and have no obligation to consult with Indian Nations. They perform these digs and assessments of culturally sensitive areas as part of the regulatory process in a lot of ways. It's very similar in a way for a university to do this biotech research and essentially be outside of the consultative requirements by the federal agencies... I'm always taken aback at how much could have been done at the university level rather than waiting 'til the regulatory level at the state or federal agency. It reminds me very closely of this biotech issue (H6, personal communication, February, 16, 2018).

This community leader "would be more interested in a State University of New York wide policy on consultation with Indigenous people" (H6, personal communication, 16 February 2018). While challenging, this suggestion offers a new idea for meaningful Indigenous participation in future governance of scientifically complex issues. How this prospective solution could still be implemented in a project so far along as the GEAC represents an important entry for dialogue around Haudenosaunee sovereignty.

The use of a GEAC for chestnut restoration should, therefore, be rooted in Free, Prior, and Informed Consent (FPIC) (H6, personal communication, 16 February 2018). The phrasing from the UN Declaration on the Rights of Indigenous Peoples has strong roots in Haudenosaunee community members, as some of their leadership were instrumental in the development of the Declaration. More generally, IEN offers this explanation:

Free, Prior, and Informed Consent is more than giving lip service to consultation. If biotechnology/genetic engineering is proposed, then the Indigenous Peoples whose forests you want to save have to be listened to and their final decision honored. Even if they refuse. (I2, personal communication, February 7, 2018).

Meaningful attention to FPIC would call for meaningful attention to different worldviews in decision-making, thus respecting tribal sovereignty in environmental governance beyond existing requirements of consultation and public comment.

Haudenosaunee Worldviews

Three themes emerge that give shape to Haudenosaunee worldviews as they relate to the GEAC case. According to our interview participants, the use of a genetically engineered organism for chestnut restoration may run counter to Indigenous worldviews.

Also important here is the recognition of Haudenosaunee (and Indigenous) broad mistrust of university research culture and agendas. Perhaps less obviously is that Haudenosaunee Traditional Ecological Knowledge is based in part on a worldview that aims to live within the cycles of Earth's seasons as they are, and restoration more generally may not fit within that worldview (Nelson 2008; Whyte 2013).

Genetically Engineered Plants

A wide range of Indigenous organizations, activists, and scholars oppose – or are at least concerned about – genetic engineering (Antoine 2014; Di Chiro 2007; Francis 2015; Harry 2001; IEN 2016; n.d.). One IEN organizer says, “our position on genetic engineering is one of opposition and based on the precautionary principle” (I2, personal communication, 7 February 2018). When pressed about what the precautionary principle means, a familiar line follows, “just because we can doesn't mean that we should” (I2, personal communication, 7 February 2018). In short, according to IEN, who broadly claims to represent Indigenous perspectives on this issue, that is not humans' role, and GE trees will never be acceptable.

Haudenosaunee community members and leaders that we spoke with also believe that genetic engineering runs counter to their worldviews, particularly with respect to making such fundamental changes. One participant said that

changing the DNA is like changing a prime number. Eventually down the road you're going to miss that prime number and everything that hinges on [it] is going to change. To me, that's what that genetically modified stuff is doing (H1, personal communication, May 9, 2017).

This comment illustrates a consistently communicated belief that foundational changes to an organism's DNA may simply be too far outside of humans' role. That genetic engineering runs counter to Haudenosaunee TEK is a consistent thread throughout participants' responses to questions about the GEAC.

Many participants predict that traditional leadership, keepers of tradition, will respond negatively to the idea of using genetically engineered chestnuts; evoking traditional leadership is one way to talk about worldviews. If elders serve to ground communities in who they are, then elders may tell Haudenosaunee communities that transgenic plants do not belong in their lands.

