Discerning modes of design in ecological restoration

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Abstract

Ecological restoration is an art and science that offers a practical approach to repairing and caring for relationships in living systems. Restorationists, a community of multiple epistemic cultures, most often frame their work as a practice of ecology. Ecology provides a systems-oriented approach to natural and life sciences that can be applied to restore and repair. Yet, the word design also frequently appears in the work of ecological restoration. What do restorationists mean when they refer to design?

In this paper, I introduce ecological restoration to a design audience and frame restoration as a repair practice that advances designed interventions in socio-ecological systems. Through three case studies from the United States context, I identify three different ways that design appears in the work of ecological restoration: planning, technology, and transitions. As these case studies show, approaching restoration as designing can make restoration processes more transformative, more inclusive of multiple worldviews, and more critical of environmental injustices. Yet, design approaches can also depoliticize ecological restoration by oversimplifying it, or by normalizing an overly technological approach that seeks quick fixes to complex problems. By bringing ecological restoration and design into deeper conversation, this piece highlights the impacts of various design postures that are brought to the work of restoring ecosystems.

Author keywords

ecological restoration; earth repair; socio-ecological systems; transition design

Introduction

Worldwide, communities and governments are responding to environmental degradation by taking up the work of ecological restoration. The term restoration describes the work done by people to return ecological structure and function to sites like wetlands, coastlines, forests, meadows, and rivers after they have been harmfully disturbed. Examples of large-scale anthropogenic disturbances that restoration responds to include some types of agriculture, aquatic eutrophication, hydrologic disruption, logging, mining and oil spills (Jones et al., 2018). Restoration may also be used to address disturbances that are not directly anthropogenic, like wildfire and flooding, or to re-introduce beneficial disturbances that promote ecosystem flourishing. Restoration is widely accepted and recognized as a useful tool for ecological repair, and features in two key United Nations frameworks. One, to restore 350 million hectares as part of the UN Decade of Restoration and the other, to preserve biodiversity through restoration of 15% of earth's degraded ecosystems by 2020, an Aichi Biodiversity target that has not yet been realized (Unit, 2020). While restoration activities receive billions in funding (USD) annually, success in ecological restoration work is a complex and elusive process of changemaking that often requires modifications in policy and human activities, in addition to ecological parameters (Christian-Smith & Merenlender, 2010). In this paper, I introduce restoration to a design audience by asserting that restoration is a design practice, illustrating the ways that design practices and postures appear in restoration, and suggesting how those ways of designing relate to the potential for a restoration initiative to effect systemic change.

The practice of restoration affirms that humans have necessary, active and beneficial roles to play in repairing and maintaining earth's ecological functions (Egan et al., 2011; Higgs, 2003; Jones et al., 2018). This stance distinguishes restoration from practices of rewilding, conservation and preservation, where people are intentionally kept out of or away from protected lands. The restoration community comprises a vast amalgam of people, institutions and local communities who practice restoration with distinct methods, motivations and visions of success (Higgs, 2003; Kimmerer, 2011; Tomblin, 2009). The practice is most broadly defined as "the process of assisting the recovery of an ecosystem that has been degraded, damaged, or destroyed." (2023). Early definitions of ecological restoration emphasize the replication of historic conditions (Higgs, 2003). However, most contemporary restoration approaches frame the work as a way to create desired ecological conditions that, while deviating from a historic baseline, are ecologically sound and culturally relevant (Coleman et al., 2020).

Restoration as Repair

Restoration can be understood as a practice of repair. In fact, it is often referred to colloquially as "earth repair" (M. Hall, 2005). Restoration has also been described as an act of "relational repair" between groups of people, as well as between people and various non-humans, for injustices past and present (Almassi, 2017). This framing reminds us that social injustice is often intertwined with ecosystem degradation, as is the case with the removal of many Indigenous people and groups from their lands in the North American context (M. M. Hall et al., 2021; Kimmerer, 2011). Holistic and durable repair of ecosystems must also consider these social contexts. Writing about repair, scholars Markus Berger and Kate Irvin theorize that repair can be either "first-order" or "second-order". First-order repair is about "a continuation of what occurred before (i.e., a car mechanic replacing a standardized part)" (2022, p. 2), whereas second order repair requires "enacting thinking and practices that challenge the status quo" and leads to "a complete transformation of the thing, system, and relationship itself" (ibid). With this framing, repair can be evaluated by the extent to which it is a systemic intervention, or simply a symptomatic fix. Restoration reflects this tension, as many projects are limited to first-order repair, prioritizing cleaning up an environmental mess without addressing its systemic root causes. Both kinds of repair are necessary, yet scholar Laura Martin argues that restoration "will offer no more than a temporary repair" (2022, p. 230) if systemic causes of degradation remain unexamined. To conceive of restoration projects as systems interventions, we must conceptualize ecosystems as socio-ecological systems that include human social dynamics and concerns (Perring et al., 2015).