However, community leaders are only recently aware of the development of genetically engineered trees, so positions may be more dynamic than they initially seem. One IEN organizer has found that amongst her contacts, “genetically engineered trees is not on anybody's radar. We're out there and hopefully, we can impart the other side of the story before any of this gets entrenched in our society, in our system” (I2, personal communication, February 2018). In other words, she wants the IEN position, one of opposition and precaution, to be heard as part of the broader societal discourse around genetically engineered trees. The Iroquois language specialist, after the tribal leaders' meeting at the USEPA, observes that, “the jury is out on GMO situation and how that affects our world and our worldview” (personal communication, 9 May 2017). In other words, he believes that Haudenosaunee leaders are still making sense of the GEAC and its possible use in restoration efforts. Moreover, no community is monolithic; in fact

there is some evidence that chestnut restoration could support some dimensions of Haudenosaunee cultural revitalization, but that the use of the GEAC does complicate that potential (see Barnhill-Dilling and Delborne 2019). Our goal in this article, however, is to make explicit how recognition of sovereignty and worldviews needs to be a part of the broader governance.

HETF leadership describes ongoing dialogue that will be required to develop a Confederacy-wide position on the use of genetic engineering. Currently, the little dialogue about genetic engineering that has taken place in these communities has focused on preventing any (commercial hybrids included) contamination of heirloom corn varieties. An HETF leader from Tuscarora Nation says people in those communities want to stop potential genetically engineered corn from reaching their fields (H6, personal communication, 16 February 2018). A Haudenosaunee position on genetically engineered plants in their territories, therefore, is “imminent... If we all do our job right, it’s to take that precautionary principle” (H6, personal communication, 16 February 2018). On the Canadian side, Akwesasne Mohawk have already instituted a ban on genetically engineered organisms, so precedent has been set (Francis 2015). But these positions are solidifying, as reflected in recent media coverage of the GEAC (Rosen 2019)

Importantly, no community is monolithic. Not everyone in the Haudenosaunee Confederacy opposes the use of the transgenic chestnut for restoration purposes. A member of the Onondaga Nation ponders how,

if you really think you can just take this wheat part [the source of the genetic insertion] and combine it with a chestnut part...and make it resistant I would say, myself, yes, ok, let’s do that. Let’s bring back something good to this world. (H6, personal communication, October 20, 2017).

While this perspective, that the ‘ends’ of a restored chestnut seem to justify the ‘means’ of its return, or worth the possible risks, is a minority view among our respondents, it does lay the groundwork for additional – nuanced – dialogs around Haudenosaunee perceptions of the GEAC. Broader governance of chestnut restoration should carve out temporal space for dialogs to unfold meaningfully in Haudenosaunee and other Indigenous communities.

The generational shifts add another dimension of complexity, where younger generations may have different perspectives from traditional elders are now taking leadership roles. One participant asks,

where are we as traditional people when all of the ones that hold the tradition are passing on and those that are getting the chance to speak are ones that have been brought up in a different natural world order. [Genetic engineering] may not be a concern for the ones that are getting leadership roles (H1, personal communication, May 9, 2018).

The younger generations have been raised eating foods that have been genetically modified, for example, and these generational differences may influence the strength of their position.

Importantly, we should not assume that Haudenosaunee or Indigenous worldviews are automatically positions of opposition, nor are they monolithic. Rather, the salient issue here is respect for sovereignty and worldview which will underpin what the Haudenosaunee positions may be about using a GE organism for species restoration.

University and Tribal Collaboration

If government based tribal consultation is limited, then looking to scientists as partners in exploring research agendas based on shared interests may be a logical alternative. Scientists are important stakeholders in the governance of emerging technologies, and many of the decisions to be made about the GEAC come from the research sphere, thus offering potential for collaboration based on mutual respect. However, as mentioned above, there is also a long history of mistrust between Indigenous communities and university scientists (I1, personal communication, 20 October 2017). Mistrust of scientific research, questions about university “intent,” their connections to broader “funding and politics,” all potentially generate what IEN organizer calls “prejudicial information,” or biased data that serves powerful corporate interests.

But more to the point here, Whyte (2013) further points out that western science is based on cosmological assumptions that, quite frankly, not everyone shares, and reminds readers that western science may not be useful to groups that do not operate with the same worldviews. One IEN organizer comments that “for far too long Western viewpoints have been forced upon us with largely disastrous results,” and they see some of these “scientific solutions” to be the “same Cavalry, different day” (I2, personal communication, 16 February 2018). In short university-based science, our participants believe, has been used as a tool to exclude Indigenous ways of understanding the world. In response, an entire “decolonizing methodologies” disciplinary agenda has emerged out of intense Indigenous mistrust of university researchers (Smith 2013; see also Lincoln, González, and González 2008; Sikes 2006).

This troubled past, paired with the importance of distinct worldviews, undergirds many responses. Of university scientists engaging Indigenous groups, one Haudenosaunee environmental leader says,

It’s so hard. I feel like scientists...don’t have any reason to communicate with Haudenosaunee communities. There’s nothing on their radar that triggers some sort of thought about Indigenous people at all. And that’s kind of the culture of the university (H6, personal communication, February 16, 2018).

That culture is reflected in the GEAC project. For example, one Onondaga representative to HETF says, “one of the conversations and ideas that we’ve had before – 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, 20 October 2017). This question highlights an important issue that has been raised in these conversations: how can the tools that are available to biotechnology researchers be offered as emancipatory for Indigenous peoples? One area for future research would be to explore how to co-produce priority research agendas with Indigenous communities that are more appropriate for their worldviews, perhaps around whether it is appropriate to use genetic technologies for conserving or restoring cultural keystone species.

Traditional Ecological Knowledge and Original Instructions

Additional considerations for Indigenous worldviews about the GEAC also stem from how Indigenous worldviews frame relationships with the non-human world. Original

Instructions – or Traditional Ecological Knowledge (TEK) – are guiding principles for humans’ relationship to the non-human world, and they are based on gratitude, reciprocity, and acceptance of Earth’s cycles as they currently exist (Nelson 2008; Whyte 2013). An understanding of these underlying worldviews is foundational to how Haudenosaunee communities make sense of the GEAC and with chestnut restoration more broadly.

The concurrent loss of chestnut and the era of Indian boarding schools mean that, in Haudenosaunee communities, a generational break has occurred, and little TEK remains specific to old relationships with the chestnut tree (see Barnhill-Dilling and Delborne 2019). However, TEK is not simply a body or process of knowledge production in relative competition with western scientific thought. Whyte and other Indigenous scholars also describe TEK as “process of participating fully and responsibly in relationship with the non-human world” (Whyte 2013). This articulation of TEK is more consistent with Original Instructions (Nelson 2008) and is a sentiment that is echoed in Haudenosaunee responses about the GEAC and chestnut restoration. According to many of our respondents, these instructions teach them that they are supposed to accept the natural world as gifts and to live within cycles as they currently exist in part because humans do not always understand complex systems:

What’s gonna happen is gonna happen. Everything is here for us to use. If we take one part of that out of the whole, then it’s collapsing... the other parts of the natural world need that influence of what’s being taken out (H1, personal communication, May 9, 2017).

Another participant notes that their “job is not to steward the environment, [their] job is to live within the existing cycles of the environment as best [they] can” (H6, personal communication, 16 February 2018). Their Original Instructions, he continues, are “to live within the cycles of what is on earth now.” They are taught to live within these cycles in large part because

Our elders teach us we are only a small part of this mysterious creation that we inhabit. Mother Nature has Rights – the animals, fish, birds, plants, the rocks and streams all have rights – and when making all the choices we have over the thousands of years we have depended on and considered the viability of the lands, air, waters, Mother Earth and Father Sky (I2, personal communication, February 7, 2018).

This worldview also extends to restoration, particularly when focusing on a single species like the chestnut. One participant does not “know why... [we] would engage with [chestnut restoration]... when there are so many bigger issues (H6, personal communication, 16 February 2018).” This participant later emphatically states that “our job is to live within what is here right now. Not to act as if we are in control of this destiny that somehow we’re going to steward the earth, somehow we’re going to protect the earth” (H6, personal communication, 16 February 2018). And when they have partnered on restoration projects, “it’s not really restoring the environment, it’s restoring our relationship. And the relationship is simply to fit within those cycles (H6, personal communication, 16 February 2018).” In other words, what Haudenosaunee community members want is to restore their ability to live in accordance with their worldviews, and to have their sovereignty honored.