Restoration as Design

Restorationists create material interventions in living systems ranging from earth moving to plant propagation in order to bring about better future conditions. Restoration is thus a practice of not only repair, but also, designing. Ecologist Eric Higgs draws the connection, noting, "Restoration is fundamentally about design, and the challenge ahead is to enlarge our capacity for good ecological design." (2003, p. 95). Discussing restoration in relation to design is inherently important because of restoration's significant contributions to a thriving and living future for both humans and non-humans. Further, despite the recognition by restorationists that design is relevant to their work, a robust dialogue is mostly absent between the fields of design and restoration, to the detriment of both. Higgs observes that, "as restorationists, we are involved in the design of ecosystems and places whether we like it or not" (271). Noting some ecologists' hesitancy to engage with design, he further argues that, *"we need to acknowledge that restoration is fundamentally a design practice [emphasis original]"* (274).

Scholars Mang and Reed (2013) and Du Plessis (2012) connect the dots between design and living systems by advancing frameworks for what they call regenerative design and development. These frameworks and tools support "design and construction of mutually beneficial and life-supporting relationships between built and natural environments" (2012, p. 15). As these proposals originate from a design and architectural posture, they emphasize changes to how the built environment is designed to benefit and regenerate natural systems. Restoration, on the other hand, primarily originates from ecological sciences, a field which has historically omitted the built environment from its study and consideration. Thus, with the exception of scholarship from designers of the built environment, design and restoration ecology mostly lack theory and frameworks to explain how their work interacts. Here, I bridge this gap and respond to Higgs' call for explicit recognition of design in restoration. I do so by identifying and discussing three ways that design is currently used to create interventions in socio-ecological systems through restoration and earth repair activities in contemporary cases from the United States context. I additionally suggest that the way we design restoration and repair will determine if the repair will catalyze beneficial systems transformations toward more sustainable and ecologically sound futures.

Design and Restoration: Three Cases

Here, I present three cases to discern and critique the roles that designing plays in restoration, so that restoration activities may yield more durable and transformative outcomes. These examples come from the American context, with start dates ranging from 2010 to 2022. They were selected because they are contemporary, self-identify as restoration projects, and illustrate three distinct modes of how design appears in restoration. As they are all ongoing projects, their ecological and social outcomes are not fully realized or understood. Restoration projects are typically evaluated in terms of recovery completeness and recovery rate based on indicators from ecological sciences (Jones et al., 2018). Instead of grading or scoring these project outcomes, my review identifies and critiques how design appears in the processes used to plan or carry out the restoration projects. I also locate the interventions in terms of their positioning as systemic leverage points using the "Places to Intervene in a System" framework by Donella Meadows (1997). This framework ranks leverage points in order of their likelihood to produce meaningful systems change, which Meadows calls "effectiveness". In this framework, a leverage point in the 12th spot is the least effective, with effectiveness increasing as the ranking proceeds from 12 up to one.

Institutional Restoration: Upper Truckee River

Design frequently appears by name in what Tomblin (2009) calls institutional restoration projects. These are projects led by state and local government agencies, or other institutions who may own or manage land, such as land trusts. Design is often considered a distinct stage in these projects, taking place between the establishment of goals and reference conditions and project implementation. In these contexts, designing is the process of solving a specific, singular problem of spatial configuration of ecosystem features (Holl, 2020).

This use of design appears in the case of the Upper Truckee River, a restoration project in the works since 2010 in the Lake Valley State Recreation Area (LVSRA) in South Lake Tahoe, California. This project aims to reduce sediment flows into Lake Tahoe from the Upper Truckee river by slowing or stopping streambank erosion in a particular river section. Erosion control measures include bank stabilizing work and re-introduction of historic river meanders, which slow down the flow of water. In addition to the river, the other significant feature of the LVSRA is an 18-hole public golf course on the river's banks. Restoration goals, which are set and managed by the California State Parks, also include creating a larger buffer zone between the river and the golf course, so that the river is less affected by the golf course and vice versa.