These impressions are reflected in conversations in the communities. When asked if the use of the GEAC for restoration somehow made it different from other genetically

engineered plants, one Onondaga elder responds, “if it’s not out there, that might be how it was supposed to be,” (H3, personal communication, 20 October 2017) noting that using the GEAC for chestnut restoration is yet another example of humans not paying attention to the natural cycles, and intervening where it is not their place.

The participants that we spoke with are well-aware of the implications of accepting the Earth’s cycles and state as they are currently. An Onondaga member of HETF says, “maybe that’s the fate of the chestnut tree - is to become extinct,” and one IEN organizer believes that “maybe we should suffer those consequences.” (I2, personal communication, 7 February 2018). Similarly, a Haudenosaunee environmental leader discusses the implications in such situations,

If those cycles include all kinds of invasive plants and all kinds of loss of species, 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 within those cycles of what is on the earth now (H6, personal communication, 16 February 2018).

As researchers and restoration proponents seek to make environmentally just decisions about the GEAC, the starkest conclusion may be that most of our respondents simply do not believe that they should participate in a restoration effort that relies on a genetically engineered organism.

Conclusion

As non-native researchers seek to partner with Indigenous communities, it is important to recognize that Indigenous worldviews are fundamentally different from western scientific thought and that tribal sovereignty should protect Indigenous communities’ ability to live in accordance with these worldviews. However, difficult histories of Indigenous life in the United States, as well as epistemic dominance of western scientific perspectives, have largely prevented Indigenous peoples from living in accordance with their worldviews. As Martin and other scholars (2016) suggest (Martin, McGuire, and Sullivan 2013), ignoring these worldview distinctions risks reproducing environmental injustices that are, again, rooted in the dominance of western scientific thinking at the exclusion of other ways of relating to and knowing and making decisions about the natural environment.

As scientists and regulators seek to engage Indigenous groups both within and beyond existing institutional configurations about the potential use of the GEAC for restoration, recognition of Haudenosaunee sovereignty and underlying worldview is foundational to a just governance process. More pointedly, recognition of sovereignty and worldview is a necessary precondition for a just decision-making process that includes Indigenous peoples. Our research activities helped restructure that initial contact to better align with the environmental justice principle of recognition, with an explicit aim of opening up space for Indigenous sovereignty and worldviews. As described above, our research interventions have supported Haudenosaunee leadership as they have exercised tribal sovereignty: they invited the GEAC scientists to their governance spaces, have been able to interrogate the project more on their terms, and have started to consider how they may frame the use of a genetically engineered, restored chestnut. From observing these activities and conducting interviews, we concluded that

recognition of sovereignty requires at minimum (1) specific consideration for traditional Haudenosaunee governance institutions, (2) an understanding of long-standing treaty agreements and their implications, and (3) appreciation for the mistrust that underpins tribal consultation processes.

As noted above, three elements of dimensions of Indigenous worldviews that we identified here include the complex Indigenous perspectives about genetically engineered plants, the troubled relationship between university researchers and Indigenous communities, and the underlying Traditional Ecological Knowledge that frames this and many environmental issues.

Because, as mentioned previously, the GEAC will likely be the first GE organism designed and approved specifically for species restoration and wild release, an environmental justice lens is particularly important as this case may well set norms for subsequent genetic technologies with similar goals. Two broad themes emerge from the data that may serve as anchor points for Indigenous environmental justice as it relates to the application of emerging genetic technologies like the GEAC. The introduction of Free, Prior, and Informed Consent (FPIC) bears direct relevance to tribal sovereignty as part of the governance of GEAC and other environmental biotechnologies. Explicit consideration of Traditional Ecological Knowledge, meanwhile, recognizes Indigenous worldviews. Both dimensions bear direct relevance to this case and to emerging genetic technologies for conservation and restoration more broadly.

Recall that if operating under its principles, Free Prior and Informed Consent may give the Haudenosaunee the right to give or withhold consent about a project that may impact their sovereign lands (United Nations 2007). FPIC is fundamentally about self-determination and is based on assumptions of power-sharing and is rooted in culturally appropriate decision-making (United Nations 2007). However, a number of conditions complicate its application, not the least of which is the fact that the United States has never ratified the declaration. Moreover, what FPIC applications actually look like in this and in other cases that seek to use genetically engineered organisms for conservation and restoration is highly uncertain. As such, an exploration of what FPIC might look like in this particular case – and in future cases where Indigenous communities are impacted by emerging biotechnologies – represents an important next in research needs.

Traditional Ecological Knowledge as it described above has the potential to play a role in facilitating cross-cultural collaboration, inviting people from different worldview traditions to engage in ongoing mutual learning “about how each approaches the very question of ‘knowledge’ in the first place, and how these different approaches can work together to better steward and manage the environment and natural resources” (Whyte 2013, 2). If TEK is framed as a collaborative tool, then consideration of TEK about the chestnut and the GEAC may create effective space for meaningful recognition of Indigenous worldviews. Again, what that consideration may look like in practice represents a much-needed next step in research needs.

The case of the genetically engineered American chestnut tree offers opportunities to recognize the importance of Indigenous sovereignty and worldviews that are more consistent with how Martin et al (2016) and Whyte (2011) articulate recognition as environmental justice. Indigenous perspectives, in the end, are about ‘finding solutions’

and those solutions may surprise everyone living and working outside of Indigenous communities. Important to note here is that recognizing sovereignty and worldviews as part of environmentally just decision-making does not default to recognizing opposition; creating space for Haudenosaunee sovereignty and worldviews means creating space for diverse perspectives. Whatever perspectives different community members may have are simply rooted in their own worldviews, a distinction that warrants recognition. In fact, one of the last things an Onondaga elder said as we wrapped up an interview around their kitchen table keeps the window of possibility open, “maybe someday we’ll have full-grown chestnuts roasting on an open fire and maybe we’ll be eating them together” (personal communication, 20 October 2017). Maybe these stakeholders will never all agree on what should be done about the American chestnut. But maybe they will. And they certainly need to keep talking about it – that is simply the just thing to do.

Acknowledgements

This article is based on work conducted for Barnhill-Dilling’s unpublished doctoral dissertation.

Funding

This work was supported by National Science Foundation (NSF 1632670).

ORCID

S. Kathleen Barnhill-Dilling  <http://orcid.org/0000-0003-3442-738X>

Jason A. Delborne  <http://orcid.org/0000-0001-6436-782X>

References

- Adamson, J. 2011. Medicine food: Critical environmental justice studies, native North American literature, and the movement for food sovereignty. *Environmental Justice* 4(4): 213–19. doi:10.1089/env.2010.0035.
- Antoine, D. 2014. Standing against GMOs is standing for sovereignty. Indian Country Today Media Network, March 5. <http://indiancountrytodaymedianetwork.com/2014/03/05/standing-against-gmos-standing-sovereignty-153849>.
- Barnes, J. C. 2018. Engineering conservation: The biogeography, biopolitics, and biotechnology of American chestnut restoration. PhD. diss., North Carolina State University, Raleigh, NC.
- Barnhill, S. K. 2009. Negotiating sacred space: Indigenous participation in local environmental governance. Masters thesis, SUNY College of Environmental Science and Forestry, Syracuse, NY.
- Barnhill-Dilling, S. K. 2018. Growing governance: Considerations for inclusive engagement for genetically modified trees. PhD. diss., North Carolina State University, Raleigh, NC.
- Barnhill-Dilling, S. K., and J. A. Delborne. 2019. The genetically modified American chestnut as opportunity for reciprocal restoration in Haudenosaunee communities. *Biological Conservation* 232:1–7. doi:10.1016/j.biocon.2019.01.018.
- Braun, V., and V. Clarke. 2006. Using thematic analysis in psychology. *Qualitative Research in Psychology* 3(2):77–101. doi:10.1191/1478088706qp063oa.
- Delborne, J. A., A. R. Binder, L. Rivers, J. C. Barnes, S. K. Barnhill-Dilling, D. George, A. Kokotovich, and J. Sudweeks. 2018. *Biotechnology, the American chestnut tree, and public*