Restorationists in the Upper Truckee currently face a daunting task. Their design must simultaneously re-establish river meanders, move the golf course holes further from the river bank, keep the golf course at 18 holes, and do all of the above within the current footprint of the LVSRA. Project backers have hired professional golf course designers to solve this restoration problem by producing a golf course design that checks all of these boxes. In the socio-ecological system of the Upper Truckee river, design is being used to change the "structure of material stocks and flows (such as transport networks, population age structures)" which Meadows (1997) rates as the 10th most effective place to intervene in a system, out of 12.

Work on this restoration project has not moved beyond the design phase in almost 10 years of deliberation due to a lack of public support and conflict amongst stakeholder groups. Despite the seemingly impossible constraints to satisfy, project backers continue to believe that a design solution exists for the LVSRA that will check all of the boxes. In a case like this, considering design as a distinct phase with pre-prescribed activities may be preventing restorationists from fully engaging with all that design has to offer to their work, as well as limiting how much learning and emergence can influence their processes.

In this case and in many other institutional projects, design serves an additional purpose of being the means for communicating and recording a plan of action for regulatory purposes. Regulators and the public may need to give approval to a specific restoration design, often communicated through 2-D schematic drawings as seen in Figure 1. In this way, design serves as a unifying vision of restoration success, yet restorationists must avoid framing ecological degradation as a purely logistical problem that a restoration design plan alone can solve. In the LVSRA case, project leaders maintain their emphasis on golf course design as the way forward, with a new course design and environmental impact statement expected in early 2023.

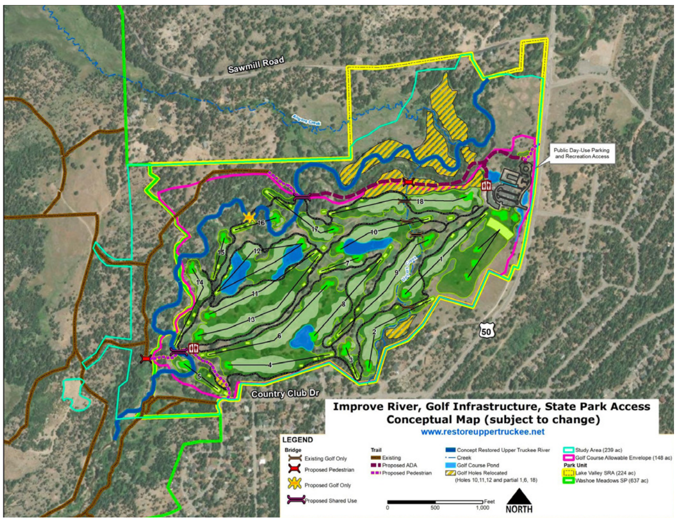

Figure 1. A proposed restoration design for the LVSRA (Source: CA State Parks)

Designing Technology for Restoration: RIBITs Interface Redesign

Design has long been associated with planning in institutional settings. Increasingly, design also interacts with restoration through technology. A 2022 collaboration between the non-profit Environmental Policy Innovation Center (EPIC) and the US Digital Service (USDS) illustrates this dynamic. In this project, an interdisciplinary team of designers and programmers worked to re-design the website interface (Figure 2) of a restoration tracking database managed by the US Army Corps of Engineers, called the Regulatory In lieu fee and Bank Information Tracking System (RIBITs). RIBITs is used to organize and track mitigation banking, a form of ecological offsetting for wetlands that shares some similarities with the practice of carbon offset trading.

The USDS and EPIC project is an example of "designing for restoration", which differs from the "designing restoration" example on the Upper Truckee River. In this case, a design process was used to update the human interface for a technological system that organizes restoration efforts. In a blog post about the effort, design project members explained that the current RIBITs system (Figure 2) was known to be difficult to use, and that a human-centered design approach was selected as a methodology for improving usability (Mahr, 2022). Over the course of several months, the project used tools like affinity diagrams, user journey maps and digital prototypes to design proposed changes to the system interface.

These redesign efforts for RIBITs will likely make a positive contribution to the system interface and perhaps make the system easier to use for those who engage with it. Yet, this project, in designing technology for restoration, exemplifies a common pattern in the way that design engages with wicked problems. This pattern appears when designers acknowledge wicked problems in designing, even citing them as a primary motivation, but focus their efforts on updating or creating technologies to mitigate the effects of the wicked problem, rather than interrogating the root causes of the problem itself.