- engagement. Raleigh, NC: Genetic Engineering and Society Center, North Carolina State University. <http://go.ncsu.edu/ges-chestnut-report>.
- Di Chiro, G. 2007. Indigenous peoples and biocolonialism: Defining the “science of environmental justice” in the century of the gene. In *Environmental justice and environmentalism: The social justice challenge to the environmental movement*, ed. Ronald Sandler and Phaedra C. Pezzullo, 251–83. Cambridge, MA: MIT Press
- Dockry, M. J., S. A. Gutterman, and M. A. Davenport. 2018. Building bridges: Perspectives on partnership and collaboration from the US forest service tribal relations program. *Journal of Forestry* 116(2):123–32. doi:10.5849/jof-2016-106.
- Francis, A. 2015. Akwesasne moves to ban genetically modified food. Aboriginal Peoples. Television Network, June 29. <http://aptn.ca/news/2015/06/29/akwesasne-moves-ban-genetically-modified-food/>
- Gonzalez, C. G. 2006. Genetically modified organisms and justice: The international environmental justice implications of biotechnology. *Georgetown International Environmental Law Review* 19:583–633.
- Harry, D. 2001. Biopiracy and globalization: Indigenous peoples face a new wave of colonialism. Indigenous Peoples Council on Biocolonialism. www.ipcb.org/publications/other_art/globalization.html.
- Holifield, R. 2012. Environmental justice as recognition and participation in risk assessment: Negotiating and translating health risk at a superfund site in Indian Country. *Annals of the Association of American Geographers* 102(3):591–613. doi:10.1080/00045608.2011.641892.
- Holifield, R., M. Porter, and G. Walker. 2009. Introduction to spaces of environmental justice: Frameworks for critical engagement. *Antipode* 41(4):591–612. doi:10.1111/j.1467-8330.2009.00690.x.
- Hudson, M., M. Roberts, L. Smith, S. J. Tiakiwai, and M. Hemi. 2012. The art of dialogue with Indigenous communities in the new biotechnology world. *New Genetics and Society* 31(1): 11–24. doi:10.1080/14636778.2011.597979.
- Indigenous Environmental Network. n.d. Indigenous peoples unite to stop genetically engineered trees: GE trees: Another form of colonization. <http://www.ienearth.org/indigenous-peoples-unite-to-stop-genetically-engineered-trees/>
- Ishiyama, N. 2003. Environmental justice and American Indian tribal sovereignty: Case study of a land–use conflict in Skull Valley, Utah. *Antipode* 35(1):119–39. doi:10.1111/1467-8330.00305.
- Jasanoff, S., J. B. Hurlbut, and K. Saha. 2015. CRISPR democracy: Gene editing and the need for inclusive deliberation. *Issues in Science and Technology* XXXII(1):25–32.
- Kolopack, P. A., and J.V. Lavery. 2017. Informed consent in field trials of gene-drive mosquitoes. *Gates Open Research* 1:14–2. doi:10.12688/gatesopenres.12771.1.
- Lincoln, Y. S., E. M. González, and Y. González. 2008. The search for emerging decolonizing methodologies in qualitative research: Further strategies for liberatory and democratic inquiry. *Qualitative Inquiry* 14(5):784–805. doi:10.1177/1077800408318304.
- Martin, A., B. Coolsaet, E. Corbera, N. M. Dawson, J. A. Fraser, I. Lehmann, and I. Rodriguez. 2016. Justice and conservation: The need to incorporate recognition. *Biological Conservation* 197:254–61. doi:10.1016/j.biocon.2016.03.021.
- Martin, A., S. McGuire, and S. Sullivan. 2013. Global environmental justice and biodiversity conservation. *The Geographical Journal* 179(2):122–31. doi:10.1111/geoj.12018.
- Merkle, S. A., G. M. Andrade, C. J. Nairn, W. A. Powell, and C. A. Maynard. 2007. Restoration of threatened species: A noble cause for transgenic trees. *Tree Genetics and Genomes* 3(2): 111–8. doi:10.1007/s11295-006-0050-4.
- Mohai, P., D. Pellow, and J. T. Roberts. 2009. Environmental justice. *Annual Review of Environment and Resources* 34(1):405–30. doi:10.1146/annurev-environ-082508-094348.
- Muller, K. V. 2007. The two” mystery” belts of grand river: A biography of the two row wampum and the friendship belt. *The American Indian Quarterly* 31(1):129–64. doi:10.1353/aiq.2007.0013.
- National Academies of Sciences, Engineering, and Medicine. 2019. *Forest health and biotechnology: Possibilities and considerations*. Washington, DC: The National Academies Press.