Project briefs that make a call to, for example, "design for mental health" or "design for sustainability" show this same pattern. The problem with this way of working is that a website or technology design can be made highly usable and reflect the results of a human-centered process while doing little to address or change the dynamics of broken systems that produce these wicked problems. This kind of designing produces only first-order repair. In this case, the broken system is the market-based wetlands offset governance system that RIBITs reports on. Mitigation banking is meant to ensure "no net loss" of wetlands. Yet, in practice, the system incentivizes novel wetland construction or wetland consolidation in exchange for the destruction of healthy, functioning wetlands. What's more, the wetlands that mitigation banking produces are often less ecologically functional and offer fewer ecosystem services than the ones they replace (Steinhoff, 2008).

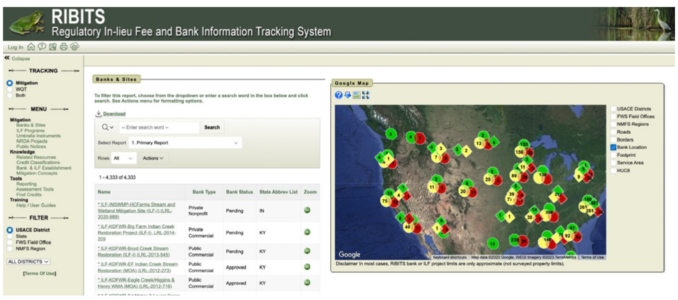

Figure 2. The RIBITs interface before the redesign effort (Source: US Army Corps of Engineers)

Design's engagements with wicked problems like wetlands protection and river restoration must produce more than first-order repair. Eric Higgs notes that "Design offers the prospect of reorienting our typical relations in a technological culture" (2003, p. 280). From a systems perspective, the proposed website redesign of RIBITs for greater usability aims to change the structure of information flows in the socio-ecological system of United States wetlands mitigation banking. This type of intervention ranks as leverage point number six of 12 in the Meadows framework. This leverage point is commonly engaged through digital technology design projects. While this particular design intervention may make the work of wetlands mitigation banking more transparent and efficient through RIBITs, this approach also normalizes a technological restoration culture. Here, rather than being used to "attune us to critical responsibilities" (ibid), such as stopping wetlands destruction in the first place, or finding creative ways to preserve them, design has been used to make the RIBITs system more navigable. These two examples show that design can be used for restoration in ways that ignore or even normalize the root causes of degradation. Instead, design must be used for more substantive change to catalyze the transformations that true earth repair requires.

Designing Transitions by Restoring: Fire Mimicry in California Oak Woodlands

In this final example, design appears in a restoration project without being explicitly named. This example illustrates the ways that restoration, as a design practice, creates meaning and culture while also solving a problem. In this case, restoration is a designed transition emerging from a community group. In contrast to the previous examples, in which design was used as a way of conceptualizing ideal spatial plans in restoration, or in advancing technological approaches, this final example shows how a designed intervention for restoration can create transformative learning and relationships to catalyze broader change.

Oak woodlands are ecologically and culturally significant features of the landscape in coastal California. Prior to Euro-American colonization, Native Californians managed oak woodlands with fire as well as hand tending (Klinger, 2006). Today, these beneficial disturbance regimes (Anderson, 2013) have largely disappeared, due to ongoing Native land dispossession. As a result, forest health has declined and these woodlands are more susceptible to disease, drought and catastrophic wildfire. Oak forests need regular episodes of low-intensity "good fire" to restore health, but many forest sites are too unhealthy or too close to human settlements for this kind of burning to be possible.

Fire Mimicry is a transitional restoration process that bridges this divide between current conditions of unhealthy, fire-prone oak forests, and a future where healthy oak trees can be tended with fire (Klinger, 2008). Fire serves many purposes in an ecosystem such as making soils more alkaline, killing pathogens, hardening oak tree bark and lowering overall fuel loads. Fire mimicry offers these benefits without direct application of fire. Phases of fire mimicry are sequenced, beginning with a stage of clearing and thinning of unhealthy or overgrown woody materials. Then, mosses and lichens are removed from the tree trunks with a mineral wash applied. Finally, the tree soil is treated with alkaline minerals, and any infection sites are surgically removed and covered with more mineral wash. The trees can be treated multiple times over several years, and observation over time is a key part of the process. Fire mimicry is generally quite safe and, with the exception of tree felling, can be easily practiced by non-experts. The method is primarily disseminated through community workshops and work weekends to non-expert and aspiring land stewards, and is not explicitly named as a design practice.

How is fire mimicry designing, and what might it teach about other ways of designing? Fire mimicry relates to design in several ways. One, it is an important example of a transitional design practice taking place at the household and community scale, what Manzini calls "diffuse and competent designing" (2015). Through gradually redesigning a landscape, fire mimicry interventions restore forests such that good fire can be returned to the landscape, transitioning forests and human communities away from the legacy of fire suppression. If those who practice fire mimicry are successful, the practice will become largely obsolete. This characteristic indicates an effective transitional practice. Those who practice fire mimicry do not explicitly self-identify as practicing design or Transition Design. Yet, the way that this practice simultaneously makes change across material and immaterial dimensions exemplifies the approach to changemaking that Transition Design proposes (Irwin, 2019; Sides et al., 2022).

Through landscape and designed transition, fire mimicry may produce second-order repair. The processes of learning and practicing fire mimicry produce what might be called "relational encounters" (Manzini, 2015) within groups of people, as well as between people and trees. These kinds of relational encounters support the kinds of transformative, systems-level change that comprise second-order repair (Dorn & Dickman, 2022). Locating these interventions in the Meadows framework, Fire Mimicry appears to act at two different levels. One, the landscape design activities change the size of buffers and stabilizing stocks (leverage point 11 of 12), such as the soil pH and the local fuel loads. At a higher level, by empowering community members to see nature as a socio-ecological system in which humans can positively contribute, fire mimicry also engages leverage point four, "the power to add, change, evolve, or self-organize system structure" (Meadows, 1997, p. 14). Fire mimicry work and the relational encounters it produces can effect change by fostering cultures of land stewardship and tree care, educating the public about the links between fire suppression and cultural suppression of native people, and ultimately, facilitating the return of indigenous land to indigenous stewardship along with the associated practices of cultural burning.

Table 1. Summary of restoration cases reviewed

Case	Location	What interventions are being designed?	Leverage Points Engaged	Design mode case exemplifies
Upper Truckee River	Lake Tahoe, USA	River and golf course layout	The structure of material stocks and flows (10)	• Designing as Planning • Professional Design
RIBITs Interface Design	Cloud Data-base, USA	Wetlands data-base interface	The structure of information flows (6)	• Designing Technology • Human-Centered Design
Fire Mimicry	Coastal California, USA	Oak forest com-position over time	• The power to change system structure (4) • The size of buffers and stocks (11)	• Diffuse designing • Designing Transitions

Conclusion

The previous three examples illustrate three different ways that design appears in the work of ecological restoration: through planning, technology, and transitions. In the example of the Upper Truckee River restoration project, design is employed in an expert-driven, problem-oriented way to serve as an official plan of record for a restoration project. This example shows how restoration is designed in institutional settings and its tendency to produce first-order repair only. The RIBITs interface design example shows how design interacts with restoration through technology, illustrating the pattern of designing "for" wicked problems through technological means. In this case, human-centered design was used to redesign the interface of a system for governing wetlands mitigation banking. While the project likely met system usability goals, it did not show evidence of deep engagement with or attempt to change the dynamics of mitigation banking. Finally, the example of fire mimicry shows how, through producing meaning and culture while also solving a problem, restoration practices can serve as designed transitional interventions. While all of these cases come from the United States context, their lessons may be relevant to other geographies. In particular, the planning and technological modes of designing identified here are likely to appear in other landscapes of ongoing settler colonialism, as these modes reflect a way of relating to land based on abstraction and control.

Together, these examples paint a picture of how design already appears in restoration. By analyzing them together, we can begin to imagine additional or modified design postures that will more consistently produce durable and holistic ecological repair. Restorationists, acting as or collaborating with designers, must bring the best version of their craft as well as critical attunement to the meaning of "nature-positive" to this challenge. In the context of restoration, designers should aim to: acknowledge and address the root causes of environmental harms, recognize that a particular design is just a snapshot in an ever-chanting system, remain open and transparent in their processes, seek out ways to engage non-experts in the design process of restoration, and center the wishes and needs of Indigenous people, local communities and the beings whose lives are most affected by environmental harms. Design postures that reflect the above suggestions have a great deal to contribute to the challenges of restoring living systems. The way that ecological repair work is done matters deeply. Through engagement in this work, design and those who practice it may also be positively transformed.

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