- Nelson, M. K. 2008. *Original instructions: Indigenous teachings for a sustainable future*. New York, NY: Simon and Schuster.
- Parmenter, J. 2013. The meaning of Kaswentha and the two row Wampum belt in Haudenosaunee (Iroquois) History: Can indigenous oral tradition be reconciled with the documentary record? *Journal of Early American History* 3(1):82–109. doi:10.1163/18770703-00301005.
- Pinchot, L. 2014. American chestnut – a test case for genetic engineering. *Forest Wisdom* 21:8–9.
- Powell, W. 2016. New genetically engineered American chestnut will help restore the decimated, iconic tree. The Conversation, January 19. <http://theconversation.com/new-genetically-engineered-american-chestnut-will-help-restore-the-decimated-iconic-tree-52191>.
- Rawlinson, M., and C. Ward, (Eds.). 2016. *The Routledge handbook of food ethics*. New York, NY: Routledge.
- Rosen, J. 2019. Should we resurrect the American chestnut tree with genetic engineering? Los Angeles Times, June 15.. <https://www.latimes.com/science/sciencenow/la-sci-genetically-modified-trees-american-chestnut-20190625-htmilstory.html>.
- Schlosberg, D., and D. Carruthers. 2010. Indigenous struggles, environmental justice, and community capabilities. *Global Environmental Politics* 10(4):12–35. doi:10.1162/GLEP_a_00029.
- Sikes, P. 2006. Decolonizing research and methodologies: Indigenous peoples and cross-cultural contexts. *Pedagogy, Culture and Society* 14(3):349–58. doi:10.1080/14681360600892017.
- Sikor, T., A. Martin, J. Fisher, and J. He. 2014. Toward an empirical analysis of justice in ecosystem governance. *Conservation Letters* 7(6):524–32. doi:10.1111/conl.12142.
- Smith, L. T. 2013. *Decolonizing methodologies: Research and indigenous peoples*. London, UK: Zed Books Ltd.
- Strauss, A., and J. Corbin. 1990. *Basics of qualitative research: Grounded theory procedures and techniques*. Newbury Park, CA: Sage Publications.
- Sze, J., and J. K. London. 2008. Environmental justice at the crossroads. *Sociology Compass* 2(4): 1331–54. doi:10.1111/j.1751-9020.2008.00131.x.
- United Nations. 2007. United Nations declaration on the rights of indigenous peoples. *United Nations for Indigenous Peoples*. <https://www.un.org/development/desa/indigenouspeoples/declaration-on-the-rights-of-indigenous-peoples.html>.
- Weaver, J. 1996. *Defending mother earth: Native American perspectives on environmental justice*. Maryknoll, New York: Orbis Books.
- Whyte, K. 2016. Indigenous food sovereignty, renewal and US settler colonialism. In *The Routledge Handbook of Food Ethics*, ed. M. Rawlinson and C. Ward. New York, NY: Routledge.
- Whyte, K. P. 2011. The recognition dimensions of environmental justice in Indian country. *Environmental Justice* 4(4):199–205. doi:10.1089/env.2011.0036.
- Whyte, K. P. 2013. On the role of traditional ecological knowledge as a collaborative concept: A philosophical study. *Ecological Processes* 2(1):1–12. doi:10.1186/2192-1709-2-7.
- Wilcox, P. L., J. A. Charity, M. R. Roberts, S. Tauwhare, B. Tipene-Matua, I. Kereama-Royal, R. Hunter, H. M. Kani, and P. Moke-Delaney. 2008. A values-based process for cross-cultural dialogue between scientists and Māori. *Journal of the Royal Society of New Zealand* 38(3):215–27. doi:10.1080/03014220809510555.
- Wilsdon, J., and R. Willis. 2004. *See-through science: Why public engagement needs to move upstream*. Project Report. Demos, London.